HANDBOOK

DORMAN LONG
MIDDLESBROUGH ENGLAND

HANDBOOK FOR CONSTRUCTIONAL ENGINEERS

CONTAINING TABLES RELATING TO STEEL
AND INFORMATION
REGARDING THE PRODUCTS AND MANUFACTURES OF

DORMAN, LONG & CO. LIMITED

MIDDLESBROUGH, ENGLAND

IRON & STEEL MANUFACTURERS
CONSTRUCTIONAL ENGINEERS . BRIDGE BUILDERS
IRON FOUNDERS

1964

CONTRACTORS TO H.M. GOVERNMENT, THE DOMINION AND COLONIAL OFFICE
AND THE CROWN AGENTS FOR OVERSEAS GOVERNMENTS
AND ADMINISTRATIONS

PRINTED AND MADE IN GREAT BRITAIN
BY THE FANFARE PRESS LTD · LONDON WC2

CONTENTS

ACKNOWLEDGMENTS

Acknowledgments are made to the following:

The British Constructional Steelwork Association and The British Steel Makers for permission to reproduce tables comprising the Handbook on Structural Steelwork, Properties and Safe Loads, prepared and issued jointly by the aforesaid.

The British Constructional Steelwork Association for permission to reproduce extracts from publications giving properties of composite sections.

The British Standards Institution for permission to print extracts from, and/or make reference to the following British Standards:

No. 4 : Part 1 : 1962 (and addendum). Structural steel sections. Hot-rolled sections.
No. 15 : 1961. Mild steel for general structural purposes.
No. 153 : Part 3A : 1954 (amended). Steel girder bridges. Loads.
No. 449 : 1959 (amended). The use of structural steel in building.
No. 639 : 1952 (amended). Covered electrodes for the metal-arc welding of mild steel.
No. 648 : 1949. Schedule of weights of building materials.
No. 916 : 1953 (amended). Black bolts, screws and nuts.
No. 968 : 1962. High yield stress (welding quality) structural steel.
No. 1501 : 1964 Structural steel for the pressure part of marine boilers.
No. 2549 : 1954. Covered electrodes for the metal-arc welding of medium-high tensile structural steel.
No. 2708 : 1956 (amended). Unified black square and hexagon bolts, screws and nuts (UNC and UNF threads). Normal series.
No. 2762 : 1956. Notch ductile steel for bridges and general bridge construction.
No. 3139 : Part 1 : 1959 (amended). High strength friction grip bolts for structural engineering. General grade bolts.
No. 3294 : Part 1 : 1960 (amended). The use of high strength friction grip bolts in structural steelwork. General grade bolts.
CP3 : Chapter V : 1952 (amended). Loading.

The Institution of Structural Engineers for permission to reproduce the formulæ and nomograms relating to portals which appeared in "*The Structural Engineer*" Vol. XXVIII, No. 9, 1950.

Professor M. R. Horne and the British Welding Research Association for information regarding the plastic properties of I sections.

Preface

THE 1964 EDITION of the Dorman Long Handbook contains the most recent information on the Company's products.

The first Dorman Long Handbook for Constructional Engineers was published in 1887 and at regular intervals for more than 75 years revised and improved information of value to engineers has been incorporated in successive editions. For three-quarters of a century the D. L. Handbook has held a unique position in the structural engineering world in every country where construction in steel has been undertaken.

In the edition now published, the advances in the higher efficiency of materials, design techniques and other relevant factors are dealt with. The varied activities of the Company are also briefly mentioned and further information, when desired, may be readily obtained from the Company's headquarters in Middlesbrough, or district offices at home and overseas.

THE DORMAN LONG UNIVERSAL MILL AT LACKENBY

is the only one in the country which rolls the full range of Universal Beams and Columns

23 sizes of Beams are available from 36″ × 16½″ down to 8″ × 5¼″, and 6 column sizes from 14″ × 16″ to 6″ × 6″ a total of 29 sizes and 106 weights.

PART I

General Information relating to the Company

DORMAN LONG & CO. LIMITED

DORMAN LONG (STEEL) LIMITED

Iron and Steel Manufacturers

DORMAN LONG (BRIDGE & ENGINEERING) LIMITED

Bridge Builders and Constructional Engineers

DORMAN LONG (CHEMICALS) LIMITED

Chemical Manufacturers

HEAD OFFICE

ZETLAND ROAD, MIDDLESBROUGH

TELEGRAMS: DORMAN, TELEX, MIDDLESBROUGH
TELEPHONE: MIDDLESBROUGH 45411
TELEX: MIDDLESBROUGH 58527

LONDON OFFICE

TERMINAL HOUSE
52 GROSVENOR GARDENS, S.W.1

TELEGRAMS: PUGILISM, SOWEST, LONDON
TELEPHONE: SLOANE 2275

DORMAN LONG (STEEL) LIMITED

Steel Sales Department, G.P.O. Box 4, Lackenby Steelworks, Middlesbrough
TELEGRAMS: BEAMS, MIDDLESBROUGH
TELEPHONE: SOUTH BANK 58411
TELEX: 58518

Raw Materials Department, G.P.O. Box 3, Royal Exchange, Middlesbrough
TELEGRAMS: DORMAN, TELEX, MIDDLESBROUGH
TELEPHONE: 45411
TELEX: 58527

Britannia Steelworks, Middlesbrough
TELEGRAMS: DORBRIT, MIDDLESBROUGH
TELEPHONE: 45461
TELEX: 58520

Cleveland Iron and Steel Works, South Bank, Middlesbrough
TELEGRAMS: BOLCKOWS, SOUTH BANK
TELEPHONE: SOUTH BANK 58471

Lackenby Steel Works, G.P.O. Box 2, Grangetown, Middlesbrough
TELEGRAMS: BEAMS, MIDDLESBROUGH
TELEPHONE: SOUTH BANK 58411
TELEX: 58518

Redcar Iron and Steel Works, Redcar, Yorks.
TELEGRAMS: REDCOAT, MIDDLESBROUGH
TELEPHONE: REDCAR 2471

Sheet Works, Ayrton Rolling Mills, Middlesbrough
TELEGRAMS: NAMROD, MIDDLESBROUGH
TELEPHONE: 45461

P.V.C. Sheet Department, Newton Aycliffe, Co. Durham
TELEGRAMS: DORPLAST, AYCLIFFE
TELEPHONE: AYCLIFFE 2343/4/5

Wire Mills, Middlesbrough
TELEGRAMS: DORMWIRE, MIDDLESBROUGH
TELEPHONE: 45461

Welding Department, Redcar, Yorks
TELEGRAMS: REDCOAT, MIDDLESBROUGH
TELEPHONE: REDCAR 2471

Foundries Department, Dock Street, Middlesbrough
TELEPHONE: 45411

DORMAN LONG (BRIDGE AND ENGINEERING) LIMITED

Bridge and Constructional Works, Middlesbrough
TELEGRAMS: DORSTRUC, MIDDLESBROUGH
TELEPHONE: 43221
TELEX: 58521

Bridge and Contracting Department, 38-40 Bute Street, Luton, Beds.
TELEGRAMS: DORMBRIDGE, LUTON
TELEPHONE: LUTON 6666

DORMAN LONG (CHEMICALS) LIMITED

Port Clarence, Middlesbrough
TELEGRAMS: DORCHEM, MIDDLESBROUGH
TELEPHONE: 57331

BRANCH OFFICES

BELFAST OFFICE

32-33 Scottish Mutual Assurance Buildings, Belfast
TELEGRAMS: DORMLONG, BELFAST, 1
TELEPHONE: BELFAST 20958

BIRMINGHAM OFFICE

Newton Chambers, Cannon Street, Birmingham, 2
TELEGRAMS: DORMANLONG, BIRMINGHAM
TELEPHONE: MIDLAND 5226

BRISTOL OFFICE

11 Quay Street, Bristol, 1
TELEGRAMS: DORLONG, BRISTOL
TELEPHONE: BRISTOL 294427/8

GLASGOW OFFICE

156 St. Vincent Street, Glasgow, C.2
TELEGRAMS: RENATO, GLASGOW
TELEPHONE: CENTRAL 6744

LEEDS OFFICE

41/43 Albion Street, Leeds, 1
TELEGRAMS: DORLONG, LEEDS
TELEPHONE: LEEDS 32055/6

MANCHESTER OFFICE

9 Albert Square, Manchester, 2
TELEGRAMS: DORLONG, MANCHESTER
TELEPHONE: BLACKFRIARS 2231

NEWCASTLE-UPON-TYNE OFFICE

Archbold House, Archbold Terrace, Jesmond, Newcastle-upon-Tyne 2
TELEGRAMS: DORLONG, NEWCASTLE-UPON-TYNE
TELEPHONE: NEWCASTLE 811264-5

NOTTINGHAM OFFICE

67 Lower Parliament Street, Nottingham
TELEGRAMS: DORLONG, NOTTINGHAM
TELEPHONE: NOTTINGHAM 53604 and 53805

SUBSIDIARY AND ASSOCIATED OVERSEAS COMPANIES

ARGENTINA, PARAGUAY, CHILE AND URUGUAY

CIA BRITANICA DE CONSTRUCCIONES DE ACERO LTDA.

Calle Belgrano 561, Buenos Aires
Works and General Offices
Calle Matanza 3,810 Esq: Ferre Nueva Pompeya, Buenos Aires
TELEGRAMS: BRITANICA, BUENOS AIRES

GHANA

DORMAN LONG (GHANA) LIMITED

P.O. Box 1343, Accra, Ghana
CABLE ADDRESS: AMENCO, ACCRA

NIGERIA

DORMAN LONG AND AMALGAMATED ENGINEERING LIMITED

P.O. Box 256, Lagos, Nigeria
CABLE ADDRESS: AMALGAM, LAGOS

SOUTH AFRICA

DORMAN LONG (AFRICA) LIMITED

Registered Office
4th Floor, Randkom Building, Smit Street, Braamfontein, Johannesburg
P.O. Box 2997
Works and Stockyards
Germiston: Union Construction Works, Davey Street, P.O. Box 68
Port Elizabeth: New Brighton, P.O. Box 9010
Durban: South African Ironworks, Maydon Road, P.O. Box 932
Cape Town: P.O. Box 11, Osborne Street, off Modderdam Road
Bellville, Cape Province
Vaal Branch: Vanderbijl Park, Vereeniging
TELEGRAMS: DORLONSA (ALL ADDRESSES)

OVERSEAS AGENCIES

BARBADOS

ATWELL DALGLIESH CO. LTD.

P.O. Box 199, Bridgetown
TELEGRAMS: JLDAL BARBADOS

BELGIUM

S/A CHIMIE ET METALLURGIE

2-4 Boulevard Barlaimont, Barrow Building, Brussels 1
CABLES: DYNAMIC

BERMUDA

BUTTERFIELD & CO. LTD.

P.O. Box 533, Hamilton
CABLES: BUTT

BURMA

BA HAN & CO.

P.O. Box 1366, Rangoon
CABLES: BAHANCO, RANGOON

CEYLON

WALKER SONS & CO. LTD.

P.O. Box 166, Colombo
TELEGRAMS: WALKERS, COLOMBO

DENMARK

P. FUNDER & SON

68 Nørre Voldgade, Copenhagen, K.
TELEGRAMS: AMULET COPENHAGEN

HENRY NIELSEN (*Chemical Products only*)

29 Amagertorv, Copenhagen
TELEGRAMS: DANOBRIT, COPENHAGEN

EIRE

DARBY & CO. (DUBLIN) LTD.

Unity Buildings, 16/17 Lower O'Connell Street, Dublin
TELEGRAMS: BUSINESS DUBLIN

FRANCE

SOCIETE METALLURGIQUE ET CHIMIQUE

"Metalchim", 16 Rue Oberkampf Paris XIe
CABLES: GOODSTEEL

U.S.S.R. AND EASTERN EUROPE

(Albania, Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Rumania and Yugoslavia)

LAMET TRADING LTD.

Murray House, 43/46 Barbican, London E.C.1
TELEGRAMS: LAMTRA, LONDON

OVERSEAS AGENCIES

HONG KONG, CHINA AND FORMOSA

THE JARDINE ENGINEERING CORPORATION, LTD.
Pedder Street, Hong Kong
TELEGRAMS: JARDENG, HONG KONG

JARDINE, MATHESON & CO. LTD.
Pedder Street, Hong Kong
TELEGRAMS: JARDINES, HONG KONG

INDIA

BALMER LAWRIE & CO. LTD.
21 Netaji Subhas Road, Calcutta
TELEGRAMS: BALMER, CALCUTTA

IRAQ

GRESHAM LINLEY LTD.
City Wall House, 129 Finsbury Pavement, London E.C.2

KENYA, UGANDA AND TANGANYIKA

ARBENZ (KENYA) LTD.
P.O. Box 7749, Nairobi
CABLES: ARBENZ - NAIROBI

KUWAIT

REZAYAT TRADING CO.
P.O. Box 106, Kuwait

NEW ZEALAND

JOHN DUTHIE, HOLDINGS LTD.
P.O. Box 1390, Willis Street, Wellington
TELEGRAMS: DARKNESS, WELLINGTON

NORWAY

ROLF LYCKE
P.O. Box 552, Radhusgaten 8, Oslo
TELEGRAMS: JERNLYCKE

NIELSEN & DANIELSEN A/S
P.O. Box 7, Tollbodgt 25, Oslo
TELEGRAMS: METAL, OSLO

PAKISTAN-EAST

WILLCOX & ISLAM (CHITTAGONG) LTD.
P.O. Box 132, Quaid-e-Azam Road, Chittagong
CABLES: WILLIS

OVERSEAS AGENCIES

PAKISTAN-WEST

WILLCOX & ISLAM LTD.
Spencers Building, McLeod Road, Karachi 1
CABLES: WILLIS

PHILIPPINES

PACIFIC EXCHANGE CORPORATION
Yutivo Building, Dasmarinas Street, Manila
TELEGRAMS: PACEXCO, MANILA

PORTUGAL

MONTEIRO GOMEZ, LTDA.
Rua Cascais 47 (Alcantara) Lisbon
TELEGRAMS: TRACTORES, LSIBON

QATAR

KASSEM & ABDULLAH SONS OF DARWISH FAKHROO
P.O. Box 71, Doha, Qatar

RIO GRANDE DO SUL (BRAZIL)

BRAZISUL REPRESENTACOES LTDA.
Porto Alegre, Andrade Neves, 1556A, Conjunto N63
CABLES: REBRAL, PORTO ALEGRE

SPAIN

J. PALOMERO CANTOS
8 Porchester Court, Porchester Gardens, London, W.2
TEL.: BAYSWATER 6739

SUDAN

EL LABOUBI COMMERCIAL HOUSE
P.O. Box 1338
Khartoum

SWEDEN

FRANZEN & FRIED A/S
16 Skeppsbron, Stockholm
TELEGRAMS: FRANZENBOLAGET OLEUM

TRINIDAD AND TOBAGO

SPROSTONS (TRINIDAD) LTD.
8 St. Vincent Street, Port of Spain, Trinidad, W.I.
TELEGRAMS: SPROSTONS, PORT OF SPAIN

U.S.A.

BRITISH WIDEFLANGE INC.
3317 Montrose Boulevard, P.O. Box 66733 Houston 6, Texas
TELEGRAMS: BWINC, HOUSTON, TEXAS

Directory for Enquiries

DEPARTMENT AND ADDRESS	PRODUCTS
DORMAN LONG (STEEL) LTD. G.P.O. Box 4, Lackenby Steelworks Middlesbrough	**Semi-finished Steel** Billets, Blooms, Slabs, Sheet Bars **Rolled Steel** Angles, Universal Beams and Columns, Channels, Plain and Bulb Flats, Sheared and Universal Plates, Slabs, Bulb Angles, Rounds and Squares. Rails, Fishplates, and Soleplates. Wire Rods and Strip. Colliery Arches
DORMAN LONG (STEEL) LTD. Raw Materials Department G.P.O. Box No. 3 Royal Exchange, Middlesbrough	**Raw Materials** Coke and Coke Breeze Pig Iron and Ferro-manganese Slag, Bricks
DORMAN LONG (STEEL) LTD. Wire Department G.P.O. Box No. 5 Middlesbrough	**Steel Wire** Bright, Galvanized, etc.
DORMAN LONG (STEEL) LTD. Sheet Department G.P.O. Box No. 6 Middlesbrough	**Sheets** Galvanized Corrugated and Black Sheeted Goods, Gutters and Downpipes Sheet Metalwork
DORMAN LONG (STEEL) LTD. P.V.C. Sheet Department Newton Aycliffe, Co. Durham	**Plastic Coated Sheets**
DORMAN LONG (BRIDGE & ENGINEERING) LTD. Bridge and Constructional Works G.P.O. Box No. 7 Middlesbrough *London Office:* Structural Sales Terminal House 52 Grosvenor Gardens, London, S.W.1	**Bridge and Constructional Steelwork** **Riveted and Welded Structures** **Storage Tanks**
DORMAN LONG (BRIDGE & ENGINEERING) LTD. Bridge and Contracting Department 38-40 Bute Street Luton, Beds.	**Bridgework design, including erection or Civil Engineering Work**
DORMAN LONG (CHEMICALS) LTD. By-Products Department Port Clarence, Middlesbrough	**Coke Oven By Products**
DORMAN LONG (STEEL) LTD. Foundries Department Dock Street, Middlesbrough	**Iron and Brass Castings**
DORMAN LONG (STEEL) LTD. Welding Department Redcar Iron & Steelworks, Redcar	**Welded Gear Wheel Blanks, Hammer Columns, Magnet and Stator Cases, Pressure Vessels, Stern Frames, Shear Frames, Press Frames**

Qualities of Steel Produced

All steel supplied by Dorman Long is made in the Company's own works by the Basic Open Hearth Process, which ensures a reliable and uniform product.

MILD STEEL

To comply with B.S. 15: 1961. *Mild Steel for General Structural Purposes*

HIGH YIELD STRESS STEEL

To comply with B.S. 968: 1962. *High Yield Stress (Welding Quality) Structural Steel*

NOTCH DUCTILE STEEL

To comply with B.S. 2762: 1956. *Notch Ductile Steel for General Structural Purposes*

BOILER QUALITY STEEL

To comply with B.S. 1501: 1964. *Structural Steel for the Pressure Parts of Marine Boilers*

SHIPBUILDING STEEL

To comply with the requirements of Lloyds, Bureau Veritas, Det Norske Veritas, and American Bureau of Shipping

MILD AND CARBON STEEL

From 0·06% to 0·85% carbon for wire rods including freecutting and cold heading qualities

CARBON AND SILICON-MANGANESE STEEL

For special, medium and heavy forgings, and stampings in a wide range of qualities

Semi-finished Products

The Company produces large quantities of

Billets, Blooms, Slabs and Sheet Bars

BILLETS, BLOOMS AND SLABS in basic open hearth steel to various specifications and with carbon content ranging from 0·05% to 0·90% for all purposes.

(1) Extra mild steel used for deep stamping, motor car wheel rims, bicycle wheel rims and steel tubes, and for case-hardening, soft wire and strip.

(2) Ordinary mild steel standing 28 to 33 tons tensile test.

(3) Steel for special, medium and heavy forgings and stampings in a wide range of qualities.

(4) High carbon steel suitable for saws, reaper knives, rifle barrels, bayonets and shells.

(5) Steels for chisels and machine tools of all kinds.

(6) Steel for hammers, picks, shovels and spades.

(7) Special steel for springs, both carbon and silicon-manganese qualities.

(8) Special rust-resisting steel.

BILLETS from 1$\frac{15}{16}$″ square upwards.

BLOOMS to meet customers' requirements.

SLABS from 4″ × 2″ upwards.

SHEET BARS. A complete range of sheet bars is rolled at our works.

Finished Products

	Pages
ROLLED CONSTRUCTIONAL SECTIONS Universal Beams, Universal Columns, Universal Bearing Piles, Structural Tees, Joists, Channels, Angles, Tees, Bulb Flats, Bulb Angles. Rolling margins, cutting tolerances, rolling programme	22–26
AUTOFAB BEAMS	27
ROLLED PLATES AND SLABS Sheared and Universal Plates with parallel rolled edges. Shearing tolerances, cold mangling. Machining and drilling of slabs.	28–32
ROLLED FLATS, SQUARES, WIRE RODS, ROUNDS RIVET BARS, HOT ROLLED STRIP	33–34
ROLLED TRACK RAILS Controlled Cooling of Rails, Bull Head Rails, Conductor Rails, Steel Soleplates, Flat Bottom Rails, Bridge Rails, Special Flat Bottom Rails.	35–39
MISCELLANEOUS ROLLED SECTIONS Bulb Plates, Round back square root Angle, Wagon Body Stanchion Section, Bobbin Sections.	40
COLLIERY ARCHES	41
PRESSED STEEL TROUGHING	41
MEDIUM PLATES, SHEETS, SHEET METALWORK AND PRESSWORK Black Steel Sheets, hard or close annealed, Galvanized Sheets plain or corrugated, Scandinavian Tiles, Gutters, Downpipes, Ridging, Louvre Blades, Flashing, Dovetail Sheeting, Pallets, Light Fabrications, Pressed Steel Troughing, Dorman Long Safety-Rail Fenders, Steel Trench Sheeting, Dorman Long Lintel, Dorman Long Plastic Coated Sheets.	42–53
WIRE PRODUCTS	54–57

UNIVERSAL BEAMS

INCHES
36 × 16½
36 × 12
33 × 11½
30 × 10½
27 × 10
24 × 12

INCHES
24 × 9
21 × 13
21 × 8¼
18 × 7½
18 × 6
16 × 7

INCHES
16 × 6
16 × 5½
15 × 6
14 × 6¾
14 × 5

INCHES
12 × 6½
12 × 5
12 × 4
10 × 5¾
10 × 4
8 × 5¼

UNIVERSAL COLUMNS

INCHES
14 × 16
14 × 14½
12 × 12

INCHES
10 × 10
8 × 8
6 × 6

UNIVERSAL BEARING PILES

INCHES
14 × 14½
12 × 12

INCHES
10 × 10
8 × 8

STRUCTURAL TEES *cut from Universal Beams*

INCHES
12 × 18
11½ × 16½
10½ × 15
10 × 13½
12 × 12
9 × 12

INCHES
13 × 10½
8¼ × 10½
7½ × 9
6 × 9
7 × 8

INCHES
6 × 8
6 × 7½
6¾ × 7
6½ × 6
5 × 6

INCHES
5¾ × 5
5½ × 8
5¼ × 4
4 × 6
4 × 5

STRUCTURAL TEES *cut from Universal Columns*

INCHES
16 × 7
14½ × 7
12 × 6

INCHES
10 × 5
8 × 4
6 × 3

LIGHT JOISTS

INCHES
8 × 4
7 × 4
6 × 3½

INCHES
5 × 3
4 × 2½
3 × 2

N.C.B. JOISTS

INCHES
5 × 4½
4½ × 2½
4 × 4

INCHES
3½ × 3½
3 × 3

CHANNELS

INCHES
17 × 4
15 × 4
12 × 4
12 × 3½
10 × 3½

INCHES
10 × 3
9 × 3½
9 × 3
8 × 3½
8 × 3

INCHES
7 × 3½
7 × 3
7 × 2⅛
6 × 3½
6 × 3

INCHES
6 × 1½
5 × 2½
4 × 2
3 × 1½

EQUAL ANGLES

INCHES
8 × 8
7 × 7
6 × 6

INCHES
5 × 5
4 × 4
3½ × 3½

INCHES
3 × 3
2½ × 2½
2¼ × 2¼

INCHES
2 × 2
1¾ × 1¾
1½ × 1½
1¼ × 1¼

UNEQUAL ANGLES

INCHES
9 × 4
8 × 6
8 × 4
7 × 3½
6 × 4

INCHES
6 × 3½
6 × 3
5 × 3½
5 × 3
4 × 3½

INCHES
4 × 3
4 × 2½
3½ × 3
3½ × 2½
3 × 2½

INCHES
3 × 2
2½ × 2
2½ × 1½
2 × 1½

TEES

INCHES
6 × 4
6 × 3
5 × 4

INCHES
5 × 3
4 × 4

INCHES
4 × 3
3½ × 3½

INCHES
3 × 3
2½ × 2½
2 × 2

BULB FLATS

13½, 12, 11 and 10 inch.

BULB ANGLES

INCHES
6 × 3
5 × 3
5 × 2½

Method of ordering material. Beams, channels, structural tees and bulb flats should be specified according to the sizes and weights per foot given in the diagrams and tables. Rails according to the published weights per yard, but angles, tees, flats, etc., to the sizes and thicknesses required.

Rolling Margins and Tolerances

The usual trade margin is claimed in rolling sectional material, namely, $2\frac{1}{2}\%$ above or below the dimensions and weights listed.

Where a minimum weight or thickness is specified the margin is 5% over and where a maximum weight or thickness is specified the margin is 5% under. In addition, for universal beams, columns and light joists any variation from the correct profile and specified dimensions shall not exceed those shown in Fig. 1 and Tables 1 and 2.

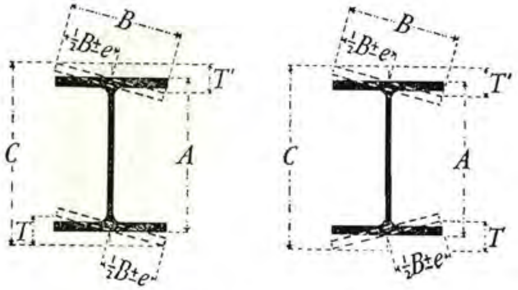


FIGURE 1: Tolerances on rolling

TABLE 1. TOLERANCES ON ROLLING FOR BEAMS

SERIAL SIZE		DEPTH A		FLANGE WIDTH B		OFF CENTRE OF WEB e max.		MAX. DEPTH AT ANY CROSS-SECTION C	
Over	up to and including								
ins.	*ins.*	*ins.*	*mm.*	*ins.*	*mm.*	*ins.*	*mm.*	*ins.*	*mm.*
—	12	$\pm\frac{1}{8}$	±3·175	$+\frac{1}{4}$ $-\frac{3}{16}$	+6·3 −4·7	$\frac{1}{8}$	3·175	$\frac{1}{4}$	6·3
12	—	$\pm\frac{1}{8}$	±3·175	$+\frac{1}{4}$ $-\frac{3}{16}$	+6·3 −4·7	$\frac{3}{16}$	4·7	$\frac{1}{4}$	6·3

TABLE 2. TOLERANCES ON OUT OF SQUARENESS OF FLANGES

WIDTH OF FLANGE				OUT OF SQUARENESS OF FLANGES $T + T^1$	
Over		Up to and including			
ins.	*mm.*	*ins.*	*mm.*	*ins.*	*mm.*
—	—	4	101·6	$\frac{1}{16}$	1·59
4	101·6	8	203·2	$\frac{1}{8}$	3·175
8	203·2	12	304·8	$\frac{3}{16}$	4·76
12	304·8	—	—	$\frac{1}{4}$	6·35

CUTTING TOLERANCES

(a) 'Specified' Lengths. When a section is specified to be cut to a certain length, it shall be cut within a margin of 1 inch (25·40 mm) under and 1 inch over the specified length, but when a minimum length is specified the margin shall be within 2 inches (50·80 mm) over.

(b) 'Exact' Lengths. When a length is specified to be 'Exact', the section shall be cold sawn within a margin of $\frac{1}{8}$ inch (3·18 mm) over and $\frac{1}{8}$ inch under the length specified for which service an extra is charged.

STRAIGHTNESS TOLERANCES. The following tolerances apply:

(a) BEAMS: $\left(\frac{1}{8} \times \frac{L}{10}\right)$ ins. *or* $\left(3{\cdot}175 \times \frac{L_m}{3{\cdot}05}\right)$ mm.

(b) (i) COLUMNS: up to, but not including, 45 ft. (13·72 m) long.

$$\left(\frac{1}{8} \times \frac{L}{10}\right) \text{ ins. } or \left(3{\cdot}175 \times \frac{L_m}{3{\cdot}05}\right) \text{ mm.}$$

with a maximum of $\frac{3}{8}$ inches (9·5 mm.).

(ii) COLUMNS: 45 ft. (13·72 m.) long and over:

$$\left(\frac{3}{8} + \left[\frac{1}{8} \times \frac{L-45}{10}\right]\right) \text{ ins. } or \left(9{\cdot}5 + \left[3{\cdot}175 \times \frac{L_m-13{\cdot}72}{3{\cdot}05}\right]\right) \text{ mm.}$$

NOTE: L is the length of the section in feet
L_m is the length of the section in metres.

Rollings

UNIVERSAL BEAMS AND COLUMNS

The range of sizes and weights has been carefully selected to cover all normal requirements, but sufficiently limited to permit good frequency of rollings. Special sections can be rolled differing, within limits, in weight per foot from the weights tabulated under each serial size. Consideration will be given to requests for untabulated sections, provided that the tonnage is sufficient to warrant special rollings.

ROLLING PROGRAMME

The company issues a rolling programme showing the sections for which rolls will be mounted during the following two weeks, and also a provisional list of sections for which it is anticipated that rolls will be mounted for a further two weeks. This programme is issued to all customers who wish to receive it.

AUTOFAB BEAMS

(AUTOmatically assembled and FABricated)

Beams made from three plates welded together are an efficient means of carrying loads beyond the capacity of Universal Beams and Columns. Plant has recently been installed to assemble and weld automatically this type of beam section. Beams are available within the following limits:

MAXIMUM OVERALL DEPTH	78″
MAXIMUM WIDTH OF FLANGE	22″
MAXIMUM THICKNESS OF FLANGE PLATES	2″
MAXIMUM LENGTH	80′ 0″
MAXIMUM WEIGHT	15 tons

These sections, known as Autofab Beams, can be made in High Yield Stress Steel or Mild Steel. The safe loads for and the properties of a range of girders within the limits specified above are tabulated for High Yield Stress Steel and Mild Steel on pages 354 to 361 and 490 to 497 respectively.

Sections having one flange wider and/or thicker than the other can be produced within the specified limits and may be used economically for crane girders and similar members or as composite beams with shear connectors and concrete decking.

In addition to the normal parallel beams of constant depth special beams can be made having a limited amount of taper in the depth of the web or having one flange curved to radius and the other straight.

It is recommended that the sizes given on pages 354 to 361 and 490 to 497 should be used where possible. If any other size of symmetrical welded girder is required the properties may be calculated by means of the tables of moments of inertia given on pages 134 to 139 and 150 to 153 on the lines of the calculations for riveted girders, an example of which appears on page 172. Due allowance must be made for any holes in the cross section of the girder. For the calculation of asymmetrical girders reference should be made to standard text books or to the Company's technical departments.

ROLLED STEEL PLATES

SHIPBUILDING THICKNESSES

Thickness inches		Length	Max. Width	Max. Area	Diameter
Twentieths	Decimals	*feet*	*inches*	*sq. feet*	*inches*
$\frac{3}{16}$	·1875	30	72	120	72
$\frac{5}{20}$	·25	35	90	260	90
$\frac{6}{20}$	·30	40	96	280	96
$\frac{7}{20}$	·35	50	96	320	96
$\frac{8}{20}$	·40	65	100	335	100
$\frac{9}{20}$	·45	65	105	360	105
$\frac{10}{20}$	·50	65	108	360	108
$\frac{11}{20}$	·55				
$\frac{12}{20}$	·60				
$\frac{13}{20}$	·65				
$\frac{14}{20}$	·70				
$\frac{15}{20}$	·75	65	108	360	108
$\frac{16}{20}$	·80				
$\frac{17}{20}$	·85				
$\frac{18}{20}$	·90				
$\frac{19}{20}$	·95				
1	1·00	65	108	360	108
$1\frac{2}{20}$	1·10	65	108	300	108
$1\frac{5}{20}$	1·25	65	108	280	108
$1\frac{8}{20}$	1·40	65	108	250	108
$1\frac{10}{20}$	1·50	60	108	230	108
$1\frac{15}{20}$	1·75	60	108	200	108
2	2·00	50	108	180	108
$2\frac{5}{20}$	2·25	40	106	160	106
$2\frac{10}{20}$	2·50	40	106	140	106
$2\frac{15}{20}$	2·75	40	106	130	106
3	3·00	40	106	120	106

The widths are the maxima, but the lengths and areas may be increased for plates below the maximum width, subject to approved specification.
Thicker sizes can also be rolled, but for these specific enquiries should be submitted.
For information on shearing, ordering, and cold mangling of plates, see notes on page 32.

ROLLED STEEL PLATES

CONSTRUCTIONAL THICKNESSES

Thickness inches		Length	Max. Width	Max. Area	Diameter
Sixteenths	Decimals	*feet*	*inches*	*sq. feet*	*inches*
$\frac{3}{16}$	·1875	30	72	120	72
$\frac{1}{4}$	·25	35	90	260	90
$\frac{5}{16}$	·3125	40	96	280	96
$\frac{3}{8}$	·375	65	100	335	100
$\frac{7}{16}$	·4375	65	105	360	105
$\frac{1}{2}$	·50	65	108	360	108
$\frac{9}{16}$	·5625				
$\frac{5}{8}$	·625				
$\frac{11}{16}$	·6875				
$\frac{3}{4}$	·75	65	108	360	108
$\frac{13}{16}$	·8125				
$\frac{7}{8}$	·875				
$\frac{15}{16}$	·9375				
1	1·00	65	108	360	108
$1\frac{1}{8}$	1·125	65	108	300	108
$1\frac{1}{4}$	1·25	65	108	280	108
$1\frac{3}{8}$	1·375	65	108	250	108
$1\frac{1}{2}$	1·50	60	108	230	108
$1\frac{5}{8}$	1·625	60	108	210	108
$1\frac{3}{4}$	1·75	60	108	200	108
$1\frac{7}{8}$	1·875	50	108	180	108
2	2·00	50	108	180	108
$2\frac{1}{4}$	2·25	40	106	160	106
$2\frac{1}{2}$	2·50	40	106	140	106
$2\frac{3}{4}$	2·75	40	106	130	106
3	3·00	40	106	120	106

The widths are the maxima, but the lengths and areas may be increased for plates below the maximum width, subject to approved specification.
Thicker sizes can also be rolled, but for these specific enquiries should be submitted.
For information on shearing, ordering, and cold mangling of plates, see notes on page 32.

ROLLED STEEL UNIVERSAL PLATES

WITH PARALLEL ROLLED EDGES

Maximum Sizes

Width in Inches	THICKNESS IN INCHES												
	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$
	EXTREME LENGTH IN FEET												
12			90	90	90	90	90	90	90	90	90	72	65
13			90	90	90	90	90	90	90	90	90	72	65
14		90	90	90	90	90	90	90	90	90	80	72	65
15	85	90	90	90	90	90	90	90	90	90	80	72	65
16	85	90	90	90	90	90	90	90	90	90	80	72	65
17	85	90	90	90	90	90	90	90	90	90	80	72	65
18	85	90	90	90	90	90	90	90	90	90	80	72	65
19	85	90	90	90	90	90	90	90	90	90	80	72	65
20	85	90	90	90	90	90	90	90	90	90	80	72	65
21	85	90	90	90	90	90	90	90	90	90	80	72	65
22	85	90	90	90	90	90	90	90	90	90	80	72	65
23	85	90	90	90	90	90	90	90	90	90	80	72	65
24	85	90	90	90	90	90	90	90	90	90	80	72	65
25	85	90	90	90	90	90	90	90	90	90	80	72	65
26	60	90	90	90	90	90	90	90	90	90	80	72	65
27	60	90	90	90	90	90	90	90	90	90	80	72	65
28	60	80	90	90	90	90	90	90	90	90	80	72	65
29	60	80	90	90	90	90	90	90	90	90	80	72	65
30	60	80	90	90	90	90	90	90	90	90	80	72	65
31	60	80	90	90	90	90	90	90	90	90	80	72	65
32	60	80	80	85	90	90	90	90	90	90	80	72	65
33	60	80	80	85	90	90	90	90	90	90	80	72	65
34	60	80	80	85	90	90	90	90	90	90	80	72	65
35	60	80	80	85	90	90	90	90	90	90	80	72	65
36	60	80	80	85	90	90	90	90	90	90	80	72	65
37		60	80	85	90	90	90	90	90	80	75	65	60
38		60	80	85	90	90	90	90	90	80	75	60	60
39		60	80	85	90	90	90	90	90	80	75	60	60
40		60	80	85	90	90	90	90	80	75	70	60	60
41		60	80	85	90	90	90	90	80	75	70	60	60
42		60	80	85	90	90	90	90	80	70	70	60	60
43			80	85	90	90	90	90	80	70	65	60	60
44			80	85	90	90	90	90	80	70	65	60	60
45			80	85	90	90	90	90	80	70	65	60	60
46			80	85	90	90	90	90	80	70	65	60	60
47			80	85	90	90	90	90	80	70	65	60	60
48			80	85	90	90	90	90	80	70	65	60	60

Intermediate widths can be supplied.

For any intermediate size, use length given for next larger size.

Thicker sizes can also be rolled, but for these specific enquiries should be submitted.

For information on shearing, ordering, and cold mangling of plates see notes on page 32.

ROLLED STEEL UNIVERSAL PLATES

WITH PARALLEL ROLLED EDGES

Maximum Sizes

THICKNESS IN INCHES													Width in Inches
$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2	$2\frac{1}{8}$	$2\frac{1}{4}$	$2\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{7}{8}$	3	
EXTREME LENGTH IN FEET													
60	56	53	48	48	45	42	40	37	36	34	33	32	12
60	56	53	48	48	45	42	40	37	36	34	33	32	13
60	56	53	48	48	45	42	40	37	36	34	33	32	14
60	56	53	48	48	45	42	40	37	36	34	33	32	15
60	56	53	48	48	45	42	40	37	36	34	33	32	16
60	56	53	48	48	45	42	40	37	36	34	33	32	17
60	56	53	48	48	45	42	40	37	36	34	33	32	18
60	56	53	48	48	45	42	40	37	36	34	33	32	19
60	56	53	48	48	45	42	40	37	36	34	33	32	20
60	56	53	48	48	45	42	40	37	36	34	33	32	21
60	56	53	48	48	45	42	40	37	36	34	33	32	22
60	56	53	48	48	45	42	40	37	36	34	33	32	23
60	56	53	48	48	45	42	40	37	36	34	33	32	24
60	56	53	48	48	45	42	40	37	36	34	33	32	25
60	56	53	48	48	45	42	40	37	36	34	33	32	26
60	56	53	48	48	45	42	40	37	36	34	33	32	27
60	56	53	48	48	45	42	40	37	36	34	33	32	28
60	56	53	48	48	45	42	40	37	36	34	33	32	29
60	56	53	48	48	45	42	40	37	36	34	33	32	30
60	56	53	48	48	45	42	40	37	36	34	33	32	31
60	56	53	48	48	45	42	40	37	36	34	33	32	32
60	56	53	48	48	45	42	40	37	36	34	33	32	33
60	56	53	48	48	45	42	40	37	36	34	33	32	34
60	56	53	48	48	45	42	40	37	36	34	33	32	35
60	56	53	48	48	45	42	40	37	36	34	33	32	36
60	56	53	48	48	45	42	40	37	36	34	33	32	37
60	56	53	48	48	45	42	40	37	36	34	33	32	38
60	56	53	48	48	45	42	40	37	36	34	33	32	39
60	56	53	48	48	45	42	40	37	36	34	33	32	40
60	56	53	48	48	45	42	40	37	36	34	33	32	41
60	56	53	48	48	45	42	40	37	36	34	33	32	42
60	56	53	48	48	45	42	40	37	36	34	33	32	43
60	56	53	48	48	45	42	40	37	36	34	33	32	44
60	56	53	48	48	45	42	40	37	36	34	33	32	45
60													46
60													47
60													48

Rolling allowances on width specified ⅛″ over and ⅛″ under.

Thicker sizes can also be rolled, but for these specific enquiries should be submitted.

For information on shearing, ordering, and cold mangling of plates see notes on page 32.

MILD STEEL SLABS

ROLLED

Steel slabs are manufactured and supplied by the Company, the size range depending on the mill finish required as listed below.
Slabs above 2¼″ thick may not be perfectly straight or flat and we shall be pleased to advise what additions should be made to finished sizes for machining by customers.

Plate Mill finish burned to size

Maximum thickness 6″
Maximum width 108″
Maximum weight 8 tons

Universal Plate—rolled edge burned to length

Maximum thickness 4″
Maximum width 45″
Maximum weight per inch of width 300 lbs

Primary Mill finish as rolled, sheared or burned to length

Maximum thickness 16″
Maximum width 64″
Maximum length 30 ft.
Maximum weight 18 tons

Primary Mill finish burned to size

Maximum thickness 16″
Maximum width 60″
Maximum length 30 ft.
Maximum weight 16 tons

MACHINED

If required the Company will machine and drill approved orders to the requirements of the London County Council and other Authorities.

PLATES, SHEARING TOLERANCES

Plates other than Universals	
Length	
Up to and including 10 ft.	minus nothing plus ½ in. max.
Over 10 ft. up to and including 20 ft.	minus nothing plus 1 in. max.
Over 20 ft.	minus nothing plus 1¼ in. max.
Width—up to and including ¾ in. thick	
Plates up to and including 72 in. wide	minus nothing plus ⅜ in. max.
Plates over 72 in. wide	minus nothing plus ½ in. max.
Width—over ¾ in. thick	
Plates up to and including 72 in. wide	minus nothing plus ½ in. max.
Plates over 72 in. wide	minus nothing plus ¾ in. max.
Universal Plates	
Length	+ 2 in.
Width	±⅛ in.

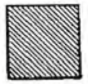
PLATES, COLD MANGLED

Where required the works are equipped for cold mangling plates **up to 2¼″ thick.**

FLATS

Width inches	Thicknesses in inches		Width inches	Thicknesses in inches	
	Minimum	Maximum		Minimum	Maximum
12	⅜	1½	4½	¼	1
11	⅜	1	4	¼	1½
10	5/16	1	3½	¼	1⅛
9	¼	1	3	¼	1⅛
8	¼	1	2¾	¼	1
7½	¼	1	2½	¼	1
7	¼	1	2¼	¼	1
6½	¼	1	2	¼	1
6	¼	1⅛	1¾	¼	1
5½	¼	1	1½	¼	¾
5	¼	1	1¼	¼	¾

SQUARES



SIDES — INCHES							
½	9/16	⅝	11/16	¾	13/16	⅞	15/16
1	1 1/16	1⅛	1 3/16	1¼	1 5/16	1⅜	1 7/16
1½	1 9/16	1⅝	1¾	1⅞	2	2⅛	2¼

CHAMFERED SQUARES

SIDES ⅝ ¾ ⅞  1 1⅛ 1¼ INCHES

WIRE RODS

Sizes from 13/16 in. to 5 S.W.G.

COIL WEIGHTS: Approximately 500/550 lbs. and 900/1,000 lbs.
COIL DIMENSIONS: Outside Diameter — 46 inches
Internal Diameter — 34 inches

ROUNDS

DIAMETERS — INCHES								
5G	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$
$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1	$1\frac{1}{16}$	$1\frac{1}{8}$	$1\frac{3}{16}$	$1\frac{1}{4}$	$1\frac{5}{16}$
$1\frac{3}{8}$	$1\frac{7}{16}$	$1\frac{1}{2}$	$1\frac{9}{16}$	$1\frac{5}{8}$	$1\frac{11}{16}$	$1\frac{3}{4}$	$1\frac{13}{16}$	$1\frac{7}{8}$
$1\frac{15}{16}$	2	$2\frac{1}{16}$	$2\frac{1}{8}$	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3	$3\frac{1}{4}$
$3\frac{1}{2}$	$3\frac{3}{4}$	4	$4\frac{1}{2}$	5	$5\frac{1}{2}$	$5\frac{3}{4}$	6	

Also 55 mm.

RIVET BARS

DIAMETERS — INCHES						
$\frac{19}{32}$	$\frac{21}{32}$	$\frac{23}{32}$	$\frac{25}{32}$	$\frac{27}{32}$	$\frac{29}{32}$	$\frac{31}{32}$
$\frac{31}{64}$	$\frac{33}{64}$	$\frac{35}{64}$	$\frac{39}{64}$	$\frac{43}{64}$	$\frac{47}{64}$	$\frac{55}{64}$

HOT ROLLED STRIP

2 inches to 12 inches Wide × ·300 inches to ·040 inches Thick

COIL WEIGHTS of approximately 250 lbs. per inch of Width

INTERNAL DIAMETER of coil 20 inches

TRACK RAILS

The Company rolls flat bottom and bull head rails for the home Railways in various sections as shown on pages 36 and 37 in lengths up to 60 feet, and the full range of British Standard flat bottom rails down to 50 lbs. per yard, shown on page 36.

Special flat bottom rails and rails below 50 lbs. per yard are also rolled, details of which are shown on page 39.

In addition, fish plates for all sections of rails are manufactured.

The Company produces high carbon rails, chromium and medium manganese rails. The Works are equipped for the controlled cooling of rails.

The sizes rolled as shown on pages 36 and 37, are under frequent revision and provided the quantity warrants the provision of the necessary rolls the Company is prepared to undertake the supply of rails to customers' own sections and specifications.

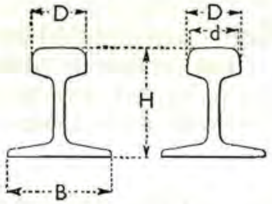
Controlled Cooling

The heat treatment of rails after rolling has now become a well established process. The carefully controlled cooling in operation at the Company's Works, from a predetermined upper temperature through the critical range to a predetermined lower temperature improves the physical properties of the rail and ensures freedom from internal stresses.

The means of regulating the extent and rate of cooling have been brought to a fine degree of precision and every rail receives the exact treatment best suited to its composition, cross sectional area, and other considerations affecting the final result. Effective control is established by means of pyrometric, electrical and mechanical devices.

By this slow cooling through the critical temperature range the possibility of the formation and development of internal cracks is avoided, ensuring sound, tough, wear-resisting rails able to resist the abrasion and shocks imposed by modern traffic conditions.

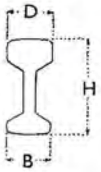
FLAT BOTTOM RAILS



SECTION	WEIGHT		HEIGHT **H**		BASE **B**		HEAD **D**		Approx. wt. of track in tons	
	lbs. per yard	kg. per m.	ins.	mm.	ins.	mm.	ins.	mm.	per mile	per km.
BS Old 1922	50	24·80	$3\frac{15}{16}$	100·01	$3\frac{15}{16}$	100·01	$2\frac{1}{16}$	52·39	79	49·1
	60	29·76	$4\frac{5}{16}$	109·54	$4\frac{5}{16}$	109·54	$2\frac{1}{4}$	57·15	94	58·4
BS Revised 1936	50	24·80	$4\frac{1}{8}$	104·78	$3\frac{15}{16}$	100·01	$2\frac{1}{16}$	52·39	79	49·1
	55	27·28	$4\frac{5}{16}$	109·54	$4\frac{1}{8}$	104·78	$2\frac{5}{32}$	54·77	86	53·4
	60	29·76	$4\frac{1}{2}$	114·30	$4\frac{5}{16}$	109·54	$2\frac{1}{4}$	57·15	94	58·4
	65	32·24	$4\frac{11}{16}$	119·06	$4\frac{7}{16}$	112·71	$2\frac{5}{16}$	58·74	102	63·4
	70	34·72	$4\frac{7}{8}$	123·83	$4\frac{5}{8}$	117·48	$2\frac{3}{8}$	60·33	110	68·4
	75	37·20	$5\frac{1}{16}$	128·59	$4\frac{13}{16}$	122·24	$2\frac{7}{16}$	61·91	118	73·3
	80	39·68	$5\frac{1}{4}$	133·35	5	127·00	$2\frac{1}{2}$	63·50	126	78·3
	85	42·16	$5\frac{7}{16}$	138·11	$5\frac{3}{16}$	131·76	$2\frac{9}{16}$	65·09	134	83·3
	90	44·64	$5\frac{5}{8}$	142·88	$5\frac{3}{8}$	136·53	$2\frac{5}{8}$	66·68	141	87·6
	95	47·13	$5\frac{13}{16}$	147·64	$5\frac{9}{16}$	141·29	$2\frac{11}{16}$	68·26	149	92·6
	100	49·61	6	152·40	$5\frac{3}{4}$	146·05	$2\frac{3}{4}$	69·85	157	97·6
	110	54·57	$6\frac{1}{4}$	158·75	6	152·40	$2\frac{7}{8}$	73·03	173	107·5
BS 1959 Sections with double tapered flanges **60a**	61·56	30·54	$4\frac{1}{2}$	114·30	$4\frac{5}{16}$	109·54	$2\frac{1}{4}$	57·15	97	60·1
65a	65·24	32·36	$4\frac{11}{16}$	119·06	$4\frac{5}{16}$	109·54	$2\frac{5}{16}$	58·74	103	63·7
70a	70·24	34·84	$4\frac{7}{8}$	123·82	$4\frac{3}{8}$	111·12	$2\frac{3}{8}$	60·32	110	68·4
75a	75·55	37·48	$5\frac{1}{16}$	128·59	$4\frac{1}{2}$	114·30	$2\frac{7}{16}$	61·91	119	73·8
80a	80·24	39·80	$5\frac{1}{4}$	133·35	$4\frac{5}{8}$	117·47	$2\frac{1}{2}$	63·50	126	78·3
85a	85·04	42·18	$5\frac{7}{16}$	138·11	$4\frac{13}{16}$	122·24	$2\frac{9}{16}$	65·09	134	83·3
90a	90·76	45·02	$5\frac{5}{8}$	142·87	5	127·00	$2\frac{5}{8}$	66·67	143	88·6
95a	95·15	47·20	$5\frac{13}{16}$	147·63	$5\frac{1}{8}$	130·17	$2\frac{3}{4}$	69·85	149	92·6
100a	100·97	50·09	6	152·40	$5\frac{1}{4}$	133·35	$2\frac{3}{4}$	69·85	159	98·6
105a	105·15	52·16	$6\frac{1}{8}$	155·57	$5\frac{3}{8}$	136·52	$2\frac{3}{4}$	69·85	165	102·6
110a	109·75	54·44	$6\frac{1}{4}$	158·75	$5\frac{1}{2}$	139·70	$2\frac{3}{4}$	69·85	172	107·0
95N	95·10	47·16	$5\frac{13}{16}$	147·63	$5\frac{1}{2}$	139·70	$2\frac{3}{4}$	69·85	149	92·6
South African Rlys.	61	30·26	$4\frac{5}{16}$	109·54	$4\frac{5}{16}$	109·54	$2\frac{1}{4}$	57·15	95	59·4
Sudan Rlys.	75	37·20	$4\frac{27}{32}$	123·03	$4\frac{9}{16}$	115·88	$2\frac{7}{16}$	61·91	118	73·3
Pacific Great Eastern Rlys.	85	42·16	$5\frac{1}{8}$	130·175	5	127·00	D=$2\frac{1}{2}$ d=$2\frac{7}{16}$	63·50 61·91	134	83·3
New Zealand Rlys.	91	45·09	$5\frac{5}{8}$	142·875	$5\frac{3}{16}$	131·76	$2\frac{9}{16}$	65·08	143	88·9
Iranian Rlys.	93·35	46·303	5·709	145·00	5·276	134·00	D=2·52 d=2·44	64·30 62·00	147	90·9
South African Rlys.	96	47·62	$5\frac{7}{8}$	149·22	5	127·00	$2\frac{11}{16}$	68·26	151	93·8
British Rlys.	98	48·61	$5\frac{5}{8}$	142·88	$5\frac{1}{2}$	139·70	$2\frac{3}{4}$	69·85	154	95·7

For rails under 50 lbs. per yard, see page 39.

BULL HEAD RAILS



SECTION	WEIGHT		HEIGHT **H**		FOOT **B**		HEAD **D**		Approx. wt. of track in tons	
	lbs. per yard	kg. per m.	ins.	mm.	ins.	mm.	ins.	mm.	per mile	per km.
BS Revised	95	47·13	$5\frac{23}{32}$	145·26	$2\frac{3}{4}$	69·85	$2\frac{3}{4}$	69·85	149	92·6
British Rlys.	$97\frac{1}{2}$	48·37	$5\frac{3}{4}$	146·05	$2\frac{3}{4}$	69·85	$2\frac{3}{4}$	69·85	153	95·1

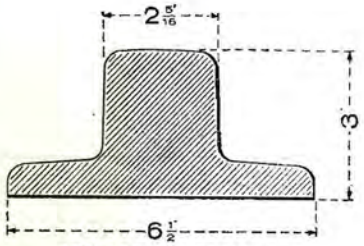
Conductor Rails

High Conductivity Rails made from low carbon steel are also produced and large quantities have been supplied to the home Railways to their own sections and specifications and to overseas Railways.

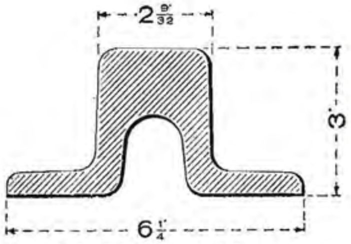
Steel Soleplates

We are manufacturers of Rolled Steel Soleplates for use with Flat Bottom Rails.

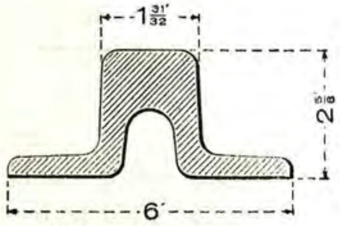
BRIDGE RAILS



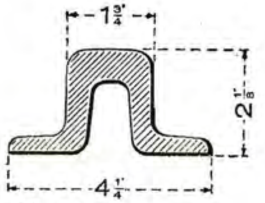
100 LBS PER YARD



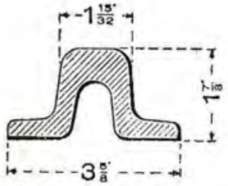
70 LBS PER YARD



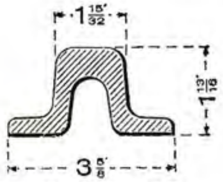
56 LBS PER YARD



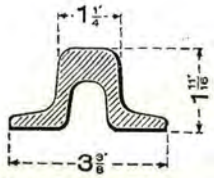
33 LBS PER YARD



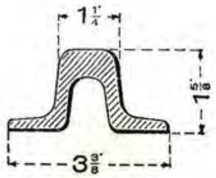
26 LBS PER YARD



24 LBS PER YARD

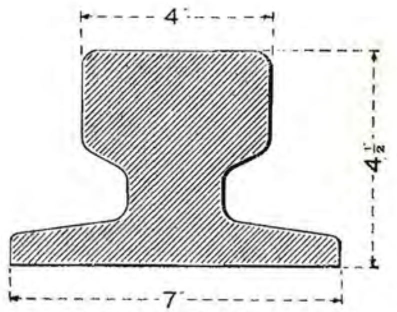


18 LBS PER YARD

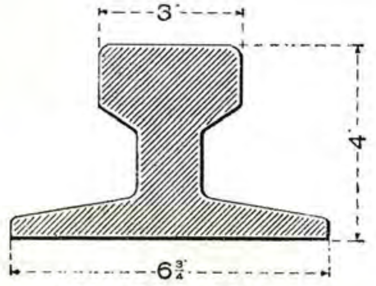


16 LBS PER YARD

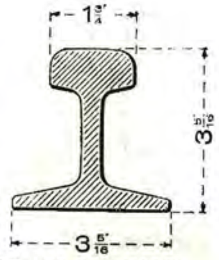
SPECIAL FLAT BOTTOM RAILS



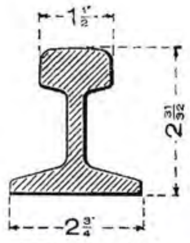
178·5 LBS PER YARD



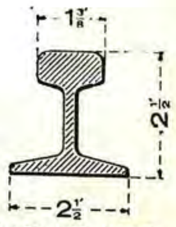
112 LBS PER YARD



35 LBS PER YARD

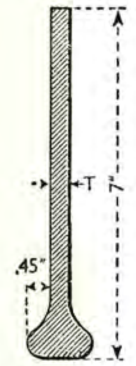


30 LBS PER YARD



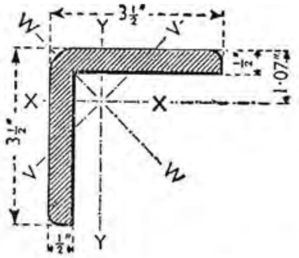
20 LBS PER YARD

MISCELLANEOUS ROLLED SECTIONS



T	Area	Wt./Ft
ins.	sq. ins.	lbs.
·30	2·67	9·06
·3125	2·75	9·36
·32	2·81	9·54
·34	2·95	10·02
·35	3·02	10·25
·36	3·09	10·49
·375	3·19	10·85
·38	3·23	10·97
·40	3·37	11·44
·42	3·51	11·92
·4375	3·63	12·34
·44	3·65	12·40
·45	3·72	12·63
·46	3·79	12·87
·48	3·93	13·35
·50	4·07	13·82

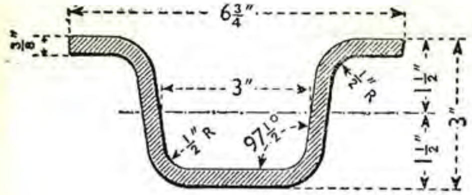
BULB PLATE



3½" × 3½" × ½" ROUND BACK SQUARE ROOT ANGLE

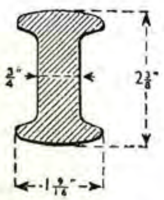
Properties of Section

Sectional Area	Sq. ins.	3·17
Weight	lbs./ft.	10·78
Moment of Inertia XX	ins.⁴	3·50
Moment of Inertia WW	ins.⁴	5·60
Moment of Inertia VV	ins.⁴	1·39
Modulus Zxx (Min.)	ins.³	1·44
Radius of Gyration rxx	ins.	1·05
Radius of Gyration rvv	ins.	0·66

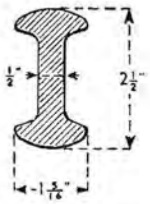


WAGON BODY STANCHION SECTION

6¾" × 3" × ⅜" Special Channel



8 lbs. per foot.



6.66 lbs. per foot.

BOBBIN SECTIONS (*Fencing Standards*)

COLLIERY ARCHES

Manufactured in accordance with N.C.B. Specification P.114/1955 in the following sizes of joists:

inches	*lbs. per foot*
3 × 3	9·86
3½ × 3½	13
4 × 4	15·5
4½ × 4½	18
5 × 4½	20
6 × 5	25

Arches supplied complete with fishplates, bolts and nuts.

The Company also supplies cambered joists and short length joists for use as plain pit props.

CORRUGATED CROWN TREES

5 ins. wide in the following thicknesses:

$\frac{5}{8}$ $\frac{9}{16}$ $\frac{1}{2}$ $\frac{7}{16}$ $\frac{3}{8}$ $\frac{5}{16}$ INCHES

In addition to being large suppliers to The National Coal Board, the Company undertakes orders from Civil Engineering Contractors for tunnel supports. The Company is also equipped to camber joists other than those specified above, and to execute any simple fabrication required.

PRESSED STEEL TROUGHING

Pressed steel troughing can be recommended for a variety of purposes and the company has equipment for producing a comprehensive range of sections.

When used for road bridges, steel troughing not only affords a watertight superstructure for carrying the roadway material, but in many cases the use of cross girders can be dispensed with, and frequently the use of main girders also.

In railway bridges it can take the place of cross girders, rail bearers and timber planking, at the same time forming a safer floor in case of derailment. A minimum construction depth of bridge floor is attained with a saving cost of approaches.

The shallower sections are especially useful for decking of footbridges, piers, floors of warehouses, ceilings of subways, strong rooms and watertight bulkheads in ships.

The dimensions, properties and safe loads for the troughing sections are given in PART V, Pages 502 to 511.

In addition to the pressed steel troughing tabulated, other sections can be pressed subject to suitable tonnages being ordered. For such requirements specific enquiries should be submitted.

BLACK STEEL SHEETS

Thicknesses, Sizes Rolled and Weights

(STANDARD SHEET AND HOOP IRON GAUGE—B.G. 1884)

Gauge	Actual	THICKNESS			Weight of Sheets per sq. foot	Widths	Maximum Length	
		In fractions of an inch	In decimals of an inch	In millimetres	lbs.	inches	ft.	ins.
6½	▬	$\frac{3}{16}$	·1875	4·750	7·64	22 to 48	12	0
8	▬		·1570	3·988	6·41	22 to 48	12	0
9	▬		·1398	3·551	5·70	22 to 48	12	0
10	▬	$\frac{1}{8}$	·1250	3·175	5·10	22 to 48	12	0
11	▬		·1113	2·827	4·54	22 to 48	12	0
12	▬		·0991	2·517	4·04	22 to 48	10	0
13	▬		·0882	2·240	3·60	22 to 48	12	0
14	▬		·0785	1·994	3·20	22 to 48	12	0
15	▬		·0699	1·775	2·85	22 to 48	12	0
16	▬	$\frac{1}{16}$	·0625	1·587	2·55	22 to 48	12	0
17	▬		·0556	1·412	2·27	22 to 48	12	0
18	▬		·0495	1·257	2·02	22 to 48	10	0
19	▬		·0440	1·118	1·80	22 to 48	10	0
20	▬		·0392	·996	1·60	22 to 48	10	0
21	▬		·0349	·886	1·42	22 to 38	10	0
						39 to 48	10	0
22	▬	$\frac{1}{32}$	·03125	·794	1·28	22 to 38	12	0
						39 to 48	10	0
23	▬		·02782	·707	1·135	22 to 38	12	0
						39 to 48	8	0
24	▬		·02476	·629	1·010	22 to 38	12	0
						39 to 48	8	0
25	▬		·02204	·560	·899	22 to 30	10	0
						31 to 40	8	0
26	▬		·01961	·498	·800	22 to 30	10	0
						31 to 40	8	0
27	▬		·01745	·4432	·712	22 to 36	8	0

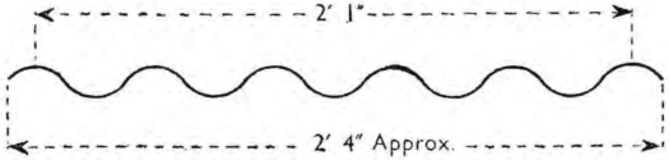
NOTE: Sheets are rolled to average gauge-weight, *i.e.*, lbs. per sq. ft., taken over all sheets in one delivery of one size and one gauge, and not on individual sheets. Flattening can be carried out either by mangling or by stretching (patent flattening). The latter process leaves an indentation at each end of the sheet and if these marks are required to be eliminated they can be sheared off. Re-shearing should be specified if exact lengths are required as the lengths of patent flattened sheets vary.

RE-SHEARING. The mill shearing margin is ¾" in the length and ¼" in the width. If closer limits are required sheets should be ordered re-sheared.

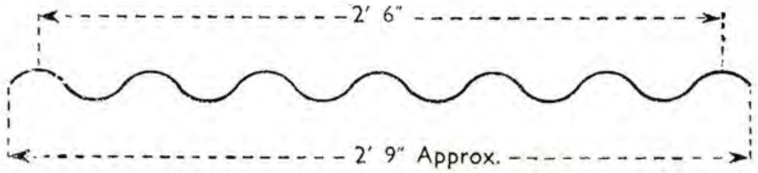
Registered Brand on Sheets

DIAMOND

CORRUGATED SHEETS

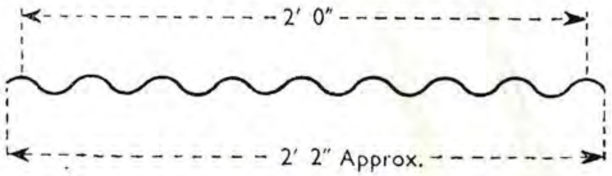


5/5″

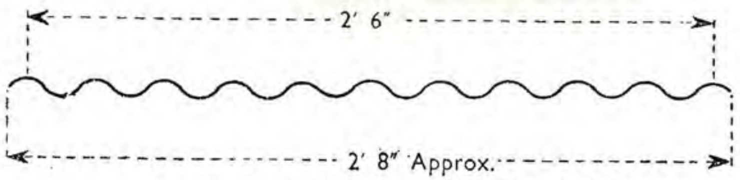


6/5″

Gauges: 14, 16, 18 & 20 B.G.

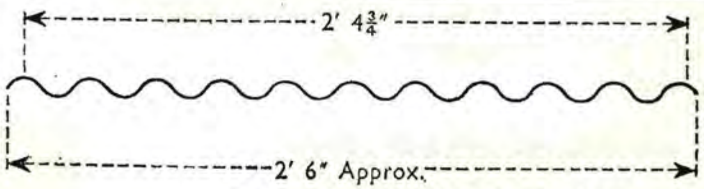


8/3″



10/3″

Gauges: 16, 18, 20, 22, 24 & 26 B.G.



10½/2⅞″

Gauges: 16, 18, 20, 22, 24 & 26 B.G.

The above sheet is suitable for use in conjunction with asbestos cement cladding, enabling lower lengths of wall cladding for farm and industrial buildings to be carried out in steel sheet.

GALVANIZED
SCANDINAVIAN TILES

Dimensions in millimetres

This form of sheet is made in a standard width of 810 mm. with four equally spaced corrugations as shown above, and in the following lengths:

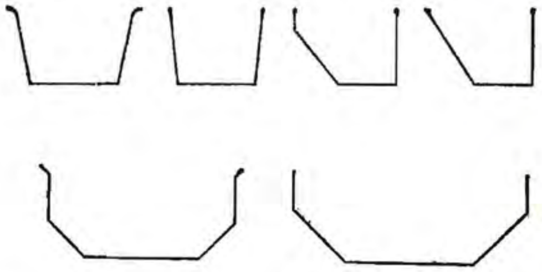
1·00, 1·25, 1·50, 1·75, 2·00, 2·25 and 2·5 metres

Gauges 20 to 26 B.G.

GALVANIZED GUTTERS AND DOWNPIPES

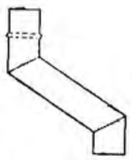
GALVANIZED AFTER MANUFACTURE

Can also be supplied Painted or Self-Colour



HEAVY GAUGE VALLEY & BOUNDARY WALL GUTTERS

DOWNPIPES
2½" to 6" Diam.
Gauges 16 to 24

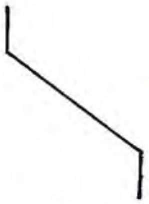


OFFSET

SHOE

HALF ROUND GUTTERS
WITH
SOCKET & SPIGOT JOINTS

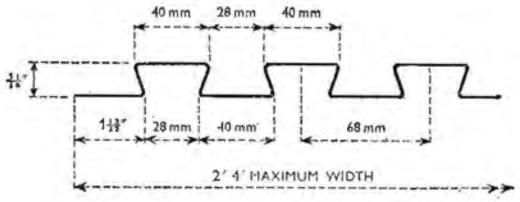
GALVANIZED RIDGING
12" to 36" Girth
16 to 26 Gauge
Length about 6′ 0"



LOUVRE BLADES
Girths up to 30"
16 Gauge up to ⅛" thick
Maximum length 10′ 0"

DOVETAIL SHEETING

Suitable for flooring and partition walling. Manufactured in gauges from 14 to 22 inclusive.



PALLETS

Enquiries are invited for steel pallets, fabricated from sheet and pressed metal sections. The Company has many existing designs for flat or post pallets with two or four way entry.

LIGHT FABRICATIONS

Bins and feeding troughs for agricultural use

Pressed steel angle, channels, and sections

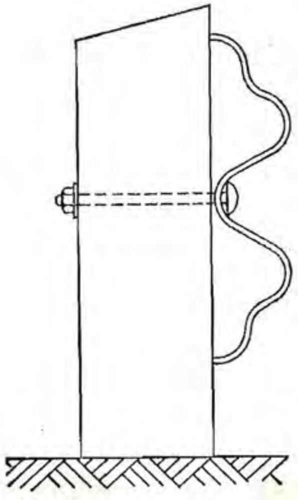
Twisted wall ties in black or galvanized finish for cavity walls

Engineers standard washers

DORMAN LONG

SAFETY-RAIL FENDERS

Provide protection for the Motorist at all danger points along roadways



Design Registration App. 895146

SPECIFICATION

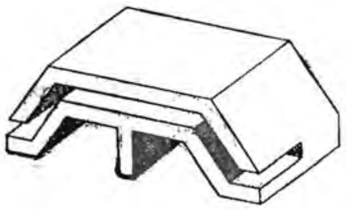
Gauge	11 BG
Overall width of Section	12½ ins.
Depth of Corrugations	3¼ ins.
Overall length of Section	11 ft. 6 ins.
Effective length of Section	10 ft. 6 ins.
Weight per lineal foot	8 lbs.

DORMAN LONG

STEEL TRENCH SHEETING

Registered Design No. 850839

Designed for temporary lining of trenches in the laying of water mains, sewage pipes, cables and similar purposes, this product is now in use on many important contracts.



Driving Cap supplied if required

Trench Sheeting can be supplied in lengths up to 14 feet.

Easily driven at foot of trench: easily withdrawn —holes drilled to facilitate this operation.

Can be used time after time.

Light to handle.

Better than timber—saves time, labour and wastage.

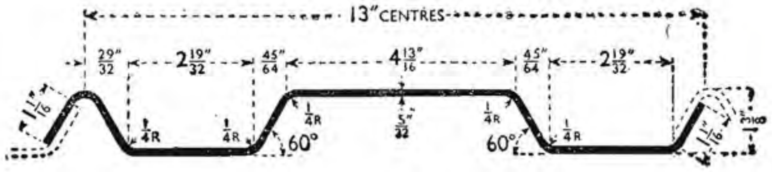
Reduces required width of excavation.

Conserves storage space.

DORMAN LONG

STEEL TRENCH SHEETING

Dimensions and Properties



Thickness $\frac{5}{32}$ ins. Depth $1\frac{3}{8}$ ins.

Area of section 2·57 sq. ins.

Weight per foot run of section $8\frac{3}{4}$ lbs. (approx.)

Elastic Modulus of section 1·016 ins.^{3}

TRENCH SHEETING

IS MANUFACTURED AT

THE COMPANY'S SHEET WORKS

MIDDLESBROUGH

DORMAN LONG

LINTEL

Specially designed for use at the heads of openings in external cavity walls, combining

in a single steel unit

the angle arch support and
the damp-course tray.

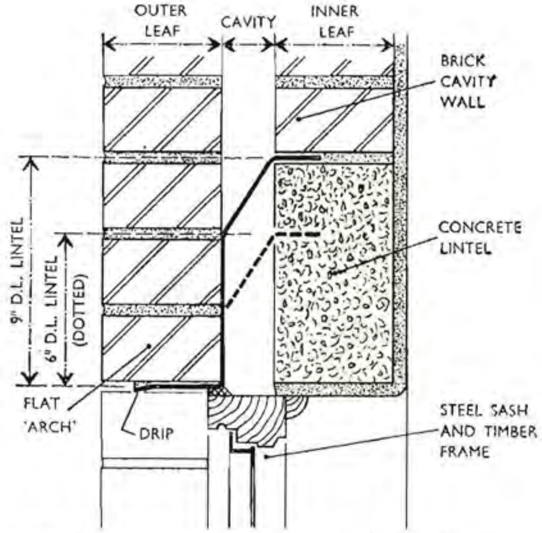
The lintel is rust proof, because it is hot-dip galvanised after manufacture.

The lintel is made the right length ready to be fixed in one simple operation.

Because it is steel, the tray is not damaged or perforated by cavity cleaning.

DORMAN LONG

LINTEL



SECTION SHOWING TYPICAL DETAIL

Cavity may be varied from 2" to 2¾". Window Frame may be located forward, fixed in reveals, or as desired.

SELECTING SUITABLE LINTELS

STANDARD SIZES—Delivery ex Stock

Clear width between brickwork	Bearing—Add to EACH end	Depth of Lintel	Thickness of metal
Up to 4′ 6″	6 ins.	6 ins.	$\frac{1}{8}$ in. min.
Over 4′ 6″ to 5′ 6″	6 ins.	9 ins.	$\frac{1}{8}$ in. min.
Over 5′ 6″ to 7′ 0″	9 ins.	9 ins.	$\frac{5}{32}$ in. min.
Over 7′ 0″ to 10′ 6″	9 ins.	9 ins.	$\frac{3}{16}$ in. only

Final overall length to be a multiple of 3 in. up to 10 ft. long, and a multiple of 6 in. from 10 ft. to 12 ft. long.

NON-STANDARD SIZES

Lintels other than the above standard sizes can be specially manufactured to suit customers' requirements. Delivery is 3/4 weeks and prices are forwarded on receipt of enquiries. A non-standard lintel may be of different thickness to a maximum of $\frac{3}{16}$ in. thick, a different depth, an alternative profile or in a length not a multiple of 3 in. or 6 in.

When ordering please state depth, thickness and overall length, including bearings.

DORMAN LONG

PLASTIC COATED STEEL SHEETS

A steel sheet coated both sides and all edges with a Polyvinyl Chloride Composition, 'VYNASOL'.

The 'VYNASOL' is mechanically applied to the steel sheet and bonded to it by a high-temperature process, leaving a characteristically grained surface of great toughness.

Extensive testing has proved that these sheets are an outstanding advance in the battle against corrosion.

The sheets are particularly suitable for industrial roof cladding. Flat coated sheets can be pressed or formed to any shape without damage to the coating; the sheets are therefore adaptable to a great variety of uses.

Dorman Long Plastic Coated Sheets are available in many colours. For further details send for illustrated brochure.

WIRE PRODUCTS

BRIGHT PATENT AND PLOUGH STEEL ROPE WIRE

GALVANIZED PATENT STEEL AND HAWSER WIRE

ORDINARY ROUND MILD STEEL OR HIGH STRAIN OVAL FENCING WIRES

GALVANIZED TELEGRAPH (HIGH CONDUCTIVITY) WIRE

GALVANIZED CABLE-ARMOURING WIRE

COLD HEADING WIRE

ANNEALED WIRE

HIGH TENSILE STEEL WIRE FOR PRESTRESSED CONCRETE

BEDDING AND SEATING WIRE

HIGH CARBON SPRING WIRES

BRIDGE WIRE

WIRE IN STRAIGHT CUT LENGTHS

IMPERIAL STANDARD WIRE GAUGE

STEEL WIRE

Table of sizes, weights, lengths and breaking loads

Approximate Dia. ins.	Size on Wire Gauge	Diameter		Sectional Area in sq. ins.	Approximate Weight lbs.			Approximate Length yards		Approximate Breaking Load lbs.	
		ins.	mm.		100 yards	1 mile	1 kilometre	1 cwt.	100 kilogrammes	25 tons per sq. in.	35 tons per sq. in.
$\frac{1}{2}$	7/0	·500	12·7	·19635	200·11	3522	2188	56	110	10995	15393
$\frac{15}{32}$	6/0	·464	11·8	·16910	172·33	3033	1885	65	128	9469	13257
$\frac{7}{16}$	5/0	·432	11·0	·14657	149·37	2629	1634	75	147	8208	11490
$\frac{13}{32}$	4/0	·400	10·2	·12568	128·07	2254	1400	87·5	172	7035	9851
$\frac{3}{8}$	3/0	·372	9·4	·10869	110·80	1950	1211	101	198	6086	8521
$\frac{11}{32}$	2/0	·348	8·8	·09510	96·93	1706	1060	115	226	5326	7457
—	1/0	·324	8·2	·08244	84·03	1479	919	133	261	4616	6463
—	1	·300	7·6	·07069	72·04	1268	788	155	305	3958	5542
—	2	·276	7·0	·05982	60·97	1073	667	183	360	3350	4690
$\frac{1}{4}$	3	·252	6·4	·04987	50·85	895	556	220	433	2792	3910
—	4	·232	5·9	·04227	43·07	758	471	260	512	2366	3313
—	5	·212	5·4	·03530	35·97	633	393	311	612	1977	2767
$\frac{3}{16}$	6	·192	4·9	·02896	29·43	518	323	380	748	1621	2269
—	7	·176	4·5	·02432	24·77	436	271	452	890	1362	1908
—	8	·160	4·1	·02011	20·45	360	224	546	1075	1125	1576
—	9	·144	3·7	·01628	16·59	292	182	675	1329	911	1276
$\frac{1}{8}$	10	·128	3·3	·01287	13·12	231	143	854	1681	720	1008
—	11	·116	3·0	·01057	10·80	190	118	1040	2047	592	828
—	12	·104	2·6	·00850	8·63	152	95	1293	2545	475	666
$\frac{3}{32}$	13	·092	2·3	·00665	6·76	119	74	1653	3254	373	521
—	14	·080	2·0	·00503	5·11	90	56	2186	4303	281	394
—	15	·072	1·8	·00407	4·15	73	45	2699	5313	227	318
$\frac{1}{16}$	16	·064	1·6	·00322	3·29	58	36	3416	6724	180	252
—	17	·056	1·4	·00246	2·50	44	27·5	4462	8783	138	192
$\frac{3}{64}$	18	·048	1·2	·00181	1·83	32·5	20·2	6073	11954	101	141
—	19	·040	1·0	·00126	1·27	22·54	14·0	8745	17214	70	98
—	20	·036	·9	·00102	1·03	18·25	11·34	10796	21251	57	79
$\frac{1}{32}$	21	·032	·8	·00080	·819	14·42	8·96	13663	26894	45	63
—	22	·028	·7	·00062	·628	11·04	6·86	17846	35128	34·4	48·2
—	23	·024	·6	·00045	·461	8·11	5·04	24290	47813	25·2	35·3
$\frac{3}{128}$	24	·022	·55	·00038	·387	6·82	4·24	28908	56903	21·2	29·8
—	25	·020	·5	·00031	·320	5·63	3·5	34978	68851	17·6	24·6
—	26	·018	·45	·00025	·259	4·56	2·84	43184	85003	14·2	19·9
—	27	·0164	·4	·00021	·215	3·79	2·35	52021	102498	11·8	16·6
$\frac{1}{64}$	28	·0148	·37	·00017	·175	3·09	1·92	63877	125735	9·6	13·5
—	29	·0136	·35	·00014	·148	2·61	1·62	75646	148903	8·1	11·4
—	30	·0124	·32	·00012	·123	2·17	1·35	90996	179118	6·	9·5

STRENGTH OF WIRE

Load in lbs. on wire to produce a tension of 1 ton per square inch

Diameter of Wire inches	Load in lbs.	Diameter of Wire inches	Load in lbs.	Diameter of Wire inches	Load in lbs.	Diameter of Wire inches	Load in lbs.	Diameter of Wire inches	Load in lbs.
·3	158·3	·265	123·6	·23	93·1	·195	66·9	·16	45
·299	157·3	·264	122·6	·229	92·3	·194	66·2	·159	44·5
·298	156·2	·263	121·7	·228	91·5	·193	65·6	·158	43·9
·297	155·2	·262	120·8	·227	90·7	·192	64·8	·157	43·4
·296	154·2	·261	119·8	·226	89·9	·191	64·2	·156	42·8
·295	153·1	·26	118·9	·225	89·1	·19	63·6	·155	42·3
·294	152·1	·259	118·	·224	88·3	·189	62·9	·154	41·7
·293	151·	·258	117·1	·223	87·5	·188	62·2	·153	41·2
·292	150·	·257	116·2	·222	86·7	·187	61·5	·152	40·6
·291	149·	·256	115·3	·221	85·9	·186	60·9	·151	40·1
·29	147·9	·255	114·4	·22	85·1	·185	60·2	·15	39·6
·289	146·9	·254	113·5	·219	84·3	·184	59·5	·149	39·
·288	145·9	·253	112·6	·218	83·6	·183	58·9	·148	38·5
·287	144·9	·252	111·7	·217	82·84	·182	58·3	·147	38·
·286	143·9	·251	110·8	·216	82·1	·181	57·7	·146	37·5
·285	142·9	·25	110·	·215	81·3	·18	57·	·145	37·
·284	141·9	·249	109·1	·214	80·6	·179	56·4	·144	36·5
·283	140·9	·248	108·2	·213	79·8	·178	55·7	·143	36·
·282	139·9	·247	107·3	·212	79·	·177	55·1	·142	35·5
·281	138·9	·246	106·4	·211	78·3	·176	54·5	·141	35·
·28	137·9	·245	105·6	·21	77·6	·175	53·8	·14	34·5
·279	136·9	·244	104·7	·209	76·9	·174	53·3	·139	34·
·278	135·9	·243	103·9	·208	76·2	·173	52·7	·138	33·5
·277	135·	·242	103·	·207	75·4	·172	52·	·137	33·
·276	134·	·241	102·2	·206	74·7	·171	51·5	·136	32·5
·275	133·	·24	101·3	·205	73·9	·17	50·9	·135	32·
·274	132·1	·239	100·5	·204	73·2	·169	50·2	·134	31·6
·273	131·1	·238	99·7	·203	72·5	·168	49·6	·133	31·1
·272	130·2	·237	98·8	·202	71·8	·167	49·	·132	30·7
·271	129·2	·236	98·	·201	71·1	·166	48·5	·131	30·2
·27	128·2	·235	97·2	·2	70·4	·165	47·9	·13	29·7
·269	127·3	·234	96·3	·199	69·7	·164	47·3	·129	29·3
·268	126·3	·233	95·5	·198	69·	·163	46·7	·128	28·8
·267	125·4	·232	94·7	·197	68·3	·162	46·2	·127	28·4
·266	124·4	·231	93·9	·196	67·6	·161	45·6	·126	28·

STRENGTH OF WIRE

Load in lbs. on wire to produce a tension of 1 ton per square inch (*continued*)

Diameter of Wire inches	Load in lbs.	Diameter of Wire inches	Load in lbs.	Diameter of Wire inches	Load in lbs.	Diameter of Wire inches	Load in lbs.	Diameter of Wire inches	Load in lbs.
·125	27·48	·100	17·59	·075	9·896	·050	4·397	·025	1·100
·124	27·05	·099	17·24	·074	9·634	·049	4·222	·024	1·013
123	26·61	·098	16·90	·073	9·375	·048	4·052	·023	·931
·122	26·19	·097	16·55	·072	9·120	·047	3·886	·022	·851
·121	25·75	·096	16·21	·071	8·862	·046	3·723	·021	·775
·120	25·33	·095	15·88	·070	8·620	·045	3·562	·020	·704
·119	24·91	·094	15·55	·069	8·375	·044	3·405	·019	·6351
·118	24·50	·093	15·22	·068	8·135	·043	3·252	·018	·5701
·117	24·08	·092	14·89	·067	7·897	·042	3·102	·017	·5085
·116	23·67	·091	14·57	·066	7·663	·041	2·957	·016	·4502
·115	23·27	·090	14·25	·065	7·433	·040	2·815	·015	·3958
·114	22·86	·089	13·94	·064	7·206	·039	2·675	·014	·3449
·113	22·46	·088	13·62	·063	6·982	·038	2·540	·013	·2973
·112	22·07	·087	13·32	·062	6·762	·037	2·408	·012	·2533
·111	21·68	·086	13·01	·061	6·546	·036	2·280	·011	·2129
·110	21·29	·085	12·71	·060	6·333	·035	2·155	·010	·1759
·109	20·90	·084	12·41	·059	6·124	·034	2·034	·009	·1425
·108	20·52	·083	12·12	·058	5·918	·033	1·915	·008	·1126
·107	20·14	·082	11·83	·057	5·716	·032	1·801	·007	·08620
·106	19·77	·081	11·54	·056	5·517	·031	1·691	·006	·06333
·105	19·40	·080	11·26	·055	5·327	·030	1·584	·005	·04398
·104	19·03	·079	10·98	·054	5·129	·029	1·478	·004	·02815
·103	18·66	·078	10·70	·053	4·941	·028	1·380	·003	·01583
·102	18·30	·077	10·43	·052	4·757	·027	1·281	·002	·007037
·101	17·95	·076	10·16	·051	4·576	·026	1·189	·001	·0017593

EXAMPLE showing the application of the above table:

Take a wire of any diameter, say ·088 inches; according to the Table a load of 13·6 lbs. on this wire would be equivalent to a tension of 1 ton per sq. inch. If such a wire on testing broke under a load of 1430 lbs., the corresponding tension would be $\frac{1430}{13{\cdot}6} = 105$ tons per sq. inch.

Constructional Departments

SPECIAL FACILITIES

COLD CAMBERING BEAMS

The maximum camber is dependent upon the size of the section and is determined by the ability of the section itself to withstand cambering without distortion.

For general guidance, the maximum camber may be taken as approximately 3 inches in 50 feet. The maximum length which can be cambered is 90 feet.

The curvature of a cambered beam will approximate to the arc of a circle over the majority of its length.

Camber should be specified by the ordinate at mid length.

When cambering less than 1½ inches in 50 feet is contemplated, it will be advisable to seek the advice of the Company, because of the difficulty of giving permanency to small cambers.

CUTTING TEES

This is done by rotary shears after which the Tees are straightened. This service can be applied to almost the full range of beams and columns except where the web thickness exceeds ¾ inch.

FOLDED PLATES AND PRESSWORK

In addition to the range of pressed steel trough sections listed in Part V, a folding machine at the Bridge & Constructional Works is capable of forming plates up to ⅜" thick in lengths up to 14′ 0″.

Hydraulic presses with capacities ranging up to 1500 tons and 30′ 0″ long, complete with heating furnaces, are also available to carry out a wide range of hot and cold forming of plates and sections.

NON-DESTRUCTIVE TESTING

There is a non-destructive testing department at Bridge & Constructional Works staffed by experienced personnel and equipped with ultra-sonic flaw detectors for the examination of plates, sections and welds, and this equipment is extensively used before, during, and after fabrication.

The department is also equipped with gamma-ray isotopes for the radiographic examination of welds, and facilities are available for the immediate developing and examination of the radiographs.

ANTI-CORROSION TREATMENT OF STEELWORK

SHOT BLASTING AND PRIMING

It is well known and has been proved both in the laboratory and in the field that the primary factor in the prevention of corrosion is the removal of mill scale and rust from the surface of the steel. It is also well established that the most efficient method of scale removal by mechanical means is the shot blasting process, giving an ideal surface for any protective coating.

Dorman Long have therefore installed shot blasting plants complete with automatic handling equipment.

All steelwork passes through these plants **before** fabrication thus ensuring that the whole surface of the steel, including the contact surfaces, is thoroughly cleaned and de-scaled.

A shop primer is applied immediately after shot blasting to protect the surface during fabrication. The completed job is then in perfect surface condition to receive any specified paint.

The two shot blasting plants in use at the Bridge & Constructional Works are of the impeller type, one plant handling the full range of roll sections up to 36 × 16½ universal beams and the other plant handling plates up to 12′ 0″ wide.

We offer the highest standard of cleaning, the regular application of the copper sulphate test and visual checking by the Swedish pictorial standards ensuring quality control of the cleaned surfaces.

The painting equipment available includes the latest type of airless spray guns, and rollers in addition to the conventional brushing.

GRIT BLASTING AND METALLIZING

Fabricated members weighing up to 100 tons can be grit blasted and metal sprayed. Grit blasting is carried out by means of compressed air plant, using chilled iron angular grit. Equipment is available for the subsequent spraying of the steelwork with zinc or aluminium coatings using the powder or wire process.

HOT DIP GALVANIZING

This method of providing protection for exposed steelwork is one of the oldest and still ranks among the most efficient. A wide variety of plant, including a large oil-fired bath with fully automatic control, recently installed at Tees Side Bridge & Engineering Works Ltd. (a member of Dorman Long Group), is able to deal with weights up to 3 tons and fabrications up to 45 ft. long.

PIG IRON

At the various Works of the Company are manufactured the following qualities of Iron:

'CLEVELAND' Brand of Cleveland Foundry Pig Iron
'CLEVELAND' Brand of Special Foundry Pig Iron
'B.S.' Brand of East Coast Hematite Pig Iron
BASIC Pig Iron for Steelmaking
FERRO-MANGANESE

Particulars and Approximate Analyses are as follows:

CLEVELAND

Grades	Combined Carbon	Graphite	Silicon	Sulphur	Phosphorus	Manganese
	%	%	%	%	%	%
Cleveland No. 1	·10	3·5	3·5/4·0	·02/·035	1 to 1·3	·50/·70
Cleveland No. 3	·15	3·45	2·5/3 & 3/3·5	·035/·05	1 to 1·3	·50/·70
Cleveland No. 4 Foundry	·25	3·41	2/2·5	·05/·08	1 to 1·3	·50/·70
Cleveland No. 4 Forge	·32	3·25	1·84	·12	1 to 1·3	·50/·70
Cleveland Silicious	·03	3·10	4/5 & 5/6	·02/·04	1 to 1·3	·50/·70
Cleveland Mottled	1·60	1·60	1·32	·23	1 to 1·3	·50/·70
Cleveland White	3·20	Trace	·46	·52	1 to 1·3	·50/·70

CLEVELAND SPECIAL

Grades	Silicon	Sulphur	Phosphorus	Manganese
	%	%	%	%
Special	1·5/4·0	·03/·05	·5/1·2	1·0/1·5

HEMATITE

Grades	Silicon	Sulphur	Phosphorus	Manganese
	%	%	%	%
B.S. Hematite No. 1	2·0/3·5	·02/·03	·04/·05	1·0/1·25 or 1·25/1·5
B.S. Hematite No. 2	1·5/3·5	·03/·05	·04/·05	
B.S. Hematite No. 3	1·5/3·5	·05/·07	·04/·05	
B.S. Hematite Silicious	3·5/4·0	·02/·035	·04/·05	
B.S. Hematite Silicious	4·0/5·0	·02/·03	·04/·05	

BASIC

	%	%	%	%
Basic	·50/1·3	·04/·08	·5/1·5	1·0/1·5

FERRO-MANGANESE

Manganese	Carbon	Iron	Silicon	Sulphur	Phosphorus	Copper	Arsenic
%	%	%	%	%	%	%	%
76/80	6·8	14·0	1·0	·02	·25	·03	·025

RAW MATERIALS

Brickworks

At the Newfield Brickworks, County Durham the Company manufacture Silica, Fireclay and Basic Refractory Products including the following:

SILICA BRICKS FOR OPEN HEARTH FURNACES

SPECIAL QUALITY LADLE FIREBRICKS AS USED IN THE COMPANY'S OWN WORKS

FIRECLAY

CHEMICALLY BONDED CHROME MAGNESITE BRICKS (METAL CLAD AND UNCLAD)

CHROME ORE PASTE

CHROME MAGNESITE PASTE

Lackenby Works

GROUND BASIC SLAG FOR FERTILIZING

Blast Furnace Slag

CRUSHED SLAG IN VARYING SIZES FOR ROADMAKING, CONCRETING, FILTER MEDIA, RAIL BALLAST AND FILL

By-Products

Port Clarence works is the largest tar distillation and benzole rectification plant in the North East and one of the most modern in the U.K. Crude tar and crude benzole from the company's South Bank and Cleveland ovens, together with supplies of crude tars and intermediate benzoles from other sources are treated in this central refinery to produce a variety of products of which the following is a selection. All the raw materials result from the carbonisation at high temperatures of Durham coal, and because of their highly aromatic characteristics are excellent raw materials for the production of pure chemicals. Facilities for export shipments in bulk of solid and liquid cargoes are available.

ACENAPHTHENE	90% purity, for dyestuffs, plastics, drugs and perfumes.
ANTHRACENE 40%	Dyestuffs.
ANTHRACENE OIL	All grades to suit buyers' requirements.
BENZOLES, PURE & MOTOR	N.B.A. Specifications.
CLARENITE, BLACK BITUMINOUS PAINT	Anti-corrosive for all steel structures.
CREOSOTE OIL	For timber preservation. All international specifications.
CRUDE TAR ACIDS	Source of phenols, cresols.
78° NAPHTHALENE	For dyestuffs, plastics.
PITCH	For briquetting, water proofing —to required specifications.
PITCH, ELECTRODE QUALITY	Use in aluminium making.
THERMOPLASTIC RESINS	Coumarone indene and coumarone styrene in wide range of melting points for floor tile, rubber and paint industries.
TOLUENE, XYLENE & SPECIAL AROMATIC SOLVENTS OF ALL GRADES.	
ROAD TAR	To B.S. Specification.

Transport Facilities

ROAD AND RAIL

All the Company's Works are rail connected with the exception of Newfield Brickworks, and the Aycliffe Plastic Coated Sheet Factory. Facilities for direct loading to road vehicles have been included as a matter of course in all post-war development and in older premises wherever it has been possible.

SHIPPING

The Port of Middlesbrough has excellent facilities for Export shipments, either from Middlesbrough Dock, the new Lackenby Deepwater quays or the public and private River Tees Wharves.

There are sailings to most parts of the World, including regular berthing of liners to:

Mediterranean
Persian Gulf
India and Pakistan
China and Far East
Australia and New Zealand
South and East Africa
Canada and U.S.A.
North and South America

with weekly services to Holland and Belgium and frequent sailings to other European and Scandinavian ports.

A regular coasting service to the Thames is available by vessels capable of carrying lengths up to 95 ft. for delivery to any point in the London area or to vessels loading in London for overseas. Also weekly vessel for direct Belfast discharge. Shipments can be arranged to all other U.K. discharging ports.

The Company has well equipped Wharves on the south bank of the Tees at Redcar, South Bank and Britannia for the shipment of steel; also oil and ore discharging berths at South Bank Wharf equipped with modern facilities for the quick handling of vessels of up to 660 ft. length and 30 ft. loaded draft.

The Company's Clarence Wharf on the north bank of the Tees is available for the discharge and shipment of general goods, with open storage for up to 3,000 tons of material. A large tank installation is also operated for the storage and shipment, in bulk, of creosote oil and refined tar by ocean-going vessels accommodated alongside.

Central Research Department

Economic conditions of operation in iron and steel manufacture call for high technical efficiency. The demands of rapidly changing practice, and the insistence on higher qualities of steels used for many purposes, together with the need of increased outputs, enhance the importance of research work in the iron and steel industry.

Dorman Long recognise that the required technical skill can only be forthcoming by ample provision of research facilities, which are being continually expanded. While each constituent Works of the Company has its own laboratories dealing with incoming raw materials and the Company's products, the Central Research Laboratories are equipped with more advanced forms of scientific instruments and equipment to enable them to deal with long term metallurgical problems, the development of new materials and processes, and special service work for the Company. The laboratories are equipped with apparatus for x-ray crystallography, metallography, petrology, and with many other types of equipment for the study of ores, slags, and refractory materials, including various types of furnace for work at high temperatures. Constant attention is given to new methods of analysis in which the latest instrumental techniques may be used, and to new methods for the examination of iron and steel products. The activities of the Central Research Department also include welding research, non-destructive testing, and testing at elevated temperatures. Close liaison with B.I.S.R.A., B.W.R.A., B.C.I.R.A., D.S.I.R., and other major research organisations is maintained, and development work is also carried out in conjunction with the British Standards Institution and the International Standards Organisation.

TESTING MACHINES

In addition to the usual works testing equipment there is at Britannia Works a 1,250-ton universal testing machine served by a 30-ton overhead electric crane.

Full-size girders and stanchions, as well as specimens, can be tested, to destruction if required. The maximum dimensions of the pieces which can be handled are as follows:

Tensile Tests:	Specimens up to 6" diameter and flat bars up to 11" × 5" in cross section. Maximum length 50 feet.
Compression Tests:	Stanchions up to 3' 9" square cross section and up to 50 feet long with either free or fixed ends.
Bending Tests:	Girders up to 20 feet span and 3' 6" wide and any reasonable depth.

In addition to testing for their own departments, the Company is prepared to carry out tests on full-size members to the requirements and instructions of clients.

Recent tests carried out to client's requirements include:

(1) Ladle crane hooks
(2) Lifting gear
(3) Welded girders
(4) Proof loading of girders, etc.
(5) Testing to destruction of 15" diameter pipes
(6) Crushing strength of concrete blocks
(7) Wide plate brittle fracture tests
(8) High tensile bridge wire, proof testing, and tests to destruction

Rail and road access to the test house is available and test pieces can be handled direct from truck by the 30-ton crane.

Enquiries as to terms and conditions of this service can be obtained from Britannia Works, Middlesbrough.

Bridge Department

Dorman Long maintain a separate department for the execution of bridge and other contracts involving erection or civil engineering work at home and abroad. This department undertakes contracts of any size, in any part of the world, involving fabricated steelwork. The department maintains a fully trained staff for the design of bridges and other structures and their foundations, and is prepared to submit designs and estimates, or to prepare quotations to customers' own designs.

The department carries an extensive range of plant and erection equipment.

The work undertaken comprises bridge foundations of all kinds, including air pressure work, the driving of steel sheet and bearing piles, shuttering for and emplacement of mass and reinforced concrete and masonry work, and the construction of steel jetties. All types of steel bridges are constructed, including movable spans, and the erection of customers' steelwork is also undertaken, whether such steelwork is supplied by the Company or not.

The department has also specialized in carrying out bridge contracts in this country for railway and highway authorities in which rapid replacement of structures under traffic is involved. Major contracts carried out by the department as Main Contractors or Sub-Contractors either alone or in association with others include:

UNITED KINGDOM:

- Lambeth Bridge, London
- Putney Bridge, London
- New Tyne Bridge, Newcastle
- Craigavon Bridge, Londonderry
- Menai Bridge, North Wales
- Tees-Newport Bridge, Middlesbrough
- Runcorn-Widnes Bridge
- Thelwall Viaduct Lancs. Superstructure
- Forth Road Bridge, Superstructure
- Severn Road Bridge Superstructure (Under Construction)
- Tay Road Bridge Superstructure (Under Construction)
- Grosvenor Railway Bridge, London, Superstructure (Under Construction)

ABROAD:

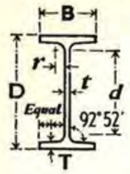
- Sydney Harbour Bridge, N.S.W.
- Khartoum-Omdurman Bridge, Sudan
- Dessouk Bridge, Egypt
- Khedive Ismail Bridge, Egypt
- Kafr el Zayat Bridge, Egypt
- Limpopo Bridge, Rhodesia
- Birchenough Bridge, Rhodesia
- Otto Beit Bridge, Rhodesia
- Storstrom Bridge, Denmark
- Bangkok Memorial Bridge, Thailand
- Vila Franca Bridge, Portugal
- Cross River Bridge, Nigeria
- Hindiya Highway Bridge, Iraq
- Nasiriyah Road Bridge, Iraq
- Qurnah Highway Bridge, Iraq
- Volta River Bridge, Ghana
- Klang Bridge, Malaya
- Rohri Channel Bridge, Pakistan
- Auckland Harbour Bridge, New Zealand

PART II

Dimensions and Properties

(ENGLISH UNITS)

of



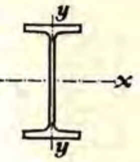
UNIVERSAL BEAMS

DIMENSIONS AND PROPERTIES

Serial Size	Weight per foot	Depth of Section D	Width of Section B	Thickness		Root Radius r	Depth between Fillets d	Area of Section
				Web t	Flange T			
ins	lbs	ins	ins	ins	ins	ins	ins	ins^2
36×16½	260	36·24	16·555	·845	1·440	·95	31·16	76·56
	230	35·88	16·475	·765	1·260	·95	31·16	67·73
36×12	194	36·48	12·117	·770	1·260	·75	32·25	57·11
	170	36·16	12·027	·680	1·100	·75	32·25	49·98
	150	35·84	11·972	·625	·940	·75	32·25	44·16
	135	35·55	11·944	·597	·795	·75	32·25	39·69
33×11½	152	33·50	11·565	·635	1·055	·70	29·79	44·71
	130	33·10	11·510	·580	·855	·70	29·79	38·26
	118	32·87	11·482	·552	·740	·70	29·79	34·69
30×10½	132	30·30	10·551	·615	1·000	·65	26·81	38·83
	116	30·00	10·500	·564	·850	·65	26·81	34·13
	99	29·68	10·444	·508	·690	·65	26·81	29·11
27×10	114	27·28	10·070	·570	·932	·60	24·04	33·53
	102	27·07	10·018	·518	·827	·60	24·04	30·01
	94	26·91	9·990	·490	·747	·60	24·04	27·65
	84	26·69	9·962	·462	·637	·60	24·04	24·71
24×12	160	24·92	12·264	·732	1·235	·65	20·93	47·05
	120	24·31	12·088	·556	·930	·65	20·93	35·29
	100	24·00	12·000	·468	·775	·65	20·93	29·43
24× 9	94	24·29	9·061	·516	·872	·50	21·38	27·63
	84	24·09	9·015	·470	·772	·50	21·38	24·71
	76	23·91	8·985	·440	·682	·50	21·38	22·37
	68	23·71	8·961	·416	·582	·50	21·38	20·00
21×13	142	21·46	13·132	·659	1·095	·65	17·72	41·78
	127	21·24	13·061	·588	·985	·65	17·72	37·38
	112	21·00	13·000	·527	·865	·65	17·72	32·97
21× 8¼	82	21·44	8·342	·502	·840	·50	18·61	24·12
	73	21·24	8·295	·455	·740	·50	18·61	21·46
	68	21·13	8·270	·430	·685	·50	18·61	20·02
	62	20·99	8·240	·400	·615	·50	18·61	18·23
	55	20·80	8·216	·376	·520	·50	18·61	16·17
18× 7½	66	18·40	7·592	·450	·770	·40	15·92	19·40
	60	18·25	7·558	·416	·695	·40	15·92	17·64
	55	18·12	7·532	·390	·630	·40	15·92	16·19
	50	18·00	7·500	·358	·570	·40	15·92	14·71
	45	17·86	7·476	·334	·500	·40	15·92	13·23

NOTE: These tables are based on Universal Beams with a flange taper of 5% (2° 52′).

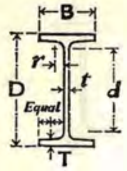
UNIVERSAL BEAMS



DIMENSIONS AND PROPERTIES

Serial Size	Moment of Inertia			Radius of Gyration		Elastic Modulus		Ratio $\frac{D}{T}$
	Axis x-x		Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	
	Gross	Net						
ins	ins^4	ins^4	ins^4	ins	ins	ins^3	ins^3	
36×16½	17234	15598	1021	15·00	3·65	951·1	123·3	25·2
	14988	13572	870·9	14·88	3·59	835·5	105·7	28·5
36×12	12103	10637	355·4	14·56	2·49	663·6	58·7	29·0
	10470	9202·0	300·6	14·47	2·45	579·1	50·0	32·9
	9012·1	7938·5	250·4	14·29	2·38	502·9	41·8	38·1
	7801·3	6900·9	207·4	14·02	2·29	438·9	34·7	44·7
33×11½	8147·6	7626·8	256·1	13·50	2·39	486·4	44·3	31·8
	6699·0	6282·2	201·4	13·23	2·29	404·8	35·0	38·7
	5896·0	5537·9	170·8	13·04	2·22	358·7	29·8	44·4
30×10½	5753·1	5350·5	185·0	12·17	2·18	379·7	35·1	30·3
	4919·1	4580·4	153·2	12·00	2·12	327·9	29·2	35·3
	4049·1	3777·2	120·2	11·79	2·03	272·8	23·0	43·0
27×10	4080·5	3777·1	149·6	11·03	2·11	299·2	29·7	29·3
	3604·1	3337·0	129·5	10·96	2·08	266·3	25·9	32·7
	3266·8	3027·1	115·1	10·87	2·04	242·8	23·0	36·0
	2827·7	2625·0	95·9	10·70	1·97	211·9	19·3	41·9
24×12	4979·2	4329·1	359·7	10·29	2·77	399·6	58·7	20·2
	3635·3	3158·5	254·0	10·15	2·68	299·1	42·0	26·1
	2987·3	2595·2	203·6	10·08	2·63	248·9	33·9	31·0
24× 9	2683·0	2458·7	102·2	9·85	1·92	220·9	22·6	27·9
	2364·3	2167·5	88·3	9·78	1·89	196·3	19·6	31·2
	2096·4	1923·9	76·5	9·68	1·85	175·4	17·0	35·1
	1815·1	1669·1	63·9	9·53	1·79	153·1	14·3	40·7
21×13	3403·9	2977·7	386·0	9·03	3·04	317·2	58·8	19·6
	3018·0	2638·8	338·6	8·99	3·01	284·2	51·8	21·6
	2621·4	2292·4	289·7	8·92	2·96	249·7	44·6	24·3
21× 8¼	1827·8	1660·6	77·1	8·70	1·79	170·5	18·5	25·5
	1600·3	1454·5	66·2	8·64	1·76	150·7	16·0	28·7
	1478·3	1344·0	60·4	8·59	1·74	139·9	14·6	30·8
	1326·8	1207·1	53·1	8·53	1·71	126·4	12·9	34·1
	1137·9	1037·6	43·9	8·39	1·65	109·4	10·7	40·0
18× 7½	1096·8	984·5	53·2	7·52	1·66	119·2	14·0	23·9
	984·0	883·5	47·1	7·47	1·63	107·8	12·5	26·3
	889·9	799·5	42·0	7·41	1·61	98·2	11·1	28·8
	800·6	719·4	37·2	7·38	1·59	89·0	9·91	31·6
	704·8	634·2	31·9	7·30	1·55	78·9	8·54	35·7

NOTE: One hole is deducted from each flange under 12 inches wide (serial size) and two holes from each flange 12 inches and over (serial size), in calculating the Net Moment of Inertia about x-x.



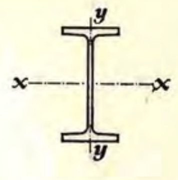
UNIVERSAL BEAMS

DIMENSIONS AND PROPERTIES

Serial Size	Weight per foot	Depth of Section **D**	Width of Section **B**	Thickness		Root Radius *r*	Depth between Fillets *d*	Area of Section
				Web *t*	Flange **T**			
ins	*lbs*	*ins*	*ins*	*ins*	*ins*	*ins*	*ins*	*ins*^{2}
18×6	55	18·31	6·042	·420	·744	·40	15·92	16·18
	50	18·16	6·011	·389	·669	·40	15·92	14·71
	45	18·00	5·982	·360	·589	·40	15·92	13·22
16×7	50	16·25	7·073	·380	·628	·40	14·07	14·70
	45	16·12	7·039	·346	·563	·40	14·07	13·24
	40	16·00	7·000	·307	·503	·40	14·07	11·77
	36	15·85	6·992	·299	·428	·40	14·07	10·59
16×6	50	16·39	6·052	·399	·711	·40	14·07	14·70
	45	16·23	6·021	·368	·631	·40	14·07	13·23
	40	16·06	5·993	·340	·546	·40	14·07	11·76
16×5½	31	15·84	5·605	·272	·440	·40	14·07	9·12
	26	15·64	5·582	·249	·340	·40	14·07	7·64
15×6	45	15·30	6·075	·381	·640	·40	13·12	13·24
	40	15·15	6·038	·344	·565	·40	13·12	11·77
	35	15·00	6·000	·306	·490	·40	13·12	10·29
14×6¾	45	14·33	6·820	·357	·618	·40	12·17	13·23
	38	14·12	6·776	·313	·513	·40	12·17	11·17
	34	14·00	6·750	·287	·453	·40	12·17	10·00
	30	13·86	6·733	·270	·383	·40	12·17	8·81
14×5	26	13·89	4·960	·257	·420	·40	12·17	7·64
	22	13·72	4·936	·233	·335	·40	12·17	6·47
12×6½	36	12·24	6·565	·305	·540	·35	10·34	10·59
	31	12·09	6·525	·265	·465	·35	10·34	9·12
	27	11·96	6·500	·240	·400	·35	10·34	7·97
12×5	32	12·22	4·930	·350	·551	·35	10·34	9·42
	28	12·07	4·893	·313	·476	·35	10·34	8·23
	25	11·96	4·864	·284	·421	·35	10·34	7·35
12×4	22	12·31	4·030	·260	·424	·30	10·84	6·47
	19	12·16	4·010	·240	·349	·30	10·84	5·62
	16·5	12·00	4·000	·230	·269	·30	10·84	4·86
10×5¾	29	10·22	5·799	·289	·500	·30	8·51	8·53
	25	10·08	5·762	·252	·430	·30	8·51	7·35
	21	9·90	5·750	·240	·340	·30	8·51	6·19
10×4	19	10·25	4·020	·250	·394	·30	8·84	5·61
	17	10·12	4·010	·240	·329	·30	8·84	4·98
	15	10·00	4·000	·230	·269	·30	8·84	4·40
8×5¼	20	8·14	5·268	·248	·378	·30	6·69	5·88
	17	8·00	5·250	·230	·308	·30	6·69	5·00

NOTE: These tables are based on Universal Beams with a flange taper of 5% (2° 52′) except for serial sizes 12×4 and 10×4 for which the flange taper is 2% (1° 9′).

UNIVERSAL BEAMS



DIMENSIONS AND PROPERTIES

Serial Size	Moment of Inertia			Radius of Gyration		Elastic Modulus		Ratio $\frac{\mathbf{D}}{\mathbf{T}}$
	Axis *x-x*		Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	
	Gross	Net						
ins	*ins*^{4}	*ins*^{4}	*ins*^{4}	*ins*	*ins*	*ins*^{3}	*ins*^{3}	
18×6	868·7	775·4	26·3	7·33	1·27	94·9	8·70	24·6
	777·9	694·7	23·1	7·27	1·25	85·7	7·69	27·1
	685·2	612·7	19·9	7·20	1·23	76·1	6·66	30·6
16×7	655·4	583·5	34·8	6·68	1·54	80·7	9·84	25·9
	583·3	519·4	30·5	6·64	1·52	72·4	8·66	28·6
	515·5	458·9	26·5	6·62	1·50	64·4	7·58	31·8
	446·3	398·6	22·1	6·49	1·45	56·3	6·34	37·0
16×6	647·2	576·1	25·1	6·64	1·31	79·0	8·31	23·1
	571·8	509·3	21·8	6·57	1·28	70·5	7·25	25·7
	495·4	442·0	18·5	6·49	1·25	61·7	6·16	29·4
16×5½	374·9	332·5	12·0	6·41	1·15	47·3	4·29	36·0
	298·1	265·8	8·96	6·25	1·08	38·1	3·21	46·0
15×6	511·2	455·3	22·7	6·21	1·31	66·8	7·49	23·9
	447·6	398·8	19·6	6·17	1·29	59·1	6·48	26·8
	385·5	343·6	16·5	6·12	1·26	51·4	5·49	30·6
14×6¾	468·1	413·6	30·7	5·95	1·52	65·3	9·01	23·2
	385·3	340·8	24·6	5·87	1·49	54·6	7·28	27·5
	339·2	300·2	21·3	5·83	1·46	48·5	6·30	30·9
	289·6	257·0	17·5	5·73	1·41	41·8	5·21	36·2
14×5	241·6	210·6	8·00	5·62	1·02	34·8	3·23	33·1
	196·2	171·8	6·17	5·51	·98	28·6	2·50	41·0
12×6½	280·8	246·1	23·7	5·15	1·50	45·9	7·23	22·7
	238·4	208·9	19·8	5·11	1·47	39·4	6·07	26·0
	204·2	179·1	16·6	5·06	1·44	34·1	5·11	29·9
12×5	227·9	197·4	10·52	4·92	1·06	37·3	4·27	22·2
	195·2	169·2	8·81	4·87	1·03	32·3	3·60	25·4
	171·6	148·8	7·59	4·83	1·02	28·7	3·12	28·4
12×4	155·7	135·1	4·55	4·91	·84	25·3	2·26	29·0
	130·1	113·4	3·67	4·81	·81	21·4	1·83	34·8
	105·3	92·5	2·79	4·65	·76	17·5	1·39	44·6
10×5¾	157·3	138·1	15·2	4·29	1·34	30·8	5·25	20·4
	133·2	116·9	12·7	4·26	1·31	26·4	4·40	23·4
	106·3	93·7	9·74	4·14	1·25	21·5	3·39	29·1
10×4	96·2	83·0	4·19	4·14	·86	18·8	2·08	26·0
	81·8	70·9	3·45	4·05	·83	16·2	1·72	30·8
	68·8	60·0	2·79	3·95	·80	13·8	1·39	37·2
8×5¼	69·2	59·9	8·50	3·43	1·20	17·0	3·23	21·5
	56·4	49·0	6·72	3·36	1·16	14·1	2·56	26·0

NOTE: One hole is deducted from each flange in calculating the Net Moment of Inertia about *x-x*.

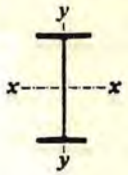
UNIVERSAL BEAMS

PLASTIC MODULI—MAJOR AXIS

Serial Size	Weight per foot	Plastic Modulus Axis x-x	Reduced Values of Plastic Modulus under Axial Load		
			Lower Values of n	Change formula at n =	Higher Values of n
ins	*lbs*	*ins*^{3}	*ins*^{3}		*ins*^{3}
36×16½	260	1076	1076 − 1734 n^2	·367	89·12 (1−n) (14·57+n)
	230	942·5	942·5 − 1499 n^2	·376	71·01 (1−n) (16·11+n)
36×12	194	766·8	766·8 − 1059 n^2	·457	67·82 (1−n) (14·36+n)
	170	667·0	667·0 − 918·4 n^2	·461	52·45 (1−n) (16·23+n)
	150	580·0	580·0 − 780·0 n^2	·480	41·50 (1−n) (18·07+n)
	135	509·2	509·2 − 659·8 n^2	·510	33·80 (1−n) (19·87+n)
33×11½	152	558·0	558·0 − 787·0 n^2	·445	43·77 (1−n) (16·11+n)
	130	465·9	465·9 − 631·0 n^2	·475	32·26 (1−n) (18·63+n)
	118	414·7	414·7 − 545·2 n^2	·498	26·88 (1−n) (20·21+n)
30×10½	132	436·7	436·7 − 612·9 n^2	·447	36·24 (1−n) (15·23+n)
	116	377·5	377·5 − 516·3 n^2	·467	28·08 (1−n) (17·23+n)
	99	315·1	315·1 − 417·1 n^2	·493	20·79 (1−n) (19·78+n)
27×10	114	342·7	342·7 − 493·1 n^2	·431	28·20 (1−n) (15·22+n)
	102	304·5	304·5 − 434·7 n^2	·438	22·67 (1−n) (16·91+n)
	94	277·8	277·8 − 390·1 n^2	·450	19·19 (1−n) (16·39+n)
	84	243·3	243·3 − 330·4 n^2	·474	15·71 (1−n) (19·98+n)
24×12	160	454·4	454·4 − 756·0 n^2	·348	45·61 (1−n) (11·85+n)
	120	336·3	336·3 − 560·0 n^2	·353	26·30 (1−n) (15·31+n)
	100	278·4	278·4 − 462·7 n^2	·356	18·50 (1−n) (18·09+n)
24× 9	94	252·7	252·7 − 369·9 n^2	·420	21·33 (1−n) (14·73+n)
	84	224·1	224·1 − 324·8 n^2	·428	17·24 (1−n) (16·27+n)
	76	200·3	200·3 − 284·3 n^2	·442	14·37 (1−n) (17·61+n)
	68	175·6	175·6 − 240·4 n^2	·468	11·41 (1−n) (19·78+n)
21×13	142	356·9	356·9 − 662·2 n^2	·303	33·68 (1−n) (12·31+n)
	127	318·1	318·1 − 594·1 n^2	·302	27·03 (1−n) (13·68+n)
	112	278·3	278·3 − 515·7 n^2	·307	21·25 (1−n) (15·29+n)
21× 8¼	82	195·2	195·2 − 289·7 n^2	·411	17·40 (1−n) (13·86+n)
	73	172·1	172·1 − 253·0 n^2	·418	14·03 (1−n) (15·24+n)
	68	159·6	159·6 − 233·0 n^2	·423	12·43 (1−n) (16·02+n)
	62	144·1	144·1 − 207·7 n^2	·432	10·34 (1−n) (17·51+n)
	55	125·2	125·2 − 173·7 n^2	·458	8·162 (1−n) (19·60+n)
18× 7½	66	136·0	136·0 − 209·1 n^2	·390	12·56 (1−n) (13·21+n)
	60	122·8	122·8 − 187·0 n^2	·397	10·27 (1−n) (14·67+n)
	55	111·7	111·7 − 168·0 n^2	·405	8·857 (1−n) (15·56+n)
	50	100·9	100·9 − 151·1 n^2	·409	7·500 (1−n) (16·65+n)
	45	89·6	89·6 − 131·0 n^2	·425	5·971 (1−n) (18·79+n)

Let p = mean axial stress,
Ys = yield stress;
then $n = \frac{p}{Ys}$

UNIVERSAL BEAMS



PLASTIC MODULI—MINOR AXIS

Serial Size	Weight per foot	Plastic Modulus Axis y-y	Reduced Values of Plastic Modulus under Axial Load		
			Lower Values of n	Change formula at n =	Higher Values of n
ins	*lbs*	*ins*^{3}	*ins*^{3}		*ins*^{3}
36×16½	260	195·6	195·6 − 40·43 n^2	·400	471·5 (1−n) (0·269+n)
	230	168·2	168·2 − 31·96 n^2	·405	417·2 (1−n) (0·252+n)
36×12	194	94·7	94·7 − 22·35 n^2	·492	302·6 (1−n) (0·089+n)
	170	80·7	80·7 − 17·27 n^2	·492	263·0 (1−n) (0·081+n)
	150	67·8	67·8 − 13·60 n^2	·507	236·8 (1−n) (0·044+n)
	135	56·9	56·9 − 11·08 n^2	·535	222·6 (1−n) (n−0·016)
33×11½	152	71·2	71·2 − 14·92 n^2	·476	219·7 (1−n) (0·113+n)
	130	56·7	56·7 − 11·06 n^2	·502	195·0 (1−n) (0·053+n)
	118	48·6	48·6 − 9·16 n^2	·523	182·5 (1−n) (0·007+n)
30×10½	132	56·4	56·4 − 12·44 n^2	·480	174·9 (1−n) (0·109+n)
	116	47·2	47·2 − 9·71 n^2	·496	157·2 (1−n) (0·070+n)
	99	37·5	37·5 − 7·14 n^2	·518	138·0 (1−n) (0·018+n)
27×10	114	47·6	47·6 − 10·30 n^2	·464	140·0 (1−n) (0·141+n)
	102	41·5	41·5 − 8·32 n^2	·467	125·3 (1−n) (0·128+n)
	94	37·1	37·1 − 7·10 n^2	·477	116·8 (1−n) (0·104+n)
	84	31·3	31·3 − 5·72 n^2	·499	107·6 (1−n) (0·055+n)
24×12	160	92·9	92·9 − 22·21 n^2	·388	210·7 (1−n) (0·306+n)
	120	66·6	66·6 − 12·81 n^2	·383	154·1 (1−n) (0·298+n)
	100	54·0	54·0 − 9·02 n^2	·382	126·6 (1−n) (0·291+n)
24× 9	94	36·1	36·1 − 7·86 n^2	·454	102·5 (1−n) (0·162+n)
	84	31·4	31·4 − 6·34 n^2	·458	91·72 (1−n) (0·147+n)
	76	27·4	27·4 − 5·23 n^2	·470	84·23 (1−n) (0·118+n)
	68	23·1	23·1 − 4·22 n^2	·493	77·73 (1−n) (0·067+n)
21×13	142	92·6	92·6 − 20·34 n^2	·338	185·5 (1−n) (0·397+n)
	127	81·8	81·8 − 16·45 n^2	·334	163·8 (1−n) (0·399+n)
	112	70·5	70·5 − 12·94 n^2	·336	143·4 (1−n) (0·389+n)
21× 8¼	82	29·5	29·5 − 6·78 n^2	·446	80·86 (1−n) (0·182+n)
	73	25·5	25·5 − 5·42 n^2	·450	71·87 (1−n) (0·167+n)
	68	23·4	23·4 − 4·74 n^2	·454	67·29 (1−n) (0·156+n)
	62	20·7	20·7 − 3·96 n^2	·461	61·50 (1−n) (0·138+n)
	55	17·3	17·3 − 3·14 n^2	·484	56·28 (1−n) (0·086+n)
18× 7½	66	22·3	22·3 − 5·11 n^2	·427	57·41 (1−n) (0·222+n)
	60	19·9	19·9 − 4·26 n^2	·430	52·46 (1−n) (0·209+n)
	55	17·8	17·8 − 3·62 n^2	·436	48·28 (1−n) (0·192+n)
	50	15·8	15·8 − 3·01 n^2	·438	43·52 (1−n) (0·184+n)
	45	13·7	13·7 − 2·45 n^2	·451	39·81 (1−n) (0·154+n)

NOTE: For explanation of tables, see notes on pages 164 – 166.

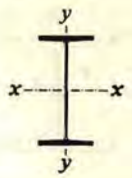
UNIVERSAL BEAMS

PLASTIC MODULI—MAJOR AXIS

Serial Size	Weight per foot	Plastic Modulus Axis x-x	Reduced Values of Plastic Modulus under Axial Load		
			Lower Values of n	Change formula at n =	Higher Values of n
ins	*lbs*	*ins*^{3}	*ins*^{3}		*ins*^{3}
18×6	55	109·7	$109{\cdot}7 - 155{\cdot}8\,n^2$	·436	$10{\cdot}91\,(1-n)\,(12{\cdot}57+n)$
	50	98·9	$98{\cdot}9 - 139{\cdot}0\,n^2$	·444	$9{\cdot}085\,(1-n)\,(13{\cdot}70+n)$
	45	87·8	$87{\cdot}8 - 121{\cdot}5\,n^2$	·457	$7{\cdot}401\,(1-n)\,(15{\cdot}08+n)$
16×7	50	91·6	$91{\cdot}6 - 142{\cdot}2\,n^2$	·387	$7{\cdot}736\,(1-n)\,(14{\cdot}44+n)$
	45	82·0	$82{\cdot}0 - 126{\cdot}7\,n^2$	·391	$6{\cdot}345\,(1-n)\,(15{\cdot}82+n)$
	40	72·7	$72{\cdot}7 - 112{\cdot}8\,n^2$	·390	$5{\cdot}096\,(1-n)\,(17{\cdot}48+n)$
	36	63·8	$63{\cdot}8 - 93{\cdot}78\,n^2$	·422	$4{\cdot}114\,(1-n)\,(19{\cdot}40+n)$
16×6	50	90·7	$90{\cdot}7 - 135{\cdot}4\,n^2$	·405	$9{\cdot}004\,(1-n)\,(12{\cdot}38+n)$
	45	80·8	$80{\cdot}8 - 118{\cdot}9\,n^2$	·415	$7{\cdot}346\,(1-n)\,(13{\cdot}61+n)$
	40	70·7	$70{\cdot}7 - 101{\cdot}6\,n^2$	·432	$5{\cdot}849\,(1-n)\,(15{\cdot}14+n)$
16×5½	31	54·1	$54{\cdot}1 - 76{\cdot}51\,n^2$	·445	$3{\cdot}794\,(1-n)\,(18{\cdot}04+n)$
	26	43·9	$43{\cdot}9 - 58{\cdot}65\,n^2$	·486	$2{\cdot}711\,(1-n)\,(21{\cdot}04+n)$
15×6	45	76·5	$76{\cdot}5 - 115{\cdot}0\,n^2$	·402	$7{\cdot}291\,(1-n)\,(12{\cdot}89+n)$
	40	67·5	$67{\cdot}5 - 100{\cdot}6\,n^2$	·409	$5{\cdot}812\,(1-n)\,(14{\cdot}34+n)$
	35	58·5	$58{\cdot}5 - 86{\cdot}54\,n^2$	·416	$4{\cdot}494\,(1-n)\,(16{\cdot}18+n)$
14×6¾	45	73·9	$73{\cdot}9 - 122{\cdot}6\,n^2$	·353	$6{\cdot}461\,(1-n)\,(13{\cdot}67+n)$
	38	61·5	$61{\cdot}5 - 99{\cdot}66\,n^2$	·366	$4{\cdot}594\,(1-n)\,(16{\cdot}16+n)$
	34	54·5	$54{\cdot}5 - 87{\cdot}11\,n^2$	·374	$3{\cdot}839\,(1-n)\,(17{\cdot}24+n)$
	30	47·1	$47{\cdot}1 - 71{\cdot}87\,n^2$	·401	$2{\cdot}863\,(1-n)\,(20{\cdot}33+n)$
14×5	26	39·8	$39{\cdot}8 - 56{\cdot}82\,n^2$	·437	$3{\cdot}012\,(1-n)\,(16{\cdot}62+n)$
	22	32·8	$32{\cdot}8 - 44{\cdot}91\,n^2$	·468	$2{\cdot}197\,(1-n)\,(19{\cdot}21+n)$
12×6½	36	51·5	$51{\cdot}5 - 91{\cdot}93\,n^2$	·321	$4{\cdot}292\,(1-n)\,(14{\cdot}10+n)$
	31	44·0	$44{\cdot}0 - 78{\cdot}47\,n^2$	·323	$3{\cdot}294\,(1-n)\,(15{\cdot}74+n)$
	27	38·0	$38{\cdot}0 - 66{\cdot}17\,n^2$	·335	$2{\cdot}533\,(1-n)\,(17{\cdot}82+n)$
12×5	32	43·0	$43{\cdot}0 - 63{\cdot}35\,n^2$	·412	$4{\cdot}545\,(1-n)\,(11{\cdot}66+n)$
	28	37·2	$37{\cdot}2 - 54{\cdot}12\,n^2$	·421	$3{\cdot}511\,(1-n)\,(13{\cdot}15+n)$
	25	32·9	$32{\cdot}9 - 47{\cdot}51\,n^2$	·428	$2{\cdot}824\,(1-n)\,(14{\cdot}55+n)$
12×4	22	29·3	$29{\cdot}3 - 40{\cdot}27\,n^2$	·459	$2{\cdot}619\,(1-n)\,(14{\cdot}21+n)$
	19	24·8	$24{\cdot}8 - 32{\cdot}94\,n^2$	·488	$1{\cdot}995\,(1-n)\,(16{\cdot}14+n)$
	16·5	20·6	$20{\cdot}6 - 25{\cdot}69\,n^2$	·541	$1{\cdot}507\,(1-n)\,(18{\cdot}36+n)$
10×5¾	29	34·6	$34{\cdot}6 - 62{\cdot}94\,n^2$	·311	$3{\cdot}202\,(1-n)\,(12{\cdot}61+n)$
	25	29·6	$29{\cdot}6 - 53{\cdot}59\,n^2$	·316	$2{\cdot}329\,(1-n)\,(14{\cdot}91+n)$
	21	24·1	$24{\cdot}1 - 39{\cdot}91\,n^2$	·357	$1{\cdot}666\,(1-n)\,(17{\cdot}40+n)$
10×4	19	21·5	$21{\cdot}5 - 31{\cdot}44\,n^2$	·421	$1{\cdot}974\,(1-n)\,(13{\cdot}56+n)$
	17	18·6	$18{\cdot}6 - 25{\cdot}87\,n^2$	·454	$1{\cdot}569\,(1-n)\,(15{\cdot}07+n)$
	15	16·0	$16{\cdot}0 - 21{\cdot}06\,n^2$	·493	$1{\cdot}235\,(1-n)\,(16{\cdot}82+n)$
8×5¼	20	19·1	$19{\cdot}1 - 34{\cdot}85\,n^2$	·312	$1{\cdot}601\,(1-n)\,(13{\cdot}95+n)$
	17	15·8	$15{\cdot}8 - 27{\cdot}17\,n^2$	·338	$1{\cdot}242\,(1-n)\,(15{\cdot}10+n)$

Let p = mean axial stress,
Ys = yield stress;
then $n = \frac{p}{Ys}$

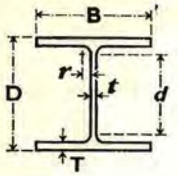
UNIVERSAL BEAMS



PLASTIC MODULI—MINOR AXIS

Serial Size	Weight per foot	Plastic Modulus Axis y-y	Reduced Values of Plastic Modulus under Axial Load		
			Lower Values of n	Change formula at n =	Higher Values of n
ins	*lbs*	*ins*^{3}	*ins*^{3}		*ins*^{3}
18×6	55	14·0	$14{\cdot}0 - 3{\cdot}57\,n^2$	·475	$41{\cdot}41\,(1-n)\,(0{\cdot}131+n)$
	50	12·4	$12{\cdot}4 - 2{\cdot}98\,n^2$	·480	$37{\cdot}81\,(1-n)\,(0{\cdot}115+n)$
	45	10·7	$10{\cdot}7 - 2{\cdot}43\,n^2$	·490	$34{\cdot}40\,(1-n)\,(0{\cdot}089+n)$
16×7	50	15·7	$15{\cdot}7 - 3{\cdot}32\,n^2$	·420	$40{\cdot}12\,(1-n)\,(0{\cdot}229+n)$
	45	13·8	$13{\cdot}8 - 2{\cdot}72\,n^2$	·421	$35{\cdot}80\,(1-n)\,(0{\cdot}221+n)$
	40	12·1	$12{\cdot}1 - 2{\cdot}16\,n^2$	·417	$31{\cdot}43\,(1-n)\,(0{\cdot}223+n)$
	36	10·2	$10{\cdot}2 - 1{\cdot}77\,n^2$	·447	$29{\cdot}39\,(1-n)\,(0{\cdot}159+n)$
16×6	50	13·3	$13{\cdot}3 - 3{\cdot}30\,n^2$	·445	$35{\cdot}68\,(1-n)\,(0{\cdot}192+n)$
	45	11·6	$11{\cdot}6 - 2{\cdot}70\,n^2$	·451	$32{\cdot}29\,(1-n)\,(0{\cdot}172+n)$
	40	9·89	$9{\cdot}89 - 2{\cdot}15\,n^2$	·464	$29{\cdot}15\,(1-n)\,(0{\cdot}140+n)$
16×5½	31	6·90	$6{\cdot}90 - 1{\cdot}31\,n^2$	·472	$21{\cdot}37\,(1-n)\,(0{\cdot}114+n)$
	26	5·24	$5{\cdot}24 - 0{\cdot}93\,n^2$	·510	$18{\cdot}83\,(1-n)\,(0{\cdot}031+n)$
15×6	45	12·0	$12{\cdot}0 - 2{\cdot}86\,n^2$	·440	$31{\cdot}92\,(1-n)\,(0{\cdot}198+n)$
	40	10·4	$10{\cdot}4 - 2{\cdot}29\,n^2$	·443	$28{\cdot}30\,(1-n)\,(0{\cdot}186+n)$
	35	8·79	$8{\cdot}79 - 1{\cdot}77\,n^2$	·446	$24{\cdot}66\,(1-n)\,(0{\cdot}172+n)$
14×6¾	45	14·3	$14{\cdot}3 - 3{\cdot}05\,n^2$	·387	$32{\cdot}95\,(1-n)\,(0{\cdot}298+n)$
	38	11·6	$11{\cdot}6 - 2{\cdot}21\,n^2$	·396	$27{\cdot}93\,(1-n)\,(0{\cdot}271+n)$
	34	10·1	$10{\cdot}1 - 1{\cdot}79\,n^2$	·402	$25{\cdot}02\,(1-n)\,(0{\cdot}254+n)$
	30	8·38	$8{\cdot}38 - 1{\cdot}40\,n^2$	·425	$22{\cdot}49\,(1-n)\,(0{\cdot}203+n)$
14×5	26	5·19	$5{\cdot}19 - 1{\cdot}05\,n^2$	·467	$15{\cdot}63\,(1-n)\,(0{\cdot}129+n)$
	22	4·07	$4{\cdot}07 - 0{\cdot}76\,n^2$	·494	$13{\cdot}67\,(1-n)\,(0{\cdot}067+n)$
12×6½	36	11·4	$11{\cdot}4 - 2{\cdot}29\,n^2$	·353	$24{\cdot}02\,(1-n)\,(0{\cdot}362+n)$
	31	9·60	$9{\cdot}60 - 1{\cdot}72\,n^2$	·351	$20{\cdot}45\,(1-n)\,(0{\cdot}357+n)$
	27	8·12	$8{\cdot}12 - 1{\cdot}33\,n^2$	·360	$17{\cdot}92\,(1-n)\,(0{\cdot}333+n)$
12×5	32	6·86	$6{\cdot}86 - 1{\cdot}81\,n^2$	·454	$18{\cdot}75\,(1-n)\,(0{\cdot}180+n)$
	28	5·79	$5{\cdot}79 - 1{\cdot}40\,n^2$	·459	$16{\cdot}39\,(1-n)\,(0{\cdot}161+n)$
	25	5·02	$5{\cdot}02 - 1{\cdot}13\,n^2$	·462	$14{\cdot}61\,(1-n)\,(0{\cdot}147+n)$
12×4	22	3·61	$3{\cdot}61 - 0{\cdot}85\,n^2$	·495	$11{\cdot}64\,(1-n)\,(0{\cdot}083+n)$
	19	2·94	$2{\cdot}94 - 0{\cdot}65\,n^2$	·519	$10{\cdot}55\,(1-n)\,(0{\cdot}026+n)$
	16·5	2·27	$2{\cdot}27 - 0{\cdot}49\,n^2$	·568	$10{\cdot}01\,(1-n)\,(n-0{\cdot}080)$
10×5¾	29	8·27	$8{\cdot}27 - 1{\cdot}78\,n^2$	·346	$16{\cdot}97\,(1-n)\,(0{\cdot}380+n)$
	25	6·95	$6{\cdot}95 - 1{\cdot}34\,n^2$	·346	$14{\cdot}44\,(1-n)\,(0{\cdot}373+n)$
	21	5·42	$5{\cdot}42 - 0{\cdot}97\,n^2$	·384	$12{\cdot}70\,(1-n)\,(0{\cdot}291+n)$
10×4	19	3·30	$3{\cdot}30 - 0{\cdot}77\,n^2$	·457	$9{\cdot}362\,(1-n)\,(0{\cdot}161+n)$
	17	2·75	$2{\cdot}75 - 0{\cdot}61\,n^2$	·487	$8{\cdot}746\,(1-n)\,(0{\cdot}094+n)$
	15	2·25	$2{\cdot}25 - 0{\cdot}48\,n^2$	·522	$8{\cdot}209\,(1-n)\,(0{\cdot}017+n)$
8×5¼	20	5·11	$5{\cdot}11 - 1{\cdot}06\,n^2$	·343	$10{\cdot}45\,(1-n)\,(0{\cdot}383+n)$
	17	4·09	$4{\cdot}09 - 0{\cdot}78\,n^2$	·368	$9{\cdot}065\,(1-n)\,(0{\cdot}327+n)$

NOTE: For explanation of tables, see notes on pages 164 – 166.



UNIVERSAL COLUMNS

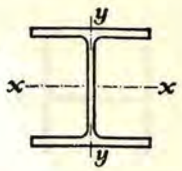
Parallel Flanges

DIMENSIONS AND PROPERTIES

Serial Size	Weight per foot	Depth of Section **D**	Width of Section **B**	Thickness		Root Radius *r*	Depth between Fillets *d*	Area of Section
				Web *t*	Flange **T**			
ins	*lbs*	*ins*	*ins*	*ins*	*ins*	*ins*	*ins*	*ins*²
14×16	426	18·69	16·695	1·875	3·033	·60	11·42	125·25
	370	17·94	16·475	1·655	2·658	·60	11·42	108·78
	314	17·19	16·235	1·415	2·283	·60	11·42	92·30
	264	16·50	16·025	1·205	1·938	·60	11·42	77·63
	228	16·00	15·865	1·045	1·688	·60	11·42	67·06
	193	15·50	15·710	·890	1·438	·60	11·42	56·73
	158	15·00	15·550	·730	1·188	·60	11·42	46·47
Column Core	320	16·81	16·710	1·890	2·093	·60	11·42	94·12
14×14½	136	14·75	14·740	·660	1·063	·60	11·42	39·98
	119	14·50	14·650	·570	·938	·60	11·42	34·99
	103	14·25	14·575	·495	·813	·60	11·42	30·26
	87	14·00	14·500	·420	·688	·60	11·42	25·56
12×12	190	14·38	12·670	1·060	1·736	·60	9·71	55·86
	161	13·88	12·515	·905	1·486	·60	9·71	47·38
	133	13·38	12·365	·755	1·236	·60	9·71	39·11
	106	12·88	12·230	·620	·986	·60	9·71	31·19
	92	12·62	12·155	·545	·856	·60	9·71	27·06
	79	12·38	12·080	·470	·736	·60	9·71	23·22
	65	12·12	12·000	·390	·606	·60	9·71	19·11
10×10	112	11·38	10·415	·755	1·248	·50	7·88	32·92
	89	10·88	10·275	·615	·998	·50	7·88	26·19
	72	10·50	10·170	·510	·808	·50	7·88	21·18
	60	10·25	10·075	·415	·683	·50	7·88	17·66
	49	10·00	10·000	·340	·558	·50	7·88	14·40
8×8	58	8·75	8·222	·510	·808	·40	6·33	17·06
	48	8·50	8·117	·405	·683	·40	6·33	14·11
	40	8·25	8·077	·365	·558	·40	6·33	11·76
	35	8·12	8·027	·315	·493	·40	6·33	10·30
	31	8·00	8·000	·288	·433	·40	6·33	9·12
6×6	25	6·37	6·080	·320	·454	·30	4·86	7·35
	20	6·20	6·018	·258	·369	·30	4·86	5·93
	15·7	6·00	6·000	·240	·269	·30	4·86	4·62

UNIVERSAL COLUMNS

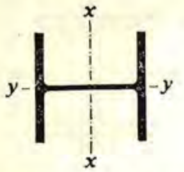
Parallel Flanges



DIMENSIONS AND PROPERTIES

Serial Size	Moment of Inertia			Radius of Gyration		Elastic Modulus		Ratio **D**/**T**
	Axis *x-x*		Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	
	Gross	Net						
ins	*ins*⁴	*ins*⁴	*ins*⁴	*ins*	*ins*	*ins*³	*ins*³	
14×16	6610·3	5904·5	2359·5	7·26	4·34	707·4	282·7	6·2
	5454·2	4866·4	1986·0	7·08	4·27	608·1	241·1	6·7
	4399·4	3920·1	1631·4	6·90	4·20	511·9	201·0	7·5
	3526·0	3138·5	1331·2	6·74	4·14	427·4	166·1	8·5
	2942·4	2616·8	1124·8	6·62	4·10	367·8	141·8	9·5
	2402·4	2134·9	930·1	6·51	4·05	310·0	118·4	10·8
	1900·6	1687·6	745·0	6·40	4·00	253·4	95·8	12·6
Column Core	4141·7	3713·8	1635·1	6·63	4·17	492·8	195·7	8·0
14×14½	1593·0	1405·9	567·8	6·31	3·77	216·0	77·0	13·9
	1373·1	1211·1	491·8	6·26	3·75	189·4	67·1	15·5
	1165·8	1028·0	419·7	6·21	3·72	163·6	57·6	17·5
	966·9	852·5	349·7	6·15	3·70	138·1	48·2	20·3
12×12	1892·6	1630·8	589·7	5·82	3·25	263·2	93·1	8·3
	1541·9	1326·9	486·3	5·70	3·20	222·2	77·7	9·3
	1221·3	1049·8	389·9	5·59	3·16	182·5	63·1	10·8
	930·7	799·6	300·9	5·46	3·11	144·5	49·2	13·1
	788·9	677·6	256·4	5·40	3·08	125·0	42·2	14·7
	663·1	569·4	216·4	5·34	3·05	107·1	35·8	16·8
	533·4	458·0	174·6	5·28	3·02	88·0	29·1	20·0
10×10	718·7	658·3	235·4	4·67	2·67	126·3	45·2	9·1
	542·4	496·6	180·6	4·55	2·63	99·7	35·2	10·9
	420·7	385·0	141·8	4·46	2·59	80·1	27·9	13·0
	343·7	314·3	116·5	4·41	2·57	67·1	23·1	15·0
	272·9	249·6	93·0	4·35	2·54	54·6	18·6	17·9
8×8	227·3	203·4	74·9	3·65	2·10	52·0	18·2	10·8
	183·7	164·1	60·9	3·61	2·08	43·2	15·0	12·4
	146·3	130·8	49·0	3·53	2·04	35·5	12·1	14·8
	126·5	113·0	42·5	3·50	2·03	31·1	10·6	16·5
	109·7	98·1	37·0	3·47	2·01	27·4	9·24	18·5
6×6	53·3	46·8	17·0	2·69	1·52	16·7	5·60	14·0
	41·9	36·8	13·4	2·66	1·50	13·5	4·46	16·8
	30·3	26·7	9·69	2·56	1·45	10·1	3·23	22·3

NOTE: One hole is deducted from each flange under 12 inches wide and two holes from each flange 12 inches and over, in calculating the Net Moment of Inertia about *x-x*.



UNIVERSAL COLUMNS

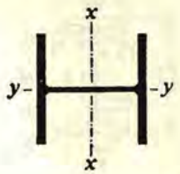
Parallel Flanges

PLASTIC MODULI—MAJOR AXIS

Serial Size	Weight per foot	Plastic Modulus Axis *x-x*	Reduced Values of Plastic Modulus under Axial Load		
			Lower Values of *n*	Change formula at *n* =	Higher Values of *n*
ins	*lbs*	*ins*³	*ins*³		*ins*³
14×16	426	869·4	869·4 — 2092 n^2	·189	235·0 (1 − n) (3·981 + n)
	370	737·1	737·1 — 1788 n^2	·192	179·6 (1 − n) (4·432 + n)
	314	610·8	610·8 — 1505 n^2	·193	131·3 (1 − n) (5·044 + n)
	264	502·2	502·2 — 1250 n^2	·196	93·98 (1 − n) (5·815 + n)
	228	426·8	426·8 — 1076 n^2	·196	70·93 (1 − n) (6·564 + n)
	193	355·0	355·0 — 903·9 n^2	·198	51·27 (1 − n) (7·575 + n)
	158	286·1	286·1 — 739·5 n^2	·198	34·84 (1 − n) (9·003 + n)
Column Core	320	591·9	591·9 — 1172 n^2	·253	132·7 (1 − n) (4·962 + n)
14×14½	136	242·7	242·7 — 605·5 n^2	·208	27·13 (1 − n) (9·868 + n)
	119	211·0	211·0 — 537·0 n^2	·205	20·95 (1 − n) (11·11 + n)
	103	180·9	180·9 — 462·5 n^2	·206	15·72 (1 − n) (12·71 + n)
	87	151·4	151·4 — 388·9 n^2	·207	11·36 (1 − n) (14·74 + n)
12×12	190	311·3	311·3 — 735·9 n^2	·207	61·59 (1 − n) (5·521 + n)
	161	259·1	259·1 — 620·1 n^2	·208	44·88 (1 − n) (6·326 + n)
	133	209·7	209·7 — 506·5 n^2	·210	30·98 (1 − n) (7·445 + n)
	106	163·5	163·5 — 392·3 n^2	·216	19·98 (1 − n) (9·055 + n)
	92	140·3	140·3 — 335·9 n^2	·219	15·02 (1 − n) (10·36 + n)
	79	119·2	119·2 — 286·8 n^2	·220	11·16 (1 − n) (11·88 + n)
	65	97·0	97·0 — 234·1 n^2	·222	7·657 (1 − n) (14·12 + n)
10×10	112	147·5	147·5 — 358·9 n^2	·203	26·10 (1 − n) (6·177 + n)
	89	114·4	114·4 — 278·8 n^2	·208	16·74 (1 − n) (7·509 + n)
	72	90·6	90·6 — 219·9 n^2	·213	11·12 (1 − n) (9·000 + n)
	60	75·0	75·0 — 187·9 n^2	·209	7·668 (1 − n) (10·80 + n)
	49	60·3	60·3 — 152·5 n^2	·209	5·293 (1 − n) (12·60 + n)
8×8	58	59·7	59·7 — 142·7 n^2	·213	8·871 (1 − n) (7·415 + n)
	48	49·0	49·0 — 122·9 n^2	·205	6·074 (1 − n) (8·873 + n)
	40	39·8	39·8 — 94·72 n^2	·221	4·310 (1 − n) (10·25 + n)
	35	34·7	34·7 — 84·20 n^2	·218	3·276 (1 − n) (11·77 + n)
	31	30·4	30·4 — 72·20 n^2	·225	2·542 (1 − n) (13·35 + n)
6×6	25	18·9	18·9 — 42·21 n^2	·236	2·288 (1 − n) (9·230 + n)
	20	15·1	15·1 — 34·07 n^2	·237	1·443 (1 − n) (11·74 + n)
	15·7	11·2	11·2 — 22·20 n^2	·283	0·8979 (1 − n) (14·42 + n)

Let p = mean axial stress
Ys = yield stress;
then $n = \frac{p}{Ys}$

UNIVERSAL COLUMNS

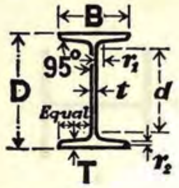


Parallel Flanges

PLASTIC MODULI—MINOR AXIS

Serial Size	Weight per foot	Plastic Modulus Axis *y-y*	Reduced Values of Plastic Modulus under Axial Load		
			Lower Values of *n*	Change formula at *n* =	Higher Values of *n*
ins	*lbs*	*ins*³	*ins*³		*ins*³
14×16	426	434·1	434·1 — 209·8 n^2	·280	642·2 (1 − n) (0·623 + n)
	370	369·7	369·7 — 164·9 n^2	·273	552·3 (1 − n) (0·617 + n)
	314	307·5	307·5 — 123·9 n^2	·264	462·3 (1 − n) (0·614 + n)
	264	253·7	253·7 — 91·31 n^2	·256	384·8 (1 − n) (0·609 + n)
	228	216·1	216·1 — 70·27 n^2	·249	329·0 (1 − n) (0·608 + n)
	193	180·1	180·1 — 51·90 n^2	·243	275·8 (1 − n) (0·605 + n)
	158	145·5	145·5 — 35·99 n^2	·236	223·4 (1 − n) (0·605 + n)
Column Core	320	303·8	303·8 — 131·7 n^2	·338	523·8 (1 − n) (0·495 + n)
14×14½	136	117·0	117·0 — 27·09 n^2	·243	184·2 (1 − n) (0·585 + n)
	119	101·8	101·8 — 21·11 n^2	·236	159·4 (1 − n) (0·590 + n)
	103	87·2	87·2 — 16·06 n^2	·233	137·0 (1 − n) (0·588 + n)
	87	73·0	73·0 — 11·67 n^2	·230	115·1 (1 − n) (0·587 + n)
12×12	190	142·6	142·6 — 54·25 n^2	·273	221·4 (1 − n) (0·588 + n)
	161	118·8	118·8 — 40·43 n^2	·265	185·5 (1 − n) (0·585 + n)
	133	96·2	96·2 — 28·58 n^2	·258	151·5 (1 − n) (0·581 + n)
	106	74·9	74·9 — 18·88 n^2	·256	120·1 (1 − n) (0·568 + n)
	92	64·2	64·2 — 14·52 n^2	·254	103·8 (1 − n) (0·563 + n)
	79	54·4	54·4 — 10·89 n^2	·251	88·37 (1 − n) (0·561 + n)
	65	44·1	44·1 — 7·53 n^2	·247	72·08 (1 − n) (0·557 + n)
10×10	112	69·1	69·1 — 23·81 n^2	·261	106·7 (1 − n) (0·594 + n)
	89	53·6	53·6 — 15·76 n^2	·256	84·03 (1 − n) (0·585 + n)
	72	42·4	42·4 — 10·68 n^2	·253	67·50 (1 − n) (0·574 + n)
	60	35·1	35·1 — 7·61 n^2	·241	55·32 (1 − n) (0·585 + n)
	49	28·2	28·2 — 5·18 n^2	·236	44·63 (1 − n) (0·583 + n)
8×8	58	27·8	27·8 — 8·32 n^2	·262	44·08 (1 − n) (0·576 + n)
	48	22·8	22·8 — 5·86 n^2	·244	35·50 (1 − n) (0·593 + n)
	40	18·5	18·5 — 4·19 n^2	·256	30·05 (1 − n) (0·559 + n)
	35	16·1	16·1 — 3·27 n^2	·248	25·98 (1 − n) (0·566 + n)
	31	14·0	14·0 — 2·60 n^2	·253	23·01 (1 − n) (0·552 + n)
6×6	25	8·55	8·55 — 2·12 n^2	·277	14·43 (1 − n) (0·527 + n)
	20	6·79	6·79 — 1·42 n^2	·270	11·49 (1 − n) (0·527 + n)
	15·7	4·94	4·94 — 0·888 n^2	·312	9·437 (1 − n) (0·435 + n)

NOTE: For explanation of tables, see notes on pages 164–166.



JOISTS

DIMENSIONS AND PROPERTIES

Size D×B	Weight per foot	Thickness		Radius		Depth between Fillets d	Ratio D/T	Area of Section
		Web t	Flange T	Root r_1	Toe r_2			
ins	*lbs*	*ins*	*ins*	*ins*	*ins*	*ins*		*ins*^{2}
8×4	17	·230	·408	·37	·125	6·34	19·6	5·00
7×4	14·5	·210	·357	·37	·125	5·44	19·6	4·26
6×3½	11·5	·194	·326	·31	·09375	4·64	18·4	3·38
5×3	9	·178	·300	·31	·09375	3·71	16·7	2·64
4×2½	6·5	·161	·261	·27	·09375	2·88	15·3	1·91
3×2	4·5	·150	·224	·27	·09375	1·98	13·4	1·32

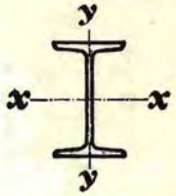
JOISTS

PLASTIC MODULI—MAJOR AXIS

Size D×B	Weight per foot	Plastic Modulus Axis *x-x*	Reduced Values of Plastic Modulus under Axial Load		
			Lower Values of n	Change formula at n =	Higher Values of n
ins	*lbs*	*ins*^{3}	*ins*^{3}		*ins*^{3}
8×4	17	15·64	15·64 − 27·2 n^2	·328	1·615 $(1-n)$ (11·38 $+n$)
7×4	14·5	11·80	11·80 − 21·6 n^2	·307	1·184 $(1-n)$ (11·59 $+n$)
6×3½	11·5	8·009	8·009 − 14·7 n^2	·304	·8468 $(1-n)$ (10·98 $+n$)
5×3	9	5·214	5·214 − 9·82 n^2	·293	·6061 $(1-n)$ (9·91 $+n$)
4×2½	6·5	2·997	2·997 − 5·66 n^2	·290	·3794 $(1-n)$ (9·07 $+n$)
3×2	4·5	1·539	1·539 − 2·92 n^2	·284	·2301 $(1-n)$ (7·63 $+n$)

Let p = mean axial stress,
Ys = yield stress;
then $n = \frac{p}{Ys}$

JOISTS

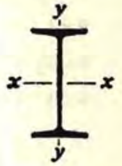


DIMENSIONS AND PROPERTIES

Size D×B	Moment of Inertia			Radius of Gyration		Elastic Modulus	
	Axis *x-x*		Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*
	Gross	Net					
ins	*ins*^{4}	*ins*^{4}	*ins*^{4}	*ins*	*ins*	*ins*^{3}	*ins*^{3}
8×4	55·11	47·01	3·91	3·32	0·88	13·78	1·95
7×4	36·57	31·15	3·36	2·93	0·89	10·45	1·68
6×3½	21·22	18·26	2·07	2·51	0·78	7·07	1·18
5×3	11·46	9·59	1·21	2·08	0·68	4·58	0·81
4×2½	5·24	4·44	0·61	1·66	0·57	2·62	0·49
3×2	2·00	1·67	0·27	1·23	0·45	1·33	0·27

NOTE: One hole is deducted from each flange in calculating the Net Moment of Inertia about *x-x*.

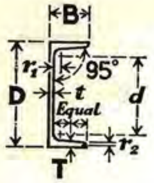
JOISTS



PLASTIC MODULI—MINOR AXIS

Serial D×B	Weight per foot	Plastic Modulus Axis *y-y*	Reduced Values of Plastic Modulus under Axial Load		
			Lower Values of n	Change formula at n =	Higher Values of n
ins	*lbs*	*ins*^{3}	*ins*^{3}		*ins*^{3}
8×4	17	3·160	3·160 − ·782 n^2	·368	6·735 $(1-n)$ (·350 $+n$)
7×4	14·5	2·722	2·722 − ·648 n^2	·345	5·483 $(1-n)$ (·392 $+n$)
6×3½	11·5	1·915	1·915 − ·476 n^2	·344	3·824 $(1-n)$ (·397 $+n$)
5×3	9	1·304	1·304 − ·350 n^2	·337	2·518 $(1-n)$ (·420 $+n$)
4×2½	6·5	0·7908	·7908 − ·228 n^2	·337	1·509 $(1-n)$ (·427 $+n$)
3×2	4·5	0·4398	·4398 − ·146 n^2	·340	·8206 $(1-n)$ (·441 $+n$)

NOTES: For explanation of tables, see notes on pages 164–166.



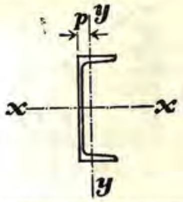
CHANNELS

DIMENSIONS AND PROPERTIES

Size D × B	Weight per foot	Thickness		Radius		Depth between Fillets d	Ratio D/T	Area of Section
		Web t	Flange T	Root r_1	Toe r_2			
ins	lbs	ins	ins	ins	ins	ins		ins²
17×4	44	·48	·663	·60	·1875	14·27	25·6	12·94
15×4	37	·41	·643	·60	·1875	12·30	23·3	10·88
12×4	31	·40	·584	·60	·1875	9·42	20·5	9·12
12×3½	28	·40	·538	·54	·125	9·66	22·3	8·23
10×3½	24	·36	·535	·54	·125	7·67	18·7	7·06
10×3	19	·32	·431	·48	·125	8·02	23·2	5·59
9×3½	22	·34	·524	·54	·125	6·69	17·2	6·47
9×3	17·5	·30	·439	48	·125	7·01	20·5	5·15
8×3½	20	·32	·507	·54	·125	5·72	15·8	5·88
8×3	16	·28	·439	·48	·125	6·00	18·2	4·70
7×3½	18	·30	·484	·54	·125	4·76	14·5	5·29
7×3	14	·26	·405	·48	·125	5·07	17·3	4·11
6×3½	16	·28	·455	·54	·125	3·82	13·2	4·71
6×3	12	·25	·355	·48	·09375	4·17	16·9	3·53
5×2½	10	·25	·363	·42	·09375	3·31	13·8	2·94
4×2	7	·24	·300	·36	·09375	2·59	13·3	2·06
3×1½	4·5	·20	·267	·30	·09375	1·80	11·2	1·32

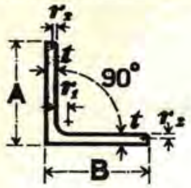
CHANNELS

DIMENSIONS AND PROPERTIES



Size D × B	Dimension p	Moment of Inertia			Radius of Gyration		Elastic Modulus	
		Axis x-x		Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y
		Gross	Net					
ins	ins	ins⁴	ins⁴	ins⁴	ins	ins	ins³	ins³
17×4	·91	514·11	442·18	15·10	6·30	1·08	60·48	4·89
15×4	·99	357·82	303·94	13·93	5·73	1·13	47·71	4·63
12×4	1·05	197·34	166·39	12·00	4·65	1·15	32·89	4·06
12×3½	·86	169·64	140·90	7·82	4·54	·97	28·27	2·96
10×3½	·95	106·86	87·36	7·27	3·89	1·01	21·37	2·85
10×3	·73	80·88	64·84	3·91	3·81	·84	16·18	1·72
9×3½	1·00	81·38	66·07	6·85	3·55	1·03	18·08	2·74
9×3	·79	62·70	49·61	3·81	3·49	·86	13·93	1·72
8×3½	1·04	59·85	48·26	6·35	3·19	1·04	14·96	2·58
8×3	·84	46·86	36·65	3·64	3·16	·88	11·71	1·68
7×3½	1·09	42·12	33·76	5·79	2·82	1·05	12·03	2·40
7×3	·87	32·13	24·96	3·22	2·79	·88	9·18	1·51
6×3½	1·13	28·01	22·31	5·17	2·44	1·05	9·34	2·18
6×3	·87	20·46	15·86	2·73	2·41	·88	6·82	1·28
5×2½	·76	11·59	8·42	1·62	1·99	·74	4·64	·93
4×2	·60	4·99	3·58	·70	1·56	·58	2·50	·50
3×1½	·47	1·78	1·22	·26	1·16	·44	1·19	·25

One hole is deducted from each flange in calculating the Net Moment of Inertia about *x-x*.



EQUAL ANGLES

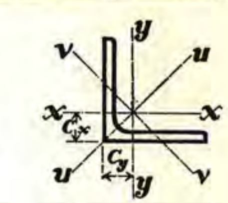
DIMENSIONS AND PROPERTIES

Size A×B	Thickness *t* (nominal)	Thickness *t* (actual)	Calculated Weight per foot	Minimum Thickness Rolled	Radii		Area of Section
					Root r_1	Toe r_2	
ins	*ins*	*ins*	*lbs*	*ins*	*ins*	*ins*	*ins*^{2}
8×8	1	*·996*	*51·0*	*·500*	*·60*	*·1875*	*15·01*
	15/16	*·933*	*48·0*				*14·12*
	7/8	·871	45·0				13·24
	13/16	*·809*	*42·0*				*12·35*
	3/4	·746	38·9				11·44
	11/16	*·683*	*35·8*				*10·52*
	5/8	·621	32·7				9·61
6×6	7/8	*·872*	*33·1*	*·371*	*·48*	*·1875*	*9·74*
	13/16	*·809*	*30·9*				*9·09*
	3/4	·747	28·7				8·44
	11/16	*·683*	*26·4*				*7·76*
	5/8	·623	24·2				7·12
	9/16	*·560*	*21·9*				*6·44*
	1/2	·496	19·5				5·74
	7/16	*·434*	*17·2*				*5·05*
	3/8	·371	14·8				4·35
5×5	3/4	*·748*	*23·6*	*·3125*	*·42*	*·1875*	*6·94*
	11/16	*·686*	*21·8*				*6·41*
	5/8	·622	19·9				5·86
	9/16	*·558*	*18·0*				*5·29*
	1/2	·496	16·1				4·74
	7/16	*·434*	*14·2*				*4·17*
	3/8	·373	12·3				3·61
4×4	3/4	*·749*	*18·5*	*·300*	*·36*	*·1875*	*5·44*
	11/16	*·686*	*17·1*				*5·03*
	5/8	·624	15·7				4·62
	9/16	*·560*	*14·2*				*4·18*
	1/2	·496	12·7				3·73
	7/16	*·434*	*11·2*				*3·30*
	3/8	·372	9·7				2·85
	5/16	*·308*	*8·1*				*2·38*

REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Equal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

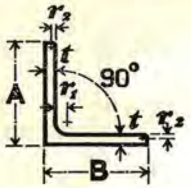
EQUAL ANGLES



DIMENSIONS AND PROPERTIES

Centre of Gravity		Moment of Inertia				Radius of Gyration				Elastic Modulus	
Cx	*Cy*	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*
ins	*ins*	*ins*^{4}	*ins*^{4}	*ins*^{4}	*ins*^{4}	*ins*	*ins*	*ins*	*ins*	*ins*^{3}	*ins*^{3}
2·36	*2·36*	*88·56*	*88·56*	*140·42*	*36·69*	*2·43*	*2·43*	*3·06*	*1·56*	*15·69*	*15·69*
2·33	*2·33*	*83·87*	*83·87*	*133·10*	*34·63*	*2·44*	*2·44*	*3·07*	*1·57*	*14·80*	*14·80*
2·31	2·31	79·15	79·15	125·71	32·59	2·45	2·45	3·08	1·57	13·91	13·91
2·29	*2·29*	*74·32*	*74·32*	*118·11*	*30·53*	*2·45*	*2·45*	*3·09*	*1·57*	*13·01*	*13·01*
2·26	2·26	69·30	69·30	110·19	28·41	2·46	2·46	3·10	1·58	12·08	12·08
2·24	*2·24*	*64·16*	*64·16*	*102·07*	*26·26*	*2·47*	*2·47*	*3·11*	*1·58*	*11·14*	*11·14*
2·21	2·21	58·99	58·99	93·86	24·12	2·48	2·48	3·12	1·58	10·20	10·20
1·81	*1·81*	*31·73*	*31·73*	*50·18*	*13·28*	*1·81*	*1·81*	*2·27*	*1·17*	*7·58*	*7·58*
1·79	*1·79*	*29·86*	*29·86*	*47·29*	*12·43*	*1·81*	*1·81*	*2·28*	*1·17*	*7·09*	*7·09*
1·77	1·77	27·96	27·96	44·34	11·59	1·82	1·82	2·29	1·17	6·60	6·60
1·74	*1·74*	*25·95*	*25·95*	*41·19*	*10·70*	*1·83*	*1·83*	*2·30*	*1·17*	*6·09*	*6·09*
1·72	1·72	24·00	24·00	38·12	9·87	1·84	1·84	2·31	1·18	5·61	5·61
1·70	*1·70*	*21·89*	*21·89*	*34·80*	*8·98*	*1·84*	*1·84*	*2·32*	*1·18*	*5·08*	*5·08*
1·67	1·67	19·68	19·68	31·29	8·06	1·85	1·85	2·33	1·18	4·54	4·54
1·65	*1·65*	*17·47*	*17·47*	*27·79*	*7·15*	*1·86*	*1·86*	*2·34*	*1·19*	*4·01*	*4·01*
1·62	1·62	15·15	15·15	24·10	6·20	1·87	1·87	2·35	1·19	3·46	3·46
1·52	*1·52*	*15·63*	*15·63*	*24·71*	*6·56*	*1·50*	*1·50*	*1·89*	*·97*	*4·49*	*4·49*
1·49	*1·49*	*14·58*	*14·58*	*23·08*	*6·07*	*1·51*	*1·51*	*1·90*	*·97*	*4·16*	*4·16*
1·47	1·47	13·45	13·45	21·32	5·57	1·52	1·52	1·91	·98	3·81	3·81
1·45	*1·45*	*12·28*	*12·28*	*19·49*	*5·06*	*1·52*	*1·52*	*1·92*	*·98*	*3·45*	*3·45*
1·42	1·42	11·10	11·10	17·64	4·56	1·53	1·53	1·93	·98	3·10	3·10
1·40	*1·40*	*9·88*	*9·88*	*15·71*	*4·05*	*1·54*	*1·54*	*1·94*	*·98*	*2·74*	*2·74*
1·37	1·37	8·63	8·63	13·73	3·53	1·55	1·55	1·95	·99	2·38	2·38
1·27	*1·27*	*7·61*	*7·61*	*11·95*	*3·27*	*1·18*	*1·18*	*1·48*	*·77*	*2·78*	*2·78*
1·24	*1·24*	*7·11*	*7·11*	*11·20*	*3·02*	*1·19*	*1·19*	*1·49*	*·77*	*2·59*	*2·58*
1·22	1·22	6·60	6·60	10·42	2·78	1·20	1·20	1·50	·78	2·37	2·37
1·20	*1·20*	*6·05*	*6·05*	*9·57*	*2·52*	*1·20*	*1·20*	*1·51*	*·78*	*2·16*	*2·16*
1·17	1·17	5·47	5·47	8·68	2·27	1·21	1·21	1·52	·78	1·94	1·94
1·15	*1·15*	*4·89*	*4·89*	*7·76*	*2·01*	*1·22*	*1·22*	*1·53*	*·78*	*1·71*	*1·71*
1·13	1·13	4·28	4·28	6·80	1·76	1·22	1·22	1·54	·78	1·49	1·49
1·10	*1·10*	*3·61*	*3·61*	*5·75*	*1·48*	*1·23*	*1·23*	*1·55*	*·79*	*1·25*	*1·25*

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square; but the radii at the root and toe will remain unchanged. In Equal Sided Angles the thickness of the flanges will be the same.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



EQUAL ANGLES

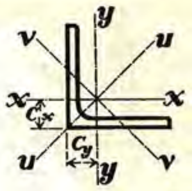
DIMENSIONS AND PROPERTIES

Size A×B	Thickness *t* (nominal)	Thickness *t* (actual)	Calculated Weight per foot	Minimum Thickness Rolled	Radii		Area of Section
					Root r_1	Toe r_2	
ins	*ins*	*ins*	*lbs*	*ins*	*ins*	*ins*	*ins²*
3½×3½	$\frac{5}{8}$	*·621*	*13·5*	*·247*	*·33*	*·1875*	*3·97*
	$\frac{9}{16}$	*·560*	*12·3*				*3·61*
	$\frac{1}{2}$	·496	11·0				3·23
	$\frac{7}{16}$	*·433*	*9·7*				*2·85*
	$\frac{3}{8}$	·371	8·4				2·47
	$\frac{5}{16}$	*·311*	*7·1*				*2·09*
	$\frac{1}{4}$	·247	5·7				1·68
3×3	$\frac{9}{16}$	*·562*	*10·4*	*·245*	*·30*	*·1875*	*3·06*
	$\frac{1}{2}$	·496	9·3				2·73
	$\frac{7}{16}$	*·432*	*8·2*				*2·41*
	$\frac{3}{8}$	·370	7·1				2·09
	$\frac{5}{16}$	*·309*	*6·0*				*1·76*
	$\frac{1}{4}$	·245	4·8				1·41
2½×2½	$\frac{1}{2}$	*·493*	*7·6*	*·200*	*·27*	*·09375*	*2·23*
	$\frac{7}{16}$	*·435*	*6·8*				*2·00*
	$\frac{3}{8}$	·372	5·9				1·73
	$\frac{5}{16}$	·311	5·0				1·47
	$\frac{1}{4}$	·245	4·0				1·18
2¼×2¼	$\frac{3}{8}$	*·367*	*5·2*	*·175*	*·26*	*·09375*	*1·53*
	$\frac{5}{16}$	·306	4·4				1·29
	$\frac{1}{4}$	·246	3·6				1·06
	$\frac{3}{16}$	·181	2·7				·79
2×2	$\frac{3}{8}$	*·370*	*4·6*	*·125*	*·24*	*·09375*	*1·35*
	$\frac{5}{16}$	·308	3·9				1·15
	$\frac{1}{4}$	·249	3·2				·94
	$\frac{3}{16}$	·183	2·4				·71

REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Equal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

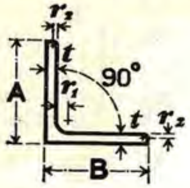
EQUAL ANGLES



DIMENSIONS AND PROPERTIES

Centre of Gravity		Moment of Inertia				Radius of Gyration				Elastic Modulus	
Cx	*Cy*	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*
ins	*ins*	*ins⁴*	*ins⁴*	*ins⁴*	*ins⁴*	*ins*	*ins*	*ins*	*ins*	*ins³*	*ins³*
1·09	*1·09*	*4·27*	*4·27*	*6·72*	*1·82*	*1·04*	*1·04*	*1·30*	*·68*	*1·77*	*1·77*
1·07	*1·07*	*3·94*	*3·94*	*6·21*	*1·66*	*1·04*	*1·04*	*1·31*	*·68*	*1·62*	*1·62*
1·05	1·05	3·57	3·57	5·65	1·49	1·05	1·05	1·32	·68	1·46	1·46
1·02	*1·02*	*3·19*	*3·19*	*5·06*	*1·32*	*1·06*	*1·06*	*1·33*	*·68*	*1·29*	*1·29*
1·00	1·00	2·80	2·80	4·44	1·15	1·06	1·06	1·34	·68	1·12	1·12
·98	*·98*	*2·40*	*2·40*	*3·81*	*·98*	*1·07*	*1·07*	*1·35*	*·69*	*·95*	*·95*
·95	·95	1·95	1·95	3·09	·80	1·08	1·08	1·36	·69	·76	·76
·95	*·95*	*2·39*	*2·39*	*3·76*	*1·03*	*·88*	*·88*	*1·11*	*·58*	*1·17*	*1·17*
·92	·92	2·17	2·17	3·43	·92	·89	·89	1·12	·58	1·05	1·05
·90	*·90*	*1·94*	*1·94*	*3·08*	*·81*	*·90*	*·90*	*1·13*	*·58*	*·93*	*·93*
·88	·88	1·71	1·71	2·71	·71	·90	·90	1·14	·58	·80	·80
·85	*·85*	*1·46*	*1·46*	*2·33*	*·60*	*·91*	*·91*	*1·15*	*·58*	*·68*	*·68*
·83	·83	1·19	1·19	1·89	·49	·92	·92	1·16	·59	·55	·55
·80	*·80*	*1·21*	*1·21*	*1·90*	*·52*	*·74*	*·74*	*·92*	*·48*	*·71*	*·71*
·78	*·78*	*1·10*	*1·10*	*1·73*	*·47*	*·74*	*·74*	*·93*	*·48*	*·64*	*·64*
·76	·76	·97	·97	1·54	·41	·75	·75	·94	·49	·56	·56
·73	·73	·84	·84	1·33	·35	·76	·76	·95	·49	·48	·48
·71	·71	·69	·69	1·09	·28	·76	·76	·96	·49	·38	·38
·69	*·69*	*·69*	*·69*	*1·08*	*·29*	*·67*	*·67*	*·84*	*·44*	*·44*	*·44*
·67	·67	·59	·59	·94	·25	·68	·68	·85	·44	·38	·38
·65	·65	·49	·49	·78	·20	·68	·68	·86	·44	·31	·31
·62	·62	·38	·38	·60	·16	·69	·69	·87	·44	·23	·23
·63	*·63*	*·47*	*·47*	*·74*	*·20*	*·59*	*·59*	*·74*	*·39*	*·34*	*·34*
·61	·61	·41	·41	·64	·17	·60	·60	·75	·39	·29	·29
·59	·59	·34	·34	·54	·14	·60	·60	·76	·39	·24	·24
·56	·56	·26	·26	·42	·11	·61	·61	·77	·39	·18	·18

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square; but the radii at the root and toe will remain unchanged. In Equal Sided Angles the thickness of the flanges will be the same.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



EQUAL ANGLES

DIMENSIONS AND PROPERTIES

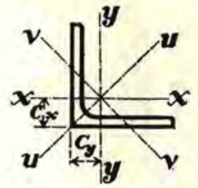
Size A×B	Thickness t (nominal)	Thickness t (actual)	Calculated Weight per foot	Minimum Thickness Rolled	Radii		Area of Section
					Root r_1	Toe r_2	
ins	ins	ins	lbs	ins	ins	ins	ins²
$1\frac{3}{4}\times1\frac{3}{4}$	$\frac{5}{16}$	*·311*	*3·4*	*·104*	*·23*	*·09375*	*1·0*
	$\frac{1}{4}$	·241	2·7				·79
	$\frac{3}{16}$	·184	2·1				·62
$1\frac{1}{2}\times1\frac{1}{2}$	$\frac{5}{16}$	*·309*	*2·85*	*·104*	*·21*	*·09375*	*·84*
	$\frac{1}{4}$	·249	2·35				·69
	$\frac{3}{16}$	·186	1·8				·53
$1\frac{1}{4}\times1\frac{1}{4}$	$\frac{1}{4}$	*·246*	*1·9*	*·104*	*·20*	*·09375*	*·56*
	$\frac{3}{16}$	·182	1·45				·43
	$\frac{1}{8}$	·122	1·0				·29
1×1	$\frac{1}{4}$	*·250*	*1·5*	*·104*	*·18*	*·09375*	*·44*
	$\frac{3}{16}$	·185	1·15				·34
	$\frac{1}{8}$	·124	·8				·24

REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Equal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

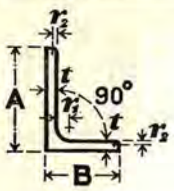
EQUAL ANGLES

DIMENSIONS AND PROPERTIES



Centre of Gravity		Moment of Inertia				Radius of Gyration				Elastic Modulus	
Cx	Cy	Axis x-x	Axis y-y	Axis u-u Max.	Axis v-v Min.	Axis x-x	Axis y-y	Axis u-u Max.	Axis v-v Min.	Axis x-x	Axis y-y
ins	ins	ins⁴	ins⁴	ins⁴	ins⁴	ins	ins	ins	ins	ins³	ins³
·55	*·55*	*·27*	*·27*	*·42*	*·11*	*·52*	*·52*	*·65*	*·34*	*·22*	*·22*
·52	·52	·22	·22	·35	·09	·52	·52	·66	·34	·18	·18
·50	·50	·17	·17	·28	·07	·53	·53	·67	·34	·14	·14
·48	*·48*	*·16*	*·16*	*·25*	*·07*	*·44*	*·44*	*·55*	*·29*	*·16*	*·16*
·46	·46	·14	·14	·21	·06	·44	·44	·56	·29	·13	·13
·44	·44	·11	·11	·17	·04	·45	·45	·57	·29	·10	·10
·40	*·40*	*·07*	*·07*	*·12*	*·03*	*·37*	*·37*	*·46*	*·24*	*·09*	*·09*
·37	·37	·06	·06	·09	·02	·37	·37	·47	·24	·07	·07
·35	·35	·04	·04	·07	·02	·38	·38	·47	·24	·05	·05
·34	*·34*	*·04*	*·04*	*·06*	*·02*	*·29*	*·29*	*·36*	*·19*	*·05*	*·05*
·31	·31	·03	·03	·05	·01	·29	·29	·37	·19	·04	·04
·29	·29	·02	·02	·03	·01	·30	·30	·37	·19	·03	·03

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square; but the radii at the root and toe will remain unchanged. In Equal Sided Angles the thickness of the flanges will be the same.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



UNEQUAL ANGLES

DIMENSIONS AND PROPERTIES

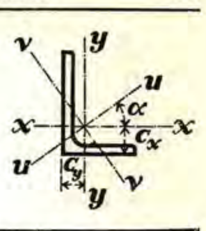
Size A×B	Thickness t (nominal)	Thickness t (actual)	Calculated Weight per foot	Minimum Thickness Rolled	Radii		Area of Section
					Root r_1	Toe r_2	
ins	*ins*	*ins*	*lbs*	*ins*	*ins*	*ins*	*ins*^{2}
9×4	$\frac{7}{8}$	*·872*	*36·1*	*·375*	*·51*	*·1875*	*10·62*
	$\frac{13}{16}$	*·810*	*33·7*				*9·91*
	$\frac{3}{4}$	·745	31·2				9·17
	$\frac{11}{16}$	*·684*	*28·8*				*8·46*
	$\frac{5}{8}$	*·622*	*26·3*				*7·74*
	$\frac{9}{16}$	*·559*	*23·8*				*7·00*
	$\frac{1}{2}$	·495	21·2				6·23
8×6	$\frac{7}{8}$	*·870*	*39·0*	*·450*	*·54*	*·1875*	*11·47*
	$\frac{13}{16}$	*·808*	*36·4*				*10·71*
	$\frac{3}{4}$	·746	33·8				9·93
	$\frac{11}{16}$	*·683*	*31·1*				*9·14*
	$\frac{5}{8}$	*·621*	*28·4*				*8·36*
	$\frac{9}{16}$	*·559*	*25·7*				*7·56*
	$\frac{1}{2}$	·495	22·9				6·73
8×4	$\frac{3}{4}$	*·747*	*28·7*	*·375*	*·48*	*·1875*	*8·44*
	$\frac{11}{16}$	*·683*	*26·4*				*7·76*
	$\frac{5}{8}$	·623	24·2				7·12
	$\frac{9}{16}$	*·560*	*21·9*				*6·44*
	$\frac{1}{2}$	·496	19·5				5·74
7×3½	$\frac{5}{8}$	*·623*	*21·0*	*·372*	*·44*	*·1875*	*6·18*
	$\frac{9}{16}$	*·559*	*19·0*				*5·58*
	$\frac{1}{2}$	·497	17·0				5·00
	$\frac{7}{16}$	·436	15·0				4·41
	$\frac{3}{8}$	*·372*	*12·9*				*3·79*
6×4	$\frac{3}{4}$	*·748*	*23·6*	*·344*	*·42*	*·1875*	*6·94*
	$\frac{11}{16}$	*·686*	*21·8*				*6·41*
	$\frac{5}{8}$	·622	19·9				5·86
	$\frac{9}{16}$	*·558*	*18·0*				*5·29*
	$\frac{1}{2}$	·496	16·1				4·74
	$\frac{7}{16}$	*·434*	*14·2*				*4·17*
	$\frac{3}{8}$	·373	12·3				3·61

REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Unequal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

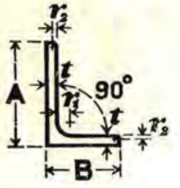
UNEQUAL ANGLES

DIMENSIONS AND PROPERTIES



Centre of Gravity		Moment of Inertia				Radius of Gyration				Angle	Elastic Modulus	
Cx	*Cy*	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *u-u*	Axis *x-x*	Axis *y-y*
ins	*ins*	*ins*^{4}	*ins*^{4}	*ins*^{4}	*ins*^{4}	*ins*	*ins*	*ins*	*ins*	*tan α*	*ins*^{3}	*ins*^{3}
3·44	*·95*	*86·63*	*10·75*	*90·02*	*7·36*	*2·86*	*1·01*	*2·91*	*·83*	*·21*	*15·57*	*3·52*
3·41	*·93*	*81·40*	*10·15*	*84·65*	*6·90*	*2·87*	*1·01*	*2·92*	*·83*	*·21*	*14·57*	*3·30*
3·39	·90	75·78	9·50	78·87	6·42	2·88	1·02	2·93	·84	·21	13·50	3·07
3·36	*·88*	*70·38*	*8·88*	*73·29*	*5·96*	*2·88*	*1·02*	*2·94*	*·84*	*·21*	*12·48*	*2·84*
3·34	*·85*	*64·75*	*8·22*	*67·47*	*5·49*	*2 89*	*1·03*	*2·95*	*·84*	*·21*	*11·43*	*2·61*
3·31	*·83*	*58·89*	*7·52*	*61·40*	*5·01*	*2·90*	*1·04*	*2·96*	*·85*	*·22*	*10·35*	*2·37*
3·28	·80	52·79	6·79	55·07	4·50	2·91	1·04	2·97	·85	·22	9·23	2·12
2·60	*1·60*	*71·88*	*34·58*	*87·66*	*18·81*	*2·50*	*1·74*	*2·76*	*1·28*	*·55*	*13·30*	*7·86*
2·57	*1·58*	*67·53*	*32·55*	*82·45*	*17·63*	*2·51*	*1·74*	*2·78*	*1·28*	*·55*	*12·44*	*7·36*
2·55	1·56	63·07	30·46	77·09	16·44	2·52	1·75	2·79	1·29	·55	11·57	6·85
2·52	*1·53*	*58·42*	*28·28*	*71·49*	*15·21*	*2·53*	*1·76*	*2·80*	*1·29*	*·55*	*10·67*	*6·33*
2·50	*1·51*	*53·74*	*26·07*	*65·82*	*13·98*	*2·54*	*1·77*	*2·81*	*1·29*	*·55*	*9·77*	*5·80*
2·48	*1·48*	*48·94*	*23·80*	*60·00*	*12·74*	*2·54*	*1·77*	*2·82*	*1·30*	*·55*	*8·86*	*5·27*
2·45	1·46	43·86	21·38	53·81	11·43	2·55	1·78	2·83	1·30	·55	7·90	4·71
2·94	*·95*	*54·69*	*9·26*	*57·89*	*6·07*	*2·55*	*1·05*	*2·62*	*·85*	*·26*	*10·80*	*3·04*
2·91	*·92*	*50·66*	*8·63*	*53·67*	*5·62*	*2·55*	*1·05*	*2·63*	*·85*	*·26*	*9·96*	*2·80*
2·89	·90	46·78	8·01	49·60	5·19	2·56	1·06	2·64	·85	·26	9·15	2·58
2·86	*·88*	*42·59*	*7·34*	*45·19*	*4·73*	*2·57*	*1·07*	*2·65*	*·86*	*·26*	*8·29*	*2·35*
2·83	·85	38·22	6·62	40·59	4·25	2·58	1·07	2·66	·86	·26	7·40	2·10
2·56	*·82*	*30·75*	*5·22*	*32·56*	*3·41*	*2·23*	*·92*	*2·30*	*·74*	*·26*	*6·92*	*1·94*
2·53	*·79*	*28·00*	*4·78*	*29·67*	*3·10*	*2·24*	*·93*	*2·31*	*·75*	*·26*	*6·26*	*1·77*
2·50	·77	25·25	4·34	26·79	2·80	2·25	·93	2·32	·75	·26	5·62	1·59
2·48	·74	22·47	3·88	23·86	2·50	2·26	·94	2·33	·75	·26	4·97	1·41
2·45	*·72*	*19·46*	*3·39*	*20·67*	*2·17*	*2·27*	*·94*	*2·33*	*·76*	*·27*	*4·28*	*1·22*
2·07	*1·07*	*24·39*	*8·60*	*27·90*	*5·09*	*1·87*	*1·11*	*2·00*	*·86*	*·43*	*6·20*	*2·94*
2·04	*1·05*	*22·71*	*8·04*	*26·03*	*4·72*	*1·88*	*1·12*	*2·02*	*·86*	*·43*	*5·74*	*2·72*
2·02	1·03	20·92	7·43	24·02	4·33	1·89	1·13	2·03	·86	·43	5·26	2·50
1·99	*1·00*	*19·06*	*6·80*	*21·92*	*3·94*	*1·90*	*1·13*	*2·04*	*·86*	*·43*	*4·76*	*2·27*
1·97	·98	17·21	6·17	19·82	3·56	1·91	1·14	2·05	·87	·44	4·27	2·04
1·95	*·95*	*15·29*	*5·50*	*17·63*	*3·16*	*1·91*	*1·15*	*2·06*	*·87*	*·44*	*3·77*	*1·81*
1·92	·93	13·34	4·82	15·40	2·76	1·92	1·15	2·06	·87	·44	3·27	1·57

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square, but the radii at the root and toe will remain unchanged. In Unequal Sided Angles the flanges may differ in thickness, but the difference shall not exceed ·05 inch.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



UNEQUAL ANGLES

DIMENSIONS AND PROPERTIES

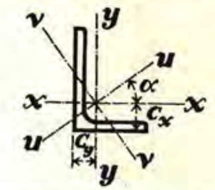
Size **A×B**	Thickness *t* (nominal)	Thickness *t* (actual)	Calculated Weight per foot	Minimum Thickness Rolled	Radii		Area of Section
					Root r_1	Toe r_2	
ins	*ins*	*ins*	*lbs*	*ins*	*ins*	*ins*	*ins*^{2}
6×3½	$\frac{5}{8}$	*·620*	*18·8*	*·308*	*41*	*·1875*	*5·53*
	$\frac{9}{16}$	*·560*	*17·1*				*5·03*
	$\frac{1}{2}$	·497	15·3				4·50
	$\frac{7}{16}$	*·436*	*13·5*				*3·97*
	$\frac{3}{8}$	·371	11·6				3·41
	$\frac{5}{16}$	*·308*	*9·7*				*2·85*
6×3	$\frac{5}{8}$	*·623*	*17·8*	*·309*	*·39*	*·1875*	*5·24*
	$\frac{9}{16}$	*·559*	*16·1*				*4·74*
	$\frac{1}{2}$	·496	14·4				4·24
	$\frac{7}{16}$	*·434*	*12·7*				*3·74*
	$\frac{3}{8}$	·373	11·0				3·24
	$\frac{5}{16}$	*·309*	*9·2*				*2·70*
5×3½	$\frac{5}{8}$	*·621*	*16·7*	*·310*	*·38*	*1875*	*4·91*
	$\frac{9}{16}$	*·561*	*15·2*				*4·47*
	$\frac{1}{2}$	·498	13·6				4·00
	$\frac{7}{16}$	*436*	*12·0*				*3·53*
	$\frac{3}{8}$	·371	10·3				3·03
	$\frac{5}{16}$	*·310*	*8·7*				*2·55*
5×3	$\frac{9}{16}$	*·560*	*14·2*	*·250*	*·36*	*·1875*	*4·18*
	$\frac{1}{2}$	·496	12·7				3·73
	$\frac{7}{16}$	*·434*	*11·2*				*3·30*
	$\frac{3}{8}$	·372	9·7				2·85
	$\frac{5}{16}$	·308	8·1				2·38
4×3½	$\frac{5}{8}$	*·623*	*14·6*	*·275*	*·35*	*·1875*	*4·30*
	$\frac{9}{16}$	*·558*	*13·2*				*3·88*
	$\frac{1}{2}$	·498	11·9				3·50
	$\frac{7}{16}$	*·435*	*10·5*				*3·08*
	$\frac{3}{8}$	·374	9·1				2·68
	$\frac{5}{16}$	·309	7·6				2·23

REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Unequal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

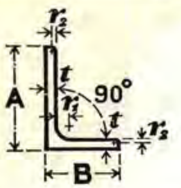
UNEQUAL ANGLES

DIMENSIONS AND PROPERTIES



Centre of Gravity		Moment of Inertia				Radius of Gyration				Angle	Elastic Modulus	
Cx	*Cy*	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *u-u*	Axis *x-x*	Axis *y-y*
ins	*ins*	*ins*^{4}	*ins*^{4}	*ins*^{4}	*ins*^{4}	*ins*	*ins*	*ins*	*ins*	*tan α*	*ins*^{3}	*ins*^{3}
2·12	*·87*	*19·89*	*5·00*	*21·78*	*3·11*	*1·90*	*·95*	*1·99*	*·75*	*·34*	*5·12*	*1·90*
2·09	*·85*	*18·24*	*4·61*	*20·00*	*2·85*	*1·90*	*·96*	*1·99*	*·75*	*·34*	*4·67*	*1·74*
2·07	·83	16·45	4·18	18·07	2·56	1·91	·96	2·00	·76	·34	4·18	1·56
2·04	*·80*	*14·66*	*3·74*	*16·12*	*2·29*	*1·92*	*·97*	*2·01*	*·76*	*·34*	*3·70*	*1·39*
2·01	·78	12·68	3·26	13·96	1·98	1·93	·98	2·02	·76	·35	3·18	1·20
1·99	*·75*	*10·70*	*2·76*	*11·78*	*1·68*	*1·94*	*·98*	*2·03*	*·77*	*·35*	*2·67*	*1·01*
2·22	*·73*	*18·88*	*3·17*	*19·95*	*2·09*	*1·90*	*·78*	*1·95*	*·63*	*·25*	*5·00*	*1·40*
2·20	*·71*	*17·23*	*2·91*	*18·23*	*1·91*	*1·91*	*·78*	*1·96*	*·63*	*·26*	*4·53*	*1·27*
2·17	·69	15·54	2·64	16·47	1·72	1·92	·79	1·97	·64	·26	4·06	1·14
2·15	*·66*	*13·83*	*2·37*	*14·66*	*1·53*	*1·92*	*·80*	*1·98*	*·64*	*·26*	*3·59*	*1·01*
2·12	·64	12·08	2·08	12·82	1·34	1·93	·80	1·99	·64	·26	3·11	·88
2·09	*·61*	*10·17*	*1·77*	*10·81*	*1·13*	*1·94*	*·81*	*2·00*	*·65*	*·26*	*2·60*	*·74*
1·69	*·95*	*11·91*	*4·76*	*13·93*	*2·74*	*1·56*	*·99*	*1·69*	*·75*	*·47*	*3·60*	*1·86*
1·67	*·92*	*10·94*	*4·39*	*12·83*	*2·50*	*1·57*	*·99*	*1·69*	*·75*	*·47*	*3·28*	*1·70*
1·64	·90	9·89	3·99	11·62	2·26	1·57	1·00	1·70	·75	·48	2·95	1·53
1·62	*·88*	*8·82*	*3·57*	*10·38*	*2·01*	*1·58*	*1·01*	*1·71*	*·75*	*·48*	*2·61*	*1·36*
1·59	·85	7·65	3·11	9·01	1·74	1·59	1·01	1·72	·76	·48	2·24	1·17
1·57	*·83*	*6·50*	*2·65*	*7·67*	*1·48*	*1·60*	*1·02*	*1·73*	*·76*	*·48*	*1·89*	*·99*
1·76	*·77*	*10·34*	*2·78*	*11·40*	*1·72*	*1·57*	*·82*	*1·65*	*·64*	*·35*	*3·19*	*1·25*
1·74	·74	9·34	2·53	10·32	1·55	1·58	·82	1·66	·64	·35	2·86	1·12
1·71	*·72*	*8·32*	*2·26*	*9·21*	*1·38*	*1·59*	*·83*	*1·67*	*·65*	*·36*	*2·53*	*·99*
1·69	·70	7·27	1·99	8·05	1·20	1·60	·84	1·68	·65	·36	2·19	·86
1·66	·67	6·13	1·69	6·80	1·02	1·60	·84	1·69	·65	·36	1·83	·72
1·29	*1·04*	*6·30*	*4·47*	*8·57*	*2·20*	*1·21*	*1·02*	*1·41*	*·72*	*·74*	*2·32*	*1·81*
1·26	*1·01*	*5·77*	*4·10*	*7·87*	*1·99*	*1·22*	*1·03*	*1·42*	*·72*	*·75*	*2·11*	*1·65*
1·24	·99	5·26	3·74	7·19	1·80	1·23	1·03	1·43	·72	·75	1·90	1·49
1·22	*·97*	*4·69*	*3·34*	*6·43*	*1·60*	*1·23*	*1·04*	*1·44*	*·72*	*·75*	*1·68*	*1·32*
1·19	·94	4·12	2·94	5·65	1·40	1·24	1·05	1·45	·72	·75	1·47	1·15
1·17	·92	3·48	2·48	4·78	1·18	1·25	1·05	1·46	·73	·75	1·23	·96

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square, but the radii at the root and toe will remain unchanged. In Unequal Sided Angles the flanges may differ in thickness, but the difference shall not exceed ·05 inch.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



UNEQUAL ANGLES

DIMENSIONS AND PROPERTIES

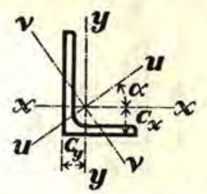
Size A×B	Thickness t (nominal)	Thickness t (actual)	Calculated Weight per foot	Minimum Thickness Rolled	Radii		Area of Section
					Root r_1	Toe r_2	
ins	ins	ins	lbs	ins	ins	ins	ins²
4×3	$\frac{9}{16}$	*·560*	*12·3*	*·250*	*·33*	*·1875*	*3·61*
	$\frac{1}{2}$	·496	11·0				3·23
	$\frac{7}{16}$	*·433*	*9·7*				*2·85*
	$\frac{3}{8}$	·371	8·4				2·47
	$\frac{5}{16}$	·311	7·1				2·09
4×2½	$\frac{7}{16}$	*·435*	*9·0*	*·248*	*·32*	*·1875*	*2·65*
	$\frac{3}{8}$	·373	7·8				2·29
	$\frac{5}{16}$	·308	6·5				1·91
	$\frac{1}{4}$	·248	5·3				1·56
3½×3	$\frac{9}{16}$	*·558*	*11·3*	*·248*	*·32*	*·1875*	*3·32*
	$\frac{1}{2}$	·499	10·2				3·00
	$\frac{7}{16}$	*·435*	*9·0*				*2·65*
	$\frac{3}{8}$	·373	7·8				2·29
	$\frac{5}{16}$	·308	6·5				1·91
	$\frac{1}{4}$	*·248*	*5·3*				*1·56*
3½×2½	$\frac{7}{16}$	*·432*	*8·2*	*·245*	*·30*	*·1875*	*2·41*
	$\frac{3}{8}$	·370	7·1				2·09
	$\frac{5}{16}$	·309	6·0				1·76
	$\frac{1}{4}$	·245	4·8				1·41
3×2½	$\frac{7}{16}$	*·435*	*7·5*	*·225*	*·29*	*·1875*	*2·21*
	$\frac{3}{8}$	·372	6·5				1·91
	$\frac{5}{16}$	·311	5·5				1·62
	$\frac{1}{4}$	·246	4·4				1·30
3×2	$\frac{7}{16}$	*·435*	*6·8*	*·187*	*·27*	*·09375*	*2·00*
	$\frac{3}{8}$	·372	5·9				1·73
	$\frac{5}{16}$	·311	5·0				1·47
	$\frac{1}{4}$	·245	4·0				1·18
	$\frac{3}{16}$	*·187*	*3·1*				*·91*

REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Unequal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

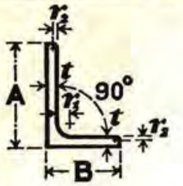
UNEQUAL ANGLES

DIMENSIONS AND PROPERTIES



Centre of Gravity		Moment of Inertia				Radius of Gyration				Angle	Elastic Modulus	
C_x	C_y	Axis x-x	Axis y-y	Axis u-u Max.	Axis v-v Min.	Axis x-x	Axis y-y	Axis u-u Max.	Axis v-v Min.	Axis u-u	Axis x-x	Axis y-y
ins	ins	ins⁴	ins⁴	ins⁴	ins⁴	ins	ins	ins	ins	tan α	ins³	ins³
1·34	*·84*	*5·49*	*2·61*	*6·65*	*1·45*	*1·23*	*·85*	*1·36*	*·63*	*·54*	*2·06*	*1·21*
1·32	·82	4·97	2·37	6·04	1·30	1·24	·86	1·37	·63	·54	1·85	1·09
1·29	*·80*	*4·44*	*2·13*	*5·40*	*1·16*	*1·25*	*·86*	*1·38*	*·64*	*·54*	*1·64*	*·96*
1·27	·77	3·88	1·87	4·74	1·01	1·25	·87	1·39	·64	·55	1·42	·84
1·24	·75	3·32	1·60	4·06	·86	1·26	·88	1·40	·64	·55	1·20	·71
1·38	*·64*	*4·18*	*1·25*	*4·67*	*·75*	*1·26*	*·69*	*1·33*	*·53*	*·38*	*1·59*	*·67*
1·36	·61	3·66	1·10	4·10	·66	1·26	·69	1·34	·54	·38	1·39	·58
1·33	·59	3·09	·94	3·47	·56	1·27	·70	1·35	·54	·39	1·16	·49
1·30	·56	2·54	·77	2·86	·46	1·28	·70	1·35	·54	·39	·94	·40
1·14	*·89*	*3·73*	*2·50*	*4·97*	*1·26*	*1·06*	*·87*	*1·22*	*·62*	*·71*	*1·58*	*1·19*
1·12	·87	3·41	2·29	4·56	1·14	1·07	·87	1·23	·62	·71	1·43	1·08
1·09	*·84*	*3·05*	*2·05*	*4·09*	*1·01*	*1·07*	*·88*	*1·24*	*·62*	*·72*	*1·27*	*·95*
1·07	·82	2·67	1·81	3·60	·88	1·08	·89	1·25	·62	·72	1·10	·83
1·04	·79	2·26	1·53	3·05	·74	1·09	·89	1·26	·62	·72	·92	·69
1·02	*·77*	*1·86*	*1·26*	*2·51*	*·61*	*1·09*	*·90*	*1·27*	*·63*	*·72*	*·75*	*·57*
1·17	*·67*	*2·84*	*1·20*	*3·36*	*·68*	*1·09*	*·70*	*1·18*	*·53*	*·49*	*1·22*	*·65*
1·15	·65	2·50	1·05	2·96	·59	1·09	·71	1·19	·53	·49	1·06	·57
1·12	·63	2·13	·91	2·53	·50	1·10	·72	1·20	·53	·50	·90	·48
1·09	·60	1·73	·74	2·06	·41	1·11	·72	1·21	·54	·50	·72	·39
·97	*·72*	*1·84*	*1·15*	*2·40*	*·59*	*·91*	*·72*	*1·04*	*·52*	*·67*	*·91*	*·65*
·94	·70	1·62	1·01	2·12	·51	·92	·73	1·05	·52	·67	·79	·56
·92	·67	1·39	·87	1·82	·44	·93	·73	1·06	·52	·68	·67	·48
·89	·65	1·13	·71	1·48	·35	·93	·74	1·07	·52	·68	·54	·38
1·05	*·56*	*1·72*	*·60*	*1·96*	*·36*	*·93*	*·55*	*·99*	*·43*	*·42*	*·89*	*·42*
1·03	·54	1·52	·54	1·74	·32	·94	·56	1·00	·43	·43	·77	·37
1·01	·51	1·31	·46	1·50	·27	·94	·56	1·01	·43	·43	·66	·31
·98	·49	1·07	·38	1·23	·22	·95	·57	1·02	·43	·44	·53	·25
·96	*·46*	*·84*	*·30*	*·97*	*·17*	*·96*	*·58*	*1·03*	*·44*	*·44*	*·41*	*·20*

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square, but the radii at the root and toe will remain unchanged. In Unequal Sided Angles the flanges may differ in thickness, but the difference shall not exceed ·05 inch.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



UNEQUAL ANGLES

DIMENSIONS AND PROPERTIES

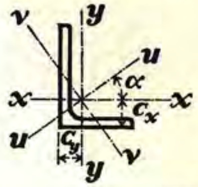
Size A×B	Thickness *t* (nominal)	Thickness *t* (actual)	Calculated Weight per foot	Minimum Thickness Rolled	Radii		Area of Section
					Root r_1	Toe r_2	
ins	*ins*	*ins*	*lbs*	*ins*	*ins*	*ins*	*ins*^{2}
2½×2	$\frac{3}{8}$	*·367*	*5·2*	*·175*	*·26*	*·09375*	*1·53*
	$\frac{5}{16}$	·306	4·4				1·29
	$\frac{1}{4}$	·246	3·6				1·06
	$\frac{3}{16}$	·181	2·7				·79
2½×1½	$\frac{5}{16}$	*·308*	*3·9*	*·125*	*·24*	*·09375*	*1·15*
	$\frac{1}{4}$	·249	3·2				·94
	$\frac{3}{16}$	·183	2·4				·71
2×1½	$\frac{5}{16}$	*·311*	*3·4*	*·125*	*·23*	*·09375*	*1·00*
	$\frac{1}{4}$	·241	2·7				·79
	$\frac{3}{16}$	·184	2·1				·62

REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Unequal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

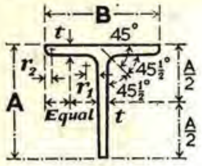
UNEQUAL ANGLES

DIMENSIONS AND PROPERTIES



Centre of Gravity		Moment of Inertia				Radius of Gyration				Angle	Elastic Modulus	
Cx	*Cy*	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *u-u*	Axis *x-x*	Axis *y-y*
ins	*ins*	*ins*^{4}	*ins*^{4}	*ins*^{4}	*ins*^{4}	*ins*	*ins*	*ins*	*ins*	*tan α*	*ins*^{3}	*ins*^{3}
·82	*·58*	*·89*	*·50*	*1·13*	*·27*	*·76*	*·57*	*·86*	*·42*	*·61*	*·53*	*·35*
·80	·55	·77	·44	·98	·23	·77	·58	·87	·42	·62	·45	·30
·78	·53	·64	·36	·82	·19	·78	·59	·88	·42	·62	·37	·25
·75	·50	·49	·28	·63	·14	·79	·59	·89	·43	·62	·28	·19
·89	*·39*	*·70*	*·19*	*·77*	*·12*	*·78*	*·40*	*·82*	*·32*	*·35*	*·43*	*·17*
·87	·37	·59	·16	·65	·10	·79	·41	·83	·32	·35	·36	·14
·84	·35	·45	·12	·50	·07	·80	·42	·84	·32	·36	·27	·11
·68	*·43*	*·37*	*·18*	*·45*	*·10*	*·61*	*·42*	*·67*	*·32*	*·53*	*·28*	*·17*
·65	·41	·30	·15	·37	·08	·62	·43	·68	·32	·54	·23	·13
·63	·38	·24	·12	·29	·06	·63	·43	·69	·32	·54	·18	·10

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square, but the radii at the root and toe will remain unchanged. In Unequal Sided Angles the flanges may differ in thickness, but the difference shall not exceed ·05 inch.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



T-BARS

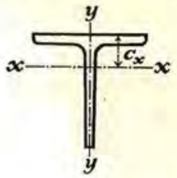
DIMENSIONS AND PROPERTIES

Size **B × A**	Thickness *t*	Weight per foot	Radius		Area of Section
			Root r_1	Toe r_2	
ins	*ins*	*lbs*	*ins*	*ins*	*ins*^{2}
6×6	·625	24·23	·48	·34	7·13
6×6	·5	19·62	·48	·34	5·77
6×4	·625	19·99	·42	·29	5·88
6×4	·5	16·22	·42	·29	4·77
6×3	·5	14·52	·39	·27	4·27
6×3	·375	11·08	·39	·27	3·26
5×4	·5	14·50	·39	·27	4·27
5×4	·375	11·06	·39	·27	3·25
5×3	·5	12·80	·36	·25	3·77
5×3	·375	9·79	·36	·25	2·88
4×4	·5	12·79	·36	·25	3·76
4×4	·375	9·77	·36	·25	2·87
4×3	·5	11·09	·33	·23	3·26
4×3	·375	8·49	·33	·23	2·50
3×3	·375	7·20	·30	·21	2·12
2½×2½	·375	5·92	·27	·19	1·74
2½×2½	·25	4·07	·27	·19	1·20
2×2	·25	3·21	·24	·17	·94
1½×1½	·25	2·36	·21	·15	·69

REMARKS

1. The dimensions, thickness and profile of Standard **Tees** shall be in accordance with the accompanying list and sketch. The Standard thickness of web shall be at a distance half-way between the extreme edge of the web and the farther side of the flange. The standard thickness of flange shall be measured at a distance half-way between the extreme edge of the flange and the nearer side of the web.
2. The tapers of the flange and web shall be such that the under side of the **flange** forms an angle of ½° with the horizontal upper side, whilst each side of the web forms an angle of ½° with vertical centre line as shown in the diagram.

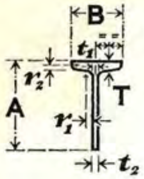
T-BARS



DIMENSIONS AND PROPERTIES

Centre of Gravity c_x	Moment of Inertia		Radius of Gyration		Elastic Modulus	
	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*
ins	*ins*^{4}	*ins*^{4}	*ins*	*ins*	*ins*^{3}	*ins*^{3}
1·69	23·31	10·87	1·81	1·23	5·40	3·62
1·63	19·04	8·56	1·82	1·22	4·36	2·85
1·02	7·33	10·93	1·12	1·36	2·46	3·64
·97	6·07	8·64	1·13	1·35	2·00	2·88
·68	2·63	8·67	·78	1·42	1·14	2·89
·63	2·06	6·40	·80	1·40	·87	2·13
1·05	5·77	5·02	1·16	1·09	1·96	2·01
1·00	4·47	3·70	1·17	1·07	1·49	1·48
·74	2·51	5·04	·82	1·16	1·11	2·01
·69	1·97	3·72	·83	1·14	·85	1·49
1·16	5·40	2·59	1·20	·83	1·90	1·30
1·10	4·19	1·90	1·21	·81	1·45	·95
·82	2·37	2·60	·85	·89	1·08	1·30
·77	1·86	1·91	·86	·87	·83	·96
·87	1·71	·81	·90	·62	·80	·54
·75	·96	·47	·74	·52	·55	·38
·70	·68	·30	·75	·50	·38	·24
·58	·34	·16	·60	·41	·24	·16
·46	·14	·07	·44	·31	·13	·09

3. Tees ordered to the standard thickness shall be practically accurate in profile.
4. Tees may be ordered by width of flange, depth of section and thickness, or by width of flange, depth of section and weight per foot, but not by both thickness and weight per foot.

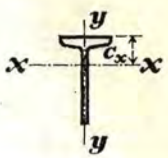


LONG STALK T-BARS

DIMENSIONS AND PROPERTIES

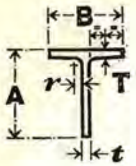
Size B × A	Thickness			Weight per foot	Radius		Area of Section
	T	t_1	t_2		Root r_1	Toe r_2	
ins	*ins*	*ins*	*ins*	*lbs*	*ins*	*ins*	*ins²*
5×10	·72	·37	·35	23·8	·53	·26	7·03
4×8	·64	·33	·31	16·81	·48	·30	4·95
3½×7	·60	·31	·29	13·74	·44	·25	4·04
3×6	·56	·29	·27	10·95	·40	·25	3·24
2½×5	·526	·27	·25	8·48	·35	·20	2·50
1¾×4½	·375	·2	·2	5·0	·3	·15	1·47
1×3	·25	·175	·175	2·45	·2	·15	·72

LONG STALK T-BARS



DIMENSIONS AND PROPERTIES

Centre of Gravity c_x	Moment of Inertia		Radius of Gyration		Elastic Modulus	
	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y
ins	*ins⁴*	*ins⁴*	*ins*	*ins*	*ins³*	*ins³*
2·75	67·54	6·56	3·09	·97	9·32	2·62
2·30	30·98	3·00	2·51	·78	5·43	1·50
2·04	19·34	1·91	2·19	·69	3·89	1·09
1·75	11·25	1·12	1·86	·59	2·65	·75
1·48	5·97	·62	1·55	·50	1·70	·50
1·44	3·03	·17	1·43	·34	·99	·19
1·11	·67	·02	·96	·17	·35	·04



STRUCTURAL TEES

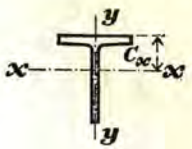
Cut from Universal Beams

DIMENSIONS AND PROPERTIES

Serial Size	Weight per foot	Width of Section **B**	Depth of Section **A**	Thickness		Root Radius *r*	Slope inside Flange	Area of Section
				Web *t*	Flange **T**			
ins	*lbs*	*ins*	*ins*	*ins*	*ins*	*ins*	*degrees*	*ins2*
12 × 18	85	12·027	18·080	·680	1·100	·75	2° 52′	24·99
	75	11·972	17·920	·625	·940	·75	2° 52′	22·08
	67·5	11·944	17·775	·597	·795	·75	2° 52′	19·85
11½ × 16½	76	11·565	16·750	·635	1·055	·70	2° 52′	22·35
	65	11·510	16·550	·580	·855	·70	2° 52′	19·13
	59	11·482	16·435	·552	·740	·70	2° 52′	17·35
10½ × 15	66	10·551	15·150	·615	1·000	·65	2° 52′	19·41
	58	10·500	15·000	·564	·850	·65	2° 52′	17·07
	49	10·444	14·840	·508	·690	·65	2° 52′	14·56
10 × 13½	57	10·070	13·640	·570	·932	·60	2° 52′	16·77
	51	10·018	13·535	·518	·827	·60	2° 52′	15·01
	47	9·990	13·455	·490	·747	·60	2° 52′	13·83
	42	9·962	13·345	·462	·637	·60	2° 52′	12·35
12 × 12	80	12·264	12·460	·732	1·235	·65	2° 52′	23·52
	60	12·088	12·155	·556	·930	·65	2° 52′	17·64
	50	12·000	12·000	·468	·775	·65	2° 52′	14·71
9 × 12	47	9·061	12·145	·516	·872	·50	2° 52′	13·81
	42	9·015	12·045	·470	·772	·50	2° 52′	12·35
	38	8·985	11·955	·440	·682	·50	2° 52′	11·18
	34	8·961	11·855	·416	·582	·50	2° 52′	10·00
13 × 10½	71	13·132	10·730	·659	1·095	·65	2° 52′	20·89
	63·5	13·061	10·620	·588	·985	·65	2° 52′	18·69
	56	13·000	10·500	·527	·865	·65	2° 52′	16·48
8¼ × 10½	41	8·342	10·720	·502	·840	·50	2° 52′	12·06
	36·5	8·295	10·620	·455	·740	·50	2° 52′	10·73
	34	8·270	10·565	·430	·685	·50	2° 52′	10·01
	31	8·240	10·495	·400	·615	·50	2° 52′	9·12
	27·5	8·216	10·400	·376	·520	·50	2° 52′	8·08
7½ × 9	33	7·592	9·200	·450	·770	·40	2° 52′	9·70
	30	7·558	9·125	·416	·695	·40	2° 52′	8·82
	27·5	7·532	9·060	·390	·630	·40	2° 52′	8·09
	25	7·500	9·000	·358	·570	·40	2° 52′	7·35
	22·5	7·476	8·930	·334	·500	·40	2° 52′	6·61

NOTE: These tables are based on Structural Tees cut from Universal Beams with a flange taper of 5% (2° 52′).

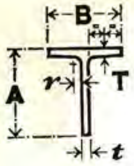
STRUCTURAL TEES



Cut from Universal Beams

DIMENSIONS AND PROPERTIES

Gravity Centre Distance *Cx*	Moment of Inertia		Radius of Gyration		Elastic Modulus		Nominal Size	Cut from Universal Beam
	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
ins	*ins4*	*ins4*	*ins*	*ins*	*ins3*	*ins3*	*ins*	*ins × ins × lbs*
4·74	784·8	150·3	5·60	2·45	58·8	25·0	$12 \times 18\frac{1}{16}$	36 × 12 × 170
4·79	696·7	125·2	5·62	2·38	53·0	20·9	$12 \times 17\frac{15}{16}$	150
4·95	634·2	103·7	5·65	2·29	49·4	17·4	$11\frac{15}{16} \times 17\frac{3}{4}$	135
4·27	591·9	128·1	5·15	2·39	47·4	22·1	$11\frac{9}{16} \times 16\frac{3}{4}$	33 × 11½ × 152
4·37	513·0	100·7	5·18	2·29	42·1	17·5	$11\frac{1}{2} \times 16\frac{9}{16}$	130
4·48	469·9	85·4	5·20	2·22	39·3	14·9	$11\frac{1}{2} \times 16\frac{7}{16}$	118
3·90	420·7	92·5	4·66	2·18	37·4	17·5	$10\frac{9}{16} \times 15\frac{1}{8}$	30 × 10½ × 132
3·94	371·8	76·6	4·67	2·12	33·6	14·6	$10\frac{1}{2} \times 15$	116
4·02	319·7	60·1	4·69	2·03	29·5	11·5	$10\frac{7}{16} \times 14\frac{13}{16}$	99
3·42	288·9	74·8	4·15	2·11	28·3	14·9	$10\frac{1}{16} \times 13\frac{5}{8}$	27 × 10 × 114
3·39	257·7	64·8	4·14	2·08	25·4	12·9	$10 \times 13\frac{9}{16}$	102
3·41	238·5	57·5	4·15	2·04	23·7	11·5	$10 \times 13\frac{7}{16}$	94
3·50	215·8	47·9	4·18	1·97	21·9	9·63	$9\frac{15}{16} \times 13\frac{3}{8}$	84
2·80	295·1	179·9	3·54	2·77	30·6	29·3	$12\frac{1}{4} \times 12\frac{7}{16}$	24 × 12 × 160
2·62	214·8	127·0	3·49	2·68	22·5	21·0	$12\frac{1}{16} \times 12\frac{1}{8}$	120
2·54	176·7	101·8	3·47	2·63	18·7	17·0	12×12	100
3·00	185·9	51·1	3·67	1·92	20·3	11·3	$9\frac{1}{16} \times 12\frac{1}{8}$	24 × 9 × 94
2·97	165·9	44·2	3·66	1·89	18·3	9·80	$9 \times 12\frac{1}{16}$	84
3·00	151·1	38·3	3·68	1·85	16·9	8·51	$9 \times 11\frac{15}{16}$	76
3·08	137·0	31·9	3·70	1·79	15·6	7·13	$8\frac{15}{16} \times 11\frac{7}{8}$	68
2·19	177·3	193·0	2·91	3·04	20·8	29·4	$13\frac{1}{8} \times 10\frac{3}{4}$	21 × 13 × 142
2·11	155·8	169·3	2·89	3·01	18·3	25·9	$13\frac{1}{16} \times 10\frac{5}{8}$	127
2·06	136·4	144·8	2·88	2·96	16·2	22·3	$13 \times 10\frac{1}{2}$	112
2·63	124·4	38·5	3·21	1·79	15·4	9·24	$8\frac{5}{16} \times 10\frac{3}{4}$	21 × 8¼ × 82
2·60	110·2	33·1	3·21	1·76	13·7	7·98	$8\frac{5}{16} \times 10\frac{5}{8}$	73
2·59	102·8	30·2	3·20	1·74	12·9	7·30	$8\frac{1}{4} \times 10\frac{9}{16}$	68
2·59	93·7	26·6	3·21	1·71	11·9	6·45	$8\frac{1}{4} \times 10\frac{1}{2}$	62
2·66	84·4	21·9	3·23	1·65	10·9	5·34	$8\frac{3}{16} \times 10\frac{3}{8}$	55
2·19	71·5	26·6	2·72	1·66	10·2	7·01	$7\frac{9}{16} \times 9\frac{3}{16}$	18 × 7½ × 66
2·17	64·8	23·5	2·71	1·63	9·32	6·23	$7\frac{9}{16} \times 9\frac{1}{8}$	60
2·16	59·6	21·0	2·71	1·61	8·63	5·57	$7\frac{9}{16} \times 9\frac{1}{16}$	55
2·14	53·9	18·6	2·71	1·59	7·85	4·96	$7\frac{1}{2} \times 9$	50
2·16	48·9	16·0	2·72	1·55	7·21	4·27	$7\frac{1}{2} \times 8\frac{15}{16}$	45



STRUCTURAL TEES

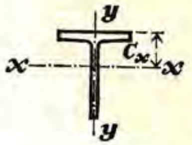
Cut from Universal Beams

DIMENSIONS AND PROPERTIES

Serial Size	Weight per foot	Width of Section **B**	Depth of Section **A**	Thickness		Root Radius *r*	Slope inside Flange	Area of Section
				Web *t*	Flange **T**			
ins	*lbs*	*ins*	*ins*	*ins*	*ins*	*ins*	*degrees*	*ins*^{2}
6 ×9	27·5	6·042	9·155	·420	·744	·40	2° 52′	8·09
	25	6·011	9·080	·389	·669	·40	2° 52′	7·35
	22·5	5·982	9·000	·360	·589	·40	2° 52′	6·61
7 ×8	25	7·073	8·125	·380	·628	·40	2° 52′	7·35
	22·5	7·039	8·060	·346	·563	·40	2° 52′	6·62
	20	7·000	8·000	·307	·503	·40	2° 52′	5·88
	18	6·992	7·925	·299	·428	·40	2° 52′	5·30
6 ×8	25	6·052	8·195	·399	·711	·40	2° 52′	7·35
	22·5	6·021	8·115	·368	·631	·40	2° 52′	6·61
	20	5·993	8·030	·340	·546	·40	2° 52′	5·88
5½×8	15·5	5·605	7·920	·272	·440	·40	2° 52′	4·56
	13	5·582	7·820	·249	·340	·40	2° 52′	3·82
6 ×7½	22·5	6·075	7·650	·381	·640	·40	2° 52′	6·62
	20	6·038	7·575	·344	·565	·40	2° 52′	5·88
	17·5	6·000	7·500	·306	·490	·40	2° 52′	5·15
6¾×7	22·5	6·820	7·165	·357	·618	·40	2° 52′	6·61
	19	6·776	7·060	·313	·513	·40	2° 52′	5·59
	17	6·750	7·000	·287	·453	·40	2° 52′	5·00
	15	6·733	6·930	·270	·383	·40	2° 52′	4·41
5 ×7	13	4·960	6·945	·257	·420	·40	2° 52′	3·82
	11	4·936	6·860	·233	·335	·40	2° 52′	3·23
6½×6	18	6·565	6·120	·305	·540	·35	2° 52′	5·29
	15·5	6·525	6·045	·265	·465	·35	2° 52′	4·56
	13·5	6·500	5·980	·240	·400	·35	2° 52′	3·99
5 ×6	16	4·930	6·110	·350	·551	·35	2° 52′	4·71
	14	4·893	6·035	·313	·476	·35	2° 52′	4·12
	12·5	4·864	5·980	·284	·421	·35	2° 52′	3·67
4 ×6	11	4·030	6·155	·260	·424	·30	1° 9′	3·24
	9·5	4·010	6·080	·240	·349	·30	1° 9′	2·81
	8·25	4·000	6·000	·230	·269	·30	1° 9′	2·43
5¾×5	14·5	5·799	5·110	·289	·500	·30	2° 52′	4·27
	12·5	5·762	5·040	·252	·430	·30	2° 52′	3·67
	10·5	5·750	4·950	·240	·340	·30	2° 52′	3·10
4 ×5	9·5	4·020	5·125	·250	·394	·30	1° 9′	2·80
	8·5	4·010	5·060	·240	·329	·30	1° 9′	2·49
	7·5	4·000	5·000	·230	·269	·30	1° 9′	2·20
5¼×4	10	5·268	4·070	·248	·378	·30	2° 52′	2·94
	8·5	5·250	4·000	·230	·308	·30	2° 52′	2·50

NOTE: These tables are based on Structural Tees cut from Universal Beams with a flange taper of 5% (2° 52′) except for serial sizes 12 × 4 and 10 × 4 for which the flange taper is 2% (1° 9′).

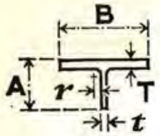
STRUCTURAL TEES



Cut from Universal Beams

DIMENSIONS AND PROPERTIES

Gravity Centre Distance *Cx*	Moment of Inertia		Radius of Gyration		Elastic Modulus		Nominal Size	Cut from Universal Beam
	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
ins	*ins*^{4}	*ins*^{4}	*ins*	*ins*	*ins*^{3}	*ins*^{3}	*ins*	*ins × ins × lbs*
2·38	62·6	13·1	2·78	1·27	9·23	4·35	$6\frac{1}{16}\times9\frac{1}{8}$	18×6 ×55
2·36	56·8	11·6	2·78	1·25	8·44	3·85	$6\times9\frac{1}{16}$	50
2·36	51·1	10·0	2·78	1·23	7·69	3·33	6×9	45
1·89	42·2	17·4	2·40	1·54	6·77	4·92	$7\frac{1}{16}\times8\frac{1}{8}$	16×7 ×50
1·87	37·8	15·2	2·39	1·52	6·10	4·33	$7\frac{1}{16}\times8\frac{1}{16}$	45
1·82	33·2	13·3	2·37	1·50	5·37	3·79	7×8	40
1·90	30·7	11·1	2·41	1·45	5·10	3·17	$7\times7\frac{15}{16}$	36
2·03	43·8	12·6	2·44	1·31	7·10	4·15	$6\frac{1}{16}\times8\frac{3}{16}$	16×6 ×50
2·01	39·3	10·9	2·44	1·28	6·45	3·62	$6\times8\frac{1}{8}$	45
2·02	35·1	9·23	2·44	1·25	5·84	3·08	6×8	40
1·99	27·1	6·01	2·44	1·15	4·57	2·14	$5\frac{5}{8}\times7\frac{15}{16}$	16×5½×31
2·08	23·2	4·48	2·46	1·08	4·05	1·61	$5\frac{9}{16}\times7\frac{13}{16}$	26
1·87	34·3	11·4	2·28	1·31	5·93	3·74	$6\frac{1}{16}\times7\frac{5}{8}$	15×6 ×45
1·84	30·3	9·78	2·27	1·29	5·28	3·24	$6\frac{1}{16}\times7\frac{9}{16}$	40
1·81	26·4	8·23	2·26	1·26	4·63	2·74	$6\times7\frac{1}{2}$	35
1·58	27·8	15·4	2·05	1·52	4·98	4·50	$6\frac{13}{16}\times7\frac{3}{16}$	14×6¾×45
1·56	23·5	12·3	2·05	1·49	4·27	3·64	$6\frac{3}{4}\times7\frac{1}{16}$	38
1·55	21·1	10·6	2·05	1·46	3·86	3·15	$6\frac{3}{4}\times7$	34
1·59	19·0	8·77	2·08	1·41	3·55	2·61	$6\frac{3}{4}\times6\frac{15}{16}$	30
1·74	17·3	4·00	2·13	1·02	3·32	1·61	$4\frac{15}{16}\times6\frac{15}{16}$	14×5 ×26
1·79	14·8	3·09	2·14	·98	2·92	1·25	$4\frac{15}{16}\times6\frac{7}{8}$	22
1·26	15·3	11·9	1·70	1·50	3·14	3·62	$6\frac{9}{16}\times6\frac{1}{8}$	12×6½×36
1·22	13·0	9·91	1·69	1·47	2·69	3·04	$6\frac{1}{2}\times6\frac{1}{16}$	31
1·21	11·4	8·30	1·69	1·44	2·39	2·55	$6\frac{1}{2}\times6$	27
1·54	15·7	5·26	1·83	1·06	3·44	2·13	$4\frac{15}{16}\times6\frac{1}{8}$	12×5 ×32
1·52	13·6	4·40	1·82	1·03	3·02	1·80	$4\frac{7}{8}\times6\frac{1}{16}$	28
1·50	12·1	3·79	1·82	1·02	2·70	1·56	$4\frac{7}{8}\times6$	25
1·63	11·7	2·27	1·90	·84	2·58	1·13	$4\times6\frac{1}{8}$	12×4 ×22
1·67	10·2	1·84	1·91	·81	2·32	·92	$4\times6\frac{1}{16}$	19
1·76	9·02	1·39	1·93	·76	2·13	·70	4×6	16·5
1·05	8·38	7·61	1·40	1·34	2·07	2·62	$5\frac{13}{16}\times5\frac{1}{8}$	10×5¾×29
1·02	7·12	6·34	1·39	1·31	1·77	2·20	$5\frac{3}{4}\times5\frac{1}{16}$	25
1·06	6·31	4·87	1·43	1·25	1·62	1·69	$5\frac{3}{4}\times4\frac{15}{16}$	21
1·29	6·81	2·09	1·56	·86	1·77	1·04	$4\times5\frac{1}{8}$	10×4 ×19
1·33	6·17	1·73	1·57	·83	1·65	·86	$4\times5\frac{1}{16}$	17
1·38	5·56	1·39	1·59	·80	1·53	·70	4×5	15
·83	3·66	4·25	1·12	1·20	1·13	1·61	$5\frac{1}{4}\times4\frac{1}{16}$	8×5¼×20
·84	3·21	3·36	1·13	1·16	1·01	1·28	$5\frac{1}{4}\times4$	17



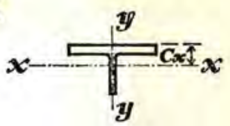
STRUCTURAL TEES

Cut from Universal Columns

DIMENSIONS AND PROPERTIES

Serial Size	Weight per foot	Width of Section B	Depth of Section A	Thickness		Root Radius r	Slope inside Flange	Area of Section
				Web t	Flange T			
ins	lbs	ins	ins	ins	ins	ins	per cent	ins²
16 ×7	79	15·550	7·500	·730	1·188	·60	0	23·24
14½×7	68	14·740	7·375	·660	1·063	·60	0	19·99
	59·5	14·650	7·250	·570	·938	·60	0	17·49
	51·5	14·575	7·125	·495	·813	·60	0	15·13
	43·5	14·500	7·000	·420	·688	·60	0	12·78
12 ×6	53	12·230	6·440	·620	·986	·60	0	15·59
	46	12·155	6·310	·545	·856	·60	0	13·53
	39·5	12·080	6·190	·470	·736	·60	0	11·61
	32·5	12·000	6·060	·390	·606	·60	0	9·55
10 ×5	44·5	10·275	5·440	·615	·998	·50	0	13·09
	36	10·170	5·250	·510	·808	·50	0	10·59
	30	10·075	5·125	·415	·683	·50	0	8·83
	24·5	10·000	5·000	·340	·558	·50	0	7·20
8 ×4	29	8·222	4·375	·510	·808	·40	0	8·53
	24	8·117	4·250	·405	·683	·40	0	7·06
	20	8·077	4·125	·365	·558	·40	0	5·88
	17·5	8·027	4·060	·315	·493	·40	0	5·15
	15·5	8·000	4·000	·288	·433	·40	0	4·56
6 ×3	12·5	6·080	3·185	·320	·454	·30	0	3·67
	10	6·018	3·100	·258	·369	·30	0	2·96
	7·85	6·000	3·000	·240	·269	·30	0	2·31

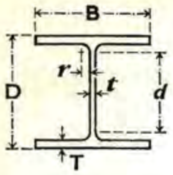
STRUCTURAL TEES



Cut from Universal Columns

DIMENSIONS AND PROPERTIES

Gravity Centre Distance Cx	Moment of Inertia		Radius of Gyration		Elastic Modulus		Nominal Size	Cut from Universal Column
	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y		
ins	ins⁴	ins⁴	ins	ins	ins³	ins³	ins	ins × ins × lbs
1·34	69·3	372·5	1·73	4·00	11·3	47·9	**$15\frac{9}{16}\times7\frac{1}{2}$**	14×16 ×158
1·31	60·1	283·9	1·73	3·77	9·89	38·5	**$14\frac{3}{4}\times7\frac{3}{8}$**	14×14½×136
1·22	50·4	245·9	1·70	3·75	8·36	33·6	**$14\frac{5}{8}\times7\frac{1}{4}$**	119
1·15	42·4	209·9	1·67	3·72	7·10	28·8	**$14\frac{9}{16}\times7\frac{1}{8}$**	103
1·08	34·9	174·8	1·65	3·70	5·88	24·1	**$14\frac{1}{2}\times7$**	87
1·20	36·7	150·4	1·53	3·11	7·01	24·6	**$12\frac{1}{4}\times6\frac{7}{16}$**	12×12 ×106
1·13	31·0	128·2	1·51	3·08	5·99	21·1	**$12\frac{1}{8}\times6\frac{5}{16}$**	92
1·06	25·8	108·2	1·49	3·05	5·03	17·9	**$12\frac{1}{16}\times6\frac{3}{16}$**	79
·98	20·6	87·3	1·47	3·02	4·06	14·6	**$12\times6\frac{1}{16}$**	65
1·07	21·3	90·3	1·28	2·63	4·88	17·6	**$10\frac{1}{4}\times5\frac{7}{16}$**	10×10 × 89
·97	16·4	70·9	1·24	2·59	3·83	13·9	**$10\frac{3}{16}\times5\frac{1}{4}$**	72
·88	12·8	58·2	1·21	2·57	3·03	11·6	**$10\frac{1}{16}\times5\frac{1}{8}$**	60
·81	9·99	46·5	1·18	2·54	2·38	9·30	**10×5**	49
·87	9·12	37·5	1·03	2·10	2·61	9·12	**$8\frac{1}{4}\times4\frac{3}{8}$**	8× 8 × 58
·78	6·92	30·5	·99	2·08	2·00	7·51	**$8\frac{1}{8}\times4\frac{1}{4}$**	48
·74	5·80	24·5	·99	2·04	1·71	6·07	**$8\frac{1}{16}\times4\frac{1}{8}$**	40
·69	4·88	21·3	·97	2·03	1·45	5·30	**$8\times4\frac{1}{16}$**	35
·67	4·32	18·5	·97	2·01	1·30	4·62	**8×4**	31
·61	2·27	8·51	·79	1·52	·88	2·80	**$6\frac{1}{16}\times3\frac{3}{16}$**	6× 6 × 25
·56	1·75	6·71	·77	1·50	·69	2·23	**$6\times3\frac{1}{8}$**	20
·56	1·47	4·85	·80	1·45	·60	1·62	**6×3**	15·7



UNIVERSAL BEARING PILES

Parallel Flanges

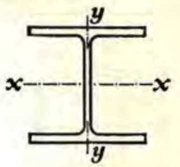
DIMENSIONS AND PROPERTIES

Serial Size	Weight per foot	Depth of Section D	Width of Section B	Thickness		Root Radius r	Depth between Fillets d	Ratio $\frac{D}{T}$
				Web t	Flange T			
ins	*lbs*	*ins*	*ins*	*ins*	*ins*	*ins*	*ins*	
14×14½	117	14·234	14·885	·805	·805	·60	11·42	17·7
	102	14·032	14·784	·704	·704	·60	11·42	19·9
	89	13·856	14·696	·616	·616	·60	11·42	22·5
	73	13·636	14·586	·506	·506	·60	11·42	26·9
12×12	74	12·122	12·217	·607	·607	·60	9·71	20·0
	53	11·780	12·046	·436	·436	·60	9·71	27·0
10×10	57	10·012	10·224	·564	·564	·50	7·88	17·8
	42	9·720	10·078	·418	·418	·50	7·88	23·3
8×8	36	8·026	8·158	·446	·446	·40	6·33	18·0

See General Notes commencing page 162.

UNIVERSAL BEARING PILES

Parallel Flanges

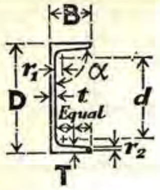


DIMENSIONS AND PROPERTIES

Area of Section	Moment of Inertia		Radius of Gyration		Elastic Modulus		Serial Size
	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	
ins^2	*ins*^{4}	*ins*^{4}	*ins*	*ins*	*ins*^{3}	*ins*^{3}	*ins*
34·44	1228·5	443·1	5·97	3·59	172·6	59·5	**14×14½**
30·01	1055·1	379·6	5·93	3·56	150·4	51·4	
26·19	909·1	326·2	5·89	3·53	131·2	44·4	
21·46	733·1	261·9	5·85	3·49	107·5	35·9	
21·76	566·5	184·7	5·10	2·91	93·5	30·2	**12×12**
15·57	394·0	127·1	5·03	2·86	66·9	21·1	
16·76	294·7	100·6	4·19	2·45	58·9	19·7	**10×10**
12·35	210·8	71·4	4·13	2·40	43·4	14·2	
10·60	119·8	40·4	3·36	1·95	29·9	9·9	**8×8**

See General Notes commencing page 162.

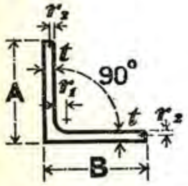
SPECIAL SECTIONS ROLLED BY DORMAN LONG



CHANNELS

DIMENSIONS AND PROPERTIES

Size D × B	Weight per foot	Thickness		Radius		Angle of Flange	Depth between Fillets d	Area of Section
		Web t	Flange T	Root r_1	Toe r^2			
ins	*lbs*	*ins*	*ins*	*ins*	*ins*	α	*ins*	*ins²*
7×2$\frac{1}{8}$	9·75	·23	·33	·33	·23	92°	5·64	2·86
6×1$\frac{1}{2}$	8·5	·25	·38	·48	·24	95°	4·25	2·50



EQUAL ANGLES

DIMENSIONS AND PROPERTIES

Size A × B	Thickness t (nominal)	Thickness t (actual)	Calculated Weight per foot	Minimum Thickness Rolled	Radii		Area of Section
					Root r_1	Toe r_2	
ins	*ins*	*ins*	*lbs*	*ins*	*ins*	*ins*	*ins²*
7×7	$\frac{7}{8}$	*·870*	*39·0*	*·500*	·54	·1875	*11·47*
	$\frac{13}{16}$	*·808*	*36·4*	*·500*			*10·71*
	$\frac{3}{4}$	·746	33·8	·500			9·93
	$\frac{11}{16}$	*·683*	*33·1*	*·500*			*9·14*
	$\frac{5}{8}$	·621	28·4	·500			8·36
	$\frac{9}{16}$	*·559*	*25·7*	*·500*			*7·56*
	$\frac{1}{2}$	·495	22·9	·500			6·73

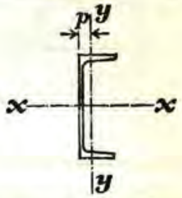
REMARKS

1. The thicknesses printed in ordinary type are the standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0.0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of standard equal angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the standard.

SPECIAL SECTIONS ROLLED BY DORMAN LONG

CHANNELS

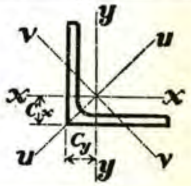
DIMENSIONS AND PROPERTIES



Size D × B	Dimension p	Moment of Inertia		Radius of Gyration		Elastic Modulus	
		Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y
ins	*ins*	*ins⁴*	*ins⁴*	*ins*	*ins*	*ins³*	*ins³*
7×2$\frac{1}{8}$	·55	20·48	1·07	2·67	·61	5·85	·68
6×1$\frac{1}{2}$	·397	12·08	·42	2·19	·41	4·02	·38

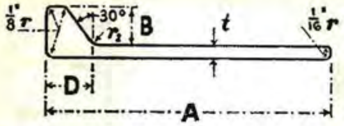
EQUAL ANGLES

DIMENSIONS AND PROPERTIES



Centre of Gravity		Moment of Inertia				Radius of Gyration				Elastic Modulus	
Cx	Cy	Axis x-x	Axis y-y	Axis u-u Max.	Axis v-v Min.	Axis x-x	Axis y-y	Axis u-u Max.	Axis v-v Min.	Axis x-x	Axis y-y
ins	*ins*	*ins⁴*	*ins⁴*	*ins⁴*	*ins⁴*	*ins*	*ins*	*ins*	*ins*	*ins³*	*ins³*
2·06	*2·06*	*51·79*	*51·79*	*82·13*	*21·46*	*2·12*	*2·12*	*2·68*	*1·37*	*10·49*	*10·49*
2·04	*2·04*	*48·70*	*48·70*	*77·29*	*20·10*	*2·13*	*2·13*	*2·69*	*1·37*	*9·81*	*9·81*
2·01	2·01	45·52	45·52	72·31	18·73	2·14	2·14	2·70	1·37	9·13	9·13
1·99	*1·99*	*42·20*	*42·20*	*67·09*	*17·32*	*2·15*	*2·15*	*2·71*	*1·38*	*8·43*	*8·43*
1·97	1·97	38·86	38·86	61·79	15·92	2·16	2·16	2·72	1·38	7·72	7·72
1·94	*1·94*	*35·42*	*35·42*	*56·34*	*14·49*	*2·16*	*2·16*	*2·73*	*1·38*	*7·00*	*7·00*
1·92	1·92	31·77	31·77	50·55	12·99	2·17	2·17	2·74	1·39	6·25	6·25

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the standards, the flanges will be longer than the standards. The profile at the back of the toe will be slightly rounded when above the standards, instead of square; but the radii at the root and toe will remain unchanged. In equal sided angles the thickness of the flanges will be the same.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



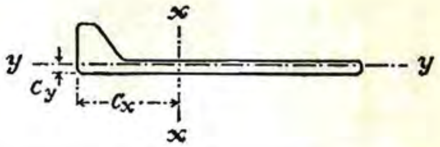
BULB FLATS

DIMENSIONS AND PROPERTIES

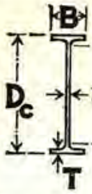
Serial Size **A**	Weight per foot	Depth of Section **B**	Dimension **D**	Radius r_2	Thickness t	Area of Section
ins	*lbs*	*ins*	*ins*	*ins*	*ins*	*ins²*
	31·19				·49	9·17
13½	33·49	1·836	1·92	·54	·54	9·85
	40·37				·69	11·87
	25·22				·45	7·42
12	27·26	1·636	1·704	·48	·50	8·02
	33·38				·65	9·82
	21·85				·43	6·43
11	23·72	1·50	1·563	·44	·48	6·98
	29·33				·63	8·63
	18·39				·40	5·41
10	20·09	1·363	1·427	·40	·45	5·91
	25·19				·60	7·41

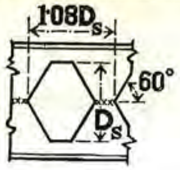
BULB FLATS

DIMENSIONS AND PROPERTIES



Centre of Gravity		Moment of Inertia		Radius of Gyration		Elastic Modulus	
C_x	C_y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y
ins	*ins*	*ins⁴*	*ins⁴*	*ins*	*ins*	*ins³*	*ins³*
5·07	·54	167·62	2·82	4·27	·55	19·89	1·57
5·19	·55	179·64	3·01	4·27	·55	21·61	1·65
5·45	·59	214·50	3·67	4·25	·56	26·66	1·90
4·54	·48	107·06	1·80	3·80	·49	14·36	1·12
4·65	·49	115·43	1·94	3·79	·49	15·71	1·18
4·90	·54	139·70	2·42	3·77	·50	19·67	1·38
4·20	·44	77·85	1·31	3·48	·45	11·46	·88
4·31	·46	84·24	1·42	3·48	·45	12·59	·93
4·53	·51	102·78	1·80	3·45	·46	15·90	1·11
3·84	·41	54·09	·91	3·16	·41	8·78	·67
3·94	·42	58·87	1·00	3·16	·41	9·71	·72
4·15	·47	72·72	1·29	3·13	·42	12·44	·87





CASTELLATED UNIVERSAL BEAMS

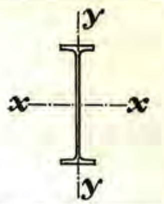
DIMENSIONS AND PROPERTIES

Serial Size		Weight per foot	Depth of Section **Dc**	Width of Section **B**	Thickness		Depth between Fillets *dc*	Area of Section	
Original	Castellated				Web *t*	Flange **T**		Gross	Net
ins	*ins*	*lbs*	*ins*	*ins*	*ins*	*ins*	*ins*	*ins*²	*ins*²
36×16½	**54×16½**	260	54·24	16·555	·845	1·440	49·16	91·77	61·35
		230	53·88	16·475	·765	1·260	49·16	81·50	53·96
36×12	**54×12**	194	54·48	12·117	·770	1·260	50·25	70·97	43·25
		170	54·16	12·027	·680	1·100	50·25	62·22	37·74
		150	53·84	11·972	·625	·940	50·25	55·41	32·91
		135	53·55	11·944	·597	·795	50·25	50·44	28·95
33×11½	**49½×11½**	152	50·00	11·565	·635	1·055	46·28	55·19	34·23
		130	49·60	11·510	·580	·855	46·28	47·83	28·69
		118	49·37	11·482	·552	·740	46·29	43·80	25·59
30×10½	**45×10½**	132	45·30	10·551	·615	1·000	41·82	48·05	29·60
		116	45·00	10·500	·564	·850	41·82	42·59	25·67
		99	44·68	10·444	·508	·690	41·81	36·73	21·49
27×10	**40½×10**	114	40·78	10·070	·570	·932	37·54	41·23	25·84
		102	40·57	10·018	·518	·827	37·54	37·00	23·02
		94	40·41	9·990	·490	·747	37·54	34·27	21·04
		84	40·19	9·962	·462	·637	37·54	30·95	18·47
24×12	**36×12**	160	36·92	12·264	·732	1·235	32·93	55·83	38·26
		120	36·31	12·088	·556	·930	32·93	41·96	28·62
		100	36·00	12·000	·468	·775	32·93	35·05	23·81
24×9	**36×9**	94	36·29	9·061	·516	·872	33·38	33·82	21·43
		84	36·09	9·015	·470	·772	33·38	30·35	19·07
		76	35·91	8·985	·440	·682	33·38	27·65	17·09
		68	35·71	8·961	·416	·582	33·38	24·99	15·01
21×13	**31½×13**	142	31·96	13·132	·659	1·095	28·22	48·70	34·86
		127	31·74	13·061	·588	·985	28·22	43·56	31·21
		112	31·50	13·000	·527	·865	28·22	38·50	27·43
21×8¼	**31½×8¼**	82	31·94	8·342	·502	·840	29·11	29·40	18·85
		73	31·74	8·295	·455	·740	29·11	26·24	16·68
		68	31·63	8·270	·430	·685	29·11	24·53	15·50
		62	31·49	8·240	·400	·615	29·11	22·43	14·03
		55	31·30	8·216	·376	·520	29·11	20·11	12·22
18×7½	**27×7½**	66	27·40	7·592	·450	·770	24·92	23·45	15·35
		60	27·25	7·558	·416	·695	24·92	21·39	13·90
		55	27·12	7·532	·390	·630	24·92	19·70	12·68
		50	27·00	7·500	·358	·570	24·92	17·93	11·49
		45	26·86	7·476	·334	·500	24·92	16·24	10·22

The overall depth, **Dc**, of the castellated section $= \mathbf{D} + \frac{\mathbf{Ds}}{2}$

where **D** = actual depth of original section
and **Ds** = serial depth of original section.

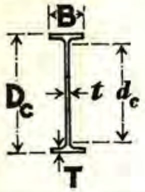
CASTELLATED UNIVERSAL BEAMS

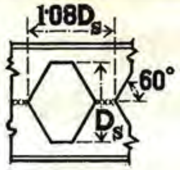


DIMENSIONS AND PROPERTIES

Serial Size	Moment of Inertia (Net)		Design Radius of Gyration*		Elastic Modulus (Net)		Pitch of Standard Castellation 1·08 Ds	Ratio **Dc**/**T**
	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
ins	*ins*⁴	*ins*⁴	*ins*	*ins*	*ins*³	*ins*³	*ins*	
54×16½	39923	1020	23·60	3·71	1472·1	123·2	38·88	37·7
	34837	870·2	23·47	3·64	1293·1	105·6	38·88	42·8
54×12	27913	354·7	23·14	2·55	1024·7	58·6	38·88	43·2
	24211	300·1	23·05	2·51	894·0	49·9	38·88	49·2
	20904	250·1	22·86	2·44	776·5	41·8	38·88	57·3
	18152	207·1	22·59	2·35	677·9	34·7	38·88	67·4
49½×11½	18734	255·8	21·37	2·44	749·3	44·2	35·64	47·4
	15471	201·2	21·09	2·35	623·8	35·0	35·64	58·0
	13653	170·6	20·90	2·28	553·1	29·7	35·64	66·7
45×10½	13277	184·7	19·32	2·23	586·2	35·0	32·40	45·3
	11391	153·0	19·15	2·17	506·3	29·1	32·40	52·9
	9412	120·0	18·94	2·09	421·3	23·0	32·40	64·8
40½×10	9417	149·3	17·47	2·15	461·8	29·7	29·16	43·8
	8338	129·4	17·40	2·12	411·1	25·8	29·16	49·1
	7573	114·9	17·30	2·09	374·8	23·0	29·16	54·1
	6575	95·8	17·13	2·02	327·2	19·2	29·16	63·1
36×12	11388	359·3	16·03	2·80	616·9	58·6	25·92	29·9
	8381	253·8	15·89	2·72	461·7	42·0	25·92	39·0
	6916	203·5	15·81	2·67	384·2	33·9	25·92	46·5
36×9	6190	102·0	15·58	1·96	341·1	22·5	25·92	41·6
	5469	88·2	15·50	1·93	303·1	19·6	25·92	46·7
	4862	76·4	15·40	1·89	270·8	17·0	25·92	52·7
	4223	63·8	15·24	1·83	236·5	14·2	25·92	61·4
31½×13	7858	385·7	14·06	3·07	491·8	58·7	22·68	29·2
	6991	338·4	14·02	3·04	440·5	51·8	22·68	32·2
	6096	289·6	13·95	3·00	387·0	44·5	22·68	36·4
31½×8¼	4203	77·0	13·71	1·82	263·2	18·5	22·68	38·0
	3691	66·1	13·64	1·79	232·6	15·9	22·68	42·9
	3416	60·3	13·60	1·77	216·0	14·6	22·68	46·2
	3072	53·1	13·54	1·74	195·1	12·9	22·68	51·2
	2644	43·8	13·39	1·69	168·9	10·7	22·68	60·2
27×7½	2523	53·2	11·82	1·68	184·1	14·0	19·44	35·6
	2269	47·0	11·76	1·66	166·5	12·4	19·44	39·2
	2057	41·9	11·71	1·64	151·7	11·1	19·44	43·0
	1855	37·1	11·67	1·62	137·4	9·9	19·44	47·4
	1637	31·9	11·59	1·58	121·9	8·5	19·44	53·7

* Design Radius of Gyration is the average between the values for the gross and net section.
These tables are based on Universal Beams with a flange taper of 5% (2° 52′).





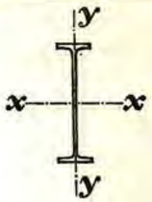
CASTELLATED UNIVERSAL BEAMS

DIMENSIONS AND PROPERTIES

Serial Size		Weight per foot	Depth of Section **Dc**	Width of Section **B**	Thickness		Depth between Fillets *dc*	Area of Section	
Original	Castellated				Web *t*	Flange **T**		Gross	Net
ins	*ins*	*lbs*	*ins*	*ins*	*ins*	*ins*	*ins*	*ins*^{2}	*ins*^{2}
18×6	**27×6**	55	27·31	6·042	·420	·744	24·92	19·96	12·40
		50	27·16	6·011	·389	·669	24·92	18·21	11·21
		45	27·00	5·982	·360	·589	24·92	16·46	9·98
16×7	**24×7**	50	24·25	7·073	·380	·628	22·07	17·74	11·66
		45	24·12	7·039	·346	·563	22·07	16·00	10·47
		40	24·00	7·000	·307	·503	22·07	14·22	9·31
		36	23·85	6·992	·299	·428	22·07	12·98	8·20
16×6	**24×6**	50	24·39	6·052	·399	·711	22·07	17·89	11·51
		45	24·23	6·021	·368	·631	22·07	16·17	10·28
		40	24·06	5·993	·340	·546	22·07	14·48	9·04
16×5½	**24×5½**	31	23·84	5·605	·272	·440	22·07	11·30	6·95
		26	23·64	5·582	·249	·340	22·07	9·63	5·65
15×6	**22½×6**	45	22·80	6·075	·381	·640	20·62	16·10	10·38
		40	22·65	6·038	·344	·565	20·62	14·35	9·19
		35	22·50	6·000	·306	·490	20·62	12·59	8·00
14×6¾	**21×6¾**	45	21·33	6·820	·357	·618	19·17	15·73	10·73
		38	21·12	6·776	·313	·513	19·17	13·36	8·98
		34	21·00	6·750	·287	·453	19·17	12·00	7·99
		30	20·86	6·733	·270	·383	19·17	10·70	6·92
14×5	**21×5**	26	20·89	4·960	·257	·420	19·17	9·44	5·84
		22	20·72	4·936	·233	·335	19·17	8·10	4·84
12×6½	**18×6½**	36	18·24	6·565	·305	·540	16·34	12·42	8·76
		31	18·09	6·525	·265	·465	16·34	10·71	7·53
		27	17·96	6·500	·240	·400	16·34	9·41	6·53
12×5	**18×5**	32	18·22	4·930	·350	·551	16·34	11·52	7·32
		28	18·07	4·893	·313	·476	16·34	10·11	6·35
		25	17·96	4·864	·284	·421	16·34	9·05	5·64
12×4	**18×4**	22	18·31	4·030	·260	·424	16·84	8·03	4·91
		19	18·16	4·010	·240	·349	16·84	7·06	4·18
		16·5	18·00	4·000	·230	·269	16·84	6·24	3·48
10×5¾	**15×5¾**	29	15·22	5·799	·289	·500	13·51	9·98	7·09
		25	15·08	5·762	·252	·430	13·51	8·61	6·09
		21	14·90	5·750	·240	·340	13·51	7·39	4·99
10×4	**15×4**	19	15·25	4·020	·250	·394	13·84	6·86	4·36
		17	15·12	4·010	·240	·329	13·84	6·18	3·78
		15	15·00	4·000	·230	·269	13·84	5·55	3·25
8×5¼	**12×5¼**	20	12·14	5·268	·248	·378	10·69	6·87	4·89
		17	12·00	5·250	·230	·308	10·69	5·92	4·08

The overall depth, **Dc**, of the castellated section $= \mathbf{D} + \frac{\mathbf{Ds}}{2}$
where **D** = actual depth of original section
and **Ds** = serial depth of original section.

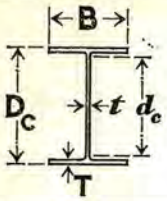
CASTELLATED UNIVERSAL BEAMS

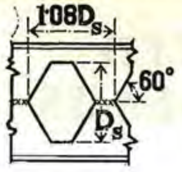


DIMENSIONS AND PROPERTIES

Serial Size	Moment of Inertia (Net)		Design Radius of Gyration*		Elastic Modulus (Net)		Pitch of Standard Castellation 1·08 Ds	Ratio **Dc**/**T**
	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
ins	*ins*^{4}	*ins*^{4}	*ins*	*ins*	*ins*^{3}	*ins*^{3}	*ins*	
27×6	2005	26·2	11·62	1·30	146·8	8·68	19·44	36·7
	1800	23·1	11·56	1·28	132·6	7·68	19·44	40·6
	1590	19·9	11·49	1·26	117·8	6·65	19·44	45·8
24×7	1510	34·7	10·50	1·56	124·6	9·83	17·28	38·6
	1348	30·5	10·46	1·54	111·7	8·65	17·28	42·8
	1194	26·5	10·44	1·53	99·5	7·57	17·28	47·7
	1037	22·1	10·31	1·47	87·0	6·33	17·28	55·7
24×6	1489	25·1	10·45	1·33	122·1	8·30	17·28	34·3
	1320	21·8	10·39	1·31	108·9	7·24	17·28	38·4
	1147	18·4	10·31	1·28	95·4	6·15	17·28	44·1
24×5½	872·3	12·0	10·22	1·17	73·2	4·28	17·28	54·2
	696·9	8·95	10·06	1·11	59·0	3·21	17·28	69·5
22½×6	1178	22·7	9·79	1·33	103·3	7·48	16·20	35·6
	1035	19·5	9·75	1·31	91·4	6·47	16·20	40·1
	893·9	16·5	9·70	1·29	79·5	5·48	16·20	45·9
21×6¾	1076	30·7	9·30	1·54	100·9	9·00	15·12	34·5
	889·9	24·6	9·22	1·51	84·3	7·27	15·12	41·2
	785·6	21·3	9·17	1·48	74·8	6·30	15·12	46·4
	673·2	17·5	9·07	1·44	64·5	5·21	15·12	54·5
21×5	562·2	7·99	8·96	1·05	53·8	3·22	15·12	49·7
	458·6	6·17	8·84	1·00	44·3	2·50	15·12	61·8
18×6½	646·4	23·7	8·02	1·51	70·9	7·23	12·96	33·8
	551·2	19·8	7·99	1·49	60·9	6·07	12·96	38·9
	473·9	16·6	7·93	1·46	52·8	5·11	12·96	44·9
18×5	526·6	10·5	7·78	1·08	57·8	4·26	12·96	33·1
	452·9	8·79	7·73	1·06	50·1	3·59	12·96	38·0
	399·4	7·57	7·69	1·04	44·5	3·11	12·96	42·7
18×4	356·8	4·54	7·76	·86	39·0	2·25	12·96	43·2
	299·4	3·66	7·67	·83	33·0	1·83	12·96	52·0
	243·6	2·78	7·51	·78	27·1	1·39	12·96	66·9
15×5¾	362·6	15·2	6·69	1·35	47·7	5·24	10·80	30·4
	308·6	12·7	6·65	1·33	40·9	4·40	10·80	35·1
	248·0	9·74	6·54	1·27	33·3	3·39	10·80	43·8
15×4	220·6	4·18	6·52	·88	28·9	2·08	10·80	38·7
	188·4	3·45	6·43	·85	24·9	1·72	10·80	46·0
	159·2	2·78	6·33	·82	21·2	1·39	10·80	55·8
12×5¼	159·8	8·49	5·35	1·21	26·3	3·22	8·64	32·1
	131·1	6·71	5·27	1·17	21·8	2·56	8·64	39·0

* Design Radius of Gyration is the average between the values for the gross and net section. These tables are based on Universal Beams with a flange taper of 5% (2° 52′) except for original serial sizes 12×4 and 10×4 for which the flange taper is 2% (1° 9′).





CASTELLATED UNIVERSAL COLUMNS

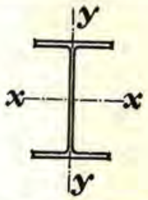
DIMENSIONS AND PROPERTIES

Serial Size		Weight per foot	Depth of Section Dc	Width of Section B	Thickness		Depth between Fillets dc	Area of Section	
Original	Castellated				Web *t*	Flange T		Gross	Net
ins	*ins*	*lbs*	*ins*	*ins*	*ins*	*ins*	*ins*	*ins*^{2}	*ins*^{2}
14×16	**21½×16**	426	26·19	16·695	1·875	3·033	18·92	139·31	111·19
		370	25·44	16·475	1·655	2·658	18·92	121·20	96·37
		314	24·69	16·235	1·415	2·283	18·92	102·91	81·69
		264	24·00	16·025	1·205	1·938	18·92	86·67	68·60
		228	23·50	15·865	1·045	1·688	18·92	74·90	59·22
		193	23·00	15·710	·890	1·438	18·92	63·40	50·05
		158	22·50	15·550	·730	1·188	18·92	51·95	41·00
Column Core	**22×16**	320	24·81	16·710	1·890	2·093	19·42	109·24	79·00
14×14½	**21×14½**	136	21·75	14·740	·660	1·063	18·42	44·60	35·36
		119	21·50	14·650	·570	·938	18·42	38·98	31·00
		103	21·25	14·575	·495	·813	18·42	33·72	26·79
		87	21·00	14·500	·420	·688	18·42	28·50	22·62
12×12	**18×12**	190	20·38	12·670	1·060	1·736	15·71	62·22	49·50
		161	19·88	12·515	·905	1·486	15·71	52·81	41·95
		133	19·38	12·365	·755	1·236	15·71	43·64	34·58
		106	18·88	12·230	·620	·986	15·71	34·91	27·47
		92	18·62	12·155	·545	·856	15·71	30·33	23·79
		79	18·38	12·080	·470	·736	15·71	26·04	20·40
		65	18·12	12·000	·390	·606	15·71	21·45	16·77
10×10	**15×10**	112	16·38	10·415	·755	1·248	12·88	36·69	29·14
		89	15·88	10·275	·615	·998	12·88	29·26	23·11
		72	15·50	10·170	·510	·808	12·88	23·73	18·63
		60	15·25	10·075	·415	·683	12·88	19·74	15·59
		49	15·00	10·000	·340	·558	12·88	16·10	12·70
8×8	**12×8**	58	12·75	8·222	·510	·808	10·33	19·10	15·02
		48	12·50	8·117	·405	·683	10·33	15·73	12·49
		40	12·25	8·077	·365	·558	10·33	13·22	10·30
		35	12·12	8·027	·315	·493	10·33	11·56	9·04
		31	12·00	8·000	·288	·433	10·33	10·27	7·97
6×6	**9×6**	25	9·37	6·080	·320	·454	7·86	8·31	6·39
		20	9·20	6·018	·258	·369	7·86	6·70	5·15
		15·7	9·00	6·000	·240	·269	7·86	5·34	3·90

The overall depth, **Dc,** of the castellated section $= \mathbf{D} + \frac{\mathbf{Ds}}{2}$

where **D** = actual depth of original section
and **Ds** = serial depth of original section, except for the 14 × 16 Series, and the Column Core Section.

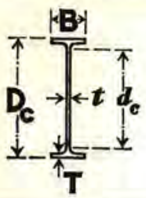
CASTELLATED UNIVERSAL COLUMNS

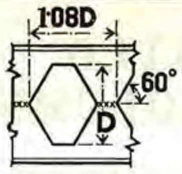


DIMENSIONS AND PROPERTIES

Serial Size	Moment of Inertia (Net)		Design Radius of Gyration*		Elastic Modulus (Net)		Pitch of Standard Castellation 1.08 Ds	Ratio $\frac{Dc}{T}$
	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
ins	*ins*^{4}	*ins*^{4}	*ins*	*ins*	*ins*^{3}	*ins*^{3}	*ins*	
21½×16	14431	2355	10·88	4·36	1102	282·2	16·20	8·6
	12105	1983	10·70	4·29	951·6	240·8	16·20	9·6
	9930	1630	10·52	4·23	804·4	200·8	16·20	10·8
	8087	1330	10·36	4·16	674·0	166·0	16·20	12·4
	6829	1124	10·25	4·12	581·2	141·7	16·20	13·9
	5644	929·7	10·13	4·07	490·8	118·4	16·20	16·0
	4521	744·7	10·02	4·02	401·8	95·8	16·20	18·9
22×16	9819	1631	10·47	4·21	791·5	195·2	17·28	11·9
21×14½	3649	567·6	9·70	3·79	335·6	77·0	15·12	20·5
	3165	491·7	9·65	3·77	294·4	67·1	15·12	22·9
	2703	419·6	9·59	3·74	254·4	57·6	15·12	26·1
	2256	349·7	9·54	3·72	214·9	48·2	15·12	30·5
18×12	4129	589·1	8·71	3·26	405·2	93·0	12·96	11·7
	3409	485·9	8·60	3·22	342·9	77·6	12·96	13·4
	2736	389·7	8·48	3·17	282·4	63·0	12·96	15·7
	2114	300·8	8·36	3·12	224·0	49·2	12·96	19·1
	1805	256·3	8·30	3·10	193·9	42·2	12·96	21·8
	1528	216·3	8·24	3·07	166·2	35·8	12·96	25·0
	1238	174·6	8·18	3·04	136·7	29·1	12·96	29·9
15×10	1607	235·2	7·09	2·69	196·2	45·2	10·80	13·1
	1233	180·6	6·96	2·64	155·3	35·1	10·80	15·9
	969·0	141·7	6·87	2·60	125·0	27·9	10·80	19·2
	798·6	116·5	6·83	2·58	104·7	23·1	10·80	22·3
	639·8	93·0	6·77	2·56	85·3	18·6	10·80	26·9
12×8	515·5	74·9	5·58	2·11	80·9	18·2	8·64	15·8
	420·9	60·9	5·54	2·09	67·3	15·0	8·64	18·3
	338·8	49·0	5·46	2·05	55·3	12·1	8·64	22·0
	294·6	42·5	5·44	2·04	48·6	10·6	8·64	24·6
	256·8	37·0	5·40	2·03	42·8	9·24	8·64	27·7
9×6	121·5	17·0	4·14	1·53	25·9	5·60	6·48	20·6
	96·4	13·4	4·10	1·51	20·9	4·46	6·48	24·9
	70·7	9·69	4·00	1·46	15·7	3·23	6·48	33·5

* Design Radius of Gyration is the average between the values for the gross and net section.

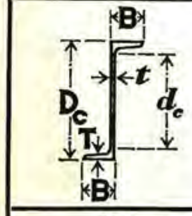


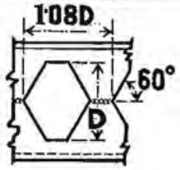


CASTELLATED JOISTS

DIMENSIONS AND PROPERTIES

Size		Weight per foot	Thickness		Depth between Fillets	Area of Section		Ratio
Original Joist Section **D×B**	Castellated Section **Dc×B**		Web *t*	Flange **T**	*dc*	Gross	Net	**Dc/T**
ins	*ins*	*lbs*	*ins*	*ins*	*ins*	*ins²*	*ins²*	
8×4	**12 ×4**	17	·230	·408	10·34	5·92	4·08	29·4
7×4	**10½×4**	14·5	·210	·357	8·94	5·00	3·53	29·4
6×3½	**9 ×3½**	11·5	·194	·326	7·64	3·96	2·80	27·6
5×3	**7½×3**	9	·178	·300	6·21	3·09	2·20	25·0
4×2½	**6 ×2½**	6·5	·161	·261	4·88	2·23	1·59	23·0
3×2	**4½×2**	4·5	·150	·224	3·48	1·55	1·10	20·1





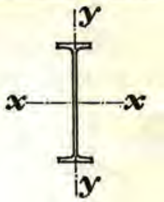
CASTELLATED ZED BEAMS

DIMENSIONS AND PROPERTIES

Size		Weight per foot	Thickness		Depth between Fillets	Area of Section		Angle α (Net Section)	Ratio
Original Channel Section **D×B**	Castellated Zed Section **Dc×B**		Web	Flange	*dc*	Gross	Net		**Dc/T**
ins	*ins*	*lbs*	*ins*	*ins*	*ins*	*ins²*	*ins²*	*degrees*	
17×4	**25½×4**	44	·48	·663	22·77	17·02	8·86	5° 11·4′	38·5
15×4	**22½×4**	37	·41	·643	19·80	13·96	7·81	6° 27·6′	35·0
12×4	**18 ×4**	31	·40	·584	15·42	11·52	6·72	8° 26·3′	30·8
12×3½	**18 ×3½**	28	·40	·538	15·66	10·63	5·83	6° 53·7′	33·5
10×3½	**15 ×3½**	24	·36	·535	12·67	8·86	5·26	9° 6·2′	28·0
10×3	**15 ×3**	19	·32	·431	13·02	7·19	3·99	7° 6·8′	34·8
9×3½	**13½×3½**	22	·34	·524	11·19	8·00	4·94	10° 32·0′	25·8
9×3	**13½×3**	17·5	·30	·439	11·51	6·50	3·80	8° 26·4′	30·8
8×3½	**12 ×3½**	20	·32	·507	9·72	7·16	4·60	12° 17·8′	23·7
8×3	**12 ×3**	16	·28	·439	10·00	5·82	3·58	10° 2·8′	27·3
7×3½	**10½×3½**	18	·30	·484	8·26	6·34	4·24	14° 32·1′	21·7
7×3	**10½×3**	14	·26	·405	8·57	5·02	3·20	11° 47·7′	25·9
6×3½	**9 ×3½**	16	·28	·455	6·82	5·55	3·87	17° 29·2′	19·8
6×3	**9 ×3**	12	·25	·355	7·17	4·28	2·78	13° 49·6′	25·4
5×2½	**7½×2½**	10	·25	·363	5·81	3·57	2·32	14° 16·7′	20·7
4×2	**6 ×2**	7	·24	·300	4·59	2·54	1·58	13° 47·2′	20·0
3×1½	**4½×1½**	4·5	·20	·267	3·30	1·62	1·02	14° 12·4′	16·9

The overall depth, **Dc**, of the castellated section = 1½**D**
where **D** = depth of original section.

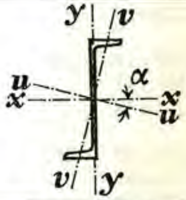
CASTELLATED JOISTS



DIMENSIONS AND PROPERTIES

Moment of Inertia (Net)		Design Radius of Gyration *		Elastic Modulus (Net)		Pitch of Standard Castellation 1.08 **D**	Size of Castellated Section
Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
ins⁴	*ins⁴*	*ins*	*ins*	*ins³*	*ins³*	*ins*	*ins*
129·3	3·90	5·24	·90	21·6	1·95	8·64	**12 ×4**
85·7	3·35	4·61	·90	16·3	1·68	7·56	**10½×4**
49·8	2·07	3·94	·79	11·1	1·18	6·48	**9 ×3½**
27·0	1·21	3·28	·68	7·20	·81	5·40	**7½×3**
12·4	·61	2·62	·57	4·13	·49	4·32	**6 ×2½**
4·75	·27	1·95	·46	2·11	·27	3·24	**4½×2**

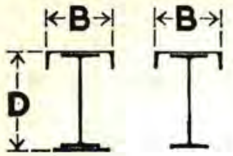
CASTELLATED ZED BEAMS



DIMENSIONS AND PROPERTIES

Moment of Inertia (Net)				Design Radius of Gyration *				Elastic Modulus (Net)		Size of Castellated Section
Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*	
ins⁴	*ins⁴*	*ins⁴*	*ins⁴*	*ins*	*ins*	*ins*	*ins*	*ins³*	*ins³*	*ins*
1202	20·87	1212	11·05	10·36	1·32	10·39	·99	94·3	5·55	**25½×4**
836·8	20·61	847·4	10·01	9·31	1·42	9·36	1·02	74·4	5·43	**22½×4**
462·7	18·51	472·7	8·52	7·51	1·47	7·58	1·02	51·4	4·87	**18 ×4**
397·3	11·35	403·0	5·62	7·40	1·22	7·45	·88	44·1	3·44	**18 ×3½**
251·1	11·44	257·5	5·12	6·27	1·31	6·35	·90	33·5	3·45	**15 ×3½**
189·3	5·71	192·2	2·81	6·19	1·05	6·23	·75	25·2	2·01	**15 ×3**
191·7	11·25	198·2	4·79	5·69	1·35	5·78	·90	28·4	3·38	**13½×3½**
147·0	5·88	150·2	2·71	5·63	1·10	5·69	·77	21·8	2·06	**13½×3**
141·4	10·91	147·9	4·40	5·10	1·39	5·21	·91	23·6	3·27	**12 ×3½**
110·2	5·93	113·6	2·56	5·06	1·15	5·13	·78	18·4	2·07	**12 ×3**
99·87	10·41	106·3	3·97	4·49	1·42	4·63	·90	19·0	3·11	**10½×3½**
75·69	5·45	78·89	2·24	4·46	1·17	4·55	·77	14·4	1·90	**10½×3**
66·71	9·75	72·99	3·48	3·88	1·46	4·04	·89	14·8	2·90	**9 ×3½**
48·27	4·70	51·08	1·89	3·84	1·17	3·94	·76	10·7	1·63	**9 ×3**
27·55	2·82	29·27	1·10	3·18	1·00	3·27	·64	7·35	1·19	**7½×2½**
11·88	1·16	12·57	·48	2·51	·77	2·58	·51	3·96	·619	**6 ×2**
4·27	·44	4·54	·17	1·88	·59	1·93	·38	1·90	·312	**4½×1½**

* Design Radius of Gyration is the average between the values for the gross and net section.



GANTRY GIRDERS

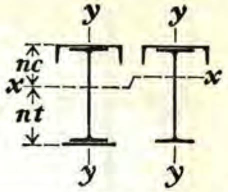
COMPOSITION AND DIMENSIONS

Size D×B *inches*	Composed of			Weight per foot in lbs	Extreme Fibre Distances		Ratio $\frac{D}{T}$ Top Flange
	Universal Beam	Top Flange Channel	Bottom Flange Plate		n_c	n_t	
37⅝×17	36×12 ×194	17×4 @44	14×⅝	267·75	17·86	19·73	27·3
37 ×17	194		—	238	15·43	21·53	26·8
36⅝×17	170		—	214	14·93	21·71	29·1
36⅜×17	150		—	194	14·44	21·88	31·8
34⅝×17	33×11½×152	17×4 @44	14×⅝	225·75	16·30	18·31	28·9
34 ×17	152		—	196	13·57	20·41	28·4
33⅝×17	130		—	174	12·96	20·62	31·7
30¾×17	30×10½×132	17×4 @44	—	176	11·95	18·83	28·0
30½×17	116		—	160	11·48	19·00	30·3
30⅜×15	116	15×4@37	—	153	11·92	18·49	30·3
27¾×17	27×10 ×114	17×4 @44	—	158	10·44	17·32	26·9
27½×17	102		—	146	10·07	17·48	28·5
27⅜×15	94	15×4@37	—	131	10·23	17·09	30·1
26 ×17	24×12 ×160	17×4 @44	14×⅝	233·75	12·30	13·72	19·0
25⅜×17	160		—	204	10·35	15·05	18·5
24¾×17	120		—	164	9·49	15·30	21·7
24½×17	100		—	144	8·95	15·53	23·8
24¾×15	24× 9 × 94	15×4 @37	—	131	9·29	15·41	26·4
24½×15	84		—	121	8·95	15·55	28·0
24¼×12	76	12×3½@28	—	104	9·26	15·05	26·7
21⅞×15	21× 8¼× 82	15×4@37	—	119	7·98	13·87	24·9
21⅝×12	73	12×3½ @28	—	101	8·20	13·44	23·7
21⅜×12	62		—	90	7·77	13·62	26·0
18¾×12	18× 7½× 66	12×3½@28	—	94	7·00	11·80	21·2
18⅝×10	60	10×3 @19	—	79	7·35	11·22	22·0
18⅜×10	50		—	69	6·96	11·36	24·5
18⅝×10	18× 6 × 55	10×3@19	—	74	7·23	11·40	24·2
18¼× 9	45	9×3@17·5	—	62·5	6·92	11·38	26·5
16⅝×12	16× 7 × 50	12×3½@28	—	78	5·77	10·88	21·6
16½×10	45	10×3 @19	—	64	6·11	10·33	23·0
16⅛×10	36		—	55	5·65	10·52	26·1
16¾×10	16× 6 × 50	10×3@19	—	69	6·37	10·34	22·3
16⅜× 9	40	9×3@17·5	—	57·5	6·03	10·33	24·7

NOTE: The above properties are based on compound girders of welded construction.

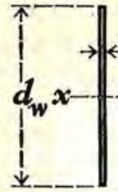
GANTRY GIRDERS

PROPERTIES



Area in square inches	Moment of Inertia			Radius of Gyration Axis y-y	Elastic Modulus			Horizontal Shear Coefficients		Size D×B *inches*
	Axis x-x	Axis y-y Top Flange only	Axis y-y Complete Section		Axis x-x n_c	Axis x-x n_t	Axis y-y Top Flange	Top Flange	Bottom Flange	
78·80	19175	691	1012	3·58	1074	971·9	81·3	0·0114	0·0089	**37⅝×17**
70·05	15464	691	870	3·52	1002	718·3	81·3	0·0121	—	**37 ×17**
62·92	13687	664	815	3·60	916·7	630·4	78·1	0·0133	—	**36⅝×17**
57·10	12088	639	765	3·66	837·3	552·4	75·2	0·0145	—	**36⅜×17**
66·40	14099	642	913	3·71	865·0	770·1	75·5	0·0141	0·0112	**34⅝×17**
57·65	10835	642	770	3·66	798·6	530·8	75·5	0·0151	—	**34 ×17**
51·20	9226	615	716	3·74	712·1	447·4	72·3	0·0169	—	**33⅝×17**
51·77	7871	606	699	3·67	658·6	418·0	71·3	0·0181	—	**30¾×17**
47·07	6926	591	667	3·77	603·5	364·4	69·5	0·0197	—	**30½×17**
45·01	6648	434	511	3·37	557·5	359·7	57·9,	0·0179	—	**30⅜×15**
46·47	5724	589	664	3·78	548·2	330·6	69·3	0·0215	—	**27¾×17**
42·95	5172	579	644	3·87	513·7	295·8	68·1	0·0229	—	**27½×17**
38·53	4575	415	473	3·50	447·2	267·7	55·4	0·0220	—	**27⅜×15**
68·74	8266	694	1017	3·85	672·0	602·3	81·6	0·0178	0·0142	**26 ×17**
59·99	6463	694	874	3·82	624·7	429·3	81·6	0·0189	—	**25⅜×17**
48·23	4952	641	768	3·99	521·8	323·6	75·4	0·0224	—	**24¾×17**
42·37	4205	616	718	4·12	470·0	270·7	72·4	0·0247	—	**24½×17**
38·51	3741	409	460	3·46	402·8	242·7	54·5	0·0241	—	**24¾×15**
35·59	3371	402	446	3·54	376·6	216·8	53·6	0·0257	—	**24½×15**
30·60	2900	208	246	2·84	313·1	192·7	34·6	0·0239	—	**24¼×12**
35·00	2613	396	435	3·52	327·4	188·3	52·8	0·0291	—	**21⅞×15**
29·69	2223	203	236	2·82	271·0	165·4	33·8	0·0272	—	**21⅝×12**
26·46	1906	196	223	2·90	245·2	140·0	32·7	0·0299	—	**21⅜×12**
27·63	1546	196	223	2·84	221·0	131·0	32·7	0·0327	—	**18¾×12**
23·23	1310	104	128	2·35	178·2	116·8	20·9	0·0282	—	**18⅝×10**
20·29	1103	99	118	2·41	158·6	97·1	19·9	0·0315	—	**18⅜×10**
21·76	1190	94	107	2·22	164·6	104·4	18·8	0·0305	—	**18⅝×10**
18·37	958	73	83	2·12	138·5	84·1	16·1	0·0329	—	**18¼× 9**
22·94	973	187	204	2·99	168·6	89·5	31·2	0·0416	—	**16⅝×12**
18·82	817	96	111	2·43	133·7	79·1	19·2	0·0368	—	**16½×10**
16·18	657	92	103	2·52	116·2	62·4	18·4	0·0418	—	**16⅛×10**
20·29	896	93	106	2·29	140·7	86·7	18·7	0·0351	—	**16¾×10**
16·90	703	72	81	2·19	116·5	68·1	16·0	0·0384	—	**16⅜× 9**

For explanation of the Tables, see notes commencing page 162.



MOMENT OF INERTIA OF RECTANGULAR PLATES

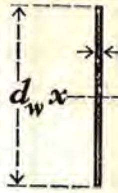
about axis x-x

Depth d_w inches	THICKNESS *t* INCHES						
	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$
1	·021	·026	·031	·036	·042	·047	·052
2	·17	·21	·25	·29	·33	·38	·42
3	·56	·70	·84	·98	1·13	1·27	1·41
4	1·33	1·67	2·00	2·33	2·67	3·00	3·33
5	2·60	3·26	3·91	4·56	5·21	5·86	6·51
6	4·50	5·63	6·75	7·88	9·00	10·13	11·25
7	7·15	8·93	10·72	12·51	14·29	16·08	17·86
8	10·67	13·33	16·00	18·67	21·33	24·00	26·67
9	15·19	18·98	22·78	26·58	30·38	34·17	37·97
10	20·83	26·04	31·25	36·46	41·67	46·87	52·08
11	27·73	34·66	41·59	48·53	55·46	62·39	69·32
12	36·00	45·00	54·00	63·00	72·00	81·00	90·00
13	45·77	57·21	68·66	80·10	91·54	103·0	114·4
14	57·17	71·46	85·75	100·0	114·3	128·6	142·9
15	70·31	87·89	105·5	123·0	140·6	158·2	175·8
16	85·33	106·7	128·0	149·3	170·7	192·0	213·3
17	102·4	127·9	153·5	179·1	204·7	230·3	255·9
18	121·5	151·9	182·3	212·6	243·0	273·4	303·8
19	142·9	178·6	214·3	250·1	285·8	321·5	357·2
20	166·7	208·3	250·0	291·7	333·3	375·0	416·7
21	192·9	241·2	289·4	337·6	385·9	434·1	482·3
22	221·8	277·3	332·8	388·2	443·7	499·1	554·6
23	253·5	316·8	380·2	443·6	507·0	570·3	633·7
24	288·0	360·0	432·0	504·0	576·0	648·0	720·0
25	325·5	406·9	488·3	569·7	651·0	732·4	813·8
26	366·2	457·7	549·3	640·8	732·3	823·9	915·4
27	410·1	512·6	615·1	717·6	820·1	922·6	1025
28	457·3	571·7	686·0	800·3	914·7	1029	1143
29	508·1	635·1	762·2	889·2	1016	1143	1270
30	562·5	703·1	843·8	984·4	1125	1266	1406
31	620·6	775·8	931·0	1086	1241	1396	1552
32	682·7	853·3	1024	1195	1365	1536	1707
33	748·7	935·9	1123	1310	1497	1685	1872
34	818·8	1024	1228	1433	1638	1842	2047
35	893·2	1117	1340	1563	1786	2010	2233

Moments of Inertia are tabulated in ins^4.

For explanation of tables see pages 163 and 172.

MOMENT OF INERTIA OF RECTANGULAR PLATES



about axis x-x

THICKNESS *t* INCHES						Depth d_w inches
$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1	
·057	·062	·068	·073	·078	·083	**1**
·46	·50	·54	·58	·63	·67	**2**
1·55	1·69	1·83	1·97	2·11	2·25	**3**
3·67	4·00	4·33	4·67	5·00	5·33	**4**
7·16	7·81	8·46	9·11	9·77	10·42	**5**
12·38	13·50	14·63	15·75	16·88	18·00	**6**
19·65	21·44	23·22	25·01	26·80	28·58	**7**
29·33	32·00	34·67	37·33	40·00	42·67	**8**
41·77	45·56	49·36	53·16	56·95	60·75	**9**
57·29	62·50	67·71	72·92	78·13	83·33	**10**
76·26	83·19	90·12	97·05	104·0	110·9	**11**
99·00	108·0	117·0	126·0	135·0	144·0	**12**
125·9	137·3	148·8	160·2	171·6	183·1	**13**
157·2	171·5	185·8	200·1	214·4	228·7	**14**
193·4	210·9	228·5	246·1	263·7	281·3	**15**
234·7	256·0	277·3	298·7	320·0	341·3	**16**
281·5	307·1	332·7	358·2	383·8	409·4	**17**
334·1	364·5	394·9	425·3	455·6	486·0	**18**
393·0	428·7	464·4	500·1	535·9	571·6	**19**
458·3	500·0	541·7	583·3	625·0	666·7	**20**
530·6	578·8	627·0	675·3	723·5	771·8	**21**
610·0	665·5	721·0	776·4	831·9	887·3	**22**
697·1	760·4	823·8	887·2	950·5	1014	**23**
792·0	864·0	936·0	1008	1080	1152	**24**
895·2	976·6	1058	1139	1221	1302	**25**
1007	1099	1190	1282	1373	1465	**26**
1128	1230	1333	1435	1538	1640	**27**
1258	1372	1486	1601	1715	1829	**28**
1397	1524	1651	1778	1905	2032	**29**
1547	1688	1828	1969	2109	2250	**30**
1707	1862	2017	2172	2327	2483	**31**
1877	2048	2219	2389	2560	2731	**32**
2059	2246	2433	2620	2808	2995	**33**
2252	2457	2661	2866	3071	3275	**34**
2456	2680	2903	3126	3350	3573	**35**

Moments of Inertia are tabulated in ins^4.

For explanation of tables see pages 163 and 172.

MOMENT OF INERTIA OF RECTANGULAR PLATES

about axis x-x

Depth d_w inches	THICKNESS *t* INCHES $\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$
36	972·0	1215	1458	1701	1944	2187	2430
39	1236	1545	1854	2163	2472	2781	3090
42	1544	1929	2315	2701	3087	3473	3859
45	1898	2373	2848	3322	3797	4271	4746
48	2304	2880	3456	4032	4608	5184	5760
51	2764	3454	4145	4836	5527	6218	6909
54	3281	4101	4921	5741	6561	7381	8201
57	3858	4823	5787	6752	7716	8681	9645
60	4500	5625	6750	7875	9000	10125	11250
63	5209	6512	7814	9116	10419	11721	13023
66	5990	7487	8984	10482	11979	13476	14974
69	6844	8555	10266	11977	13688	15399	17110
72	7776	9720	11664	13608	15552	17496	19440
75	8789	10986	13184	15381	17578	19775	21973
78	9887	12358	14830	17301	19773	22245	24716
81	11072	13840	16608	19375	22143	24911	27679
84	12348	15435	18522	21609	24696	27783	30870
87	13719	17149	20578	24008	27438	30867	34297
90	15188	18984	22781	26578	30375	34172	37969
93	16757	20947	25136	39326	33515	37704	41894
96	18432	23040	27648	32256	36864	41472	46080
99	20215	25268	30322	35375	40429	45483	50536
102	22109	27636	33163	38690	44217	49744	55271
108	26244	32805	39366	45927	52488	59049	65610
114	30866	38582	46298	54015	61731	69447	77164
120	36000	45000	54000	63000	72000	81000	90000
126	41675	52093	62512	72930	83349	93768	104186
132	47916	59895	71874	83853	95832	107811	119790
138	54752	68439	82127	95815	109503	123191	136879
144	62208	77760	93312	108864	124416	139968	155520
150	70313	87891	105469	123047	140625	158203	175781
156	79092	98865	118638	138411	158184	177957	197730
162	88574	110717	132860	155004	177147	199290	221434
168	98784	123480	148176	172872	197568	222264	246960
180	121500	151875	182250	212625	243000	273375	303750

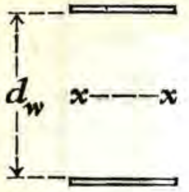
Moments of Inertia are tabulated in ins^4.
For explanation of tables see pages 163 and 172.

MOMENT OF INERTIA OF RECTANGULAR PLATES

about axis x-x

THICKNESS *t* INCHES $\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1	Depth d_w inches
2673	2916	3159	3402	3645	3888	**36**
3398	3707	4016	4325	4634	4943	**39**
4245	4631	5016	5402	5788	6174	**42**
5221	5695	6170	6645	7119	7594	**45**
6336	6912	7488	8064	8640	9216	**48**
7600	8291	8982	9672	10363	11054	**51**
9021	9842	10662	11482	12302	13122	**54**
10610	11575	12539	13504	14468	15433	**57**
12375	13500	14625	15750	16875	18000	**60**
14326	15628	16930	18233	19535	20837	**63**
16471	17969	19466	20963	22461	23958	**66**
18821	20532	22243	23954	25665	27376	**69**
21384	23328	25272	27216	29160	31104	**72**
24170	26367	28564	30762	32959	35156	**75**
27188	29660	32131	34603	37074	39546	**78**
30447	33215	35983	38751	41519	44287	**81**
33957	37044	40131	43218	46305	49392	**84**
37727	41156	44586	48016	51446	54875	**87**
41766	45563	49359	53156	56953	60750	**90**
46083	50272	54462	58651	62840	67030	**93**
50688	55296	59904	64512	69120	73728	**96**
55590	60644	65697	70751	75805	80858	**99**
60798	66326	71853	77380	82907	88434	**102**
72171	78732	85293	91854	98415	104976	**108**
84880	92597	100313	108029	115746	123462	**114**
99000	108000	117000	126000	135000	144000	**120**
114605	125024	135442	145861	156279	166698	**126**
131769	143748	155727	167706	179685	191664	**132**
150567	164255	177942	191630	205318	219006	**138**
171072	186624	202176	217728	233280	248832	**144**
193359	210938	228516	246094	263672	281250	**150**
217503	237276	257049	276822	296595	316368	**156**
243577	265721	287864	310007	332151	354294	**162**
271656	296352	321048	345744	370440	395136	**168**
334125	364500	394875	425250	455625	486000	**180**

Moments of Inertia are tabulated in ins^4.
For explanation of tables see pages 163 and 172.



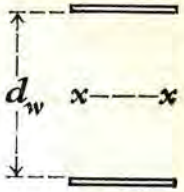
MOMENT OF INERTIA OF TWO FLANGES

per inch of width

Distance d_w *inches*	THICKNESS OF EACH FLANGE IN INCHES								
	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$
36	248·1	333·1	419·2	506·5	595·0	684·7	775·5	867·6	960·8
39	290·7	390·1	490·7	592·6	695·7	800·2	905·9	1013	1121
42	336·7	451·6	567·8	685·4	804·4	924·7	1046	1169	1294
45	386·1	517·6	650·6	785·0	920·8	1058	1197	1337	1479
48	438·8	588·1	738·9	891·3	1045	1201	1358	1516	1676
51	494·9	663·1	832·9	1004	1177	1352	1529	1707	1886
54	554·4	742·6	932·5	1124	1318	1513	1710	1908	2109
57	617·2	826·6	1038	1251	1466	1682	1901	2121	2343
60	683·5	915·1	1149	1384	1621	1861	2102	2345	2590
63	753·1	1008	1265	1524	1785	2048	2313	2580	2850
66	826·1	1106	1387	1671	1957	2245	2535	2827	3121
69	902·4	1208	1515	1824	2136	2450	2766	3085	3405
72	982·2	1314	1648	1985	2324	2665	3008	3354	3702
75	1065	1425	1787	2152	2519	2888	3260	3634	4011
78	1152	1541	1932	2326	2722	3121	3522	3926	4332
81	1242	1661	2082	2506	2933	3362	3794	4228	4666
84	1335	1785	2238	2694	3152	3613	4076	4543	5012
87	1431	1914	2399	2888	3378	3872	4369	4868	5370
90	1531	2048	2567	3088	3613	4141	4671	5204	5741
93	1635	2186	2739	3296	3856	4418	4984	5552	6124
96	1742	2328	2918	3510	4106	4705	5306	5911	6519
99	1852	2475	3102	3731	4364	5000	5639	6282	6927
102	1965	2627	3291	3959	4630	5305	5982	6663	7347
108	2202	2943	3687	4435	5186	5941	6699	7460	8225
114	2453	3278	4106	4938	5773	6613	7455	8302	9152
120	2717	3630	4547	5468	6392	7321	8253	9189	10129
126	2995	4001	5011	6025	7043	8065	9091	10121	11155
132	3286	4389	5497	6609	7725	8845	9969	11098	12230
138	3590	4796	6005	7219	8438	9661	10888	12119	13355
144	3908	5220	6536	7857	9183	10513	11847	13186	14530
150	4240	5663	7090	8522	9959	11401	12847	14298	15754
156	4585	6123	7666	9214	10767	12325	13887	15455	17028
162	4944	6602	8265	9933	11606	13285	14968	16657	18351
168	5316	7098	8886	10679	12477	14281	16090	17904	19723
180	6100	8145	10195	12252	14313	16381	18454	20533	22617

For explanation of table see pages 163 and 172.

MOMENT OF INERTIA OF TWO FLANGES



per inch of width

THICKNESS OF EACH FLANGE IN INCHES									Distance d_w *inches*
$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3	
1055	1151	1248	1346	1445	1648	1855	2068	2286	**36**
1231	1342	1454	1567	1682	1916	2155	2400	2651	**39**
1420	1547	1676	1806	1937	2205	2478	2757	3042	**42**
1622	1767	1913	2061	2210	2514	2823	3139	3461	**45**
1838	2002	2167	2333	2501	2843	3190	3545	3906	**48**
2068	2251	2436	2622	2810	3192	3580	3976	4379	**51**
2311	2515	2720	2928	3137	3561	3993	4432	4878	**54**
2567	2793	3021	3251	3482	3951	4428	4912	5405	**57**
2837	3086	3337	3590	3845	4361	4885	5418	5958	**60**
3121	3394	3669	3947	4226	4792	5365	5948	6539	**63**
3418	3716	4017	4320	4625	5242	5868	6502	7146	**66**
3728	4053	4381	4710	5042	5713	6393	7082	7781	**69**
4052	4405	4760	5118	5477	6204	6940	7686	8442	**72**
4390	4771	5155	5542	5930	6715	7510	8315	9131	**75**
4741	5152	5566	5982	6401	7247	8103	8969	9846	**78**
5105	5548	5993	6440	6890	7799	8718	9648	10589	**81**
5483	5958	6435	6915	7397	8371	9355	10351	11358	**84**
5875	6382	6893	7406	7922	8963	10015	11079	12155	**87**
6280	6822	7367	7915	8465	9576	10698	11832	12978	**90**
6698	7276	7856	8440	9026	10209	11403	12610	13829	**93**
7130	7744	8362	8982	9605	10862	12130	13412	14706	**96**
7576	8228	8883	9541	10202	11535	12880	14239	15611	**99**
8035	8725	9419	10117	10817	12229	13653	15091	16542	**102**
8993	9765	10540	11319	12101	13676	15265	16869	18486	**108**
10006	10863	11724	12589	13457	15205	16968	18745	20538	**114**
11072	12020	12971	13926	14885	16815	18760	20721	22698	**120**
12193	13235	14281	15331	16385	18506	20643	22796	24966	**126**
13367	14508	15654	16803	17957	20278	22615	24970	27342	**132**
14596	15841	17090	18343	19601	22131	24678	27243	29826	**138**
15878	17231	18589	19951	21317	24065	26830	29615	32418	**144**
17215	18680	20150	21625	23105	26079	29073	32086	35118	**150**
18605	20188	21775	23368	24965	28175	31405	34656	37926	**156**
20050	21754	23463	25178	26897	30352	33828	37324	40842	**162**
21548	23378	25214	27055	28901	32610	36340	40092	43866	**168**
24707	26803	28905	31012	33125	37369	41635	45925	50238	**180**

For explanation of table see pages 163 and 172.

MOMENT OF INERTIA OF FOUR EQUAL ANGLES

about axis x-x

Depth d_w inches	ANGLES							
	8″×8″				6″×6″			
	1″	7/8″	3/4″	5/8″	3/4″	5/8″	1/2″	3/8″
36	15043	13353	11611	9817	9010	7647	6202	4728
39	17995	15965	13875	11724	10730	9103	7378	5622
42	21217	18815	16345	13805	12602	10687	8658	6594
45	24709	21904	19020	16058	14626	12399	10041	7645
48	28472	25230	21902	18484	16802	14239	11528	8774
51	32504	28795	24989	21084	19130	16207	13118	9981
54	36807	32599	28283	23856	21610	18304	14811	11266
57	41379	36641	31782	26802	24242	20529	16607	12630
60	46222	40921	35487	29920	27025	22882	18507	14072
63	51335	45439	39398	33212	29961	25363	20510	15592
66	56718	50196	43516	36676	33049	27972	22617	17190
69	62371	55190	47839	40314	36288	30710	24827	18867
72	68294	60424	52368	44125	39680	33575	27140	20622
75	74487	65895	57103	48108	43223	36569	29556	22455
78	80951	71605	62044	52265	46918	39692	32076	24367
81	87684	77553	67191	56595	50765	42942	34699	26357
84	94688	83740	72544	61098	54765	46321	37426	28425
87	101962	90165	78103	65773	58916	49827	40255	30571
90	109506	96828	83867	70622	63219	53462	43188	32796
93	117320	103729	89838	75644	67674	57225	46225	35099
96	125404	110869	96015	80839	72280	61117	49365	37480
99	133758	118247	102398	86207	77039	65136	52608	39939
102	142382	125864	108986	91747	81950	69284	55954	42477
108	160441	141811	122781	103348	92227	77964	62957	47788
114	179581	158712	137400	115641	103112	87157	70373	53411
120	199800	176566	152843	128626	114604	96863	78202	59348
126	221101	195374	169109	142303	126705	107082	86445	65597
132	243482	215135	186199	156673	139413	117813	95101	72160
138	266943	235848	204113	171734	152728	129057	104170	79036
144	291484	257516	222851	187488	166652	140814	113653	86225
150	317106	280136	242413	203933	181183	153084	123549	93727
156	343809	303710	262798	221071	196322	165866	133858	101543
162	371592	328237	284008	238901	212068	179162	144580	109671
168	400455	353717	306041	257422	228422	192970	155716	118112
180	461423	407537	352578	296543	262954	222124	179227	135935
Nominal space '*s*'	5/8″	5/8″	5/8″	5/8″	1/2″	1/2″	1/2″	1/2″
I*y*	781·9	680·9	580·8	481·5	249·0	206·4	163·3	121·4

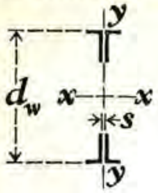
Moments of Inertia I*x* and I*y* are tabulated in ins⁴.
For explanation of tables see pages 163 and 172.

MOMENT OF INERTIA OF FOUR EQUAL ANGLES

about axis x-x

ANGLES										Depth d_w inches
5″×5″			4″×4″			3½″×3½″		3″×3″		
5/8″	1/2″	3/8″	5/8″	1/2″	3/8″	1/2″	3/8″	1/2″	3/8″	
6454	5252	4031	5224	4252	3264	3732	2864	3198	2455	**36**
7668	6237	4784	6195	5039	3867	4419	3389	3783	2903	**39**
8988	7307	5603	7249	5894	4521	5164	3959	4417	3388	**42**
10413	8462	6486	8386	6817	5226	5967	4574	5100	3911	**45**
11944	9703	7435	9606	7806	5983	6829	5232	5833	4471	**48**
13580	11029	8449	10909	8863	6791	7749	5936	6615	5069	**51**
15321	12440	9527	12295	9986	7650	8727	6683	7446	5705	**54**
17168	13937	10671	13764	11177	8561	9763	7475	8326	6378	**57**
19120	15518	11880	15317	12436	9523	10858	8312	9255	7089	**60**
21177	17186	13154	16952	13761	10536	12011	9193	10234	7837	**63**
23340	18938	14493	18671	15154	11601	13222	10118	11262	8623	**66**
25609	20775	15897	20472	16614	12717	14491	11088	12339	9446	**69**
27982	22698	17366	22357	18141	13884	15818	12102	13465	10307	**72**
30462	24706	18900	24325	19736	15103	17204	13161	14640	11206	**75**
33046	26800	20499	26376	21397	16372	18648	14264	15865	12142	**78**
35736	28978	22163	28510	23126	17693	20150	15411	17139	13116	**81**
38531	31242	23892	30727	24922	19066	21710	16603	18462	14127	**84**
41432	33591	25687	33027	26786	20490	23328	17839	19834	15176	**87**
44438	36026	27546	35410	28716	21965	25005	19120	21256	16262	**90**
47550	38545	29470	37876	30714	23491	26740	20445	22727	17386	**93**
50767	41150	31460	40425	32779	25069	28533	21815	24247	18548	**96**
54089	43840	33514	43058	34911	26698	30385	23228	25816	19747	**99**
57517	46616	35634	45773	37111	28378	32294	24687	27434	20984	**102**
64689	52422	40068	51453	41711	31892	36288	27737	30819	23570	**108**
72283	58570	44762	57466	46581	35612	40515	30964	34400	26306	**114**
80298	65059	49716	63810	51719	39537	44974	34370	38179	29193	**120**
88734	71889	54931	70487	57126	43667	49666	37953	42154	32230	**126**
97593	79060	60406	77497	62802	48002	54592	41713	46326	35417	**132**
106873	86571	66141	84838	68747	52543	59750	45652	50694	38755	**138**
116574	94424	72136	92512	74961	57289	65141	49768	55260	42243	**144**
126697	102618	78391	100518	81444	62240	70765	54061	60023	45881	**150**
137242	111153	84907	108857	88196	67396	76621	58533	64982	49669	**156**
148209	120029	91683	117528	95217	72758	82711	63182	70138	53608	**162**
159597	129247	98719	126531	102506	78324	89033	68008	75491	57697	**168**
183638	148704	113571	145534	117892	90073	102377	78195	86788	66326	**180**
1/2″	1/2″	1/2″	3/8″	3/8″	3/8″	3/8″	3/8″	5/16″	5/16″	Nominal space '*s*'
123·1	97·36	72·60	63·02	49·55	36·75	34·05	25·13	21·44	15·73	I*y*

Moments of Inertia I*x* and I*y* are tabulated in ins⁴.
For explanation of tables see pages 163 and 172.



MOMENT OF INERTIA OF FOUR UNEQUAL ANGLES

LONG LEGS BACK TO BACK

about axis x-x

Depth d_w inches	ANGLES							
	9″×4″			8″×6″			8″×4″	
	$\frac{3}{4}''$	$\frac{5}{8}''$	$\frac{1}{2}''$	$\frac{3}{4}''$	$\frac{5}{8}''$	$\frac{1}{2}''$	$\frac{5}{8}''$	$\frac{1}{2}''$
36	8138	6917	5611	9740	8245	6688	6682	5434
39	9828	8349	6768	11671	9874	8005	8050	6530
42	11684	9920	8036	13782	11654	9443	9534	7730
45	13705	11630	9417	16071	13584	11002	11146	9033
48	15891	13480	10910	18539	15665	12683	12886	10439
51	18242	15469	12516	21185	17896	14484	14755	11949
54	20758	17597	14233	24011	20277	16407	16751	13562
57	23440	19865	16063	27016	22809	18451	18876	15278
60	26286	22272	18004	30199	25491	20616	21129	17098
63	29297	24818	20058	33561	28324	22903	23511	19021
66	32474	27503	22224	37102	31307	25310	26020	21047
69	35815	30328	24502	40822	34440	27839	28658	23177
72	39322	33292	26893	44720	37724	30489	31424	25410
75	42994	36396	29395	48798	41158	33260	34318	27746
78	46830	39639	32010	53054	44743	36153	37341	30186
81	50832	43021	34737	57489	48478	39166	40491	32728
84	54999	46542	37575	62103	52363	42301	43770	35375
87	59331	50203	40526	66896	56399	45557	47177	38124
90	63828	54003	43590	71868	60585	48934	50712	40977
93	68490	57943	46765	77018	64922	52432	54375	43933
96	73317	62021	50053	82347	69409	56051	58167	46993
99	78310	66239	53452	87855	74047	59792	62087	50156
102	83467	70597	56964	93542	78835	63654	66135	53422
108	94277	79729	64324	105453	88862	71741	74615	60264
114	105747	89419	72133	118078	99490	80313	83608	67520
120	117877	99667	80390	131419	110720	89370	93114	75189
126	130668	110471	89096	145475	122552	98911	103133	83271
132	144119	121833	98251	160247	134986	108937	113665	91767
138	158230	133752	107854	175734	148021	119448	124709	100676
144	173002	146228	117906	191936	161657	130443	136267	109998
150	188434	159262	128406	208854	175896	141924	148337	119733
156	204526	172853	139355	226487	190736	153889	160920	129882
162	221279	187001	150753	244835	206177	166339	174015	140444
168	238691	201706	162599	263898	222220	179273	187624	151420
180	275498	232789	187637	304171	256112	206596	216379	174610
Nominal space '*s*'	$\frac{5}{8}''$	$\frac{5}{8}''$	$\frac{5}{8}''$	$\frac{5}{8}''$	$\frac{5}{8}''$	$\frac{5}{8}''$	$\frac{5}{8}''$	$\frac{5}{8}''$
I*y*	92·04	74·94	58·16	260·5	215·0	170·0	73·99	57·60

Moments of Inertia I*x* and I*y* are tabulated in ins^4.
For explanation of tables see pages 163 and 172.

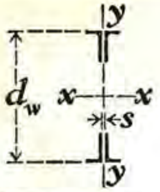
MOMENT OF INERTIA OF FOUR UNEQUAL ANGLES

LONG LEGS BACK TO BACK

about axis x-x

ANGLES									Depth d_w inches
7″×3½″		6″×4″			6″×3½″		6″×3″		
$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{5}{8}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	
4901	3748	6065	4937	3791	4631	3534	4306	3311	**36**
5876	4490	7241	5891	4521	5531	4219	5148	3957	**39**
6940	5300	8522	6930	5316	6512	4965	6067	4661	**42**
8094	6179	9908	8054	6176	7574	5772	7062	5423	**45**
9339	7126	11400	9264	7101	8717	6640	8133	6243	**48**
10673	8141	12998	10559	8091	9940	7570	9281	7122	**51**
12097	9225	14700	11939	9146	11245	8561	10504	8058	**54**
13611	10377	16508	13404	10266	12630	9613	11804	9053	**57**
15215	11597	18422	14955	11451	14097	10727	13181	10107	**60**
16909	12885	20441	16591	12701	15644	11902	14633	11218	**63**
18693	14242	22565	18312	14016	17272	13139	16162	12388	**66**
20567	15667	24795	20118	15397	18982	14437	17767	13616	**69**
22531	17160	27130	22010	16842	20772	15796	19448	14902	**72**
24585	18722	29570	23987	18352	22643	17216	21205	16247	**75**
26729	20352	32116	26049	19928	24595	18698	23039	17649	**78**
28963	22050	34768	28196	21568	26628	20241	24949	19110	**81**
31286	23817	37524	30429	23274	28741	21846	26935	20629	**84**
33700	25652	40387	32747	25044	30936	23512	28997	22207	**87**
36204	27555	43354	35150	26880	33212	25239	31136	23842	**90**
38798	29526	46427	37639	28781	35568	27028	33350	25536	**93**
41481	31566	49605	40212	30746	38006	28877	35642	27288	**96**
44255	33674	52889	42871	32777	40524	30789	38009	29099	**99**
47118	35850	56278	45616	34873	43123	32761	40452	30967	**102**
53115	40408	63373	51360	39260	48565	36890	45568	34879	**108**
59472	45238	70889	57445	43906	54330	41265	50989	39024	**114**
66189	50342	78827	63872	48813	60418	45885	56715	43402	**120**
73266	55719	87186	70639	53981	66831	50750	62745	48013	**126**
80702	61369	95967	77748	59408	73567	55861	69081	52856	**132**
88498	67292	105170	85197	65096	80627	61217	75722	57933	**138**
96655	73489	114794	92988	71044	88010	66818	82667	63242	**144**
105171	79959	124840	101120	77252	95717	72665	89918	68785	**150**
114046	86701	135308	109592	83720	103748	78757	97473	74560	**156**
123282	93717	146197	118406	90448	112102	85094	105334	80569	**162**
132878	101007	157508	127561	97437	120780	91677	113499	86810	**168**
153148	116405	181394	146893	112194	139107	105579	130745	99992	**180**
$\frac{5}{8}''$	$\frac{5}{8}''$	$\frac{1}{2}''$	$\frac{1}{2}''$	$\frac{1}{2}''$	$\frac{1}{2}''$	$\frac{1}{2}''$	$\frac{1}{2}''$	$\frac{1}{2}''$	Nominal space '*s*'
40·73	29·70	67·88	53·25	39·40	37·55	27·41	25·39	18·51	I*y*

Moments of Inertia I*x* and I*y* are tabulated in ins^4.
For explanation of tables see pages 163 and 172.



MOMENT OF INERTIA OF FOUR UNEQUAL ANGLES

LONG LEGS BACK TO BACK

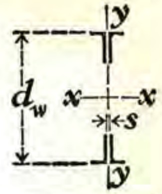
about axis x-x

Depth d_w *inches*	ANGLES									
	$5'' \times 3\frac{1}{2}''$			$5'' \times 3''$		$4'' \times 3\frac{1}{2}''$			$4'' \times 3''$	
	$\frac{5}{8}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{5}{8}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{1}{2}''$	$\frac{3}{8}''$
36	5271	4321	3295	3989	3064	4825	3952	3041	3621	2779
39	6276	5143	3920	4751	3647	5725	4687	3605	4298	3297
42	7369	6036	4598	5581	4282	6703	5485	4217	5033	3859
45	8550	7001	5332	6478	4969	7757	6346	4877	5826	4465
48	9820	8039	6120	7442	5706	8890	7269	5585	6677	5116
51	11179	9148	6962	8474	6495	10099	8256	6342	7586	5812
54	12625	10329	7859	9572	7335	11386	9306	7147	8554	6552
57	14160	11583	8811	10738	8227	12750	10419	8000	9580	7336
60	15784	12908	9817	11971	9170	14191	11595	8901	10664	8164
63	17496	14306	10878	13272	10164	15710	12834	9850	11807	9037
66	19296	15775	11993	14639	11209	17306	14135	10848	13007	9955
69	21184	17316	13163	16074	12306	18980	15500	11893	14266	10917
72	23161	18930	14388	17576	13454	20730	16928	12987	15583	11923
75	25226	20615	15667	19145	14653	22558	18418	14129	16958	12974
78	27380	22373	17001	20782	15904	24464	19972	15319	18392	14069
81	29622	24203	18389	22485	17206	26446	21589	16557	19883	15208
84	31952	26104	19832	24256	18559	28506	23268	17844	21433	16392
87	34371	28078	21329	26094	19964	30644	25011	19179	23041	17621
90	36878	30123	22881	28000	21420	32858	26816	20561	24708	18894
93	39473	32241	24487	29972	22927	35150	28685	21992	26432	20211
96	42157	34430	26148	32012	24485	37519	30616	23472	28215	21572
99	44929	36692	27864	34119	26095	39966	32610	24999	30056	22978
102	47789	39026	29634	36293	27756	42490	34668	26575	31955	24429
108	53775	43909	33338	40843	31232	47770	38971	29870	35928	27463
114	60114	49080	37261	45662	34914	53359	43527	33358	40134	30675
120	66807	54540	41402	50750	38800	59257	48334	37039	44573	34064
126	73853	60287	45761	56107	42892	65465	53394	40913	49244	37632
132	81253	66323	50338	61733	47189	71982	58705	44980	54149	41376
138	89006	72647	55134	67627	51691	78808	64268	49239	59286	45299
144	97112	79258	60147	73791	56399	85943	70082	53690	64657	49399
150	105572	86158	65380	80223	61311	93388	76149	58335	70260	53677
156	114385	93346	70830	86925	66429	101142	82468	63172	76096	58133
162	123552	100822	76499	93895	71752	109205	89038	68202	82164	62766
168	133072	108586	82386	101134	77281	117578	95860	73424	88466	67577
180	153173	124978	94815	116419	88953	135251	110261	84448	101768	77731
Nominal space '*s*'	$\frac{1}{2}''$	$\frac{1}{2}''$	$\frac{1}{2}''$	$\frac{1}{2}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$
I*y*	47·10	37·08	27·10	24·84	18·14	43·68	34·41	25·46	22·62	16·56

Moments of Inertia I*x* and I*y* are tabulated in ins^4.

For explanation of tables see pages 163 and 172.

MOMENT OF INERTIA OF FOUR UNEQUAL ANGLES



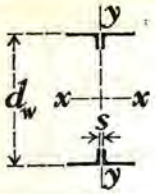
LONG LEGS BACK TO BACK

about axis x-x

ANGLES										Depth d_w *inches*
$4'' \times 2\frac{1}{2}''$		$3\frac{1}{2}'' \times 3''$			$3\frac{1}{2}'' \times 2\frac{1}{2}''$		$3'' \times 2\frac{1}{2}''$			
$\frac{3}{8}''$	$\frac{1}{4}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{5}{16}''$	$\frac{3}{8}''$	$\frac{1}{4}''$	$\frac{3}{8}''$	$\frac{5}{16}''$	$\frac{1}{4}''$	
2555	1747	3436	2639	2211	2382	1624	2230	1892	1521	**36**
3033	2073	4071	3126	2617	2823	1923	2638	2238	1799	**39**
3553	2427	4760	3653	3059	3301	2248	3080	2613	2099	**42**
4114	2809	5503	4222	3534	3817	2599	3557	3017	2424	**45**
4716	3219	6300	4832	4044	4371	2975	4069	3450	2771	**48**
5359	3658	7152	5484	4589	4962	3376	4615	3913	3142	**51**
6044	4124	8057	6176	5168	5591	3803	5195	4404	3536	**54**
6770	4618	9016	6910	5781	6257	4256	5809	4925	3954	**57**
7537	5140	10029	7686	6429	6961	4734	6458	5474	4395	**60**
8346	5691	11097	8502	7112	7703	5237	7142	6053	4859	**63**
9196	6269	12218	9360	7828	8482	5766	7859	6661	5346	**66**
10087	6875	13393	10259	8580	9299	6320	8612	7298	5857	**69**
11019	7510	14623	11199	9365	10153	6899	9398	7964	6391	**72**
11993	8172	15906	12181	10185	11045	7505	10219	8659	6948	**75**
13007	8863	17244	13203	11040	11974	8135	11074	9383	7529	**78**
14064	9581	18635	14267	11929	12941	8791	11964	10136	8133	**81**
15161	10328	20081	15373	12853	13945	9473	12888	10919	8761	**84**
16300	11103	21580	16519	13811	14988	10180	13847	11730	9411	**87**
17479	11905	23134	17707	14803	16067	10912	14839	12571	10085	**90**
18701	12736	24741	18936	15830	17184	11670	15867	13441	10783	**93**
19963	13594	26403	20206	16891	18339	12453	16928	14340	11503	**96**
21267	14481	28118	21518	17987	19532	13262	18024	15268	12247	**99**
22612	15396	29888	22871	19117	20762	14096	19155	16225	13014	**102**
25425	17310	33589	25700	21481	23334	15841	21519	18226	14619	**108**
28404	19335	37507	28695	23983	26057	17687	24020	20344	16317	**114**
31548	21473	41640	31854	26622	28930	19636	26660	22578	18108	**120**
34856	23723	45990	35179	29399	31954	21686	29436	24929	19992	**126**
38330	26085	50556	38669	32314	35128	23838	32350	27396	21970	**132**
41969	28560	55337	42323	35367	38452	26092	35402	29979	24040	**138**
45773	31146	60335	46143	38558	41926	28448	38592	32679	26205	**144**
49742	33845	65549	50128	41886	45551	30905	41919	35495	28462	**150**
53876	36655	70979	54278	45352	49326	33465	45383	38428	30813	**156**
58175	39578	76626	58592	48957	53251	36126	48985	41477	33257	**162**
62639	42613	82488	63072	52698	57326	38889	52725	44642	35794	**168**
72062	49019	94861	72527	60596	65928	44720	60617	51322	41148	**180**
$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{5}{16}''$	$\frac{5}{16}''$	$\frac{5}{16}''$	Nominal space '*s*'
10·29	6·60	22·55	16·54	13·51	10·08	6·46	9·61	7·93	6·18	I*y*

Moments of Inertia I*x* and I*y* are tabulated in ins^4.

For explanation of tables see pages 163 and 172.



MOMENT OF INERTIA OF FOUR UNEQUAL ANGLES

SHORT LEGS BACK TO BACK

about axis x-x

Depth d_w inches	ANGLES							
	9″ × 4″			8″ × 6″			8″ × 4″	
	¾″	⅝″	½″	¾″	⅝″	½″	⅝″	½″
36	10763	9135	7398	10869	9195	7454	8361	6779
39	12727	10798	8740	12919	10924	8851	9887	8012
42	14857	12599	10194	15148	12804	10369	11541	9348
45	17151	14540	11760	17555	14833	12009	13323	10788
48	19610	16620	13438	20142	17013	13769	15233	12330
51	22235	18840	15229	22907	19344	15651	17271	13977
54	25025	21198	17131	25851	21825	17654	19437	15726
57	27979	23697	19146	28974	24456	19778	21732	17579
60	31099	26334	21273	32276	27238	22023	24155	19535
63	34384	29111	23512	35756	30170	24389	26706	21595
66	37834	32027	25863	39416	33252	26877	29385	23758
69	41449	35082	28327	43254	36485	29486	32193	26024
72	45229	38277	30902	47271	39869	32216	35129	28393
75	49174	41611	33590	51467	43403	35067	38192	30866
78	53284	45084	36390	55842	47087	38039	41385	33442
81	57559	48697	39302	60395	50921	41133	44705	36122
84	62000	52449	42326	65128	54906	44348	48153	38905
87	66605	56340	45462	70039	59042	47684	51730	41791
90	71376	60371	48711	75129	63327	51141	55435	44780
93	76311	64541	52072	80398	67764	54719	59268	47873
96	81412	68850	55544	85846	72350	58418	63229	51069
99	86677	73299	59129	91472	77087	62239	67319	54369
102	92108	77887	62826	97278	81975	66181	71536	57771
108	103465	87480	70557	109425	92201	74428	80356	64887
114	115482	97631	78736	122287	103028	83160	89689	72416
120	128159	108340	87364	135865	114457	92377	99535	80358
126	141497	119605	96441	150159	126488	102078	109893	88713
132	155495	131428	105966	165167	139121	112265	120764	97482
138	170153	143808	115939	180891	152355	122935	132148	106664
144	185472	156745	126362	197330	166191	134091	144045	116260
150	201450	170240	137232	214485	180628	145731	156455	126268
156	218090	184292	148552	232354	195667	157857	169377	136690
162	235389	198901	160320	250939	211308	170466	182812	147525
168	253349	214067	172537	270240	227550	183561	196760	158774
180	291249	246072	198316	310987	261839	211205	226195	182511
Nominal space '*s*'	⅝″	⅝″	⅝″	⅝″	⅝″	⅝″	⅝″	⅝″
I*y*	804·9	670·9	532·9	577·6	479·4	380·8	478·8	380·2

Moments of Inertia I*x* and I*y* are tabulated in ins⁴.
For explanation of tables see pages 163 and 172.

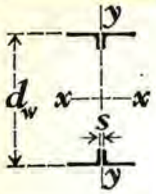
MOMENT OF INERTIA OF FOUR UNEQUAL ANGLES

SHORT LEGS BACK TO BACK

about axis x-x

ANGLES									Depth d_w inches
7″ × 3½″		6″ × 4″			6″ × 3½″		6″ × 3″		
½″	⅜″	⅝″	½″	⅜″	½″	⅜″	½″	⅜″	
5953	4546	6778	5514	4231	5320	4057	5090	3910	**36**
7032	5367	8024	6524	5004	6287	4792	6008	4613	**39**
8200	6256	9375	7620	5842	7335	5588	7002	5375	**42**
9458	7213	10831	8801	6744	8464	6446	8073	6194	**45**
10807	8239	12393	10067	7712	9673	7365	9220	7072	**48**
12245	9333	14060	11418	8745	10964	8345	10443	8009	**51**
13773	10496	15832	12854	9843	12335	9387	11742	9003	**54**
15391	11726	17710	14376	11006	13788	10490	13118	10056	**57**
17100	13025	19693	15983	12234	15321	11654	14570	11167	**60**
18898	14393	21782	17675	13527	16935	12880	16098	12336	**63**
20786	15828	23976	19453	14886	18630	14167	17702	13563	**66**
22764	17332	26276	21315	16309	20406	15515	19383	14849	**69**
24832	18904	28681	23264	17797	22263	16925	21140	16193	**72**
26990	20545	31191	25297	19350	24201	18396	22973	17595	**75**
29238	22253	33807	27415	20969	26220	19928	24882	19055	**78**
31576	24030	36528	29619	22652	28320	21522	26868	20574	**81**
34004	25876	39354	31908	24400	30501	23177	28929	22151	**84**
36521	27789	42286	34283	26214	32762	24894	31067	23786	**87**
39129	29771	45324	36742	28092	35105	26672	33282	25479	**90**
41827	31822	48466	39287	30036	37528	28511	35572	27230	**93**
44615	33940	51715	41917	32045	40033	30411	37939	29040	**96**
47492	36127	55068	44633	34118	42618	32373	40382	30908	**99**
50460	38382	58527	47433	36257	45284	34396	42901	32834	**102**
56665	43097	65761	53290	40729	50859	38626	48168	36862	**108**
63230	48085	73417	59488	45462	56758	43102	53740	41122	**114**
70155	53347	81495	66028	50455	62980	47823	59617	45615	**120**
77440	58881	89994	72908	55708	69527	52790	65799	50341	**126**
85085	64689	98914	80129	61221	76396	58001	72286	55300	**132**
93089	70770	108257	87691	66995	83590	63459	79078	60492	**138**
101453	77124	118021	95595	73028	91107	69161	86175	65917	**144**
110178	83751	128206	103839	79322	98948	75109	93577	71574	**150**
119262	90652	138813	112425	85876	107112	81302	101283	77465	**156**
128705	97825	149842	121351	92690	115601	87741	109295	83589	**162**
138509	105272	161293	130619	99765	124413	94425	117612	89946	**168**
159196	120985	185458	150177	114694	143007	108529	135160	103358	**180**
⅝″	⅝″	½″	½″	½″	½″	½″	½″	½″	Nominal space '*s*'
259·6	193·6	204·3	162·2	121·4	162·3	120·6	161·7	121·1	I*y*

Moments of Inertia I*x* and I*y* are tabulated in ins⁴.
For explanation of tables see pages 163 and 172.



MOMENT OF INERTIA OF FOUR UNEQUAL ANGLES

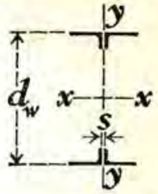
SHORT LEGS BACK TO BACK

about axis x-x

Depth d_w inches	ANGLES									
	$5'' \times 3\frac{1}{2}''$			$5'' \times 3''$		$4'' \times 3\frac{1}{2}''$			$4'' \times 3''$	
	$\frac{5}{8}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{5}{8}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{1}{2}''$	$\frac{3}{8}''$
36	5730	4696	3579	4459	3422	4961	4063	3126	3828	2937
39	6779	5553	4231	5266	4040	5874	4808	3698	4524	3469
42	7916	6482	4936	6140	4708	6865	5617	4318	5278	4046
45	9142	7483	5697	7081	5429	7932	6488	4986	6090	4667
48	10456	8556	6512	8090	6200	9077	7422	5702	6961	5333
51	11858	9701	7381	9166	7023	10300	8420	6467	7890	6043
54	13348	10919	8305	10309	7897	11599	9480	7279	8877	6798
57	14927	12208	9284	11519	8822	12976	10603	8140	9922	7596
60	16595	13569	10317	12797	9799	14430	11789	9049	11025	8440
63	18350	15002	11405	14142	10827	15962	13039	10007	12187	9327
66	20194	16507	12547	15554	11906	17571	14351	11012	13407	10260
69	22127	18084	13744	17033	13037	19257	15726	12066	14685	11236
72	24147	19734	14996	18580	14219	21020	17164	13167	16021	12257
75	26257	21455	16302	20193	15452	22861	18665	14317	17416	13322
78	28454	23248	17663	21874	16737	24779	20229	15515	18868	14432
81	30740	25113	19078	23622	18072	26775	21856	16762	20379	15586
84	33114	27051	20548	25438	19460	28848	23546	18056	21949	16785
87	35576	29060	22072	27320	20898	30998	25299	19399	23576	18028
90	38127	31141	23651	29270	22388	33225	27115	20790	25262	19316
93	40767	33295	25284	31287	23929	35530	28994	22229	27005	20647
96	43494	35520	26973	33371	25521	37912	30936	23716	28807	22024
99	46310	37817	28715	35523	27165	40371	32940	25251	30668	23444
102	49214	40187	30512	37742	28860	42908	35008	26835	32586	24910
108	55288	45141	34271	42381	32404	48214	39333	30146	36598	27973
114	61715	50384	38247	47289	36153	53828	43909	33650	40842	31214
120	68496	55915	42442	52466	40107	59752	48737	37347	45319	34633
126	75630	61734	46855	57911	44267	65985	53817	41237	50029	38230
132	83117	67841	51486	63626	48631	72528	59149	45319	54972	42004
138	90958	74236	56336	69610	53201	79380	64733	49594	60148	45956
144	99152	80920	61404	75862	57976	86541	70569	54062	65557	50085
150	107700	87891	66690	82383	62957	94011	76656	58722	71199	54392
156	116601	95150	72194	89174	68143	101791	82995	63575	77073	58877
162	125856	102698	77917	96233	73533	109880	89587	68621	83181	63540
168	135464	110533	83858	103561	79130	118278	96430	73859	89521	68380
180	155740	127068	96395	119024	90937	136002	110872	84914	102900	78593
Nominal space '*s*'	$\frac{1}{2}''$	$\frac{1}{2}''$	$\frac{1}{2}''$	$\frac{1}{2}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$
I*y*	121·6	96·94	71·74	96·26	71·78	62·55	49·55	36·84	49·12	36·42

Moments of Inertia I*x* and I*y* are tabulated in ins^4.
For explanation of tables see pages 163 and 172.

MOMENT OF INERTIA OF FOUR UNEQUAL ANGLES

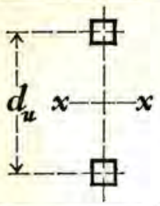


SHORT LEGS BACK TO BACK

about axis x-x

ANGLES										Depth d_w inches
$4'' \times 2\frac{1}{2}''$		$3\frac{1}{2}'' \times 3''$			$3\frac{1}{2}'' \times 2\frac{1}{2}''$		$3'' \times 2\frac{1}{2}''$			
$\frac{3}{8}''$	$\frac{1}{4}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{5}{16}''$	$\frac{3}{8}''$	$\frac{1}{4}''$	$\frac{3}{8}''$	$\frac{5}{16}''$	$\frac{1}{4}''$	
2776	1897	3533	2713	2272	2517	1716	2292	1945	1563	**36**
3275	2237	4177	3207	2685	2971	2024	2706	2296	1845	**39**
3815	2605	4875	3741	3132	3462	2357	3154	2676	2149	**42**
4396	3001	5627	4317	3613	3990	2716	3637	3084	2478	**45**
5019	3425	6433	4934	4129	4556	3100	4154	3522	2829	**48**
5683	3877	7293	5592	4679	5160	3510	4706	3990	3204	**51**
6388	4357	8207	6291	5264	5801	3945	5291	4486	3602	**54**
7135	4865	9176	7032	5883	6480	4406	5912	5011	4023	**57**
7922	5401	10198	7814	6536	7196	4892	6566	5566	4468	**60**
8751	5965	11274	8637	7224	7950	5404	7255	6149	4936	**63**
9622	6557	12404	9502	7947	8742	5941	7979	6762	5427	**66**
10533	7178	13589	10408	8704	9571	6504	8737	7403	5941	**69**
11486	7826	14827	11355	9495	10437	7092	9529	8074	6479	**72**
12480	8502	16119	12343	10321	11342	7705	10355	8774	7041	**75**
13515	9206	17466	13373	11181	12283	8344	11216	9503	7625	**78**
14592	9939	18866	14443	12076	13263	9008	12112	10261	8233	**81**
15709	10699	20320	15556	13005	14280	9698	13041	11049	8864	**84**
16868	11488	21829	16709	13969	15334	10414	14006	11865	9519	**87**
18069	12304	23391	17904	14967	16426	11154	15004	12710	10197	**90**
19310	13148	25008	19139	15999	17556	11920	16037	13585	10898	**93**
20593	14021	26678	20417	17066	18723	12712	17104	14488	11622	**96**
21917	14922	28403	21735	18168	19928	13529	18206	15421	12370	**99**
23283	15850	30181	23095	19304	21170	14372	19342	16383	13141	**102**
26137	17791	33901	25938	21679	23768	16133	21718	18394	14753	**108**
29157	19845	37836	28946	24192	26515	17997	24231	20521	16459	**114**
32341	22010	41987	32119	26843	29413	19962	26881	22765	18257	**120**
35691	24288	46355	35457	29631	32462	22029	29669	25125	20149	**126**
39205	26678	50938	38961	32558	35660	24198	32595	27602	22135	**132**
42885	29180	55738	42629	35622	39009	26468	35658	30195	24213	**138**
46730	31794	60754	46462	38824	42508	28841	38859	32904	26385	**144**
50740	34520	65986	50461	42164	46158	31315	42197	35730	28650	**150**
54914	37358	71434	54624	45641	49958	33891	45673	38672	31008	**156**
59254	40308	77098	58953	49257	53908	36569	49286	41731	33460	**162**
63759	43371	82978	63446	53010	58008	39349	53037	44906	36005	**168**
73264	49833	95387	72928	60930	66659	45214	60952	51605	41374	**180**
$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{3}{8}''$	$\frac{5}{16}''$	$\frac{5}{16}''$	$\frac{5}{16}''$	Nominal space '*s*'
36·50	24·01	34·05	25·15	20·62	24·83	16·21	15·73	13·05	10·22	I*y*

Moments of Inertia I*x* and I*y* are tabulated in ins^4.
For explanation of tables see pages 163 and 172.



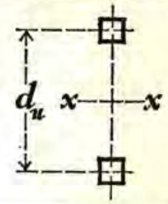
SECOND MOMENT OF A PAIR OF UNIT AREAS

about axis x-x

Distance d_u *inches*	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
30	450·0	453·0	456·0	459·1	462·1	465·1	468·2	471·3	474·3	477·4
31	480·5	483·6	486·7	489·9	493·0	496·1	499·3	502·5	505·6	508·8
32	512·0	515·2	518·4	521·7	524·9	528·1	531·4	534·7	537·9	541·2
33	544·5	547·8	551·1	554·5	557·8	561·1	564·5	567·9	571·2	574·6
34	578·0	581·4	584·8	588·3	591·7	595·1	598·6	602·1	605·5	609·0
35	612·5	616·0	619·5	623·1	626·6	630·1	633·7	637·3	640·8	644·4
36	648·0	651·6	655·2	658·9	662·5	666·1	669·8	673·5	677·1	680·8
37	684·5	688·2	691·9	695·7	699·4	703·1	706·9	710·7	714·4	718·2
38	722·0	725·8	729·6	733·5	737·3	741·1	745·0	748·9	752·7	756·6
39	760·5	764·4	768·3	772·3	776·2	780·1	784·1	788·1	792·0	796·0
40	800·0	804·0	808·0	812·1	816·1	820·1	824·2	828·3	832·3	836·4
41	840·5	844·6	848·7	852·9	857·0	861·1	865·3	869·5	873·6	877·8
42	882·0	886·2	890·4	894·7	898·9	903·1	907·4	911·7	915·9	920·2
43	924·5	928·8	933·1	937·5	941·8	946·1	950·5	954·9	959·2	963·6
44	968·0	972·4	976·8	981·3	985·7	990·1	994·6	999·1	1004	1008
45	1013	1017	1022	1026	1031	1035	1040	1044	1049	1053
46	1058	1063	1067	1072	1076	1081	1086	1090	1095	1100
47	1105	1109	1114	1119	1123	1128	1133	1138	1142	1147
48	1152	1157	1162	1166	1171	1176	1181	1186	1191	1196
49	1201	1205	1210	1215	1220	1225	1230	1235	1240	1245
50	1250	1255	1260	1265	1270	1275	1280	1285	1290	1295
51	1301	1306	1311	1316	1321	1326	1331	1336	1342	1347
52	1352	1357	1362	1368	1373	1378	1383	1389	1394	1399
53	1405	1410	1415	1420	1426	1431	1436	1442	1447	1453
54	1458	1463	1469	1474	1480	1485	1491	1496	1502	1507
55	1513	1518	1524	1529	1535	1540	1546	1551	1557	1562
56	1568	1574	1579	1585	1590	1596	1602	1607	1613	1619
57	1625	1630	1636	1642	1647	1653	1659	1665	1670	1676
58	1682	1688	1694	1699	1705	1711	1717	1723	1729	1735
59	1741	1746	1752	1758	1764	1770	1776	1782	1788	1794
60	1800	1806	1812	1818	1824	1830	1836	1842	1848	1854
61	1861	1867	1873	1879	1885	1891	1897	1903	1910	1916
62	1922	1928	1934	1941	1947	1953	1959	1966	1972	1978
63	1985	1991	1997	2003	2010	2016	2022	2029	2035	2042
64	2048	2054	2061	2067	2074	2080	2087	2093	2100	2106

For explanation of table see pages 163 and 172.

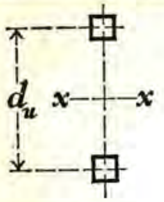
SECOND MOMENT OF A PAIR OF UNIT AREAS



about axis x-x

Distance d_u *inches*	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
65	2113	2119	2126	2132	2139	2145	2152	2158	2165	2171
66	2178	2185	2191	2198	2204	2211	2218	2224	2231	2238
67	2245	2251	2258	2265	2271	2278	2285	2292	2298	2305
68	2312	2319	2326	2332	2339	2346	2353	2360	2367	2374
69	2381	2387	2394	2401	2408	2415	2422	2429	2436	2443
70	2450	2457	2464	2471	2478	2485	2492	2499	2506	2513
71	2521	2528	2535	2542	2549	2556	2563	2570	2578	2585
72	2592	2599	2606	2614	2621	2628	2635	2643	2650	2657
73	2665	2672	2679	2686	2694	2701	2708	2716	2723	2731
74	2738	2745	2753	2760	2768	2775	2783	2790	2798	2805
75	2813	2820	2828	2835	2843	2850	2858	2865	2873	2880
76	2888	2896	2903	2911	2918	2926	2934	2941	2949	2957
77	2965	2972	2980	2988	2995	3003	3011	3019	3026	3034
78	3042	3050	3058	3065	3073	3081	3089	3097	3105	3113
79	3121	3128	3136	3144	3152	3160	3168	3176	3184	3192
80	3200	3208	3216	3224	3232	3240	3248	3256	3264	3272
81	3281	3289	3297	3305	3313	3321	3329	3337	3346	3354
82	3362	3370	3378	3387	3395	3403	3411	3420	3428	3436
83	3445	3453	3461	3469	3478	3486	3494	3503	3511	3520
84	3528	3536	3545	3553	3562	3570	3579	3587	3596	3604
85	3613	3621	3630	3638	3647	3665	3664	3672	3681	3689
86	3698	3707	3715	3724	3732	3741	3750	3758	3767	3776
87	3785	3793	3802	3811	3819	3828	3837	3846	3854	3863
88	3872	3881	3890	3898	3907	3916	3925	3934	3943	3952
89	3961	3969	3978	3987	3996	4005	4014	4023	4032	4041
90	4050	4059	4068	4077	4086	4095	4104	4113	4122	4131
91	4141	4150	4159	4168	4177	4186	4195	4204	4214	4223
92	4232	4241	4250	4260	4269	4278	4287	4297	4306	4315
93	4325	4334	4343	4352	4362	4371	4380	4390	4399	4409
94	4418	4427	4437	4446	4456	4465	4475	4484	4494	4503
95	4513	4522	4532	4541	4551	4560	4570	4579	4589	4598
96	4608	4618	4627	4637	4646	4656	4666	4675	4685	4695
97	4705	4714	4724	4734	4743	4753	4763	4773	4782	4792
98	4802	4812	4822	4831	4841	4851	4861	4871	4881	4891
99	4901	4910	4920	4930	4940	4950	4960	4970	4980	4990

For explanation of table see pages 163 and 172.



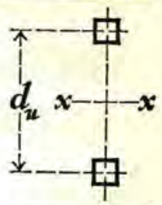
SECOND MOMENT OF A PAIR OF UNIT AREAS

about axis x-x

Distance d_u *inches*	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
100	5000	5010	5020	5030	5040	5050	5060	5070	5080	5090
101	5101	5111	5121	5131	5141	5151	5161	5171	5182	5192
102	5202	5212	5222	5233	5243	5253	5263	5274	5284	5294
103	5305	5315	5325	5335	5346	5356	5366	5377	5387	5398
104	5408	5418	5429	5439	5450	5460	5471	5481	5492	5502
105	5513	5523	5534	5544	5555	5565	5576	5586	5597	5607
106	5618	5629	5639	5650	5660	5671	5682	5692	5703	5714
107	5725	5735	5746	5757	5767	5778	5789	5800	5810	5821
108	5832	5843	5854	5864	5875	5886	5897	5908	5919	5930
109	5941	5951	5962	5973	5984	5995	6006	6017	6028	6039
110	6050	6061	6072	6083	6094	6105	6116	6127	6138	6149
111	6161	6172	6183	6194	6205	6216	6227	6238	6250	6261
112	6272	6283	6294	6306	6317	6328	6339	6351	6362	6373
113	6385	6396	6407	6418	6430	6441	6452	6464	6475	6487
114	6498	6509	6521	6532	6544	6555	6567	6578	6590	6601
115	6613	6624	6636	6647	6659	6670	6682	6693	6705	6716
116	6728	6740	6751	6763	6774	6786	6798	6809	6821	6833
117	6845	6856	6868	6880	6891	6903	6915	6927	6938	6950
118	6962	6974	6986	6997	7009	7021	7033	7045	7057	7069
119	7081	7092	7104	7116	7128	7140	7152	7164	7176	7188
120	7200	7212	7224	7236	7248	7260	7272	7284	7296	7308
121	7321	7333	7345	7357	7369	7381	7393	7405	7418	7430
122	7442	7454	7466	7479	7491	7503	7515	7528	7540	7552
123	7565	7577	7589	7601	7614	7626	7638	7651	7663	7676
124	7688	7700	7713	7725	7738	7750	7763	7775	7788	7800
125	7813	7825	7838	7850	7863	7875	7888	7900	7913	7925
126	7938	7951	7963	7976	7988	8001	8014	8026	8039	8052
127	8065	8077	8090	8103	8115	8128	8141	8154	8166	8179
128	8192	8205	8218	8230	8243	8256	8269	8282	8295	8308
129	8321	8333	8346	8359	8372	8385	8398	8411	8424	8437
130	8450	8463	8476	8489	8502	8515	8528	8541	8554	8567
131	8581	8594	8607	8620	8633	8646	8659	8672	8686	8699
132	8712	8725	8738	8752	8765	8778	8791	8805	8818	8831
133	8845	8858	8871	8884	8898	8911	8924	8938	8951	8965
134	8978	8991	9005	9018	9032	9045	9059	9072	9086	9099

For explanation of table see pages 163 and 172.

SECOND MOMENT OF A PAIR OF UNIT AREAS



about axis x-x

Distance d_u *inches*	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
135	9113	9126	9140	9153	9167	9180	9194	9207	9221	9234
136	9248	9262	9275	9289	9302	9316	9330	9343	9357	9371
137	9385	9398	9412	9426	9439	9453	9467	9481	9494	9508
138	9522	9536	9550	9563	9577	9591	9605	9619	9633	9647
139	9661	9674	9688	9702	9716	9730	9744	9758	9772	9786
140	9800	9814	9828	9842	9856	9870	9884	9898	9912	9926
141	9941	9955	9969	9983	9997	10011	10025	10039	10054	10068
142	10082	10096	10110	10125	10139	10153	10167	10182	10196	10210
143	10225	10239	10253	10267	10282	10296	10310	10325	10339	10354
144	10368	10382	10397	10411	10426	10440	10455	10469	10484	10498
145	10513	10527	10542	10556	10571	10585	10600	10614	10629	10643
146	10658	10673	10687	10702	10716	10731	10746	10760	10775	10790
147	10805	10819	10834	10849	10863	10878	10893	10908	10922	10937
148	10952	10967	10982	10996	11011	11026	11041	11056	11071	11086
149	11101	11115	11130	11145	11160	11175	11190	11205	11220	11235
150	11250	11265	11280	11295	11310	11325	11340	11355	11370	11385
151	11401	11416	11431	11446	11461	11476	11491	11506	11522	11537
152	11552	11567	11582	11598	11613	11628	11643	11659	11674	11689
153	11705	11720	11735	11750	11766	11781	11796	11812	11827	11843
154	11858	11873	11889	11904	11920	11935	11951	11966	11982	11997
155	12013	12028	12044	12059	12075	12090	12106	12121	12137	12152
156	12168	12184	12199	12215	12230	12246	12262	12277	12293	12309
157	12325	12340	12356	12372	12387	12403	12419	12435	12450	12466
158	12482	12498	12514	12529	12545	12561	12577	12593	12609	12625
160	12800	12816	12832	12848	12864	12880	12896	12912	12928	12944
162	13122	13138	13154	13171	13187	13203	13219	13236	13252	13268
164	13448	13464	13481	13497	13514	13530	13547	13563	13580	13596
166	13778	13795	13811	13828	13844	13861	13878	13894	13911	13928
168	14112	14129	14146	14162	14179	14196	14213	14230	14247	14264
170	14450	14467	14484	14501	14518	14535	14552	14569	14586	14603
172	14792	14809	14826	14844	14861	14878	14895	14913	14930	14947
174	15138	15155	15173	15190	15208	15225	15243	15260	15278	15295
176	15488	15506	15523	15541	15558	15576	15594	15611	15629	15647
178	15842	15860	15878	15895	15913	15931	15949	15967	15985	16003
180	16200	16218	16236	16254	16272	16290	16308	16326	16344	16362

For explanation of table see pages 163 and 172.

AREAS IN SQUARE INCHES TO BE DEDUCTED FOR ONE HOLE THROUGH A MEMBER

Dia. of Hole in inches	THICKNESS OF MEMBER AT HOLE — IN INCHES														
	¼	5/16	⅜	7/16	½	9/16	⅝	11/16	¾	13/16	⅞	15/16	1	1¼	1½
⅜	·094	·117	·141	·164	·188										
7/16	·109	·137	·164	·191	·219	·246									
½	·125	·156	·188	·219	·250	·281	·313								
9/16	·141	·176	·211	·246	·281	·316	·352	·387							
⅝	·156	·195	·234	·273	·313	·352	·391	·430	·469						
11/16	·172	·215	·258	·301	·344	·387	·430	·473	·516	·559	·602				
¾	·188	·234	·281	·328	·375	·422	·469	·516	·563	·609	·656	·703	·750		
13/16	·203	·254	·305	·355	·406	·457	·508	·559	·609	·660	·711	·762	·813	1·016	
⅞	·219	·273	·328	·383	·438	·492	·547	·602	·656	·711	·766	·820	·875	1·094	1·313
15/16	·234	·293	·352	·410	·469	·527	·586	·645	·703	·762	·820	·879	·938	1·172	1·406
1	·250	·313	·375	·438	·500	·563	·625	·688	·750	·813	·875	·938	1·000	1·250	1·500
1 1/16	·266	·332	·398	·465	·531	·598	·664	·730	·797	·863	·930	·996	1·063	1·328	1·594

SPACING OF HOLES IN COLUMNS, BEAMS & TEES

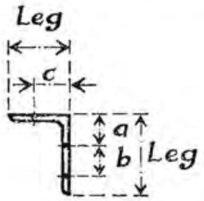
Dimensions				Recommended Dia. of rivet or bolt	Dimensions		Recommended Dia. of rivet or bolt	Dimensions		Recommended Dia. of rivet or bolt
Nominal Flange Width	E	C	E		Nominal Flange Width	C		Nominal Flange Width	C	
ins	ins			ins	ins	ins	ins	ins	ins	ins
16½	3	5½	3	⅞	9	5½	⅞	5¾	2¾	¾
16	3	5½	3	⅞	8¼	5½	⅞	5¼	2¾	¾
14½	–	5½	–	⅞	8	5½	⅞	5	2¾	¾
13	–	5½	–	⅞	7½	3½	⅞	4	2¼	⅝
12	–	5½	–	⅞	7	3½	⅞	3½	2	½
11½	–	5½	–	⅞	6¾	3½	⅞	3	1½	½
10½	–	5½	–	⅞	6½	3½	⅞	2½	1⅜	⅜
10	–	5½	–	⅞	6	3½	¾	2	1⅛	¼

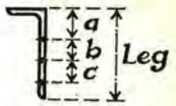
The centres tabulated are not intended as standards for all types of details, but as providing the greatest uniformity of gauge lines over the widest range of flange widths.

SPACING OF HOLES IN CHANNELS

Dimensions		Recommended Dia. of rivet or bolt
Nominal Flange Width	C	
ins	ins	ins
4	2¼	⅞
3½	2	⅞
3	1¾	¾
2½	1⅜	¾
2	1⅛	⅝
1½	⅞	½

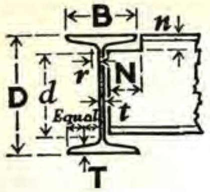
SPACING OF HOLES IN ANGLES





Dimensions in inches				Dimensions in inches				Dimensions in inches				Dimensions in inches			
LEG	*a*	*b*	*c*	LEG	*a*	*b*	*c*	LEG	*a*	*b*	*c*	LEG	*a*	*b*	*c*
9	3	4	–	4	–	–	2¼	2	–	–	1⅛	9	3	2	2
8	3	3	4½	3½	–	–	2	1¾	–	–	1	8	2½	2	2
7	2½	3	4	3	–	–	1¾	1½	–	–	⅞				
6	2¼	2¼	3½	2½	–	–	1⅜	1¼	–	–	¾				
5	2	1¾	3	2¼	–	–	1¼	1	–	–	⅝				

NOTE. The above spacings are modified in the case of Standard End Connections (pages 514–523) in order to maintain standard cross-centres of holes for varying web thicknesses and to provide clearance for high strength friction grip bolts.



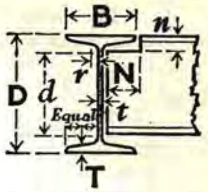
UNIVERSAL BEAMS

DIMENSIONS FOR DETAILING

Serial Size	Weight per foot	Depth of Section D	Root Radius r	Flange			Web			Notch	
				Width B	Thickness T	Inside Slope	Thickness t	Depth d	$\frac{t}{2}+\frac{1}{16}''$	N	n
inches	lbs	inches	inches	inches	inches	degrees	inches	inches	inches	inches	inches
36×16 1/2	260	36 1/4	15/16	16 9/16	1 7/16	2° 52′	7/8	31 3/16	1/2	8 1/2	2 5/8
	230	35 7/8	15/16	16 1/2	1 1/4	2° 52′	3/4	31 3/16	7/16	8 1/2	2 3/8
36×12	194	36 1/2	3/4	12 1/8	1 1/4	2° 52′	3/4	32 1/4	7/16	6 1/4	2 1/8
	170	36 3/16	3/4	12	1 1/8	2° 52′	11/16	32 1/4	3/8	6 1/4	2
	150	35 13/16	3/4	12	15/16	2° 52′	5/8	32 1/4	3/8	6 1/4	1 7/8
	135	35 9/16	3/4	11 15/16	13/16	2° 52′	5/8	32 1/4	3/8	6 1/4	1 3/4
33×11 1/2	152	33 1/2	11/16	11 9/16	1 1/16	2° 52′	5/8	29 13/16	3/8	6	1 7/8
	130	33 1/8	11/16	11 1/2	7/8	2° 52′	9/16	29 13/16	3/8	6	1 3/4
	118	32 7/8	11/16	11 1/2	3/4	2° 52′	9/16	29 13/16	5/16	6	1 5/8
30×10 1/2	132	30 5/16	5/8	10 9/16	1	2° 52′	5/8	26 13/16	3/8	5 1/2	1 3/4
	116	30	5/8	10 1/2	7/8	2° 52′	9/16	26 13/16	3/8	5 1/2	1 5/8
	99	29 11/16	5/8	10 7/16	11/16	2° 52′	1/2	26 13/16	5/16	5 1/2	1 1/2
27×10	114	27 1/4	5/8	10 1/16	15/16	2° 52′	9/16	24 1/16	3/8	5 1/4	1 5/8
	102	27 1/16	5/8	10	13/16	2° 52′	1/2	24 1/16	5/16	5 1/4	1 5/8
	94	26 15/16	5/8	10	3/4	2° 52′	1/2	24 1/16	5/16	5 1/4	1 1/2
	84	26 11/16	5/8	9 15/16	5/8	2° 52′	7/16	24 1/16	5/16	5 1/4	1 3/8
24×12	160	24 15/16	5/8	12 1/4	1 1/4	2° 52′	3/4	20 15/16	7/16	6 1/2	2
	120	24 5/16	5/8	12 1/16	15/16	2° 52′	9/16	20 15/16	5/16	6 1/2	1 3/4
	100	24	5/8	12	3/4	2° 52′	7/16	20 15/16	5/16	6 1/2	1 5/8
24× 9	94	24 5/16	1/2	9 1/16	7/8	2° 52′	1/2	21 3/8	5/16	5	1 1/2
	84	24 1/16	1/2	9	3/4	2° 52′	1/2	21 3/8	5/16	5	1 3/8
	76	23 15/16	1/2	9	11/16	2° 52′	7/16	21 3/8	5/16	5	1 3/8
	68	23 11/16	1/2	8 15/16	9/16	2° 52′	7/16	21 3/8	1/4	5	1 1/4
21×13	142	21 7/16	5/8	13 1/8	1 1/8	2° 52′	11/16	17 3/4	3/8	6 3/4	1 7/8
	127	21 1/4	5/8	13 1/16	1	2° 52′	9/16	17 3/4	3/8	6 3/4	1 7/8
	112	21	5/8	13	7/8	2° 52′	1/2	17 3/4	5/16	6 3/4	1 3/4
21× 8 1/4	82	21 7/16	1/2	8 5/16	13/16	2° 52′	1/2	18 5/8	5/16	4 1/2	1 1/2
	73	21 1/4	1/2	8 5/16	3/4	2° 52′	7/16	18 5/8	5/16	4 1/2	1 3/8
	68	21 1/8	1/2	8 1/4	11/16	2° 52′	7/16	18 5/8	1/4	4 1/2	1 3/8
	62	21	1/2	8 1/4	5/8	2° 52′	3/8	18 5/8	1/4	4 1/2	1 1/4
	55	20 13/16	1/2	8 3/16	1/2	2° 52′	3/8	18 5/8	1/4	4 1/2	1 1/8
18× 7 1/2	66	18 3/8	3/8	7 9/16	3/4	2° 52′	7/16	15 15/16	5/16	4 1/4	1 1/4
	60	18 1/4	3/8	7 9/16	11/16	2° 52′	7/16	15 15/16	1/4	4 1/4	1 1/4
	55	18 1/8	3/8	7 9/16	5/8	2° 52′	3/8	15 15/16	1/4	4 1/4	1 1/8
	50	18	3/8	7 1/2	9/16	2° 52′	3/8	15 15/16	1/4	4 1/4	1 1/8
	45	17 7/8	3/8	7 1/2	1/2	2° 52′	5/16	15 15/16	1/4	4 1/4	1

The dimension 'N' is based upon the outstand from web face to flange edge + 1/2″, to nearest 1/4″ above, and makes due allowance for rolling tolerance.

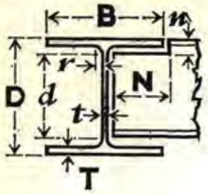
UNIVERSAL BEAMS



DIMENSIONS FOR DETAILING

Serial Size	Weight per foot	Depth of Section D	Root Radius r	Flange			Web			Notch	
				Width B	Thickness T	Inside Slope	Thickness t	Depth d	$\frac{t}{2}+\frac{1}{16}''$	N	n
inches	lbs	inches	inches	inches	inches	degrees	inches	inches	inches	inches	inches
18×6	55	18 5/16	3/8	6 1/16	3/4	2° 52′	7/16	15 15/16	1/4	3 1/2	1 1/4
	50	18 3/16	3/8	6	11/16	2° 52′	3/8	15 15/16	1/4	3 1/2	1 1/8
	45	18	3/8	6	9/16	2° 52′	3/8	15 15/16	1/4	3 1/2	1 1/8
16×7	50	16 1/4	3/8	7 1/16	5/8	2° 52′	3/8	14 1/16	1/4	4	1 1/8
	45	16 1/8	3/8	7 1/16	9/16	2° 52′	3/8	14 1/16	1/4	4	1 1/8
	40	16	3/8	7	1/2	2° 52′	5/16	14 1/16	3/16	4	1
	36	15 7/8	3/8	7	7/16	2° 52′	5/16	14 1/16	3/16	4	1
16×6	50	16 3/8	3/8	6 1/16	11/16	2° 52′	3/8	14 1/16	1/4	3 1/2	1 1/4
	45	16 1/4	3/8	6	5/8	2° 52′	3/8	14 1/16	1/4	3 1/2	1 1/8
	40	16 1/16	3/8	6	9/16	2° 52′	5/16	14 1/16	1/4	3 1/2	1
16×5 1/2	31	15 13/16	3/8	5 5/8	7/16	2° 52′	1/4	14 1/16	3/16	3 1/4	1
	26	15 5/8	3/8	5 9/16	5/16	2° 52′	1/4	14 1/16	3/16	3 1/4	7/8
15×6	45	15 5/16	3/8	6 1/16	5/8	2° 52′	3/8	13 1/8	1/4	3 1/2	1 1/8
	40	15 1/8	3/8	6 1/16	9/16	2° 52′	3/8	13 1/8	1/4	3 1/2	1 1/8
	35	15	3/8	6	1/2	2° 52′	5/16	13 1/8	3/16	3 1/2	1
14×6 3/4	45	14 5/16	3/8	6 13/16	5/8	2° 52′	3/8	12 3/16	1/4	3 3/4	1 1/8
	38	14 1/8	3/8	6 3/4	1/2	2° 52′	5/16	12 3/16	1/4	3 3/4	1
	34	14	3/8	6 3/4	7/16	2° 52′	5/16	12 3/16	3/16	3 3/4	1
	30	13 7/8	3/8	6 3/4	3/8	2° 52′	1/4	12 3/16	3/16	3 3/4	7/8
14×5	26	13 7/8	3/8	4 15/16	7/16	2° 52′	1/4	12 3/16	3/16	3	7/8
	22	13 3/4	3/8	4 15/16	5/16	2° 52′	1/4	12 3/16	3/16	3	7/8
12×6 1/2	36	12 1/4	3/8	6 9/16	9/16	2° 52′	5/16	10 5/16	3/16	3 3/4	1
	31	12 1/16	3/8	6 1/2	7/16	2° 52′	1/4	10 5/16	3/16	3 3/4	7/8
	27	11 15/16	3/8	6 1/2	3/8	2° 52′	1/4	10 5/16	3/16	3 3/4	7/8
12×5	32	12 1/4	3/8	4 15/16	9/16	2° 52′	3/8	10 5/16	1/4	3	1
	28	12 1/16	3/8	4 7/8	1/2	2° 52′	5/16	10 5/16	1/4	3	7/8
	25	11 15/16	3/8	4 7/8	7/16	2° 52′	5/16	10 5/16	3/16	3	7/8
12×4	22	12 5/16	5/16	4	7/16	1° 9′	1/4	10 13/16	3/16	2 1/2	3/4
	19	12 3/16	5/16	4	3/8	1° 9′	1/4	10 13/16	3/16	2 1/2	3/4
	16·5	12	5/16	4	1/4	1° 9′	1/4	10 13/16	3/16	2 1/2	5/8
10×5 3/4	29	10 1/4	5/16	5 13/16	1/2	2° 52′	5/16	8 1/2	3/16	3 1/2	7/8
	25	10 1/16	5/16	5 3/4	7/16	2° 52′	1/4	8 1/2	3/16	3 1/2	7/8
	21	9 7/8	5/16	5 3/4	5/16	2° 52′	1/4	8 1/2	3/16	3 1/2	3/4
10×4	19	10 1/4	5/16	4	3/8	1° 9′	1/4	8 13/16	3/16	2 1/2	3/4
	17	10 1/8	5/16	4	5/16	1° 9′	1/4	8 13/16	3/16	2 1/2	3/4
	15	10	5/16	4	1/4	1° 9′	1/4	8 13/16	3/16	2 1/2	5/8
8×5 1/4	20	8 1/8	5/16	5 1/4	3/8	2° 52′	1/4	6 11/16	3/16	3 1/4	3/4
	17	8	5/16	5 1/4	5/16	2° 52′	1/4	6 11/16	3/16	3 1/4	3/4

The dimension 'N' is based upon the outstand from web face to flange edge + 1/2″, to nearest 1/4″ above, and makes due allowance for rolling tolerance.



UNIVERSAL COLUMNS

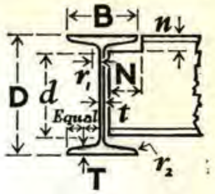
DIMENSIONS FOR DETAILING

Serial Size	Weight per foot	Depth of Section D	Root Radius r	Flange			Web			Notch	
				Width B	Thickness T	Inside Slope	Thickness t	Depth d	$\frac{t}{2}+\frac{1}{16}''$	N	n
inches	*lbs*	*inches*	*inches*	*inches*	*inches*	*degrees*	*inches*	*inches*	*inches*	*inches*	*inches*
14×16	426	$18\frac{11}{16}$	$\frac{5}{8}$	$16\frac{11}{16}$	$3\frac{1}{16}$	0	$1\frac{7}{8}$	$11\frac{7}{16}$	1	8	$3\frac{3}{4}$
	370	$17\frac{15}{16}$	$\frac{5}{8}$	$16\frac{1}{2}$	$2\frac{11}{16}$	0	$1\frac{5}{8}$	$11\frac{7}{16}$	$\frac{7}{8}$	8	$3\frac{3}{8}$
	314	$17\frac{3}{16}$	$\frac{5}{8}$	$16\frac{1}{4}$	$2\frac{5}{16}$	0	$1\frac{7}{16}$	$11\frac{7}{16}$	$\frac{3}{4}$	8	3
	264	$16\frac{1}{2}$	$\frac{5}{8}$	16	$1\frac{15}{16}$	0	$1\frac{3}{16}$	$11\frac{7}{16}$	$\frac{11}{16}$	8	$2\frac{5}{8}$
	228	16	$\frac{5}{8}$	$15\frac{7}{8}$	$1\frac{11}{16}$	0	$1\frac{1}{16}$	$11\frac{7}{16}$	$\frac{9}{16}$	8	$2\frac{3}{8}$
	193	$15\frac{1}{2}$	$\frac{5}{8}$	$15\frac{11}{16}$	$1\frac{7}{16}$	0	$\frac{7}{8}$	$11\frac{7}{16}$	$\frac{1}{2}$	8	$2\frac{1}{8}$
	158	15	$\frac{5}{8}$	$15\frac{9}{16}$	$1\frac{3}{16}$	0	$\frac{3}{4}$	$11\frac{7}{16}$	$\frac{7}{16}$	8	$1\frac{7}{8}$
Column Core	320	$16\frac{13}{16}$	$\frac{5}{8}$	$16\frac{11}{16}$	$2\frac{1}{16}$	0	$1\frac{7}{8}$	$11\frac{7}{16}$	1	8	$2\frac{3}{4}$
$14\times14\frac{1}{2}$	136	$14\frac{3}{4}$	$\frac{5}{8}$	$14\frac{3}{4}$	$1\frac{1}{16}$	0	$\frac{11}{16}$	$11\frac{7}{16}$	$\frac{3}{8}$	$7\frac{3}{4}$	$1\frac{3}{4}$
	119	$14\frac{1}{2}$	$\frac{5}{8}$	$14\frac{5}{8}$	$\frac{15}{16}$	0	$\frac{9}{16}$	$11\frac{7}{16}$	$\frac{3}{8}$	$7\frac{3}{4}$	$1\frac{5}{8}$
	103	$14\frac{1}{4}$	$\frac{5}{8}$	$14\frac{9}{16}$	$\frac{13}{16}$	0	$\frac{1}{2}$	$11\frac{7}{16}$	$\frac{5}{16}$	$7\frac{3}{4}$	$1\frac{1}{2}$
	87	14	$\frac{5}{8}$	$14\frac{1}{2}$	$\frac{11}{16}$	0	$\frac{7}{16}$	$11\frac{7}{16}$	$\frac{1}{4}$	$7\frac{3}{4}$	$1\frac{3}{8}$
12×12	190	$14\frac{3}{8}$	$\frac{5}{8}$	$12\frac{11}{16}$	$1\frac{3}{4}$	0	$1\frac{1}{16}$	$9\frac{11}{16}$	$\frac{9}{16}$	$6\frac{1}{2}$	$2\frac{3}{8}$
	161	$13\frac{7}{8}$	$\frac{5}{8}$	$12\frac{1}{2}$	$1\frac{1}{2}$	0	$\frac{7}{8}$	$9\frac{11}{16}$	$\frac{1}{2}$	$6\frac{1}{2}$	$2\frac{1}{8}$
	133	$13\frac{3}{8}$	$\frac{5}{8}$	$12\frac{3}{8}$	$1\frac{1}{4}$	0	$\frac{3}{4}$	$9\frac{11}{16}$	$\frac{7}{16}$	$6\frac{1}{2}$	$1\frac{7}{8}$
	106	$12\frac{7}{8}$	$\frac{5}{8}$	$12\frac{1}{4}$	1	0	$\frac{5}{8}$	$9\frac{11}{16}$	$\frac{3}{8}$	$6\frac{1}{2}$	$1\frac{5}{8}$
	92	$12\frac{5}{8}$	$\frac{5}{8}$	$12\frac{1}{8}$	$\frac{7}{8}$	0	$\frac{9}{16}$	$9\frac{11}{16}$	$\frac{5}{16}$	$6\frac{1}{2}$	$1\frac{1}{2}$
	79	$12\frac{3}{8}$	$\frac{5}{8}$	$12\frac{1}{16}$	$\frac{3}{4}$	0	$\frac{1}{2}$	$9\frac{11}{16}$	$\frac{5}{16}$	$6\frac{1}{2}$	$1\frac{3}{8}$
	65	$12\frac{1}{8}$	$\frac{5}{8}$	12	$\frac{5}{8}$	0	$\frac{3}{8}$	$9\frac{11}{16}$	$\frac{1}{4}$	$6\frac{1}{2}$	$1\frac{1}{4}$
10×10	112	$11\frac{3}{8}$	$\frac{1}{2}$	$10\frac{7}{16}$	$1\frac{1}{4}$	0	$\frac{3}{4}$	$7\frac{7}{8}$	$\frac{7}{16}$	$5\frac{1}{2}$	$1\frac{3}{4}$
	89	$10\frac{7}{8}$	$\frac{1}{2}$	$10\frac{1}{4}$	1	0	$\frac{5}{8}$	$7\frac{7}{8}$	$\frac{3}{8}$	$5\frac{1}{2}$	$1\frac{1}{2}$
	72	$10\frac{1}{2}$	$\frac{1}{2}$	$10\frac{3}{16}$	$\frac{13}{16}$	0	$\frac{1}{2}$	$7\frac{7}{8}$	$\frac{5}{16}$	$5\frac{1}{2}$	$1\frac{3}{8}$
	60	$10\frac{1}{4}$	$\frac{1}{2}$	$10\frac{1}{16}$	$\frac{11}{16}$	0	$\frac{7}{16}$	$7\frac{7}{8}$	$\frac{1}{4}$	$5\frac{1}{2}$	$1\frac{1}{4}$
	49	10	$\frac{1}{2}$	10	$\frac{9}{16}$	0	$\frac{5}{16}$	$7\frac{7}{8}$	$\frac{1}{4}$	$5\frac{1}{2}$	$1\frac{1}{8}$
8×8	58	$8\frac{3}{4}$	$\frac{3}{8}$	$8\frac{1}{4}$	$\frac{13}{16}$	0	$\frac{1}{2}$	$6\frac{5}{16}$	$\frac{5}{16}$	$4\frac{1}{2}$	$1\frac{1}{4}$
	48	$8\frac{1}{2}$	$\frac{3}{8}$	$8\frac{1}{8}$	$\frac{11}{16}$	0	$\frac{3}{8}$	$6\frac{5}{16}$	$\frac{1}{4}$	$4\frac{1}{2}$	$1\frac{1}{8}$
	40	$8\frac{1}{4}$	$\frac{3}{8}$	$8\frac{1}{16}$	$\frac{9}{16}$	0	$\frac{3}{8}$	$6\frac{5}{16}$	$\frac{1}{4}$	$4\frac{1}{2}$	1
	35	$8\frac{1}{8}$	$\frac{3}{8}$	8	$\frac{1}{2}$	0	$\frac{5}{16}$	$6\frac{5}{16}$	$\frac{1}{4}$	$4\frac{1}{2}$	1
	31	8	$\frac{3}{8}$	8	$\frac{7}{16}$	0	$\frac{5}{16}$	$6\frac{5}{16}$	$\frac{3}{16}$	$4\frac{1}{2}$	$\frac{7}{8}$
6×6	25	$6\frac{3}{8}$	$\frac{5}{16}$	$6\frac{1}{16}$	$\frac{7}{16}$	0	$\frac{5}{16}$	$4\frac{7}{8}$	$\frac{1}{4}$	$3\frac{1}{2}$	$\frac{7}{8}$
	20	$6\frac{3}{16}$	$\frac{5}{16}$	6	$\frac{3}{8}$	0	$\frac{1}{4}$	$4\frac{7}{8}$	$\frac{3}{16}$	$3\frac{1}{2}$	$\frac{3}{4}$
	15·7	6	$\frac{5}{16}$	6	$\frac{1}{4}$	0	$\frac{1}{4}$	$4\frac{7}{8}$	$\frac{3}{16}$	$3\frac{1}{2}$	$\frac{5}{8}$

The dimension ' N ' is based upon the outstand from web face to flange edge + $\frac{1}{2}''$, to nearest $\frac{1}{4}''$ above, and makes due allowance for rolling tolerance.

JOISTS

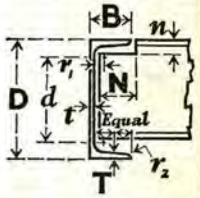
DIMENSIONS FOR DETAILING



Size D×B	Weight per foot	Depth of Section D	Root Radius r_1	Toe Radius r_2	Flange			Web			Notch	
					Width B	Thickness T	Inside Slope	Thickness t	Depth d	$\frac{t}{2}+\frac{1}{16}''$	N	n
inches	*lbs*	*inches*	*inches*	*inches*	*inches*	*inches*	*degrees*	*inches*	*inches*	*inches*	*inches*	*inches*
8×4	17	8	$\frac{3}{8}$	$\frac{1}{8}$	4	$\frac{7}{16}$	5	$\frac{1}{4}$	$6\frac{5}{16}$	$\frac{3}{16}$	2	$\frac{7}{8}$
7×4	14·5	7	$\frac{3}{8}$	$\frac{1}{8}$	4	$\frac{3}{8}$	5	$\frac{3}{16}$	$5\frac{7}{16}$	$\frac{3}{16}$	2	$\frac{3}{4}$
$6\times3\frac{1}{2}$	11·5	6	$\frac{5}{16}$	$\frac{1}{8}$	$3\frac{1}{2}$	$\frac{5}{16}$	5	$\frac{3}{16}$	$4\frac{5}{8}$	$\frac{3}{16}$	$1\frac{3}{4}$	$\frac{3}{4}$
5×3	9	5	$\frac{5}{16}$	$\frac{1}{8}$	3	$\frac{5}{16}$	5	$\frac{3}{16}$	$3\frac{11}{16}$	$\frac{1}{8}$	$1\frac{1}{2}$	$\frac{5}{8}$
$4\times2\frac{1}{2}$	6·5	4	$\frac{1}{4}$	$\frac{1}{8}$	$2\frac{1}{2}$	$\frac{1}{4}$	5	$\frac{3}{16}$	$2\frac{7}{8}$	$\frac{1}{8}$	$1\frac{1}{4}$	$\frac{5}{8}$
3×2	4·5	3	$\frac{1}{4}$	$\frac{1}{8}$	2	$\frac{1}{4}$	5	$\frac{1}{8}$	2	$\frac{1}{8}$	1	$\frac{1}{2}$

CHANNELS

DIMENSIONS FOR DETAILING



Size D×B	Weight per foot	Depth of Section D	Root Radius r_1	Toe Radius r_2	Flange			Web			Notch	
					Width B	Thickness T	Inside Slope	Thickness t	Depth d	$t+\frac{1}{16}''$	N	n
inches	*lbs*	*inches*	*inches*	*inches*	*inches*	*inches*	*degrees*	*inches*	*inches*	*inches*	*inches*	*inches*
17×4	44	17	$\frac{5}{8}$	$\frac{3}{16}$	4	$\frac{11}{16}$	5	$\frac{1}{2}$	$14\frac{1}{4}$	$\frac{9}{16}$	4	$1\frac{3}{8}$
15×4	37	15	$\frac{5}{8}$	$\frac{3}{16}$	4	$\frac{5}{8}$	5	$\frac{7}{16}$	$12\frac{5}{16}$	$\frac{1}{2}$	4	$1\frac{3}{8}$
12×4	31	12	$\frac{5}{8}$	$\frac{3}{16}$	4	$\frac{9}{16}$	5	$\frac{3}{8}$	$9\frac{7}{16}$	$\frac{7}{16}$	4	$1\frac{1}{4}$
$12\times3\frac{1}{2}$	28	12	$\frac{9}{16}$	$\frac{1}{8}$	$3\frac{1}{2}$	$\frac{9}{16}$	5	$\frac{3}{8}$	$9\frac{11}{16}$	$\frac{7}{16}$	$3\frac{1}{2}$	$1\frac{1}{4}$
$10\times3\frac{1}{2}$	24	10	$\frac{9}{16}$	$\frac{1}{8}$	$3\frac{1}{2}$	$\frac{9}{16}$	5	$\frac{3}{8}$	$7\frac{11}{16}$	$\frac{7}{16}$	$3\frac{1}{2}$	$1\frac{1}{8}$
10×3	19	10	$\frac{1}{2}$	$\frac{1}{8}$	3	$\frac{7}{16}$	5	$\frac{5}{16}$	8	$\frac{3}{8}$	3	1
$9\times3\frac{1}{2}$	22	9	$\frac{9}{16}$	$\frac{1}{8}$	$3\frac{1}{2}$	$\frac{1}{2}$	5	$\frac{5}{16}$	$6\frac{11}{16}$	$\frac{3}{8}$	$3\frac{1}{2}$	$1\frac{1}{8}$
9×3	17·5	9	$\frac{1}{2}$	$\frac{1}{8}$	3	$\frac{7}{16}$	5	$\frac{5}{16}$	7	$\frac{3}{8}$	3	1
$8\times3\frac{1}{2}$	20	8	$\frac{9}{16}$	$\frac{1}{8}$	$3\frac{1}{2}$	$\frac{1}{2}$	5	$\frac{5}{16}$	$5\frac{3}{4}$	$\frac{3}{8}$	$3\frac{1}{2}$	$1\frac{1}{8}$
8×3	16	8	$\frac{1}{2}$	$\frac{1}{8}$	3	$\frac{7}{16}$	5	$\frac{1}{4}$	6	$\frac{5}{16}$	3	1
$7\times3\frac{1}{2}$	18	7	$\frac{9}{16}$	$\frac{1}{8}$	$3\frac{1}{2}$	$\frac{1}{2}$	5	$\frac{5}{16}$	$4\frac{3}{4}$	$\frac{3}{8}$	$3\frac{1}{2}$	$1\frac{1}{8}$
7×3	14	7	$\frac{1}{2}$	$\frac{1}{8}$	3	$\frac{3}{8}$	5	$\frac{1}{4}$	$5\frac{1}{16}$	$\frac{5}{16}$	3	1
$6\times3\frac{1}{2}$	16	6	$\frac{9}{16}$	$\frac{1}{8}$	$3\frac{1}{2}$	$\frac{7}{16}$	5	$\frac{1}{4}$	$3\frac{13}{16}$	$\frac{5}{16}$	$3\frac{1}{2}$	$1\frac{1}{8}$
6×3	12	6	$\frac{1}{2}$	$\frac{1}{8}$	3	$\frac{3}{8}$	5	$\frac{1}{4}$	$4\frac{3}{16}$	$\frac{5}{16}$	3	$\frac{7}{8}$
$5\times2\frac{1}{2}$	10	5	$\frac{7}{16}$	$\frac{1}{8}$	$2\frac{1}{2}$	$\frac{3}{8}$	5	$\frac{1}{4}$	$3\frac{5}{16}$	$\frac{5}{16}$	$2\frac{1}{2}$	$\frac{7}{8}$
4×2	7	4	$\frac{3}{8}$	$\frac{1}{8}$	2	$\frac{5}{16}$	5	$\frac{1}{4}$	$2\frac{9}{16}$	$\frac{5}{16}$	2	$\frac{3}{4}$
$3\times1\frac{1}{2}$	4·5	3	$\frac{5}{16}$	$\frac{1}{8}$	$1\frac{1}{2}$	$\frac{1}{4}$	5	$\frac{3}{16}$	$1\frac{13}{16}$	$\frac{1}{4}$	$1\frac{1}{2}$	$\frac{5}{8}$

The dimension ' N ' in the case of joists is equal to half the flange width, i.e. ' B/2 ' and in the case of channels is equal to the flange width ' B '.

SURFACE AREAS OF UNIVERSAL BEAMS

Serial Size	Weight per foot	Surface Area		
		per foot	per ton	two end faces
ins	*lbs*	*ft²*	*ft²*	*ft²*
36×16½	260	11·17	96·1	1·06
	230	11·09	107·9	·94
36×12	194	9·80	113·1	·79
	170	9·73	128·3	·69
	150	9·67	144·3	·61
	135	9·62	159·6	·55
33×11½	152	9·15	134·9	·62
	130	9·08	156·3	·53
	118	9·03	171·5	·48
30×10½	132	8·30	140·8	·54
	116	8·24	159·1	·47
	99	8·18	185·1	·40
27×10	114	7·65	150·4	·47
	102	7·61	167·0	·42
	94	7·58	180·5	·38
	84	7·54	200·9	·34
24×12	160	7·94	111·1	·65
	120	7·81	145·8	·49
	100	7·74	173·3	·41
24× 9	94	6·85	163·3	·38
	84	6·81	181·5	·34
	76	6·77	199·5	·31
	68	6·73	221·8	·28
21×13	142	7·66	120·8	·58
	127	7·61	134·1	·52
	112	7·56	151·1	·46
21× 8¼	82	6·14	167·7	·34
	73	6·10	187·3	·30
	68	6·08	200·0	·28
	62	6·05	218·6	·25
	55	6·01	245·1	·22
18× 7½	66	5·41	183·8	·27
	60	5·38	201·0	·25
	55	5·36	217·9	·23
	50	5·33	238·8	·20
	45	5·30	264·1	·18
18×6	55	4·90	199·5	·22
	50	4·87	218·1	·20
	45	4·84	241·0	·18
16×7	50	4·90	219·4	·20
	45	4·87	242·4	·18
	40	4·84	271·1	·16
	36	4·82	299·6	·15
16×6	50	4·59	205·5	·20
	45	4·55	226·8	·18
	40	4·52	253·4	·16
16×5½	31	4·37	315·4	·13
	26	4·33	373·2	·11
15×6	45	4·41	219·7	·18
	40	4·38	245·4	·16
	35	4·35	278·6	·14
14×6¾	45	4·50	224·0	·18
	38	4·46	262·7	·16
	34	4·43	292·1	·14
	30	4·40	329·2	·12
14×5	26	3·84	330·6	·11
	22	3·80	387·3	·09
12×6½	36	4·08	253·9	·15
	31	4·05	292·5	·13
	27	4·02	332·5	·11
12×5	32	3·54	247·6	13
	28	3·51	280·8	·11
	25	3·49	312·6	·10
12×4	22	3·30	335·8	·09
	19	3·27	383·1	·08
	16·5	3·24	439·2	·07
10×5¾	29	3·50	270·6	·12
	25	3·47	311·6	·10
	21	3·44	366·4	·09
10×4	19	2·95	347·0	·08
	17	2·93	387·4	·07
	15	2·91	435·2	·06
8×5¼	20	2·99	335·0	·08
	17	2·96	390·6	·07

For explanation of table, see page 192.

SURFACE AREAS OF UNIVERSAL COLUMNS, JOISTS & CHANNELS

UNIVERSAL COLUMNS

Serial Size	Weight per foot	Surface Area		
		per foot	per ton	two end faces
ins.	*lbs*	*ft²*	*ft²*	*ft²*
14×16	426	8·28	43·6	1·74
	370	8·12	49·2	1·51
	314	7·95	56·8	1·28
	264	7·80	66·2	1·08
	228	7·69	75·6	·93
	193	7·59	88·1	·79
	158	7·48	106·0	·65
Column Core	320	7·97	55·8	1·31
14×14½	136	7·18	118·3	·56
	119	7·12	134·1	·49
	103	7·06	153·8	·42
	87	7·01	180·7	·36
12×12	190	6·36	75·0	·78
	161	6·25	86·9	·66
	133	6·14	103·4	·54
	106	6·03	127·5	·43
	92	5·98	145·5	·38
	79	5·93	168·2	·32
	65	5·87	202·4	·27
10×10	112	5·17	103·5	·46
	89	5·06	127·4	·36
	72	4·98	155·0	·29
	60	4·93	183·7	·25
	49	4·87	223·0	·20
8×8	58	4·06	156·7	·24
	48	4·00	186·6	·20
	40	3·95	221·3	·16
	35	3·92	250·7	·14
	31	3·89	281·4	·13
6×6	25	2·99	268·3	·10
	20	2·95	328·2	·08
	15·7	2·92	416·3	·06

JOISTS

Size	Weight per foot	Surface Area		
		per foot	per ton	two end faces
ins.	*lbs*	*ft²*	*ft²*	*ft²*
8×4	17	2·52	331·7	·07
7×4	14·5	2·35	364·1	·06
6×3½	11·5	2·04	397·8	·05
5×3	9	1·72	427·9	·04
4×2½	6·5	1·40	482·4	·03
3×2	4·5	1·07	534·4	·02

CHANNELS

Size	Weight per foot	Surface Area		
		per foot	per ton	two end faces
ins.	*lbs*	*ft²*	*ft²*	*ft²*
17×4	44	3·99	203·0	·18
15×4	37	3·66	221·9	·15
12×4	31	3·17	228·7	·13
12×3½	28	3·01	241·3	·11
10×3½	24	2·69	250·9	·10
10×3	19	2·54	299·3	·08
9×3½	22	2·52	257·0	·09
9×3	17·5	2·37	303·9	·07
8×3½	20	2·36	264·4	·08
8×3	16	2·21	309·6	·07
7×3½	18	2·20	273·3	·07
7×3	14	2·05	327·7	·06
6×3½	16	2·03	284·5	·07
6×3	12	1·88	351·6	·05
5×2½	10	1·56	349·6	·04
4×2	7	1·24	396·9	·03
3×1½	4·5	·92	460·1	·02

For explanation of table, see page 192.

General Notes on the Tables in Parts II III IV and V

SECTIONS

The universal beams and columns, the joists, channels and angles in Parts II, III, IV and V and the short and long stalk tee bars, structural tees cut from universal sections and the universal bearing piles in Part II, are as contained in B.S.4 Part 1, 1962.

Special sections and bulb flats are included in Part II; pressed trough sections are included in Part V; Autofab beams in Parts IV & V.

WEIGHTS

The weights per foot have been calculated on the basis that a cubic foot of steel weighs 489·6 pounds, i.e. a piece of steel 1 inch square by 1 foot long weighs 3·4 pounds. A rolling margin of $\pm 2\frac{1}{2}\%$ should be allowed on the weights of sections listed.

For compound stanchions composed of channels with flange plates an allowance has been made for rivet heads based on a rivet pitch of 6 inches. Two rows of rivets have been allowed through each flange plate in each case. The nominal diameter of the rivets allowed is printed in the tables below the safe loads for the relative section. No allowance has been made for rivet heads nor weld metal in the weights of gantry girders, laced or battened stanchions, struts or ties. No allowance has been made for the weights of end nor intermediate connections, caps, bases, lacing bars or battens; where these items form part of the construction their weight is additional and must be calculated separately.

AREAS

The areas tabulated are the gross areas of the sections in square inches, except the effective areas of ties, which are net areas (see page 184) and cased section areas of cased stanchions, which areas include concrete (see page 181); also, gross and net areas have been given for castellated sections.

MOMENTS OF INERTIA

In Part II the gross moments of inertia about both principal axes have been tabulated in inch units for each rolled section, and gantry girder; moments of inertia about the major and minor axes have been tabulated for angles and castellated zed sections.

Net moments of inertia relative to the *x-x* axis have been evaluated for universal beams and columns, joists and channels, having holes deducted from each flange in accordance with the following table:—

Section	Flange Breadth	No. of Holes per Flange	Dia. of Holes
COLUMNS BEAMS AND JOISTS	12 to $16\frac{1}{2}$	2	$\frac{15}{16}$
	$6\frac{1}{2}$ up to but not including 12	1	$\frac{15}{16}$
	$4\frac{1}{2}$ up to but not including $6\frac{1}{2}$	1	$\frac{13}{16}$
	4	1	$\frac{11}{16}$
	$3\frac{1}{2}$ and 3	1	$\frac{9}{16}$
	$2\frac{1}{2}$	1	$\frac{7}{16}$
	2	1	$\frac{3}{8}$
CHANNELS	$2\frac{1}{2}$ to 4	1	$\frac{13}{16}$
	2	1	$\frac{11}{16}$
	$1\frac{1}{2}$	1	$\frac{9}{16}$

Net moments of inertia have been calculated for castellated sections.

Moments of inertia, where applicable, have been repeated on the right hand pages of the safe load tables in Parts IV and V for convenient reference; Autofab Beams have been tabulated in Parts IV and V.

For the design of plate girders the gross moments of inertia relative to the *x-x* axis have been tabulated for a suitable range of web plates, flange plates and flange angles; also, gross moments of inertia relative to the *y-y* axis have been tabulated for flange angles. Second moments have been tabulated for unit areas.

ELASTIC MODULI

In Part II the gross moduli of section about both principal axes have been tabulated for each rolled section, and gantry girder; the moduli relative to the *x-x* and *y-y* axes for angles and relative to the *x-x* axis for tees are the lesser values for these axes. For castellated sections the net elastic moduli have been evaluated. The moduli of universal beams and columns, joists, channels and angles have been repeated on the right hand pages of the safe load tables in Parts IV and V; Autofab Beams have been tabulated in Parts IV and V.

Also in Parts IV and V the gross moduli about both principal axes have been tabulated for compound stanchions and struts; for asymmetrical sections, the moduli of section have been based on the extreme fibre distance indicated in the tables and suitable allowance should be made in calculating bending stresses at positions less remote from the neutral axis.

RADII OF GYRATION

In Part II the radii of gyration about both axes have been tabulated for each rolled section and castellated section; also, the radii of gyration about the major and minor axes for angles and castellated zed sections, and about the *y-y* axis for gantry girders. Relevant radii of gyration have been repeated in the safe load tables.

In Parts IV and V the radii of gyration have been tabulated for compound stanchions, struts and ties.

The least radius of gyration for each stanchion and strut has been printed in prominent type.

Reference should be made to *Notes on Tables for Cased Stanchions*, commencing page 181, for information on the radii of gyration of cased stanchions.

$\frac{D}{T}$ RATIO

In Part II the ratio of the depth of section D, to mean or effective thickness of flange, T, has been tabulated for each universal beam, column and bearing pile, joist, channel, castellated section and gantry girder.

Where relevant, the values have been repeated on the right hand pages in Parts IV and V, values for Autofab Beams have also been tabulated in Parts IV and V.

HORIZONTAL SHEAR

Values have been tabulated for gantry girders and each coefficient is equal to $a.y \div I$ in which:—

a = cross sectional area, in square inches, of the channel and/or plate on the relevant flange

y = normal distance, in inches, from the centroid of such channel and/or plate to the neutral axis

I = moment of inertia of girder, in inches^4.

The horizontal shear in tons per inch run, due to the vertical loading and which has to be transmitted by the flange welding, is equal to the vertical shear in tons at the section, multiplied by the relevant horizontal shear coefficient.

PLASTIC DESIGN

SECTION PROPERTIES

In Part II the full plastic moduli and reduced plastic moduli have been tabulated for universal beams, columns and joists to facilitate the plastic design of members subject to bending only or to a combination of bending and axial load.

When an **I** section is loaded to full plasticity by a combination of axial thrust and bending about the major axis, the neutral axis may lie either in the web or in the flange whose outer fibres are in tension, dependent upon the relative values of thrust and bending. Different formulæ giving the reduced plastic moduli under combined loading have, therefore, to be used. The formula for lower values of n is to be used for values of n below the change values and indicates that the neutral axis is in the web. The formula for higher values of n is to be used for values of n above the change values and indicates that the neutral axis is in the tension flange. The same principles apply to an **I** section loaded axially and bent about the minor axis, lower values of n again indicating that the neutral axis lies in the web and higher values indicating that it lies outside of the web.

The value n is given by, $n = p/Ys$ where p = the mean axial stress.

For high yield steel, Ys is taken as 23 tons/in^2 for joists and universal beams also for universal columns of thickness not exceeding 2 inches. For thicker sections, the yield stress is by agreement and a value of 22 tons/in^2 has been used elsewhere in this book for such sections.

For mild steel, Ys is taken as 16 tons/in^2 for joists also for universal beams and columns having flange thickness not exceeding 1½ inches, and for other sections and plates not exceeding ¾ inch: and 15 tons/in^2 for sections other than universal beams and columns and for plates over ¾ inch up to and including 1½ inches: and at 14·75 tons/in^2 for universal columns and plates over 1½ inches.

When the full plastic moment of a section is being used in design, as in the following example, adequate lateral restraint must be provided at suitable intervals.

EXAMPLE: Find the full plastic moment Mp of a 14 × 6¾ @ 45 UB in mild steel bent about its major axis under (*a*) no axial load, (*b*) 20 tons axial load, (*c*) 80 tons axial load.

(*a*) No axial load. Plastic Modulus axis x-x = 73·9 in^3

$$Mp = 73{\cdot}9 \times 16{\cdot}0 = 1182 \text{ tons in.}$$

(*b*) Axial load 20 tons. Area = 13·23 in^2

$$n = \frac{20}{13{\cdot}23 \times 16{\cdot}0} = {\cdot}094 \text{ (less than } 0{\cdot}353)$$

Reduced Plastic Modulus

$$= 73{\cdot}9 - 122{\cdot}6 \times {\cdot}094^2 = 72{\cdot}8 \text{ in}^3$$

$$Mp = 72{\cdot}8 \times 16{\cdot}0 = 1165 \text{ tons in.}$$

(*c*) Axial load 80 tons.

$$n = \frac{80}{13{\cdot}23 \times 16{\cdot}0} = {\cdot}378 \text{ (greater than } 0{\cdot}353)$$

Reduced Plastic Modulus

$$= 6{\cdot}461\,(1 - {\cdot}378)\,(13{\cdot}67 + {\cdot}378) = 56{\cdot}5 \text{ in}^3$$

$$Mp = 56{\cdot}5 \times 16{\cdot}0 = 904 \text{ tons in.}$$

WIDTH TO THICKNESS RATIOS *B/T*

Plastic hinge action is not permissible, whether a section is used as a beam or column, if the flange width to thickness ratio exceeds 15 in the case of high yield steel or 18 in the case of mild steel. Sections excluded for this reason are marked 'No' in table overleaf.

WEB-DEPTH RATIOS *(D−2T)/t*

If the web depth to thickness ratio exceeds 44 in the case of high yield steel or 53 in the case of mild steel, premature web buckling occurs if the mean axial stress exceeds a value related to the size of the section. No universal column sections are liable to such web buckling and no universal beam sections are liable if used as beams. Some universal beam sections, when used as columns with factored mean axial stresses greater than about 5 tons/in^2 may be unsatisfactory in this respect. Sections so affected are indicated in the table below which gives the factored limiting mean axial stress on the full area up to which the sections may be used with assumed plastic hinge action.

Table showing suitability of universal sections for plastic action

SECTION		Limiting mean axial stress tons/inch²	
Serial size in inches	Weight per foot in pounds	HYS	MS
UNIVERSAL BEAMS			
36×12	170	6·9	Yes
36×12	150	5·2	7·0
36×12	135	4·5	6·4
33×11½	152	7·0	Yes
33×11½	130	5·2	7·0
33×11½	118	No	6·2
30×10½	132	8·7	Yes
30×10½	116	7·0	Yes
30×10½	99	4·7	6·5
27×10	114	9·3	Yes
27×10	102	7·0	Yes
27×10	94	5·9	Yes
27×10	84	No	6·5
24×12	100	No	Yes
24×9	84	7·4	Yes
24×9	76	6·0	Yes
24×9	68	No	Yes
21×8¼	68	8·2	Yes
21×8¼	62	6·8	Yes
21×8¼	55	No	Yes
18×7½	50	7·4	Yes
18×7½	45	6·2	Yes
18×6	45	8·5	Yes
16×7	40	6·3	Yes
16×7	36	No	Yes
16×5½	31	4·6	6·0
16×5½	26	No	5·0
UNIVERSAL BEAMS			
15×6	35	8·2	Yes
14×6¾	34	7·4	Yes
14×6¾	30	No	Yes
14×5	26	6·2	Yes
14×5	22	4·5	6·1
12×6½	27	No	Yes
12×4	19	8·5	Yes
12×4	16·5	8·2	Yes
10×5¾	21	No	Yes
8×5¼	17	No	Yes
UNIVERSAL COLUMNS			
14×14½	119	No	Yes
14×14½	103	No	Yes
14×14½	87	No	No
12×12	79	No	Yes
12×12	65	No	No
10×10	49	No	Yes
8×8	35	No	Yes
8×8	31	No	No
6×6	20	No	Yes
6×6	15·7	No	No

Universal sections marked 'Yes' and other serial sizes and weights not included in above table are suitable for plastic action.

For further information on the use of Universal and other sections in plastic design, designers are referred to "Plastic Properties of Rolled Sections", published by the British Welding Research Association. Reference may be made also to B.C.S.A. Publication No. 21 : 1963, "Plastic Design in Steel to B.S. 968", by Professor Sir John Baker and to B.C.S.A. Publication No. 23 : 1964, "The Plastic Design of Columns", by Professor M. R. Horne.

Acknowledgment is made to Professor M. R. Horne and the British Welding Research Association for information regarding the plastic properties of I sections. Further acknowledgment is made to Professor M. R. Horne for the information given here.

PRESSED STEEL TROUGH SECTIONS

Properties and safe loads for sections in mild steel have been tabulated in Part V.

For notes on Pressed Steel Troughing see page 41

Notes
on Safe Load Tables for Beams

WORKING STRESSES

For High Yield Stress (Welding Quality) Structural Steel to B.S. 968 : 1962. The tabulated values have been based on the stresses as given in B.S. 449 : 1959, as amended.

The permissible working stresses are:

BENDING	Tons/inch²
Universal Beams and Columns, Joists and Channels with material up to and including 2 in. thickness	14·5
Over 2 ins.	$Ys \div 1{\cdot}52$
Compound Girders composed of universal beams, joists or channels plated, with material up to and including 2 in.	14·5
Over 2 ins.	$Ys \div 1{\cdot}52$

where *Ys = yield stress agreed with manufacturer, with a maximum value of* 22·0 *tons/in²*.

SHEAR IN UNSTIFFENED WEBS	
Universal Beams and Columns and Joists	8·5
Channels, single	8·0

For Mild Steel to B.S. 15 : 1961. The tabulated values have been based on the stresses as given in B.S. 449 : 1959, as amended.

The permissible working stresses are:

BENDING	Tons/inch²
Universal Beams and Columns, Joists and Channels with material up to and including 1½ in. thickness	10·5
Over 1½ in.	10·0
Compound Girders composed of universal beams, joists or channels plated, with plate thickness up to and including ¾ in.	10·5
Over ¾ in.	10·0

SHEAR IN UNSTIFFENED WEBS	
Universal Beams and Columns and Joists	6·0
Channels, single up to and including ¾ in. thickness	6·0

WEB BUCKLING

The buckling values for the unstiffened webs of joists, channels and beams have been calculated in accordance with the formula in clause 28*a*(i) of B.S. 449 : 1959, namely: $W = p_c.t.\,B.$

where W = permissible reaction or concentrated load in tons on the unstiffened web.

p_c = axial stress in tons/inch^2 for struts, as given in clause 30*a* of B.S. 449 : 1959, as amended, for a slenderness ratio of $\frac{d_3\sqrt{3}}{t}$

d_3 = clear depth of web between root fillets.

t = web thickness.

$B = \frac{1}{2}D + tp + lb$ for end bearings of simply supported beams, or

$= D + 2tp + lb$ for intermediate bearings,

in which,

D = depth in inches of the beam.

tp = thickness in inches of the bearing and/or flange plate (if any).

lb = length in inches of the stiff portion of the bearing; lb shall not be taken as greater than half the depth of beam for simply supported beams and the full depth of beam for an intermediate bearing over which the beam is continuous, unless the web is stiffened.

WEB CRUSHING

To prevent local crushing of the web the direct bearing stress delivered to the root of the web should not exceed 17 ton/inch^2 for High Yield Stress (Welding Quality) Structural Steel to B.S. 968 : 1962, or 12 tons/inch^2 for Mild Steel to B.S. 15 : 1961, when the load is assumed to be dispersed at an angle of 30° through the flange and bearing and/or flange plate(s) (if any). The tables give separately the loads that may be dispersed to the web through the flange and through the plates (if any); and also the load for each inch of stiff bearing.

WEB BUCKLING AND CRUSHING

EXAMPLE: Required the maximum permissible reaction and uniformly distributed load in terms of the web capacity for a mild steel girder composed of one beam 36 in. × 16½ in. @ 260 lbs/ft and having a 1½ in. thick flange plate at each end, when the stiff length of each end bearing is 4 in., see pages 370 and 371.

Web buckling value = $Cj + tp.Cp + lb.Cb$
= 118·95 + 1½ × 6·56 + 4 × 6·56
= 118·95 + 9·84 + 26·24 = 155·03 tons.

Direct bearing value = $Cj + tp.Cp + lb.Cb.$
= 44·61 + 1½ × 17·56 + 4 × 10·14
= 44·61 + 26·34 × 40·56 = 111·51 tons.

The lesser of these two values is 111·51 tons which is thus the limiting reaction for the unstiffened web for this case. The corresponding uniformly distributed load is 111·51 ×2 = 223 tons.

COMBINED STRESSES

Where bending and shear stresses, or bearing, bending and shear stresses, are co-existent under conditions of unfavourable loading, the beam should be checked in accordance with clauses 14*c* and *d* of B.S. 449 : 1959, as amended 1962. (Reproduced on page 636.)

DEFLECTION COEFFICIENTS

Clause 15 of B.S. 449 : 1959, as amended 1964, includes the requirement that the maximum deflection due to loads other than the weight of the structural floors or roof, steelwork and casing, if any, shall not exceed 1/360th of the span. For a simply supported beam, the uniformly distributed load W_D, in tons, to produce this deflection, is:

$$W_D = C.I$$

where C = tabulated deflection coefficient $= \frac{384E}{5 \times 360 \times 144\,L^2}$

E = modulus of elasticity, taken as 13000 tons/inch^2

L = length of span, in feet

I = moment of inertia of beam, in inches^4

The load W_D will be less than the tabular load if the span exceeds 11·95 times the beam depth for high yield steel or 16·51 times the beam depth for mild steel. For such cases, it may be necessary to confirm not only that the total load is within the capacity of the beam but also that the loads to be considered for deflection purposes do not exceed W_D.

The table below gives limiting values of the span to depth ratio for uniformly loaded simply supported beams for high yield steel and for mild steel for various ratios of Wd to Wt where Wd = load considered for deflection purposes and Wt = total load on beam. If the appropriate span to depth ratio is exceeded, then the relevant deflection will exceed 1/360th of the span unless the bending stress is reduced.

Maximum Stress	Limiting values of span to depth ratio for *Wd*/*Wt*					
	1·0	**0·9**	**0·8**	**0·7**	**0·6**	**0·5**
14·5 Tons/sq. in.	11·95	13·28	14·94	17·08	19·92	23·91
13·5 ,, ,,	12·84	14·27	16·05	18·34	21·40	25·68
10·5 ,, ,,	16·51	18·34	20·63	23·58	27·51	33·02
10·0 ,, ,,	17·33	19·26	21·67	24·76	28·89	34·67
9·5 ,, ,,	18·25	20·27	22·81	26·07	30·41	36·49

EXAMPLE: An 18 × 6 @ 55 UB of high yield steel has a simply supported span of 24 feet and carries a distributed imposed load of 24 tons in addition to the load of 12 tons due to weight of structural floor, steelwork and casing. The total distributed load on the beam is thus 36 tons. Ascertain if the beam complies with clause 15.

Reference to pages 244 and 245 shows that the tabular load for the span is 38·2 tons and that the deflection coefficient is 0·0334 also that the moment of inertia is 868·7 inches^4, therefore

$$W_D = C.I = 0{\cdot}0334 \times 868{\cdot}7 = 29{\cdot}0 \text{ tons.}$$

The total load of 36 tons on the beam is less than the tabular load of 38·2 tons and also the imposed load of 24 tons is less than the W_D value of 29·0 tons, therefore the total load is within the permissible limit and also the relevant maximum deflection is within the Clause 15 limit.

TABULAR LOADS

The tabular loads have all been calculated as uniformly distributed loads on simply supported beams and include the weights of the beams, the maximum flexural stresses being as follows:

	Tons/inch^2
For H.Y.S. to B.S. 968 : 1962	
U. Beams, Joists and Channels	14·5
Autofab Beams	13·5
For Mild Steel to B.S. 15 : 1961	
U. Beams, Joists and Channels	10·5
Autofab Beams, up to & incl. ¾ in. material	10·0
,, ,, over ¾ in.	9·5

i.e., tabular loads are based on the assumption that the compression flange is adequately restrained laterally throughout its length or at intervals sufficiently frequent to comply with clause 19 of B.S. 449, as amended.

Tabular loads have been printed in three different styles of type to draw attention to special criteria that may affect the working capacity of the beam. Bold face, italic and ordinary types have been used in that sequence to give maximum clarity and the significance of each for rolled sections is explained below; the significance of each for Autofab Beams is explained in the footnotes on pages 354 to 361 and 490 to 497.

Bold face type. Safe loads printed in bold face type are greater than the web buckling capacity provided by the beam, joist or channel alone and therefore web stiffeners may be necessary if sufficient additional capacity is not provided by the stiff bearing and bearing plate (if any). As indicated in example on page 168, the web should also be checked for direct bearing stress at the root and if this is excessive, means should be taken to relieve the stress at the root.

Ordinary type. Safe loads printed in ordinary type are such that a beam supporting the full amount of the tabular load will have a total maximum deflection exceeding 1/360th of the span. For such cases, the deflection capacity should be inspected as indicated in example on page 169.

Italic type. Safe loads printed in italic type are within the web buckling capacity of the unstiffened web and produce a total deflection not exceeding 1/360th of the span.

BEAMS WITHOUT LATERAL SUPPORT

The flexural compressive stress for beams, joists and channels having uniform cross section throughout and having no or only intermittent lateral support, must not exceed the lesser value of p_{bc} given in Tables 2 and 4 of B.S. 449 : 1959 (amended) for High Yield Stress (Welding Quality) Structural Steel to B.S. 968 : 1962 and in Tables 2 and 3 of B.S. 449 : 1959 (amended) for Mild Steel to B.S. 15 : 1961. The relevant values in Table 2 have been listed under "Working Stresses" on page 167 and Tables 3 and 4 have been combined on page 171.

EXAMPLE: Required the allowable stress, p_{bc}, and the safe uniformly distributed load, W, for a beam 21 in. × 8¼ in. @ 68 lbs/ft in mild steel spanning 24 ft without lateral restraint and having the ends of the compression flange partially restrained. Effective length = 0·85 of span (see clause 26 of B.S. 449 : 1959):

$$l/r_y = 0{\cdot}85 \times 288/1{\cdot}74 = 140 \quad D/T = 30{\cdot}8.$$

$$\text{From Table 3, } p_{bc} = \underline{6{\cdot}9 \text{ tons/inch}^2}$$

$$W = 6{\cdot}9 \times 139{\cdot}9 \times 8 \div 288 = \underline{26{\cdot}8 \text{ tons.}}$$

The critical span, ***Lc***, has been tabulated for each section and represents the maximum effective length of the compression flange which may be permitted without reduction of flexural stress.

Tables 3 and 4 of B.S. 449 : 1959, amended, *combined to give allowable stresses* p_{bc} *in bending in tons/inch*^{2} *for beams of High Yield Stress (Welding Quality) Structural Steel to B.S.* 968 : 1962 (HYS) *and for beams of Mild Steel to B.S.* 15 : 1961 (MS).

l/ry	D/T																*l/ry*
	10		15		20		25		30		35		40		50		
	HYS	MS	HYS	MS	HYS	MS	HYS	MS	HYS	MS	HYS	MS	HYS	MS	HYS	MS	
50	14·5	10·5	14·5	10·5	14·5	10·5	14·5	10·5	14·5	10·5	14·5	10·5	14·5	10·5	14·5	10·5	50
55	14·5	10·5	14·5	10·5	14·5	10·5	14·2	10·5	14·2	10·5	14·2	10·5	14·2	10·5	14·2	10·5	55
60	14·5	10·5	14·5	10·5	14·5	10·5	13·6	10·5	13·6	10·5	13·6	10·5	13·6	10·5	13·6	10·5	60
65	14·5	10·5	14·5	10·5	14·2	10·5	13·0	10·5	13·0	10·5	13·0	10·5	13·0	10·5	13·0	10·5	65
70	14·5	10·5	14·5	10·5	13·6	10·5	12·4	10·5	12·4	10·5	12·4	10·5	12·4	10·5	12·4	10·5	70
75	14·5	10·5	14·2	10·5	13·1	10·5	11·7	10·5	11·7	10·5	11·7	10·5	11·7	10·5	11·7	10·5	75
80	14·5	10·5	13·7	10·5	12·6	10·5	11·1	10·5	11·1	10·5	11·1	10·5	11·1	10·5	11·1	10·5	80
85	14·1	10·5	13·2	10·5	12·1	10·5	10·5		10·5		10·5		10·5		10·5		85
90	13·7	10·5	12·8	10·5	11·5	10·5	10·2		10·2		10·2		10·2		10·2		90
95	13·3	10·5	12·3	10·5	11·0	10·5	9·9		9·9		9·9		9·9		9·9		95
100	12·9	10·5	11·9	10·5	10·5		9·5		9·5		9·5		9·5		9·5		100
105	12·5	10·5	11·4	10·5	10·2		9·2		9·2		9·2		9·2		9·2		105
110	12·1	10·5	11·0	10·5	9·9		8·9		8·9		8·9		8·9		8·9		110
115	11·7	10·5	10·5		9·7		8·6		8·6		8·6		8·6		8·6		115
120	11·3	10·5	10·3		9·4		8·2		8·2		8·2		8·2		8·2		120
130	10·5		9·8		8·8		7·6		7·6		7·6		7·6		7·6		130
140	10·1		9·3		8·3		6·9		6·9		6·9		6·9		6·9		140
150	9·6		8·8		7·7		6·3		6·3		6·3		6·3		6·3		150
160	9·2		8·3		7·2		5·9		5·6		5·6		5·6		5·6		160
170	8·8		7·9		6·6		5·6		5·2		5·0		5·0		5·0		170
180	8·4		7·4		6·1		5·4		5·0		4·7		4·4		4·4		180
190	8·0		6·9		5·8		5·2		4·7		4·4		4·1		3·8		190
200	7·5		6·4		5·6		4·9		4·5		4·2		3·9		3·5		200
210	7·4		6·2		5·4		4·7		4·3		4·0		3·7		3·4		210
220	7·2		6·0		5·2		4·6		4·1		3·8		3·5		3·1		220
230	7·1		5·9		5·0		4·4		4·0		3·6		3·3		3·0		230
240	6·9		5·7		4·9		4·2		3·8		3·5		3·1		2·8		240
250	6·8		5·6		4·7		4·1		3·7		3·3		3·0		2·7		250
260	6·7		5·5		4·5		4·0		3·5		3·2		2·9		2·6		260
270	6·6		5·3		4·4		3·8		3·3		3·0		2·8		2·5		270
280	6·5		5·2		4·3		3·7		3·2		2·9		2·7		2·4		280
290	6·4		5·1		4·1		3·6		3·1		2·8		2·6		2·3		290
300	6·3		4·9		4·0		3·5		3·0		2·7		2·5		2·2		300

Intermediate values may be obtained by linear interpolation

Notes on Plate Girders

AUTOFAB BEAMS

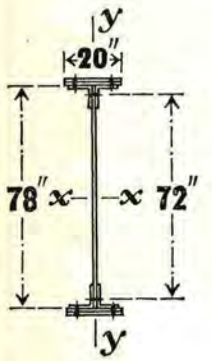
Considerable economy in the production of plate girders can be achieved by the use of the Company's Autofab installation: for particulars of the facility, see page 27.

Properties and safe loads for a range of Autofab Beams in H.Y.S. and M.S. have been tabulated on pages 354 to 361 and 490 to 497 respectively.

PROPERTIES

The properties of a wide range of plate girders, whether of riveted or welded construction, may readily be derived from the tables on pages 132 to 151.

EXAMPLE: Required the gross and net moments of inertia, and section modulus about the ***x-x*** axis and radius of gyration about the ***y-y*** axis of a girder composed of two 20 in. × ¾ in. plates and two 8 in. × 8 in. × ¾ in. angles each flange and a 78 in. × ⅝ in. web plate, with ⅞ in. diameter riveting.



I_x of flange plates = 20 × 4741 = 94820 in^4
I_x of flange angles = 62044 in^4
I_x of web plate = 24716 in^4
gross I_x = 181580 in^4

deduction for holes (using table on page 149):

$$\left.\begin{array}{l} 2 \times \frac{15}{16} \times 2\frac{1}{4} \times 3101 = 13082 \\ 1 \times \frac{15}{16} \times 2\frac{1}{8} \times 2592 = 5164 \end{array}\right\} = 18246 \text{ in}^4$$

net I_x = 163334 in^4

I_y of flange plates = 4 × 500 = 2000 in^4
I_y of flange angles (page 138) = 580·8 in^4
I_y of web plate (neglect) —
gross I_y = 2580·8 in^4

Area of Section:
flange plates 4 × 20 × ¾ = 60 in^2
flange angles 4 × 11·44 = 45·76 in^2
web plate 78 × ⅝ = 48·75 in^2
154·51 in^2

$$r_y = \sqrt{\frac{2580{\cdot}8}{154{\cdot}51}} = 4{\cdot}09 \text{ ins.}$$

The values in tables on pages 148 to 151 do not include the moment of inertia of the unit areas about their own axes. Hence in calculating the net I_x the deduction for holes is approximate but the degree of error is so small that it may be neglected. The gross I_y and r_y are also approximate, the moment of inertia of the web plate about the ***y-y*** axis having been neglected, but here again the degree of error is extremely small.

The properties of girders having web-depths intermediate between those tabulated, and of riveted-type girders having web-depth slightly less than the depth over flange angles, may be obtained by interpolation.

WORKING STRESSES

For High Yield Stress (Welding Quality) Structural Steel to B.S. 968 : 1962 The permissible working stresses as given in B.S. 449 : 1959 : Amendment No. 3, 1962, are:

BENDING	Tons/inch²
Plate Girders with single or multiple webs with material up to and including 2 in. thickness	13·5
over 2 in.	*Ys* ÷ 1·63

Where Ys = yield stress agreed with manufacturer, with a maximum value of 22·0 *tons/ins²*

AVERAGE SHEAR IN UNSTIFFENED WEBS	
Up to and including 2 in. thickness	8·0
over 2 in.	7·0

For Mild Steel to B.S. 15 : 1961 The permissible working stresses as given in B.S. 449 : 1959, are:

BENDING	Tons/inch²
Plate Girders with single or multiple webs with material up to and including ¾ in. thickness	10·0
over ¾ in.	9·5

AVERAGE SHEAR IN UNSTIFFENED WEBS	
Up to and including ¾ in. thickness	6·0
over ¾ in.	5·5

SHEAR

The shear value for the web of a plate girder is controlled by the ratio ***d/t*** and the stiffener spacing in terms of ***d***, where ***d*** is the clear distance between flange angles or, where there are no flange angles, the clear distance between flanges, ignoring fillets, and ***t*** is the web thickness.

Tables 13 and 12 of B.S. 449 : 1959 give the allowable average shear in stiffened webs of steel to B.S. 968 and 15 respectively, and are repeated overleaf:

B.S. 449:1959 (Amended)

Table 13. *Allowable average Shear Stress in Stiffened Webs of Steel to B.S.* 968 : 1962:

$\frac{d}{t}$	Stress (tons/sq. in.) for different distances between stiffeners												
	0·3d	0·4d	0·5d	0·6d	0·7d	0·8d	0·9d	d	1·1d	1·2d	1·3d	1·4d	1·5d
75	8·5	8·5	8·5	8·5	8·5	8·5	8·5	8·5	8·5	8·5	8·5	8·5	8·4
80	8·5	8·5	8·5	8·5	8·5	8·5	8·5	8·5	8·5	8·5	8·4	8·3	8·3
90	8·5	8·5	8·5	8·5	8·5	8·5	8·5	8·5	8·3	8·2	8·1	8·0	7·9
100	8·5	8·5	8·5	8·5	8·5	8·5	8·3	8·2	8·0	7·9	7·8	7·7	7·6
110	8·5	8·5	8·5	8·5	8·4	8·2	8·1	7·9	7·7	7·6	7·4	7·3	7·2
120	8·5	8·5	8·5	8·5	8·2	8·0	7·8	7·6	7·4	7·3	7·1	7·0	6·9
130	8·5	8·5	8·5	8·2	7·9	7·7	7·5	7·4	7·1	7·0	6·8	6·7	6·5
140	8·5	8·5	8·4	8·0	7·7	7·4	7·2	7·1	6·8	6·6	6·5	6·3	6·2
150	8·5	8·5	8·2	7·8	7·5	7·2	7·0	6·8	6·5	6·3	6·1	6·0	5·8
160	8·5	8·5	8·0	7·6	7·2	6·9	6·7	6·5	6·2	6·0	5·8	5·6	5·5
170	8·5	8·4	7·8	7·4	7·0	6·7	6·4	6·2	5·9	5·7	5·5	5·3	5·1
180	8·5	8·2	7·7	7·2	6·8	6·4	6·2	6·0	5·6	5·4	5·2	5·0	4·8
190	8·5	8·1	7·5	6·9	6·5	6·2	5·9						
200	8·4	7·9	7·3	6·7	6·3	5·9	5·6						
210	8·3	7·7	7·1	6·5	6·0	5·6							
220	8·1	7·6	6·9	6·3	5·8	5·4							
230	8·0	7·4	6·7	6·1	5·6								
240	7·9	7·3	6·5	5·9	5·3								

The average stress shown in Table 11 of B.S. 449 : 1959, Amendment No. 3, 1962, shall not be exceeded

The ratio of the clear web depth to the thickness of the web for unstiffened webs shall not exceed 75.

B.S. 449:1959 (Amended)

Table 12 *Allowable average Shear Stress in Stiffened Webs of Steel to B.S.* 15 : 1961:

$\frac{d}{t}$	Stress (tons/sq. in.) for different distances between stiffeners											
	0·4d	0·5d	0·6d	0·7d	0·8d	0·9d	d	1·1d	1·2d	1·3d	1·4d	1·5d
100	6·0	6·0	6·0	6·0	6·0	6·0	6·0	6·0	6·0	6·0	5·9	5·8
110	6·0	6·0	6·0	6·0	6·0	6·0	6·0	5·9	5·8	5·8	5·7	5·6
120	6·0	6·0	6·0	6·0	6·0	6·0	5·9	5·8	5·7	5·6	5·5	5·4
130	6·0	6·0	6·0	6·0	5·9	5·8	5·7	5·6	5·5	5·4	5·3	5·3
140	6·0	6·0	6·0	5·9	5·8	5·7	5·6	5·4	5·3	5·2	5·1	5·1
150	6·0	6·0	6·0	5·8	5·6	5·5	5·4	5·3	5·1	5·0	4·9	4·8
160	6·0	6·0	5·8	5·6	5·5	5·3	5·2	5·1	5·0	4·8	4·7	4·7
170	6·0	6·0	5·7	5·5	5·3	5·2	5·1	4·9	4·8	4·7	4·6	4·5
180	6·0	5·9	5·6	5·4	5·2	5·0	4·9	4·7	4·6	4·5	4·4	4·3
190	6·0	5·8	5·5	5·2	5·0	4·9						
200	6·0	5·7	5·4	5·1	4·9	4·7						
210	5·9	5·6	5·2	5·0	4·8							
220	5·8	5·4	5·1	4·8	4·6							
230	5·8	5·4	5·0	4·7								
240	5·7	5·2	4·9	4·6								

The average stress shown in Table 11 of B.S. 449 : 1959 shall not be exceeded

The ratio of the clear web depth to the thickness of the web for unstiffened webs shall not exceed 85.

TABULAR LOADS

In Parts IV and V the tabular loads for a selected range of simply supported Autofab Welded Beams have been calculated as uniformly distributed loads and include the weight of the girders. Lateral restraint is assumed and the flexural stress is in accordance with the permissible stresses tabulated on page 173, except where the load is reduced to comply with shear limit indicated by obelus (†).

Tabular loads printed in ordinary type produce a deflection exceeding 1/360th of the span.

Stiffeners spaced at less than 1½*d* are required for tabular loads printed in prominent type, and at 1½*d* for loads printed in italic and ordinary type, where *d* is the depth of the web.

Dimensions and Properties are tabulated for the gross sections of the girders.

Notes on Safe Load Tables for Columns, Stanchions and Struts

AXIAL STRESSES

The tabulated safe loads on stanchions and struts have been calculated in accordance with the permissible axial stresses in struts specified in clause 30 of B.S. 449 : 1959, amended. The appropriate sections of Table 17 of the above clause are reprinted below for steel to B.S. 968 : 1962 and to B.S. 15 : 1961.

Table 17B *Allowable Stresses p_c on Gross Section for Axial Compression for High Yield Stress (Welding Quality) Structural Steel to B.S.* 968 : 1962 *for Thickness Not Exceeding 2 in.*

l/r	*pc* in tons/sq. in. for steel to B.S. 968										*l/r*
	0	1	2	3	4	5	6	7	8	9	
0	13·50	13·50	13·50	13·50	13·50	13·49	13·49	13·49	13·49	13·49	0
10	13·49	13·48	13·47	13·46	13·45	13·43	13·42	13·41	13·39	13·37	10
20	13·36	13·34	13·32	13·30	13·27	13·25	13·23	13·20	13·17	13·14	20
30	13·11	13·08	13·04	13·01	12·97	12·93	12·89	12·84	12·80	12·75	30
40	12·70	12·64	12·59	12·53	12·47	12·40	12·33	12·26	12·19	12·11	40
50	12·03	11·95	11·86	11·77	11·67	11·57	11·47	11·36	11·25	11·14	50
60	11·02	10·90	10·78	10·65	10·52	10·39	10·25	10·11	9·97	9·83	60
70	9·69	9·55	9·40	9·26	9·11	8·97	8·82	8·68	8·54	8·39	70
80	8·25	8·11	7·97	7·84	7·70	7·57	7·44	7·31	7·18	7·06	80
90	6·94	6·82	6·70	6·58	6·47	6·36	6·25	6·14	6·04	5·93	90
100	5·83	5·73	5·64	5·54	5·45	5·36	5·27	5·19	5·10	5·02	100
110	4·94	4·86	4·78	4·70	4·63	4·56	4·49	4·42	4·35	4·28	110
120	4·22	4·15	4·09	4·03	3·97	3·91	3·85	3·80	3·74	3·69	120
130	3·63	3·58	3·53	3·48	3·43	3·39	3·34	3·29	3·25	3·20	130
140	3·16	3·12	3·08	3·04	3·00	2·96	2·92	2·88	2·84	2·81	140
150	2·77	2·74	2·70	2·67	2·63	2·60	2·57	2·54	2·51	2·48	150
160	2·45	2·42	2·39	2·36	2·33	2·31	2·28	2·25	2·23	2·20	160
170	2·18	2·15	2·13	2·10	2·08	2·06	2·04	2·01	1·99	1·97	170
180	1·95	1·93	1·91	1·89	1·87	1·85	1·83	1·81	1·79	1·77	180
190	1·75	1·74	1·72	1·70	1·68	1·67	1·65	1·63	1·62	1·60	190
200	1·59	1·57	1·56	1·54	1·53	1·51	1·50	1·48	1·47	1·45	200
210	1·44	1·43	1·41	1·40	1·39	1·38	1·36	1·35	1·34	1·33	210
220	1·32	1·30	1·29	1·28	1·27	1·26	1·25	1·24	1·23	1·22	220
230	1·21	1·20	1·18	1·17	1·17	1·16	1·15	1·14	1·13	1·12	230
240	1·11	1·10	1·09	1·08	1·07	1·06	1·06	1·05	1·04	1·03	240
250	1·02										250
300	0·71										300
350	0·52										350

Intermediate values may be obtained by linear interpolation.

For steel to B.S. 968 for thickness of material exceeding 2 in., the allowable stress p_c on gross section for axial compression must be calculated in accordance with the procedure in Appendix B, taking *Ys* equal to the value of the yield stress agreed with the manufacturer, with a maximum value of 22 tons/ins².

Table 17A *Allowable Stresses p_c on Gross Section for Axial Compression for Mild Steel to B.S.* 15 : 1961.

l/r	*pc* in tons/sq. in. for steel to B.S. 15 or B.S. 2762										*l/r*
	0	1	2	3	4	5	6	7	8	9	
0	9·50	9·49	9·48	9·46	9·45	9·44	9·43	9·42	9·41	9·39	0
10	9·38	9·38	9·37	9·36	9·36	9·35	9·34	9·33	9·32	9·31	10
20	9·29	9·28	9·27	9·25	9·24	9·22	9·21	9·19	9·17	9·15	20
30	9·13	9·11	9·09	9·07	9·05	9·02	9·00	8·97	8·94	8·92	30
40	8·89	8·86	8·82	8·79	8·76	8·72	8·68	8·64	8·61	8·56	40
50	8·52	8·48	8·43	8·38	8·34	8·29	8·23	8·18	8·13	8·07	50
60	8·01	7·95	7·89	7·83	7·76	7·70	7·63	7·56	7·49	7·42	60
70	7·35	7·27	7·20	7·12	7·04	6·97	6·89	6·81	6·73	6·65	70
80	6·57	6·49	6·40	6·32	6·24	6·16	6·08	6·00	5·92	5·83	80
90	5·75	5·68	5·60	5·52	5·44	5·36	5·29	5·21	5·14	5·06	90
100	4·99	4·92	4·85	4·78	4·71	4·64	4·58	4·51	4·44	4·38	100
110	4·32	4·26	4·20	4·14	4·08	4·02	3·96	3·91	3·85	3·80	110
120	3·74	3·69	3·64	3·59	3·54	3·49	3·45	3·40	3·35	3·31	120
130	3·26	3·22	3·18	3·14	3·09	3·05	3·01	2·97	2·94	2·90	130
140	2·86	2·83	2·79	2·75	2·72	2·69	2·65	2·62	2·59	2·56	140
150	2·52	2·49	2·46	2·43	2·41	2·38	2·35	2·32	2·29	2·27	150
160	2·24	2·21	2·19	2·16	2·14	2·12	2·09	2·07	2·05	2·02	160
170	2·00	1·98	1·96	1·94	1·91	1·89	1·87	1·85	1·83	1·81	170
180	1·80	1·78	1·76	1·74	1·72	1·70	1·69	1·67	1·65	1·64	180
190	1·62	1·60	1·59	1·57	1·56	1·54	1·53	1·51	1·50	1·48	190
200	1·47	1·45	1·44	1·43	1·41	1·40	1·39	1·37	1·36	1·35	200
210	1·34	1·32	1·31	1·30	1·29	1·28	1·27	1·25	1·24	1·23	210
220	1·22	1·21	1·20	1·19	1·18	1·17	1·16	1·15	1·14	1·13	220
230	1·12	1·11	1·10	1·09	1·08	1·07	1·07	1·06	1·05	1·04	230
240	1·03	1·02	1·02	1·01	1·00	0·99	0·98	0·98	0·97	0·96	240
250	0·95										250
300	0·67										300
350	0·49										350

Intermediate values may be obtained by linear interpolation.

For material over ¾ in. thick, other than rolled **I** beams or channels, and for Universal Beams and Columns of thickness exceeding 1½ in., the limiting allowable stress is 9·0 tons/sq. in.

EFFECTIVE LENGTHS

The effective length to be used in calculating the ratio of slenderness of a compression member is governed by clauses 30 and 31 of B.S. 449 : 1959 and several examples giving guidance for typical cases are given in Appendix D of that document.

The basic requirements are that the actual length *L* should be measured between the centres of intersections and the effective length *l* should be obtained by multiplying *L* by the appropriate factor derived from the following list which incorporates the requirement given in clause 30.*c.* for angle struts.

END CONDITIONS OR CONNECTIONS	EFFECTIVE LENGTH FACTOR
Effectively held in position and restrained in direction at both ends	0·70
Effectively held in position at both ends and restrained in direction at one end	0·85
Effectively held in position at both ends but not restrained in direction	1·00

continued on p. 178

END CONDITIONS OR CONNECTIONS	EFFECTIVE LENGTH FACTOR
Effectively held in position and restrained in direction at one end and at the other partially restrained in direction, but not held in position	1·50
Effectively held in position and restrained in direction at one end, but not held in position or restrained in direction, at the other end	2·00
Single angle and double angle strut, double bolted, double riveted or welded to one side of a gusset	0·85
Double angle strut connected to both sides of a gusset, double bolted, double riveted or welded	0·70–0·85
Single angle strut, single bolted or riveted to one side of a gusset. The calculated stress not to exceed 80% of values of Table 17, B.S. 449 : 1959, as amended.	1·00

TABULAR LOADS AND MAXIMUM SLENDERNESS RATIOS

Safe Loads have been tabulated for compression members having slenderness ratios not exceeding the maximum values specified in clause 33 of B.S. 449 : 1959.

For stanchions and columns, safe loads have not been tabulated for effective lengths giving a ratio of slenderness in excess of 180.

For struts composed of two angles or two channels connected to both sides of a gusset or section by not less than two bolts, two rivets or by welding, safe loads have not been tabulated for effective lengths giving a ratio of slenderness in excess of 250 and italic type indicates the safe loads on effective lengths producing a ratio of slenderness in excess of 180.

For single and double angle struts connected to one side of a gusset by not less than two bolts, two rivets or by welding, the effective length factor, 0·85, has already been taken into account in the safe loads tabulated for these sections. Loads have not been tabulated for effective lengths giving slenderness ratios in excess of 250. Italic type indicates the safe loads for effective lengths producing a slenderness ratio in excess of 180.

Loads printed in italics for double bolted, double riveted, or welded angle or channel struts include the 25% increase of permissible stress in accordance with clauses 13 and 33 (ii) and are applicable to wind forces only.

For single angle struts, single bolted or riveted, the effective length is the length between intersections shown at the head of the tables. Loads have not been tabulated for effective lengths producing a slenderness ratio in excess of 180. The tabular loads have been based on 80% of the values given in Table 17 for these sections. Loads printed in italics indicate that the safe load capacity of the strut exceeds the black bolt value.

The tabulated safe loads on laced and battened stanchions or struts have been based on the assumption that the shafts are efficiently braced by lacing bars or batten plates complying with clauses 35 and 36 of B.S. 449 : 1959, as amended.

For compound struts, the tabulated safe loads have been based on the assumption that the members are connected together along their length by means complying with clause 37 of B.S. 449 : 1959, as amended.

$\frac{D}{T}$ RATIO

The ratio of the depth of section *D*, to mean or effective thickness of flange *T*, has been tabulated for each beam, channel or column section for use in the design of stanchions subject to bending. Designers are referred to clause 19 of B.S. 449 : 1959, as amended. In cases where lateral stability of twin beam compound stanchions must be considered, special analysis should be undertaken if greater economy of steel is required.

ECCENTRIC LOADING ON COMPRESSION MEMBERS

When compression members are subjected to eccentric loading, then the tabulated safe loads are generally inappropriate and each member must be designed so that the quantity

$$\frac{f_c}{p_c} + \frac{f_{bc}}{p_{bc}} \not> 1 \qquad \text{(see also page 180)}$$

where f_c = the calculated average axial compressive stress

p_c = the allowable compressive stress in axially loaded struts as specified in Table 17 of B.S. 449 : 1959, as amended.

f_{bc} = the calculated resultant compressive stress due to bending about both rectangular axes and

p_{bc} = the appropriate allowable compressive stress for members subject to bending as given in clause 19 of the same specification and amendments.

In single storey buildings the horizontal deflection at the cap should not exceed 1/325th of the height, but this limit may be waived in cases where greater deflection would not impair the strength and efficiency of the structure nor lead to damage to finishings.

For single angle struts and for double angle struts connected to one side of a gusset plate, the reduced stresses stipulated in clause 30.*c* of B.S. 449 : 1959 make allowance for the bending stresses produced by normal eccentricity of the end connection so that the above ratio formula is deemed to be automatically satisfied for these cases.

For other sections, definite eccentricities are stipulated in clause 34.*a* depending on the type of connection.

On effectively jointed and continuous stanchions calculated in accordance with the 'simple design' methods, the bending moments due to eccentricities of loading at any one floor may be considered to be ineffective at the floor levels above and below that floor. These bending moments may be divided equally between the upper and lower stanchion lengths, provided the moment of inertia of either stanchion divided by its actual length is not greater than 1½ times the corresponding value for the other portion of the stanchion. If this ratio is exceeded the bending moments must be divided between the stanchion lengths in proportion to these ratios.

COMBINED AXIAL LOAD AND BENDING

The stress ratio relationship to unity stated on page 247 also applies when bending is due to causes other than eccentricity.

When either f_c or f_{bc}, or both, include stresses due to wind pressure, the sum of the ratios may be increased to but must not exceed 1·25 provided that the member is satisfactory when the stresses due to wind pressure are excluded and the sum of the ratios limited to 1·00.

SPACING OF SECTIONS

For double channel plated stanchions, the distance from the edge of the flange plate to the edge of the channel flange is 1 inch for all channels over 10 inches in depth and ½ inch for channels 10 inches or less in depth. For laced beam or channel stanchions, the distance between the centres of beam webs or the space between the channel webs has been fixed to the nearest ½ inch so that the radii of gyration are approximately equal about both axes.

For struts composed of two channels or two angles with gusset plate between, the spacing of the members has been varied between $\frac{5}{16}$ inch and ⅝ inch to accord with the probable thickness of the gusset plate for each case.

For angle struts with gusset plate on back of angles the same spacing has been adopted.

Notes on
Safe Load Tables
for Cased Stanchions

GENERAL

The tables relate to single universal beams, universal columns and joists solidly cased in concrete and employed as stanchions. The notes on pages 176–180 are generally applicable to the tables of cased stanchions except in so far as they are modified by the following:

CASING

The tables for cased columns have been based on the assumption that the concrete casing and reinforcement comply with clause 30.*b* of B.S. 449 : 1959. This clause stipulates that:

(i) The steel strut is unpainted and solidly encased in ordinary dense concrete, with ⅜ in. aggregate (unless solidity can be obtained with a larger aggregate) and of a works strength not less than 3000 lb/in^2 at 28 days when tested in accordance with B.S. 1881, 'Methods for Testing Concrete', Part 7, 'Making and Curing Compression Test Cubes in the Field', and Part 8, 'Test for Compressive Strength of Moulded Cubes'.

(ii) The minimum width of solid casing is equal to $B + 4$ in., where B is the width overall of the steel flange or flanges in inches.

(iii) The surface and edges of the steel strut have a concrete cover of not less than 2 in.

(iv) The casing is effectively reinforced with wire to B.S. 785, 'Rolled steel bars and hard drawn steel wire for concrete reinforcement'. The wire shall be at least $\frac{3}{16}$ in. diameter and the reinforcement shall be in the form of stirrups or binding at not more than 6 in. pitch, so arranged as to pass through the centre of the covering of the edges and outer faces of the flanges and supported by and attached to longitudinal spacing bars not less than 4 in number.

AREAS

The tabular core areas are the gross areas of the steel section forming the core of the stanchion. The tabular cased section areas are the gross areas of the composite member and represent the sum of the steel core area and area of encasing concrete, that is to say, the area $B_c \times D_c$.

RADII OF GYRATION

Radii of gyration have been tabulated for each section relative to the principal axes. The radius of gyration about the *x-x* axis is not considered to be altered by the casing and is identical with that for the uncased section. Two radii of gyration have been tabulated for each section relative to the *y-y* axis. That for the core only makes no allowance for the casing and has been derived from the gross moment of inertia of the steel shaft. That for the cased section has been tabulated as $0{\cdot}2(B + 4)$ inches, or as the radius of gyration relative to the *y-y* axis of steel core, whichever is the greater.

TABULAR LOADS

The tabular loads have been calculated on the basis of the concrete casing assisting in carrying the load in accordance with clause 30.*b* of B.S. 449 : 1959, namely:

$$W = p_c \times a_s + \frac{p_c \times a_c}{30} \text{ for steel to B.S. 15 : 1961.}$$

$$W = p_c \times a_s + \frac{p_c \times a_c}{3p_n} \text{ for steel to B.S. 968 : 1962.}$$

Where $W =$ safe axial load in tons on the cased column, which in no case shall exceed twice that which would be permitted on the uncased section.

$p_c =$ permissible axial stress for the encased steel section as given by Table 17, B.S. 449 : 1959 as amended.

$p_n =$ numerical value of p_{bc} given in Table 2 B.S. 449 : 1959 and Amendments No. 2, 1961 and No. 3, 1962.

$a_s =$ area in square inches of the steel core section,

$a_c =$ gross area in square inches of the composite member, i.e. $B_c \times D_c$. It should be noted that a_c is not the net area of the concrete encasing.

The safe loads have been tabulated for effective slenderness ratios not exceeding 180 for the cased section and the term 'effective length' at the head of each table is applicable only to the cased section. The slenderness ratio of the uncased section, measured over its full length centre to centre of connections, should in no case exceed 250. Tabular loads are not given beyond this limit, using for the purpose the lengths at the head of each table as actual lengths. Tabular loads printed in italics indicate axial loads on the cased strut which are restricted to twice that which would be permitted on the uncased section.

The sizes of casings used in calculating the tabular loads for joists have been based on the surface or edge of the steel core receiving 2 inches and in the case of universal columns and beams not less than 2 inches and not more than 2⅛ inches concrete cover. (Overall dimensions of concrete to nearest ¼-inch). When the designer is required to compute safe loads for greater cover thicknesses, it is permissible to use the concrete casing as assisting the steel core up to a limit of 3 inches cover; all concrete outside this limit to be ignored.

ECCENTRIC LOADING

No provision is made in B.S. 449 : 1959 for the possibility of the concrete casing assisting the steel core in resisting bending moments caused by eccentric loading. Bending moments due to eccentric loading or other causes must therefore be deemed to be taken by the steel core alone.

Cased struts must be designed so that the quantity

$$\frac{F}{W} + \frac{f_{bc}}{p_{bc}} \ngtr 1.$$

where $F =$ the calculated axial load on the cased member.

$W =$ the allowable axial load determined in accordance with clause 30.*b* of B.S. 449 : 1959.

$f_{bc} =$ the calculated resultant compressive stress due to bending about both rectangular axes.

$p_{bc} =$ the appropriate allowable compressive stress for members subject to bending as given in clause 19.*a* of B.S. 449 : 1959 and Amendments No. 2, 1961 and No. 3, 1962.

Notes on Safe Load Tables for Angle Ties

AREAS The gross area has been tabulated for each section and also the effective area corresponding to the particular end connection, except in the tables for ties formed of two angles with gussets between the angles.

Gross Area The gross area is the total cross sectional area of the entire tie.

Effective Area Each effective area is the area of the portion of the tie attached to the end connection plus the area allowance specified in clause 42 of B.S. 449 : 1959 for the outstanding portion. The area of the attached portion is reduced by the cross sectional area of the holes deducted in each instance.

MAXIMUM LENGTHS OF TIES In a roof truss, the effective length of any tie subject to possible reversal of stress due to the action of wind forces must not exceed 350 times the appropriate radius of gyration.

SPACING OF ANGLES IN COMPOUND TIES The safe loads on the angle ties are not related to the spacing of the angles; but if the ties are subjected to reversal of stress, then the maximum permissible effective length as a strut may be partially controlled by the spacing.

HOLES The number and diameter of holes deducted from each angle have been related to the length of the attached leg or legs and are indicated in the tables opposite the corresponding safe load or loads.

Where the holes are staggered, account must be taken where necessary of any tendency of the member to fail along a diagonal section through the holes.

WORKING STRESSES The tabulated safe load values have been based on the following permissible working stresses on the effective area of the ties, as given in B.S. 449 : 1959, as amended.

For High Yield Stress (Welding Quality) Structural Steel to B.S. 968 : 1962.

For angles up to and including 2-inch thickness	13·5 tons/inch^2

For Mild Steel to B.S. 15 : 1961.

For angles up to and including ¾-inch thickness	9·5 tons/inch^2
For angles over ¾-inch thick	9·0 tons/inch^2

As the effective area of each tie is dependent on the type of section and on its type of end fastening, the loads tabulated for one condition are not usually appropriate to other conditions.

END CONNECTIONS Allowance for the eccentricity of a normal end connection is made in the specified method of calculation of the effective areas of angle ties and the allowance has been incorporated into the tabulated safe loads.

LUG ANGLES Lug angles may be used to augment the strength of the end connections of an angle tie provided that the lug angles and their connections to the gussets must each be capable of developing a strength not less than 20% in excess of the force in the outstanding leg of the angle and the attachment of the lug angle to the angle tie must be capable of developing 40% in excess of that force.

Safe loads for single angle ties with lug angles incorporated in the end connections have been tabulated alongside the safe loads for angle ties without lug angles.

INTERMEDIATE FASTENINGS Compound angle ties must have the component members connected together by tacking rivets or welding at a pitch not exceeding 3 ft 6 ins and solid distance pieces must be provided at each such fastening where the angles are not in contact.

Where compound angle ties are not connected together to act as a unit, the tables for single angle ties may be of service in determining the safe load.

Notes on Safe Load Tables for Universal Beams, Columns, Joists and Channels as Ties

AREAS The gross and net areas for stated numbers of holes deducted have been tabulated for each section. The area and safe load reduction per hole in the web is also tabulated.

WORKING STRESSES The tabulated safe load values have been based on the following permissible working stresses on the effective area of the ties, as given in B.S. 449 : 1959 and Amendments No. 2 : 1961 and No. 3 : 1962.

For High Yield Stress (Welding Quality) Structural Steel to B.S. 968 : 1962.

Sections up to and including	
2 inch thickness	13·5 tons/inch^2
Over 2 ins.	*Ys* ÷ 1·63

For Mild Steel to B.S. 15 : 1961.

Joists and channels	9·5 tons/inch^2
Universal Beams and Columns	
Up to and including ¾ inch	9·5 tons/inch^2
Over ¾ in.	9·0 tons/inch^2

Notes on Tables of Rivets and Bolts

WORKING STRESSES Safe load values have been tabulated in Parts IV and V in accordance with the permissible stresses as given in B.S. 449 : 1959, Amendment No. 2 : 1961, and reproduced below:

	Steel to B.S. 15 : 1961		**Steel to B.S. 968 : 1962**	
	Single Shear Tons/in^2	Bearing (Double Shear) Tons/in^2	Single Shear Tons/in^2	Bearing (Double Shear) Tons/in^2
Power Driven Shop Rivets	6·5	19·0	9·0	27·0
Power Driven Field Rivets	6·0	17·5	8·5	25·0
Hand Driven Rivets	5·5	16·0	7·5	23·0
Close Tolerance and Turned Bolts	6·0	19·0	9·0	27·0
Black Bolts	5·0	12·5	7·0	12·5*

**This value is not specified in B.S. 449 : 1959, Amendment No. 2 : 1961 and for the purpose of tabulation has been taken the same as for mild steel.*

MULTIPLE SHEAR For rivets and bolts in double shear, the area to be assumed must be twice the area for single shear. Where the rivets or bolts are in single shear, the permissible bearing stress must be reduced by 20%.

CRITICAL VALUES Bearing values printed in ordinary type are less than single shear. In these cases, the bearing values are the determining factors. Bearing values printed in prominent type are greater than single and less than double shear, so that in the case of:

(*a*) single shear, the shearing value is the criterion.

(*b*) double shear, the bearing value is the criterion.

Bearing values printed in light type are equal to or greater than double shear. In these cases, the shearing values are the criterion.

DIMENSIONS AND WEIGHTS The leading dimensions and approximate weights have been tabulated on pages 708 to 712

Notes on High Strength Friction Grip Bolts

DIMENSIONS AND PROPERTIES The bolts, nuts and washers must comply with B.S. 3139 : 1959, 'High Strength Friction Grip Bolts for Structural Engineering, Part 1. General Grade Bolts'.

APPLICATION This must conform to B.S. 3294 : 1960 and Amendment No. 1 : 1962, 'The Use of High Strength Friction Grip Bolts in Structural Steelwork, Part 1. General Grade Bolts'.

LENGTH OF BOLTS The length of the bolt should be calculated by adding to the grip the allowance given in Table 1 below to allow for the thickness of one nut and of two flat washers and for sufficient protrusion of the bolt end. Where taper washers are used instead of flat washers an additional allowance of $\frac{1}{16}$ in. for each taper washer should be made when calculating the length of the bolt.

Table 1. Bolt Length Allowances

B.S. 3294 : Part 1 : 1960

Bolt Diameter, inches	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{2}$
Allowances to add to grip, inches	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	$2\frac{1}{8}$

SURFACES IN CONTACT At the time of assembly, surfaces in contact must be free of paint or any other applied finish, oil, dirt, loose rust, loose scale, burrs and other defects which would prevent solid seating of the parts or would interfere with the development of friction between them.

If any other surface condition, including a machined surface, is desired, it will be the responsibility of the Engineer to determine the slip factor to be used in the particular case.

HOLES IN MEMBERS All holes must be drilled and burrs must be removed. Where the number of plies in the grip does not exceed three, the diameters of the holes must be $\frac{1}{16}$ in. larger than those of the bolts. Where the number of plies in the grip exceeds three, the diameters of the holes in the two outer plies must be as above and the diameters of the holes in the inner plies must be not less than $\frac{1}{16}$ in. and not more than $\frac{1}{8}$ in. larger than those of the bolts.

Where high strength friction grip bolts are used, the deduction in cross sectional area of connected tension members must be in accordance with B.S. 449 : 1959 except that, in calculating the area to be deducted, the actual diameter of the hole must be used. No deduction should be made in the case of compression members.

The distance from the centre of any hole to the edge of a member and the distance between the centres of holes must be in accordance with B.S. 449 : 1959.

MINIMUM PLY THICKNESS In connections using these bolts, no outer ply must be smaller in thickness than half the diameter of the bolt or $\frac{3}{8}$ in. whichever is less.

Wherever possible, this condition for minimum thickness should be observed for inner plies.

DESIGN (*a*) *Shear Connections.* In connections subject only to shear in the plane of the friction faces, the number of friction grip bolts and their disposition must be such that the resulting load at any bolt position does not exceed the value:

$$\frac{\text{Slip Factor}}{\text{Load Factor}} \times \text{number of effective interfaces} \times \text{proof load of one bolt}$$

in which

Slip Factor is the ratio of the load per effective interface required to produce slip in a pure shear joint to the total shank tension induced in the bolt (or bolts).

Load Factor is the numerical value by which the load which would cause slip in a joint is divided to give the permissible working load on the joint.

Effective Interface is a common contact surface between two load-transmitting plies, excluding packing pieces, through which the bolt passes.

Proof Load is the appropriate load given in Table 3 below.

The load factor may be taken as 1·4 for structures and materials covered by B.S. 449 : 1959 (amended 1962). Where the effect of wind forces on the structure has to be taken into consideration, this load factor may be reduced to 1·2 provided the connections are adequate when wind forces are neglected.

In all cases where surfaces in contact comply with the conditions set out above, the slip factor may be taken as 0·45.

Shear values of bolts per interface have been tabulated in Parts IV and V, using the above numerical factors as the basis.

(*b*) *Connections subject to external tension only in the direction of the bolt axes.* In these cases, the maximum permissible external tension on any bolt must not exceed 0·6 of the proof load of the bolts used, as given in Table 3. However, where fatigue conditions are involved, the maximum permissible external tension on any bolt must be limited to 0·5 of the proof load.

(*c*) *Connections subject to external tension in addition to shear.* An externally applied tension in the direction of the bolt axis reduces the effective clamping action of a bolt which has been tightened to induce shank tension. To allow for this effect, the permissible resulting load at any bolt position, as calculated from the expression in (*a*) above, must be reduced by substituting for the proof load of the bolt an effective clamping force obtained by subtracting 1·7 times the applied external tensile load from the proof load.

Under this rule, the effective clamping action of a bolt is considered to cease when the externally applied tension reaches 0·6 of its proof load, which is the maximum permissible value—see (*b*) above.

Table 3. Proof Loads of Bolts (minimum shank tension)
B.S. 3294 : Part 1, 1960

Bolt Diameter inches	Proof Load (minimum shank tension) tons	Bolt Diameter inches	Proof Load (minimum shank tension) tons
½	5·37	1	21·09
⅝	8·56	1⅛	25·20
¾	12·67	1¼	32·00
⅞	16·09	1½	46·04

NOTE 1. The proof loads in the Table are those specified in Table 2 of B.S. 3139, 'High strength friction grip bolts for structural engineering', Part 1, 'General grade bolts'.

NOTE 2. The torque necessary to induce a specified tension is determined by actual site conditions and equipment.

NOTE 3. For calibration purposes, the minimum shank tensions are to be increased by 10 per cent (see clause 8.*b*).

DIMENSIONS AND WEIGHTS The leading dimensions and approximate weights have been tabulated on pages 712 and 713.

Notes on Welding

WORKING STRESSES Safe Loads for Fillet and Butt Welds tabulated in Parts IV and V have been calculated in accordance with the permissible stresses in Welds for Mild Steel to B.S. 15 : 1961 and High Yield Stress (welding quality) Structural Steel to B.S. 968 : 1962, specified in clause 53 of B.S. 449 : 1959, as stated below.

FILLET WELDS The allowable stresses in Fillet Welds based on a thickness equal to the throat thickness, are:

(1) For Steel to B.S. 15 : 1961 with Electrodes to B.S. 639	7·0 Tons/inch²
(2) For Steel to B.S. 968 : 1962 with Electrodes to B.S. 2549	8·5 Tons/inch²
(3) For Steel to B.S. 968 : 1962 with Electrodes to B.S. 639	7·0 Tons/inch²

BUTT WELDS Butt Welds must be treated as parent metal with a thickness equal to the throat thickness (or a reduced throat thickness as specified in clause 54 of B.S. 449 : 1959, for certain butt welds) and the stresses must not exceed those allowed for the parent metal, thus:

(1) For Steel to B.S. 15 : 1961 with Electrodes to B.S. 639	the stresses must not exceed those allowed for the mild steel.
(2) For Steel to B.S. 968 : 1962 with Electrodes to B.S. 2549	the stresses must not exceed those allowed for the H.Y.S. Steel.
(3) For Steel to B.S. 968 : 1962 with Electrodes to B.S. 639	the stresses must not exceed those allowed for Mild Steel to B.S. 15 : 1961.

COMBINED STRESSES When welds are subject to a combination of stresses, the strength should be checked in accordance with clause 53.*a*(ii) of B.S. 449 : 1959.

Note on
Surface Areas

Surface areas of universal beams, columns, joists and channels have been tabulated in Part II for use when calculating areas to be painted, shot or grit blasted, metal sprayed or similarly treated.

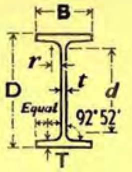
PART III

Dimensions and Properties

(METRIC UNITS)

of

to B.S. 4 : Part I : 1962, *amended*



UNIVERSAL BEAMS

Taper Flanges

DIMENSIONS AND PROPERTIES

METRIC

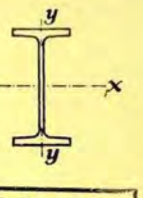
Serial Size	Weight		Depth of Section **D**	Width of Section **B**	Thickness		Root Radius *r*	Depth between Fillets *d*	Area of Section
	per foot	per metre			Web *t*	Flange **T**			
ins	*lbs*	*Kg*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*cm²*
36 × 16½	260	387	920	420	21·5	36·6	24·1	791	493·9
	230	343	911	418	19·4	32·0	24·1	791	436·9
36 × 12	194	289	927	308	19·6	32·0	19·1	819	368·5
	170	253	918	305	17·3	27·9	19·1	819	322·5
	150	223	910	304	15·9	23·9	19·1	819	284·9
	135	201	903	303	15·2	20·2	19·1	819	256·1
33 × 11½	152	226	851	294	16·1	26·8	17·8	757	288·4
	130	194	841	292	14·7	21·7	17·8	757	246·9
	118	176	835	291·6	14·0	18·8	17·8	757	223·8
30 × 10½	132	196	770	268	15·6	25·4	16·5	681	250·5
	116	173	762	267	14·3	21·6	16·5	681	220·2
	99	147	754	265	12·9	17·5	16·5	681	187·8
27 × 10	114	170	693	256	14·5	23·7	15·2	611	216·3
	102	152	688	254·5	13·2	21·0	15·2	611	193·6
	94	140	684	254	12·4	19·0	15·2	611	178·4
	84	125	678	253	11·7	16·2	15·2	611	159·4
24 × 12	160	238	633	312	18·6	31·4	16·5	532	303·5
	120	179	617	307	14·1	23·6	16·5	532	227·7
	100	149	610	305	11·9	19·7	16·5	532	189·9
24 × 9	94	140	617	230	13·1	22·1	12·7	543	178·2
	84	125	612	229	11·9	19·6	12·7	543	159·4
	76	113	607	228	11·2	17·3	12·7	543	144·3
	68	101	602	227·6	10·6	14·8	12·7	543	129·0
21 × 13	142	211	545	334	16·7	27·8	16·5	450	269·6
	127	189	539	332	14·9	25·0	16·5	450	241·2
	112	167	533	330	13·4	22·0	16·5	450	212·7
21 × 8¼	82	122	545	212	12·8	21·3	12·7	473	155·6
	73	109	539	211	11·6	18·8	12·7	473	138·4
	68	101	537	210	10·9	17·4	12·7	473	129·1
	62	92	533	209	10·2	15·6	12·7	473	117·6
	55	82	528	208·7	9·6	13·2	12·7	473	104·3
18 × 7½	66	98	467	193	11·4	19·6	10·2	404	125·2
	60	89	464	192	10·6	17·7	10·2	404	113·8
	55	82	460	191	9·9	16·0	10·2	404	104·4
	50	74	457	190·5	9·1	14·5	10·2	404	94·9
	45	67	454	190	8·5	12·7	10·2	404	85·4

UNIVERSAL BEAMS

Taper Flanges

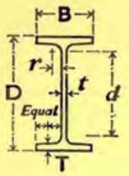
DIMENSIONS AND PROPERTIES

METRIC



Moment of Inertia			Radius of Gyration		Elastic Modulus		Plastic Modulus	
Axis *x-x*		Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*
Gross	Net							
cm⁴	*cm⁴*	*cm⁴*	*cm*	*cm*	*cm³*	*cm³*	*cm³*	*cm³*
717328	649238	42479	38·1	9·27	15586	2021	17628	3206
623868	564909	36250	37·8	9·11	13691	1733	15445	2756
503780	442745	14793	37·0	6·34	10874	961	12566	1552
435802	383016	12512	36·8	6·23	9490	819	10930	1322
375110	330425	10424	36·3	6·05	8241	686	9505	1112
324715	287237	8632	35·6	5·81	7192	569	8345	932
339130	317451	10662	34·3	6·08	7971	726	9144	1166
278833	261485	8385	33·6	5·83	6633	574	7635	929
245412	230504	7111	33·1	5·64	5879	438	6795	797
239463	222705	7701	30·9	5·54	6223	575	7156	925
204747	190651	6377	30·5	5·38	5374	478	6186	773
168535	157219	5002	30·0	5·16	4471	377	5163	615
169843	157215	6225	28·0	5·36	4902	487	5616	781
150015	138896	5391	27·8	5·28	4364	424	4989	680
135973	125997	4789	27·6	5·18	3979	377	4552	608
117700	109262	3992	27·2	5·00	3472	315	3937	513
207252	180191	14973	26·1	7·02	6549	961	7447	1522
151313	131467	10572	25·8	6·81	4901	689	5512	1092
124342	108020	8473	25·6	6·68	4079	556	4562	834
111675	102339	4253	25·0	4·88	3620	370	4141	591
98410	90218	3676	24·8	4·80	3217	321	3672	514
87262	80079	3184	24·6	4·70	2874	279	3283	449
75549	69474	2658	24·2	4·54	2509	234	2877	379
141682	123941	16064	22·9	7·72	5199	963	5849	1518
125619	109835	14093	22·8	7·64	4657	850	5212	1340
109110	95417	12058	22·6	7·53	4091	730	4560	1156
76078	69119	3208	22·1	4·54	2794	303	3198	484
66610	60541	2755	21·9	4·46	2469	262	2820	419
61531	55942	2512	21·8	4·41	2293	239	2616	383
55225	50243	2212	21·7	4·34	2072	211	2362	340
47363	43189	1826	21·3	4·18	1793	175	2051	284
45653	40978	2216	19·1	4·21	1954	230	2229	366
40957	36774	1960	19·0	4·15	1767	204	2012	325
37039	33278	1746	18·8	4·09	1610	183	1830	292
33324	29944	1547	18·7	4·04	1458	162	1654	260
29337	26396	1328	18·5	3·95	1293	140	1469	225

NOTE: One hole is deducted from each flange under 12 inches wide (serial size) and two holes from each flange 12 inches and over (serial size), in calculating the Net Moment of Inertia about *x-x*.



UNIVERSAL BEAMS

Taper Flanges

DIMENSIONS AND PROPERTIES

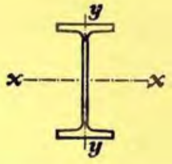
METRIC

Serial Size	Weight		Depth of Section **D**	Width of Section **B**	Thickness		Root Radius *r*	Depth between Fillets *d*	Area of Section
	per foot	per metre			Web *t*	Flange **T**			
ins	*lbs*	*Kg*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*cm²*
18×6	55	82	465	153·5	10·7	18·9	10·2	404	104·4
	50	74	461	152·7	9·9	17·0	10·2	404	94·9
	45	67	457	151·9	9·1	15·0	10·2	404	85·3
16×7	50	74	413	180	9·7	16·0	10·2	357	94·9
	45	67	409	179	8·8	14·3	10·2	357	85·4
	40	60	406	178	7·8	12·8	10·2	357	75·9
	36	54	403	177·6	7·6	10·9	10·2	357	68·3
16×6	50	74	416	154	10·1	18·1	10·2	357	94·8
	45	67	412	153	9·4	16·0	10·2	357	85·3
	40	59	408	152	8·6	13·9	10·2	357	75·8
16×5½	31	46	402	142·4	6·9	11·2	10·2	357	58·9
	26	39	397	141·8	6·3	8·6	10·2	357	49·3
15×6	45	67	389	154	9·7	16·3	10·2	333	85·4
	40	60	385	153	8·7	14·4	10·2	333	75·9
	35	52	381	152	7·8	12·4	10·2	333	66·4
14×6¾	45	67	364	173	9·1	15·7	10·2	309	85·3
	38	57	359	172	8·0	13·0	10·2	309	72·1
	34	51	356	171·5	7·3	11·5	10·2	309	64·5
	30	45	352	171	6·9	9·7	10·2	309	56·9
14×5	26	39	353	126	6·5	10·7	10·2	309	49·3
	22	33	348	125	5·9	8·5	10·2	309	41·7
12×6½	36	54	311	167	7·7	13·7	8·9	263	68·3
	31	46	307	166	6·7	11·8	8·9	263	58·8
	27	40	304	165	6·1	10·2	8·9	263	51·4
12×5	32	48	310	125	8·9	14·0	8·9	263	60·8
	28	42	307	124	8·0	12·1	8·9	263	53·1
	25	37	304	123·5	7·2	10·7	8·9	263	47·4
12×4	22*	33	313	102·4	6·6	10·8	7·6	275	41·8
	19*	28	309	101·9	6·1	8·9	7·6	275	36·3
	16·5*	25	305	101·6	5·8	6·8	7·6	275	31·4
10×5¾	29	43	260	147	7·3	12·7	7·6	216	55·0
	25	37	256	146·4	6·4	10·9	7·6	216	47·4
	21	31	251	146	6·1	8·6	7·6	216	39·9
10×4	19*	28	260	102·1	6·4	10·0	7·6	224	36·2
	17*	25	257	101·9	6·1	8·4	7·6	224	32·1
	15*	22	254	101·6	5·8	6·8	7·6	224	28·4
8×5¼	20	30	207	134	6·3	9·6	7·6	170	38·0
	17	25	203	133	5·8	7·8	7·6	170	32·3

NOTE: Beams marked * have 2% taper flanges; all other beams have 5% taper flanges.

UNIVERSAL BEAMS

Taper Flanges

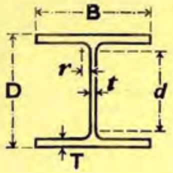


DIMENSIONS AND PROPERTIES

METRIC

Moment of Inertia			Radius of Gyration		Elastic Modulus		Plastic Modulus	
Axis *x-x*		Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*
Gross	Net							
cm⁴	*cm⁴*	*cm⁴*	*cm*	*cm*	*cm³*	*cm³*	*cm³*	*cm³*
36160	32275	1093	18·6	3·24	1555	142	1797	229
32380	28917	963	18·5	3·18	1404	126	1620	203
28522	25501	829	18·3	3·12	1248	109	1439	176
27279	24287	1448	17·0	3·91	1322	161	1502	257
24279	21619	1269	16·9	3·86	1186	142	1343	226
21458	19101	1104	16·8	3·81	1056	124	1191	198
18576	16591	922	16·5	3·67	923	104	1046	167
26938	23981	1047	16·9	3·32	1294	136	1486	218
23798	21200	908	16·7	3·26	1155	119	1323	190
20619	18396	768	16·5	3·18	1011	101	1158	162
15603	13838	500	16·3	2·91	776	70·3	886	113
12408	11062	373	15·9	2·75	625	52·6	719	85·8
21276	18949	947	15·8	3·33	1095	123	1254	196
18632	16599	814	15·7	3·27	968	106	1106	170
16046	14300	685	15·5	3·21	842	90·0	959	144
19483	17215	1278	15·1	3·87	1071	148	1210	234
16038	14185	1026	14·9	3·78	894	119	1007	190
14118	12495	885	14·8	3·71	794	103	893	165
12052	10697	730	14·6	3·58	685	85·4	772	137
10054	8765	333	14·3	2·60	570	52·9	652	85·1
8167	7152	257	14·0	2·48	469	41·0	538	66·6
11686	10243	988	13·1	3·81	752	119	843	187
9924	8695	825	13·0	3·73	646	99·5	721	157
8500	7455	691	12·9	3·66	560	83·7	623	133
9485	8215	438	12·5	2·68	611	69·9	705	112
8124	7041	367	12·4	2·63	530	59·0	609	94·9
7143	6195	316	12·3	2·58	470	51·1	539	82·3
6482	5624	189	12·5	2·13	415	37·0	480	59·1
5415	4719	153	12·2	2·05	351	30·0	407	48·2
4381	3851	116	11·8	1·92	287	22·9	337	37·2
6546	5748	633	10·9	3·40	504	86·0	567	135
5544	4866	528	10·8	3·33	433	72·1	484	114
4427	3900	406	10·5	3·18	352	55·5	395	88·8
4004	3457	174	10·5	2·19	308	34·1	353	54·1
3404	2953	144	10·3	2·11	265	28·2	305	45·1
2863	2498	116	10·0	2·02	225	22·8	262	36·8
2880	2493	354	8·71	3·05	279	52·9	313	83·7
2348	2040	280	8·53	2·95	231	41·9	259	67·0

NOTE: One hole is deducted from each flange in calculating the Net Moment of Inertia about *x-x*.



UNIVERSAL COLUMNS

Parallel Flanges

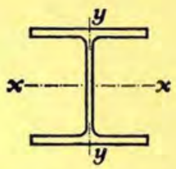
DIMENSIONS AND PROPERTIES

METRIC

Serial Size	Weight		Depth of Section **D**	Width of Section **B**	Thickness		Root Radius *r*	Depth between Fillets *d*	Area of Section
	per foot	per metre			Web *t*	Flange **T**			
ins	*lbs*	*Kg*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*cm²*
14×16	426	634	475	424	47·6	77·0	15·2	290	808·1
	370	550	456	418	42·0	67·5	15·2	290	701·8
	314	467	437	412	35·9	58·0	15·2	290	595·5
	264	393	419	407	30·6	49·2	15·2	290	500·9
	228	339	406	403	26·5	42·9	15·2	290	432·7
	193	287	394	399	22·6	36·5	15·2	290	366·0
	158	235	381	395	18·5	30·2	15·2	290	299·8
Column Core	320	476	427	424	48·0	53·2	15·2	290	607·2
14×14½	136	202	375	374	16·8	27·0	15·2	290	257·9
	119	177	368	372	14·5	23·8	15·2	290	225·7
	103	153	362	370	12·6	20·7	15·2	290	195·2
	87	129	356	368	10·7	17·5	15·2	290	164·9
12×12	190	283	365	322	26·9	44·1	15·2	247	360·4
	161	240	353	318	23·0	37·7	15·2	247	305·6
	133	198	340	314	19·2	31·4	15·2	247	252·3
	106	158	327	311	15·7	25·0	15·2	247	201·2
	92	137	321	309	13·8	21·7	15·2	247	174·6
	79	117	314	307	11·9	18·7	15·2	247	149·8
	65	97	308	305	9·9	15·4	15·2	247	123·3
10×10	112	167	289	265	19·2	31·7	12·7	200	212·4
	89	133	276	261	15·6	25·3	12·7	200	168·9
	72	107	267	258	13·0	20·5	12·7	200	136·6
	60	89	260	256	10·5	17·3	12·7	200	114·0
	49	73	254	254	8·6	14·2	12·7	200	92·9
8×8	58	86	222	209	13·0	20·5	10·2	161	110·1
	48	71	216	206	10·3	17·3	10·2	161	91·1
	40	59	210	205	9·3	14·2	10·2	161	75·8
	35	52	206	204	8·0	12·5	10·2	161	66·4
	31	46	203	203	7·3	11·0	10·2	161	58·8
6×6	25	37	162	154	8·1	11·5	7·6	123·5	47·4
	20	30	157	153	6·6	9·4	7·6	123·5	38·2
	15·7	23	152	152	6·1	6·8	7·6	123·5	29·8

UNIVERSAL COLUMNS

Parallel Flanges

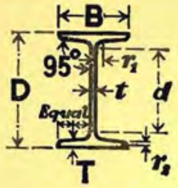


DIMENSIONS AND PROPERTIES

METRIC

Moment of Inertia			Radius of Gyration		Elastic Modulus		Plastic Modulus	
Axis *x-x*		Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*
Gross	Net							
cm⁴	*cm⁴*	*cm⁴*	*cm*	*cm*	*cm³*	*cm³*	*cm³*	*cm³*
275140	245765	98211	18·4	11·0	11592	4632	14247	7114
227023	202556	82665	18·0	10·8	9964	3951	12078	6058
183119	163167	67905	17·5	10·7	8388	3293	10009	5038
146765	130632	55410	17·1	10·5	7004	2723	8229	4157
122474	108919	46816	16·8	10·4	6027	2324	6994	3541
99994	88860	38714	16·5	10·3	5080	1940	5818	2952
79110	70243	31008	16·3	10·2	4153	1570	4689	2384
172391	154580	68057	16·8	10·6	8075	3207	9700	4979
66307	58518	23632	16·0	9·58	3540	1262	3976	1917
57153	50410	20470	15·9	9·53	3104	1100	3457	1668
48525	42789	17470	15·8	9·45	2681	944	2964	1430
40246	35484	14555	15·6	9·40	2264	790	2482	1196
78777	67879	24545	14·8	8·26	4314	1525	5101	2337
64177	55230	20239	14·5	8·13	3641	1273	4245	1947
50832	43696	16230	14·2	8·03	2991	1034	3436	1576
38740	33282	12524	13·9	7·90	2368	806	2680	1228
32838	28204	10673	13·7	7·82	2049	691	2298	1052
27601	23700	9006	13·6	7·75	1756	587	1953	892
22202	19063	7268	13·4	7·67	1442	477	1589	723
29914	27401	9796	11·9	6·78	2070	741	2417	1132
22575	20670	7519	11·6	6·68	1634	576	1875	879
17510	16025	5901	11·3	6·58	1313	457	1485	695
14307	13082	4849	11·2	6·53	1099	379	1228	575
11360	10389	3873	11·05	6·45	895	305	989	462
9462	8464	3119	9·27	5·33	851	299	979	456
7647	6830	2536	9·17	5·28	708	246	802	374
6088	5444	2041	8·97	5·18	581	199	652	303
5263	4703	1770	8·89	5·16	510	174	568	264
4564	4083	1539	8·81	5·11	449	151	497	230
2218	1948	709	6·83	3·86	274	91·8	310	140
1742	1532	558	6·76	3·81	221	73·1	247	111
1263	1113	403	6·50	3·68	166	52·9	184	80·9

NOTE: One hole is deducted from each flange under 12 inches wide and two holes from each flange 12 inches and over, in calculating the Net Moment of Inertia about *x-x*.

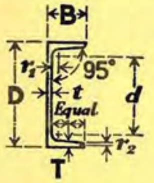


JOISTS

DIMENSIONS AND PROPERTIES

METRIC

Size D × B		Weight		Thickness		Radius		Depth between Fillets d	Area of Section
		per foot	per metre	Web t	Flange T	Root r_1	Toe r_2		
inches	mm	lbs	Kg	mm	mm	mm	mm	mm	cm^2
8 × 4	203 × 102	17	25·30	5·8	10·4	9·4	3·2	161·1	32·26
7 × 4	178 × 102	14·5	21·56	5·3	9·1	9·4	3·2	138·2	27·49
6 × 3½	152 × 89	11·5	17·10	4·9	8·3	7·9	2·4	117·7	21·81
5 × 3	127 × 76	9	13·38	4·5	7·6	7·9	2·4	94·2	17·06
4 × 2½	102 × 63	6·5	9·66	4·1	6·6	6·9	2·4	73·2	12·32
3 × 2	76 × 51	4·5	6·70	3·8	5·7	6·9	2·4	50·2	8·54



CHANNELS

DIMENSIONS AND PROPERTIES

METRIC

Size D × B		Weight		Thickness		Radius		Depth between Fillets d	Area of Section
		per foot	per metre	Web t	Flange T	Root r_1	Toe r_2		
inches	mm	lbs	Kg	mm	mm	mm	mm	mm	cm^2
17 × 4	432 × 102	44	65·48	12·2	16·8	15·2	4·8	362·4	83·49
15 × 4	381 × 102	37	55·05	10·4	16·3	15·2	4·8	312·4	70·19
12 × 4	305 × 102	31	46·14	10·2	14·8	15·2	4·8	239·2	58·83
12 × 3½	305 × 89	28	41·65	10·2	13·7	13·7	3·2	245·4	53·11
10 × 3½	254 × 89	24	35·70	9·1	13·6	13·7	3·2	194·7	45·52
10 × 3	254 × 76	19	28·26	8·1	10·9	12·2	3·2	203·8	36·03
9 × 3½	229 × 89	22	32·73	8·6	13·3	13·7	3·2	169·8	41·73
9 × 3	229 × 76	17·5	26·04	7·6	11·2	12·2	3·2	178·0	33·20
8 × 3½	203 × 89	20	29·76	8·1	12·9	13·7	3·2	145·2	37·94
8 × 3	203 × 76	16	23·80	7·1	11·2	12·2	3·2	152·5	30·34
7 × 3½	178 × 89	18	26·79	7·6	12·3	13·7	3·2	121·0	34·15
7 × 3	178 × 76	14	20·82	6·6	10·3	12·2	3·2	128·8	26·54
6 × 3½	152 × 89	16	23·81	7·1	11·6	13·7	3·2	97·0	30·36
6 × 3	152 × 76	12	17·86	6·3	9·0	12·2	2·4	105·9	22·77
5 × 2½	127 × 63	10	14·89	6·3	9·2	10·7	2·4	84·0	18·98
4 × 2	102 × 51	7	10·41	6·1	7·6	9·1	2·4	65·7	13·28
3 × 1½	76 × 38	4·5	6·69	5·1	6·8	7·6	2·4	45·8	8·53

JOISTS

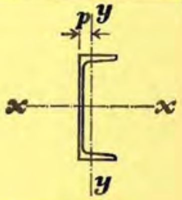
DIMENSIONS AND PROPERTIES

METRIC

Size D × B	Moment of Inertia			Radius of Gyration		Elastic Modulus		Plastic Modulus	
	Axis x-x		Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y
	Gross	Net							
inches	cm^4	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3
8 × 4	2294	1957	162·6	8·43	2·25	225·8	32·02	256·3	51·78
7 × 4	1522	1297	139·7	7·44	2·25	171·2	27·50	193·4	44·61
6 × 3½	883·1	760·1	86·29	6·36	1·99	115·9	19·41	131·2	31·39
5 × 3	477·0	399·3	50·37	5·29	1·72	75·12	13·22	85·44	21·37
4 × 2½	218·2	184·9	25·41	4·21	1·44	42·95	8·00	49·11	12·96
3 × 2	83·07	69·57	11·22	3·12	1·15	21·80	4·42	25·22	7·21

NOTE: One hole is deducted from each flange in calculating the Net Moment of Inertia about *x-x*.

CHANNELS

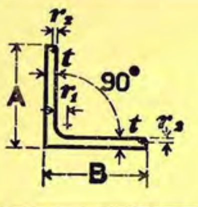


DIMENSIONS AND PROPERTIES

METRIC

Size D × B	Dimension p	Moment of Inertia			Radius of Gyration		Elastic Modulus	
		Axis x-x		Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y
		Gross	Net					
inches	cm	cm^4	cm^4	cm^4	cm	cm	cm^3	cm^3
17 × 4	2·32	21399	18405	628·6	16·01	2·74	991·1	80·15
15 × 4	2·52	14894	12651	579·8	14·57	2·87	781·8	75·87
12 × 4	2·66	8214	6926	499·6	11·82	2·91	539·0	66·60
12 × 3½	2·18	7061	5865	325·4	11·53	2·47	463·3	48·49
10 × 3½	2·42	4448	3636	302·4	9·88	2·58	350·2	46·71
10 × 3	1·86	3367	2699	162·6	9·67	2·12	265·1	28·22
9 × 3½	2·53	3387	2750	285·0	9·01	2·61	296·4	44·82
9 × 3	2·00	2610	2065	158·7	8·87	2·19	228·3	28·22
8 × 3½	2·65	2491	2009	264·4	8·10	2·64	245·2	42·34
8 × 3	2·13	1950	1525	151·4	8·02	2·23	192·0	27·59
7 × 3½	2·76	1753	1405	241·0	7·16	2·66	197·2	39·29
7 × 3	2·20	1337	1039	134·0	7·10	2·25	150·4	24·73
6 × 3½	2·86	1166	928·7	215·1	6·19	2·66	153·0	35·70
6 × 3	2·21	851·6	660·0	113·8	6·11	2·24	111·8	21·05
5 × 2½	1·94	482·6	350·3	67·24	5·04	1·88	75·99	15·25
4 × 2	1·51	207·7	148·8	29·11	3·95	1·48	40·89	8·16
3 × 1½	1·19	74·14	50·72	10·66	2·95	1·12	19·46	4·08

One hole is deducted from each flange in calculating the Net Moment of Inertia about *x-x*.



EQUAL ANGLES

DIMENSIONS AND PROPERTIES

METRIC

Size A×B	Nominal Thickness	Size A×B	Thickness *t* (actual)	Calculated Weight per metre	Minimum Thickness Rolled	Radius		Sectional Area
						Root	Toe	
ins	*ins*	*mm*	*mm*	*kg*	*mm*	*mm*	*mm*	*cm*^{2}
8×8	1	**203·2×203·2**	*25·30*	*75·93*	*12·70*	*15·2*	*4·8*	*96·81*
	$\frac{15}{16}$		*23·70*	*71·44*				*91·09*
	$\frac{7}{8}$		22·12	66·99				85·42
	$\frac{13}{16}$		*20·55*	*62·50*				*79·69*
	$\frac{3}{4}$		18·95	57·89				73·82
	$\frac{11}{16}$		*17·35*	*53·25*				*67·89*
	$\frac{5}{8}$		15·77	48·64				62·02
6×6	$\frac{7}{8}$	**152·4×152·4**	*22·15*	*49·27*	*9·42*	*12·2*	*4·8*	*62·83*
	$\frac{13}{16}$		*20·55*	*45·98*				*58·63*
	$\frac{3}{4}$		18·97	42·71				54·45
	$\frac{11}{16}$		*17·35*	*39·28*				*50·09*
	$\frac{5}{8}$		15·82	36·04				45·95
	$\frac{9}{16}$		*14·22*	*32·59*				*41·55*
	$\frac{1}{2}$		12·60	29·04				37·03
	$\frac{7}{16}$		*11·02*	*25·57*				*32·61*
	$\frac{3}{8}$		9·42	22·00				28·06
5×5	$\frac{3}{4}$	**127·0×127·0**	*19·00*	*35·13*	*7·94*	*10·7*	*4·8*	*44·80*
	$\frac{11}{16}$		*17·42*	*32·44*				*41·37*
	$\frac{5}{8}$		15·80	29·63				37·78
	$\frac{9}{16}$		*14·17*	*26·77*				*34·14*
	$\frac{1}{2}$		12·60	23·97				30·56
	$\frac{7}{16}$		*11·02*	*21·12*				*26·93*
	$\frac{3}{8}$		9·47	18·28				23·31
4×4	$\frac{3}{4}$	**101·6×101·6**	*19·02*	*27·54*	*7·62*	*9·1*	*4·8*	*35·12*
	$\frac{11}{16}$		*17·42*	*25·45*				*32·45*
	$\frac{5}{8}$		15·85	23·35				29·78
	$\frac{9}{16}$		*14·22*	*21·15*				*26·96*
	$\frac{1}{2}$		12·60	18·90				24·09
	$\frac{7}{16}$		*11·02*	*16·68*				*21·27*
	$\frac{3}{8}$		9·45	14·42				18·39
	$\frac{5}{16}$		*7·82*	*12·05*				*15·37*

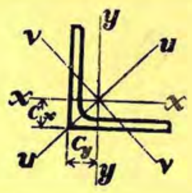
REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Equal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

EQUAL ANGLES

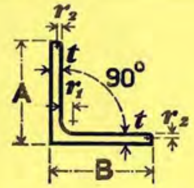
DIMENSIONS AND PROPERTIES

METRIC



Centre of Gravity		Moment of Inertia				Radius of Gyration				Elastic Modulus	
Cx	*Cy*	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*
cm	*cm*	*cm*^{4}	*cm*^{4}	*cm*^{4}	*cm*^{4}	*cm*	*cm*	*cm*	*cm*	*cm*^{3}	*cm*^{3}
5·99	*5·99*	*3686*	*3686*	*5845*	*1527*	*6·17*	*6·17*	*7·77*	*3·97*	*257*	*257*
5·93	*5·93*	*3491*	*3491*	*5540*	*1442*	*6·19*	*6·19*	*7·80*	*3·98*	*243*	*243*
5·87	5·87	3294	3294	5232	1357	6·21	6·21	7·83	3·99	228	228
5·81	*5·81*	*3094*	*3094*	*4916*	*1271*	*6·23*	*6·23*	*7·85*	*3·99*	*213*	*213*
5·75	5·75	2885	2885	4587	1183	6·25	6·25	7·88	4·00	198	198
5·69	*5·69*	*2671*	*2671*	*4248*	*1093*	*6·27*	*6·27*	*7·91*	*4·01*	*183*	*183*
5·63	5·63	2455	2455	3907	1004	6·29	6·29	7·94	4·02	167	167
4·60	*4·60*	*1321*	*1321*	*2089*	*553*	*4·58*	*4·58*	*5·77*	*2·97*	*124*	*124*
4·54	*4·54*	*1243*	*1243*	*1968*	*517*	*4·61*	*4·61*	*5·79*	*2·97*	*116*	*116*
4·49	4·49	1164	1164	1846	482	4·62	4·62	5·82	2·98	108	108
4·42	*4·42*	*1080*	*1080*	*1714*	*446*	*4·64*	*4·64*	*5·85*	*2·98*	*99·8*	*99·8*
4·37	4·37	999	999	1587	411	4·66	4·66	5·88	2·99	91·9	91·9
4·31	*4·31*	*911*	*911*	*1448*	*374*	*4·68*	*4·68*	*5·90*	*3·00*	*83·3*	*83·3*
4·24	4·24	819	819	1303	335	4·70	4·70	5·93	3·01	74·5	74·5
4·18	*4·18*	*727*	*727*	*1156*	*297*	*4·72*	*4·72*	*5·96*	*3·02*	*65·7*	*65·7*
4·11	4·11	631	631	1003	258	4·74	4·74	5·98	3·03	56·7	56·7
3·85	*3·85*	*651*	*651*	*1028*	*273*	*3·81*	*3·81*	*4·79*	*2·47*	*73·5*	*73·5*
3·79	*3·79*	*607*	*607*	*961*	*253*	*3·83*	*3·83*	*4·82*	*2·47*	*68·1*	*68·1*
3·73	3·73	560	560	888	232	3·85	3·85	4·85	2·48	62·4	62·4
3·67	*3·67*	*511*	*511*	*811*	*211*	*3·87*	*3·87*	*4·87*	*2·48*	*56·6*	*56·6*
3·61	3·61	462	462	734	190	3·89	3·89	4·90	2·49	50·8	50·8
3·55	*3·55*	*411*	*411*	*654*	*169*	*3·91*	*3·91*	*4·93*	*2·50*	*44·9*	*44·9*
3·49	3·49	359	359	571	147	3·92	3·92	4·95	2·51	39·0	39·0
3·22	*3·22*	*317*	*317*	*497*	*136*	*3·00*	*3·00*	*3·76*	*1·97*	*45·6*	*45·6*
3·16	*3·16*	*296*	*296*	*466*	*126*	*3·02*	*3·02*	*3·79*	*1·97*	*42·3*	*42·3*
3·10	3·10	275	275	434	116	3·04	3·04	3·82	1·97	38·9	38·9
3·04	*3·04*	*252*	*252*	*399*	*105*	*3·06*	*3·06*	*3·85*	*1·97*	*35·4*	*35·4*
2·98	2·98	228	228	361	94·3	3·08	3·08	3·87	1·98	31·7	31·7
2·92	*2·92*	*203*	*203*	*323*	*83·8*	*3·09*	*3·09*	*3·90*	*1·99*	*28·1*	*28·1*
2·86	2·86	178	178	283	73·1	3·11	3·11	3·92	1·99	24·4	24·4
2·79	*2·79*	*150*	*150*	*239*	*61·7*	*3·13*	*3·13*	*3·94*	*2·00*	*20·4*	*20·4*

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square, but the radii at the root and toe will remain unchanged. In Equal Sided Angles the thickness of the flanges will be the same.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



EQUAL ANGLES

DIMENSIONS AND PROPERTIES

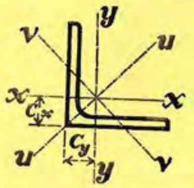
METRIC

Size A×B	Nominal Thickness	Size A×B	Thickness *t* (actual)	Calculated Weight per metre	Minimum Thickness Rolled	Radius		Sectional Area
						Root	To	
ins	*ins*	*mm*	*mm*	*kg*	*mm*	*mm*	*mm*	*cm²*
3½×3½	5/8	**88·9×88·9**	*15·77*	*20·09*	*6·27*	*8·4*	*4·8*	*25·61*
	9/16		*14·22*	*18·29*				*23·32*
	1/2		12·60	16·36				20·87
	7/16		*11·00*	*14·43*				*18·40*
	3/8		9·42	12·49				15·92
	5/16		*7·90*	*10·57*				*13·47*
	1/4		6·27	8·48				10·81
3 ×3	9/16	**76·2×76·2**	*14·27*	*15·48*	*6·22*	*7·6*	*4·8*	*19·74*
	1/2		12·60	13·83				17·64
	7/16		*10·97*	*12·19*				*15·55*
	3/8		9·40	10·56				13·47
	5/16		*7·85*	*8·92*				*11·37*
	1/4		6·22	7·16				9·12
2½×2½	1/2	**63·5×63·5**	*12·52*	*11·30*	*5·08*	*6·9*	*2·4*	*14·41*
	7/16		*11·05*	*10·11*				*12·89*
	3/8		9·45	8·77				11·18
	5/16		7·90	7·44				9·48
	1/4		6·22	5·95				7·59
2¼×2¼	3/8	**57·2×57·2**	*9·32*	*7·73*	*4·445*	*6·6*	*2·4*	*9·86*
	5/16		7·77	6·55				8·35
	1/4		6·25	5·35				6·82
	3/16		4·60	4·01				5·11
2 ×2	3/8	**50·8×50·8**	*9·40*	*6·84*	*3·175*	*6·1*	*2·4*	*8·72*
	5/16		7·82	5·80				7·39
	1/4		6·32	4·77				6·08
	3/16		4·65	3·58				4·56

REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Equal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

EQUAL ANGLES

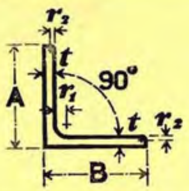


DIMENSIONS AND PROPERTIES

METRIC

Centre of Gravity		Moment of Inertia				Radius of Gyration				Elastic Modulus	
Cx	*Cy*	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*
cm	*cm*	*cm⁴*	*cm⁴*	*cm⁴*	*cm⁴*	*cm*	*cm*	*cm*	*cm*	*cm³*	*cm³*
2·78	*2·78*	*178*	*178*	*280*	*75·7*	*2·63*	*2·63*	*3·30*	*1·72*	*29·1*	*29·1*
2·72	*2·72*	*164*	*164*	*259*	*69·1*	*2·65*	*2·65*	*3·33*	*1·72*	*26·6*	*26·6*
2·66	2·66	149	149	235	62·0	2·67	2·67	3·36	1·72	23·9	23·9
2·60	*2·60*	*133*	*133*	*211*	*55·0*	*2·69*	*2·69*	*3·38*	*1·73*	*21·1*	*21·1*
2·54	2·54	116	116	185	47·9	2·70	2·70	3·41	1·74	18·3	18·3
2·48	*2·48*	*99·8*	*99·8*	159	*41·0*	*2·72*	*2·72*	*3·43*	*1·74*	*15·6*	*15·6*
2·41	2·41	81·0	81·0	129	33·3	2·74	2·74	3·45	1·75	12·5	12·5
2·41	*2·41*	*99·6*	*99·6*	*157*	*42·7*	*2·25*	*2·25*	*2·82*	*1·47*	*19·1*	*19·1*
2·35	2·35	90·4	90·4	143	38·2	2·26	2·26	2·84	1·47	17·1	17·1
2·29	*2·29*	*80·9*	*80·9*	*128*	*33·8*	*2·28*	*2·28*	*2·87*	*1·47*	*15·2*	*15·2*
2·23	2·23	71·1	71·1	113	29·5	2·30	2·30	2·89	1·48	13·2	13·2
2·16	*2·16*	*60·9*	*60·9*	*96·8*	*25·1*	*2·31*	*2·31*	*2·92*	*1·49*	*11·2*	*11·2*
2·10	2·10	49·6	49·6	78·8	20·3	2·33	2·33	2·94	1·49	8·97	8·97
2·03	*2·03*	*50·4*	*50·4*	*78·9*	*21·8*	*1·87*	*1·87*	*2·34*	*1·23*	*11·7*	*11·7*
1·98	*1·98*	*45·8*	*45·8*	*72·1*	*19·5*	*1·89*	*1·89*	*2·36*	*1·23*	*10·5*	*10·5*
1·92	1·92	40·5	40·5	64·0	17·0	1·90	1·90	2·38	1·23	9·15	9·15
1·86	1·86	35·0	35·0	55·5	14·6	1·92	1·92	2·42	1·24	7·80	7·80
1·80	1·80	28·6	28·6	45·4	11·8	1·94	1·94	2·45	1·25	6·28	6·28
1·76	*1·76*	*28·6*	*28·6*	*45·0*	*12·1*	*1·70*	*1·70*	*2·14*	*1·11*	*7·22*	*7·22*
1·70	1·70	24·7	24·7	39·1	10·3	1·72	1·72	2·16	1·11	6·15	6·15
1·64	1·64	20·6	20·6	32·6	8·53	1·74	1·74	2·19	1·12	5·05	5·05
1·57	1·57	15·8	15·8	25·0	6·51	1·76	1·76	2·21	1·13	3·81	3·81
1·60	*1·60*	*19·6*	*19·6*	*30·8*	*8·42*	*1·50*	*1·50*	*1·88*	*·98*	*5·64*	*5·64*
1·54	1·54	17·0	17·0	26·8	7·17	1·52	1·52	1·91	·98	4·81	4·81
1·49	1·49	14·3	14·3	22·7	5·95	1·53	1·53	1·93	·99	3·98	3·98
1·42	1·42	11·0	11·0	17·4	4·54	1·55	1·55	1·95	1·00	3·00	3·00

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square, but the radii at the root and toe will remain unchanged. In Equal Sided Angles the thickness of the flanges will be the same.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



EQUAL ANGLES

DIMENSIONS AND PROPERTIES

METRIC

Size A×B	Nominal Thickness	Size A×B	Thickness t (actual)	Calculated Weight per metre	Minimum Thickness Rolled	Radius Root	Radius Toe	Sectional Area
ins	*ins*	*mm*	*mm*	*kg*	*mm*	*mm*	*mm*	*cm²*
1¾×1¾	5/16	**44·5×44·5**	*7·90*	*5·06*	*2·64*	*5·8*	*2·4*	*6·45*
	1/4		6·12	4·01				5·12
	3/16		4·67	3·13				3·99
1½×1½	5/16	**38·1×38·1**	*7·85*	*4·24*	*2·64*	*5·3*	*2·4*	*5·40*
	1/4		6·32	3·49				4·46
	3/16		4·72	2·68				3·41
1¼×1¼	1/4	**31·8×31·8**	*6·25*	*2·83*	*2·64*	*5·1*	*2·4*	*3·61*
	3/16		4·62	2·16				2·75
	1/8		3·10	1·49				1·90
1 ×1	1/4	**25·4×25·4**	*6·35*	*2·23*	*2·64*	*4·6*	*2·4*	*2·84*
	3/16		4·70	1·72				2·19
	1/8		3·15	1·19				1·52

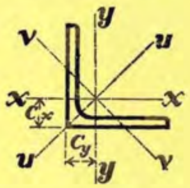
REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Equal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

EQUAL ANGLES

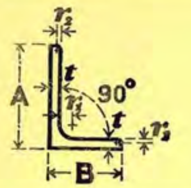
DIMENSIONS AND PROPERTIES

METRIC



Centre of Gravity Cx	Centre of Gravity Cy	Moment of Inertia Axis x-x	Moment of Inertia Axis y-y	Moment of Inertia Axis u-u Max.	Moment of Inertia Axis v-v Min.	Radius of Gyration Axis x-x	Radius of Gyration Axis y-y	Radius of Gyration Axis u-u Max.	Radius of Gyration Axis v-v Min.	Elastic Modulus Axis x-x	Elastic Modulus Axis y-y
cm	*cm*	*cm⁴*	*cm⁴*	*cm⁴*	*cm⁴*	*cm*	*cm*	*cm*	*cm*	*cm³*	*cm³*
1·39	*1·39*	*11·1*	*11·1*	*17·5*	*4·75*	*1·31*	*1·31*	*1·65*	*·86*	*3·64*	*3·64*
1·32	1·32	9·09	9·09	14·4	3·80	1·33	1·33	1·68	·86	2·91	2·91
1·26	1·26	7·24	7·24	11·5	3·00	1·35	1·35	1·70	·87	2·28	2·28
1·23	*1·23*	*6·69*	*6·69*	*10·5*	*2·92*	*1·11*	*1·11*	*1·39*	*·73*	*2·59*	*2·59*
1·17	1·17	5·67	5·67	8·94	2·41	1·13	1·13	1·42	·73	2·15	2·15
1·11	1·11	4·47	4·47	7·08	1·86	1·14	1·14	1·44	·74	1·66	1·66
1·01	*1·01*	*3·10*	*3·10*	*4·87*	*1·34*	*·93*	*·93*	*1·16*	*·61*	*1·43*	*1·43*
·95	·95	2·45	2·45	3·87	1·03	·94	·94	1·19	·61	1·10	1·10
·88	·88	1·74	1·74	2·75	·72	·96	·96	1·20	·62	·76	·76
·85	*·85*	*1·50*	*1·50*	*2·33*	*·68*	*·73*	*·73*	*·91*	*·49*	*·89*	*·89*
·79	·79	1·20	1·20	1·89	·51	·74	·74	·93	·48	·69	·69
·73	·73	·86	·86	1·37	·36	·75	·75	·95	·49	·48	·48

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square, but the radii at the root and toe will remain unchanged. In Equal Sided Angles the thickness of the flanges will be the same.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



UNEQUAL ANGLES

DIMENSIONS AND PROPERTIES

METRIC

Size A×B	Nominal Thickness	Size A×B	Thickness t (actual)	Calculated Weight per metre	Minimum Thickness Rolled	Radius		Sectional Area
						Root	Toe	
ins	*ins*	*mm*	*mm*	*kg*	*mm*	*mm*	*mm*	*cm²*
9×4	7/8	**228·6×101·6**	*22·15*	*53·72*	*9·525*	*13·0*	*4·8*	*68·49*
	13/16		*20·57*	*50·17*				*63·97*
	3/4		18·92	46·40				59·17
	11/16		*17·37*	*42·83*				*54·61*
	5/8		*15·80*	*39·16*				*49·93*
	9/16		*14·20*	*35·39*				*45·13*
	1/2		12·57	31·53				40·20
8×6	7/8	**203·2×152·4**	*22·10*	*58·04*	*11·43*	*13·7*	*4·8*	*74·00*
	13/16		*20·52*	*54·17*				*69·07*
	3/4		18·95	50·27				64·10
	11/16		*17·35*	*46·26*				*58·99*
	5/8		*15·77*	*42·28*				*53·91*
	9/16		*14·20*	*38·26*				*48·78*
	1/2		12·57	34·06				43·44
8×4	3/4	**203·2×101·6**	*18·97*	*42·71*	*9·525*	*12·2*	*4·8*	*54·45*
	11/16		*17·35*	*39·28*				*50·09*
	5/8		15·82	36·04				45·95
	9/16		*14·22*	*32·59*				*41·55*
	1/2		12·60	29·04				37·03
7×3½	5/8	**177·8× 88·9**	*15·82*	*31·27*	*9·45*	*11·2*	*4·8*	*39·87*
	9/16		*14·20*	*28·25*				*36·02*
	1/2		12·62	25·29				32·24
	7/16		11·07	22·34				28·48
	3/8		*9·45*	*19·20*				*24·48*
6×4	3/4	**152·4×101·6**	*19·00*	*35·13*	*8·74*	*10·7*	*4·8*	*44·80*
	11/16		*17·42*	*32·44*				*41·37*
	5/8		15·80	29·63				37·78
	9/16		*14·17*	*26·77*				*34·14*
	1/2		12·60	23·97				30·56
	7/16		*11·02*	*21·12*				*26·93*
	3/8		9·47	18·28				23·31

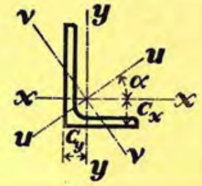
REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Unequal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

UNEQUAL ANGLES

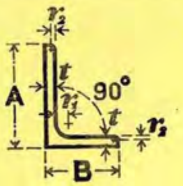
DIMENSIONS AND PROPERTIES

METRIC



Centre of gravity		Moment of Inertia				Radius of Gyration				Angle	Elastic Modulus	
Cx	Cy	Axis x-x	Axis y-y	Axis u-u Max.	Axis v-v Min.	Axis x-x	Axis y-y	Axis u-u Max.	Axis v-v Min.	Axis u-u	Axis x-x	Axis y-y
cm	*cm*	*cm⁴*	*cm⁴*	*cm⁴*	*cm⁴*	*cm*	*cm*	*cm*	*cm*	*tan α*	*cm³*	*cm³*
8·73	*2·41*	*3606*	*447*	*3747*	*306*	*7·26*	*2·56*	*7·40*	*2·11*	*·21*	*255*	*57·8*
8·67	*2·35*	*3388*	*423*	*3523*	*287*	*7·28*	*2·57*	*7·42*	*2·12*	*·21*	*239*	*54·1*
8·60	2·29	3154	396	3283	267	7·30	2·59	7·45	2·13	·21	221	50·3
8·54	*2·23*	*2929*	*369*	*3051*	*248*	*7·32*	*2·60*	*7·47*	*2·13*	*·21*	*205*	*46·6*
8·47	*2·17*	*2695*	*342*	*2808*	*229*	*7·35*	*2·62*	*7·50*	*2·14*	*·21*	*187*	*42·8*
8·40	*2·10*	*2451*	*313*	*2556*	*208*	*7·37*	*2·63*	*7·53*	*2·15*	*·22*	*170*	*38·9*
8·33	2·04	2197	283	2292	187	7·39	2·65	7·55	2·16	·22	151	34·8
6·59	*4·07*	*2992*	*1439*	*3648*	*783*	*6·36*	*4·41*	*7·02*	*3·25*	*·55*	*218*	*129*
6·53	*4·01*	*2811*	*1355*	*3432*	*734*	*6·38*	*4·43*	*7·05*	*3·26*	*·55*	*204*	*121*
6·47	3·95	2625	1268	3209	684	6·40	4·45	7·08	3·27	·55	190	112
6·41	*3·89*	*2432*	*1177*	*2976*	*633*	*6·42*	*4·47*	*7·10*	*3·28*	*·55*	*175*	*104*
6·35	*3·83*	*2237*	*1085*	*2740*	*582*	*6·44*	*4·49*	*7·13*	*3·29*	*·55*	*160*	*95·1*
6·29	*3·77*	*2037*	*990*	*2497*	*530*	*6·46*	*4·51*	*7·16*	*3·30*	*·55*	*145*	*86·3*
6·22	3·70	1826	890	2240	476	6·48	4·53	7·18	3·31	·55	129	77·1
7·46	*2·41*	*2277*	*386*	*2409*	*253*	*6·47*	*2·66*	*6·65*	*2·15*	*·26*	*177*	*49·7*
7·40	*2·35*	*2109*	*359*	*2234*	*234*	*6·49*	*2·68*	*6·68*	*2·16*	*·26*	*163*	*46·0*
7·33	2·29	1947	333	2064	216	6·51	2·69	6·70	2·17	·26	150	42·4
7·27	*2·23*	*1773*	*305*	*1881*	*197*	*6·53*	*2·71*	*6·73*	*2·18*	*·26*	*136*	*38·5*
7·20	2·16	1591	276	1689	177	6·55	2·73	6·75	2·19	·26	121	34·5
6·49	*2·08*	*1280*	*217*	*1355*	*142*	*5·67*	*2·33*	*5·83*	*1·89*	*·26*	*113*	*31·9*
6·43	*2·01*	*1165*	*199*	*1235*	*129*	*5·69*	*2·35*	*5·85*	*1·89*	*·26*	*103*	*28·9*
6·36	1·95	1051	181	1115	117	5·71	2·37	5·88	1·90	·26	92·0	26·0
6·29	1·89	935	162	993	104	5·73	2·38	5·91	1·91	·26	81·4	23·1
6·22	*1·83*	*810*	*141*	*861*	*90·3*	*5·75*	*2·40*	*5·93*	*1·92*	*·27*	*70·1*	*20·0*
5·25	*2·73*	*1015*	*358*	*1161*	*212*	*4·76*	*2·83*	*5·09*	*2·17*	*·43*	*102*	*48·2*
5·19	*2·67*	*945*	*335*	*1083*	*196*	*4·78*	*2·84*	*5·12*	*2·18*	*·43*	*94·1*	*44·7*
5·13	2·61	871	309	1000	180	4·80	2·86	5·14	2·19	·43	86·1	41·0
5·07	*2·55*	*794*	*283*	*913*	*164*	*4·82*	*2·88*	*5·17*	*2·19*	*·43*	*78·0*	*37·2*
5·00	2·48	716	257	825	148	4·84	2·90	5·19	2·20	·44	70·0	33·4
4·94	*2·42*	*637*	*229*	*734*	*132*	*4·86*	*2·92*	*5·22*	*2·21*	*·44*	*61·8*	*29·6*
4·88	2·36	555	201	641	*115*	4·88	2·93	5·24	2·22	·44	53·6	25·7

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square, but the radii at the root and toe will remain unchanged. In Unequal Sided Angles the flanges may differ in thickness, but the difference shall not exceed ·05 inch.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



UNEQUAL ANGLES

DIMENSIONS AND PROPERTIES

METRIC

Size A×B	Nominal Thickness	Size A×B	Thickness *t* (actual)	Calculated Weight per metre	Minimum Thickness Rolled	Radius Root	Radius Toe	Sectional Area
ins	*ins*	*mm*	*mm*	*kg*	*mm*	*mm*	*mm*	*cm²*
6×3½	$\frac{5}{8}$	**152·4×88·9**	*15·75*	*27·96*	*7·82*	*10·4*	*4·8*	*35·66*
	$\frac{9}{16}$		*14·22*	*25·44*				*32·43*
	$\frac{1}{2}$		12·62	22·75				29·00
	$\frac{7}{16}$		*11·07*	*20·10*				*25·63*
	$\frac{3}{8}$		9·42	17·24				21·99
	$\frac{5}{16}$		*7·82*	*14·43*				*18·40*
6×3	$\frac{5}{8}$	**152·4×76·2**	*15·82*	*26·50*	*7·85*	*9·9*	*4·8*	*33·78*
	$\frac{9}{16}$		*14·20*	*23·96*				*30·56*
	$\frac{1}{2}$		12·60	21·43				27·33
	$\frac{7}{16}$		*11·02*	*18·90*				*24·10*
	$\frac{3}{8}$		9·47	16·37				20·87
	$\frac{5}{16}$		*7·85*	*13·68*				*17·44*
5×3½	$\frac{5}{8}$	**127·0×88·9**	*15·77*	*24·84*	*7·87*	9·7	*4·8*	*31·67*
	$\frac{9}{16}$		*14·25*	*22·62*				*28·84*
	$\frac{1}{2}$		12·65	20·24				25·81
	$\frac{7}{16}$		*11·07*	*17·87*				*22·79*
	$\frac{3}{8}$		9·42	15·34				19·56
	$\frac{5}{16}$		*7·87*	*12·93*				*16·48*
5×3	$\frac{9}{16}$	**127 ×76·2**	*14·22*	*21·15*	*6·35*	*9·1*	*4·8*	*26·96*
	$\frac{1}{2}$		12·60	18·90				24·09
	$\frac{7}{16}$		*11·02*	*16·68*				*21·27*
	$\frac{3}{8}$		9·45	14·42				18·39
	$\frac{5}{16}$		7·82	12·05				15·37
4×3½	$\frac{5}{8}$	**101·6×88·9**	*15·82*	*21·73*	*6·985*	*8·9*	*4·8*	*27·71*
	$\frac{9}{16}$		*14·17*	*19·66*				*25·06*
	$\frac{1}{2}$		12·65	17·70				22·57
	$\frac{7}{16}$		*11·05*	*15·61*				*19·90*
	$\frac{3}{8}$		9·50	13·54				17·27
	$\frac{5}{16}$		7·85	11·30				14·41

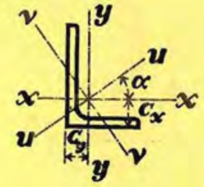
REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Unequal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

UNEQUAL ANGLES

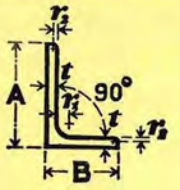
DIMENSIONS AND PROPERTIES

METRIC



Centre of gravity		Moment of Inertia				Radius of Gyration				Angle	Elastic Modulus	
Cx	*Cy*	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *u-u*	Axis *x-x*	Axis *y-y*
cm	*cm*	*cm⁴*	*cm⁴*	*cm⁴*	*cm⁴*	*cm*	*cm*	*cm*	*cm*	*tan α*	*cm³*	*cm³*
5·37	*2·22*	*828*	*208*	*907*	*129*	*4·82*	*2·42*	*5·04*	*1·90*	*·34*	*83·9*	*31·2*
5·31	*2·16*	*759*	*192*	*833*	*118*	*4·84*	*2·43*	*5·07*	*1·91*	*·34*	*76·5*	*28·5*
5·25	2·10	685	174	752	107	4·86	2·45	5·09	1·92	·34	68·5	25·6
5·19	*2·04*	*610*	*156*	*671*	*95·2*	*4·88*	*2·47*	*5·12*	*1·93*	*·34*	*60·7*	*22·7*
5·11	1·97	528	136	581	82·6	4·90	2·48	5·14	1·94	·35	52·1	19·6
5·04	*1·91*	*445*	*115*	*490*	*69·9*	*4·92*	*2·50*	*5·16*	*1·95*	*·35*	*43·7*	*16·5*
5·65	*1·86*	*786*	*132*	*830*	*87·2*	*4·82*	*1·98*	*4·96*	*1·61*	*·25*	*81·9*	*22·9*
5·59	*1·80*	*717*	*121*	*759*	*79·3*	*4·84*	*1·99*	*4·98*	*1·61*	*·26*	*74·3*	*20·8*
5·52	1·74	647	110	685	71·5	4·87	2·01	5·01	1·62	·26	66·6	18·7
5·46	*1·68*	*575*	*98·6*	*610*	*63·7*	*4·89*	*2·02*	*5·03*	*1·63*	*·26*	*58·8*	*16·6*
5·39	1·62	503	86·7	534	55·7	4·91	2·04	5·06	1·63	·26	51·0	14·4
5·32	*1·55*	*424*	*73·6*	*450*	*47·2*	*4·93*	*2·05*	*5·08*	*1·64*	*·26*	*42·7*	*12·1*
4·29	*2·40*	*496*	*198*	*580*	*114*	*3·95*	*2·50*	*4·28*	*1·90*	*·47*	*59·0*	*30·5*
4·24	*2·34*	*456*	*183*	*534*	*104*	*3·98*	*2·52*	*4·30*	*1·90*	*·47*	*53·8*	*27·9*
4·17	2·28	412	166	484	93·9	3·99	2·54	4·33	1·91	·48	48·3	25·1
4·11	*2·22*	*367*	*149*	*432*	*83·6*	*4·01*	*2·55*	*4·35*	*1·92*	*·48*	*42·7*	*22·3*
4·04	2·16	318	129	375	72·5	4·03	2·57	4·38	1·92	·48	36·8	19·2
3·98	*2·10*	*271*	*110*	*319*	*61·7*	*4·05*	*2·59*	*4·40*	*1·94*	*·48*	*31·0*	*16·2*
4·47	*1·95*	*430*	*116*	*475*	*71·5*	*4·00*	*2·07*	*4·20*	*1·63*	*·35*	*52·3*	*20·4*
4·41	1·89	389	105	429	64·4	4·02	2·09	4·22	1·63	·35	46·9	18·3
4·35	*1·83*	*346*	*94·2*	*383*	*57·3*	*4·04*	*2·10*	*4·24*	*1·64*	*·36*	*41·5*	*16·3*
4·28	1·77	302	82·8	335	50·0	4·06	2·12	4·27	1·65	·36	35·9	14·1
4·21	1·70	255	70·2	283	42·3	4·07	2·14	4·29	1·66	·36	30·1	11·9
3·27	*2·64*	*262*	*186*	*357*	*91·5*	*3·08*	*2·59*	*3·59*	*1·82*	*·74*	*38·1*	*29·7*
3·21	*2·58*	*240*	*170*	*328*	*83·0*	*3·10*	*2·61*	*3·62*	*1·82*	*·75*	*34·6*	*27·0*
3·15	2·52	219	156	299	75·0	3·11	2·62	3·64	1·82	·75	31·2	24·4
3·09	*2·46*	*195*	*139*	*268*	*66·6*	*3·13*	*2·64*	*3·67*	*1·83*	*·75*	*27·6*	*21·6*
3·03	2·40	171	122	235	58·2	3·15	2·66	3·69	1·84	·75	24·0	18·8
2·96	2·33	145	103	199	49·1	3·17	2·68	3·72	1·85	·75	20·1	15·8

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square, but the radii at the root and toe will remain unchanged. In Unequal Sided Angles the flanges may differ in thickness, but the difference shall not exceed ·05 inch.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



UNEQUAL ANGLES

DIMENSIONS AND PROPERTIES

METRIC

Size A×B	Nominal Thickness	Size A×B	Thickness *t* (actual)	Calculated Weight per metre	Minimum Thickness Rolled	Radius		Sectional Area
						Root	Toe	
ins	*ins*	*mm*	*mm*	*kg*	*mm*	*mm*	*mm*	*cm²*
4×3	9/16	**101·6×76·2**	*14·22*	*18·29*	*6·35*	*8·4*	*4·8*	*23·32*
	1/2		12·60	16·36				20·87
	7/16		*11·00*	*14·43*				*18·40*
	3/8		9·42	12·49				15·92
	5/16		7·90	10·57				13·48
4×2½	7/16	**101·6×63·5**	*11·05*	*13·38*	*6·30*	*8·1*	*4·8*	*17·07*
	3/8		9·47	11·60				14·79
	5/16		7·82	9·68				12·35
	1/4		6·30	7·88				10·05
3½×3	9/16	**88·9×76·2**	*14·17*	*16·81*	*6·30*	*8·1*	*4·8*	*21·44*
	1/2		12·67	15·19				19·36
	7/16		*11·05*	*13·38*				*17·07*
	3/8		9·47	11·60				14·79
	5/16		7·82	9·68				12·35
	1/4		*6·30*	*7·88*				*10·05*
3½×2½	7/16	**88·9×63·5**	*10·97*	*12·19*	*6·22*	*7·6*	*4·8*	*15·55*
	3/8		9·40	10·56				13·47
	5/16		7·85	8·92				11·37
	1/4		6·22	7·16				9·12
3×2½	7/16	**76·2×63·5**	*11·05*	*11·16*	*5·715*	*7·4*	*4·8*	*14·23*
	3/8		9·45	9·67				12·33
	5/16		7·90	8·18				10·43
	1/4		6·25	6·55				8·36
3×2	7/16	**76·2×50·8**	*11·05*	*10·11*	*4·75*	*6·9*	*2·4*	*12·89*
	3/8		9·45	8·77				11·18
	5/16		7·90	7·44				9·48
	1/4		6·22	5·95				7·59
	3/16		*4·75*	*4·61*				*5·88*

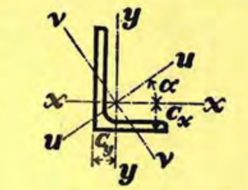
REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Unequal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

UNEQUAL ANGLES

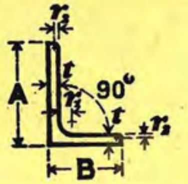
DIMENSIONS AND PROPERTIES

METRIC



Centre of gravity		Moment of Inertia				Radius of Gyration				Angle Axis *u-u*	Elastic Modulus	
Cx	*Cy*	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.	Axis *x-x*	Axis *y-y*	Axis *u-u* Max.	Axis *v-v* Min.		Axis *x-x*	Axis *y-y*
cm	*cm*	*cm⁴*	*cm⁴*	*cm⁴*	*cm⁴*	*cm*	*cm*	*cm*	*cm*	*tan α*	*cm³*	*cm³*
3·40	*2·14*	*228*	*109*	*277*	*60·4*	*3·13*	*2·16*	*3·44*	*1·61*	*·54*	*33·8*	*19·9*
3·34	2·08	207	98·8	251	54·3	3·15	2·18	3·47	1·61	·54	30·3	17·8
3·28	*2·02*	*185*	*88·5*	*225*	*48·2*	*3·17*	*2·19*	*3·50*	*1·62*	*·54*	*26·8*	*15·8*
3·22	1·96	162	77·8	197	42·0	3·19	2·21	3·52	1·62	·55	23·3	13·7
3·16	1·90	138	66·8	169	35·9	3·20	2·23	3·54	1·63	·55	19·7	11·7
3·51	*1·62*	*174*	*51·9*	*194*	*31·4*	*3·19*	*1·74*	*3·38*	*1·36*	*·38*	*26·1*	*11·0*
3·45	1·56	152	45·8	171	27·5	3·21	1·76	3·40	1·36	·38	22·7	9·56
3·38	1·49	129	38·9	145	23·2	3·23	1·78	3·42	1·37	·39	19·0	8·02
3·31	1·43	106	32·2	119	19·1	3·25	1·79	3·44	1·38	·39	15·4	6·54
2·89	*2·26*	*155*	*104*	*207*	*52·4*	*2·69*	*2·20*	*3·11*	*1·56*	*·71*	*25·9*	*19·4*
2·84	2·21	142	95·4	190	47·5	2·71	2·22	3·13	1·57	·71	23·4	17·6
2·77	*2·14*	*127*	*85·4*	*170*	*42·0*	*2·73*	*2·24*	*3·16*	*1·57*	*·72*	*20·7*	*15·6*
2·71	2·08	111	75·1	150	36·7	2·74	2·25	3·18	1·58	·72	18·0	13·6
2·65	2·02	94·2	63·7	127	30·9	2·76	2·27	3·21	1·58	·72	15·1	11·4
2·58	*1·96*	*77·5*	*52·5*	*104*	*25·5*	*2·78*	*2·29*	*3·23*	*1·59*	*·72*	*12·3*	*9·27*
2·97	*1·71*	*118*	*49·8*	*140*	*28·2*	*2·76*	*1·79*	*3·00*	*1·35*	*·49*	*20·0*	*10·7*
2·91	1·65	104	43·9	123	24·6	2·78	1·80	3·02	1·35	·49	17·4	9·34
2·85	1·59	88·8	37·7	106	21·0	2·79	1·82	3·05	1·36	·50	14·7	7·92
2·78	1·53	72·1	30·7	85·8	17·0	2·81	1·83	3·07	1·37	·50	11·8	6·37
2·46	*1·83*	*76·6*	*47·8*	*99·9*	*24·4*	*2·32*	*1·83*	*2·65*	*1·31*	*·67*	*14·8*	*10·6*
2·40	1·77	67·3	42·1	88·2	21·3	2·34	1·85	2·67	1·31	·67	12·9	9·20
2·34	1·71	57·8	36·2	75·9	18·1	2·35	1·86	2·70	1·32	·68	10·9	7·81
2·27	1·64	46·9	29·5	61·7	14·7	2·37	1·88	2·72	1·33	·68	8·77	6·27
2·68	*1·42*	*71·7*	*25·1*	*81·7*	*15·1*	*2·36*	*1·40*	*2·52*	*1·08*	*·42*	*14·5*	*6·86*
2·62	1·36	63·2	22·3	72·3	13·2	2·38	1·41	2·54	1·09	·43	12·6	5·99
2·56	1·30	54·5	19·3	62·5	11·3	2·40	1·43	2·57	1·09	·43	10·8	5·12
2·49	1·24	44·4	15·9	51·1	9·21	2·42	1·45	2·59	1·10	·44	8·66	4·13
2·43	*1·18*	*34·9*	*12·6*	*40·2*	*7·26*	*2·44*	*1·46*	*2·62*	*1·11*	*·44*	*6·72*	*3·22*

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square, but the radii at the root and toe will remain unchanged. In Unequal Sided Angles the flanges may differ in thickness, but the difference shall not exceed ·05 inch.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



UNEQUAL ANGLES

DIMENSIONS AND PROPERTIES

METRIC

Size A×B	Nominal Thickness	Size A×B	Thickness t (actual)	Calculated Weight per metre	Minimum Thickness Rolled	Radius Root	Radius Toe	Sectional Area
ins	*ins*	*mm*	*mm*	*kg*	*mm*	*mm*	*mm*	*cm²*
2½×2	$\frac{3}{8}$	**63·5×50·8**	*9·32*	*7·73*	*4·445*	*6·6*	*2·4*	*9·86*
	$\frac{5}{16}$		7·77	6·55				8·35
	$\frac{1}{4}$		6·25	5·35				6·82
	$\frac{3}{16}$		4·60	4·01				5·11
2½×1½	$\frac{5}{16}$	**63·5×38·1**	*7·82*	*5·80*	*3·175*	*6·1*	*2·4*	*7·39*
	$\frac{1}{4}$		6·32	4·77				6·08
	$\frac{3}{16}$		4·65	3·58				4·56
2×1½	$\frac{5}{16}$	**50·8×38·1**	*7·90*	*5·06*	*3·175*	*5·8*	*2·4*	*6·45*
	$\frac{1}{4}$		6·12	4·01				5·12
	$\frac{3}{16}$		4·67	3·13				3·99

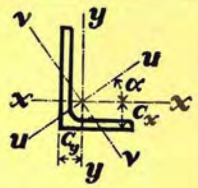
REMARKS

1. The thicknesses printed in ordinary type are the Standards. For the information of designers of structural steelwork the properties are given of sections differing from the standard thicknesses in steps of 0·0625 inch, but other intermediate thicknesses can be obtained.
2. The dimensions, thickness and profile of Standard Unequal Angles shall be in accordance with the accompanying list and sketch, but finished sections in which the angle between the flanges is not less than 89° nor more than 91° shall be accepted as conforming to the Standard.

UNEQUAL ANGLES

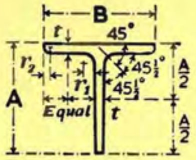
DIMENSIONS AND PROPERTIES

METRIC



Centre of gravity		Moment of Inertia				Radius of Gyration				Angle	Elastic Modulus	
Cx	Cy	Axis x-x	Axis y-y	Axis u-u Max.	Axis v-v Min.	Axis x-x	Axis y-y	Axis u-u Max.	Axis v-v Min.	Axis u-u	Axis x-x	Axis y-y
cm	*cm*	*cm⁴*	*cm⁴*	*cm⁴*	*cm⁴*	*cm*	*cm*	*cm*	*cm*	*tan α*	*cm³*	*cm³*
2·09	*1·46*	*37·2*	*20·9*	*47·0*	*11·1*	*1·94*	*1·46*	*2·18*	*1·06*	*·61*	*8·73*	*5·78*
2·03	1·40	32·1	18·1	40·7	9·50	1·96	1·47	2·21	1·07	·62	7·44	4·93
1·97	1·35	26·7	15·1	34·0	7·86	1·98	1·49	2·23	1·07	·62	6·10	4·06
1·90	1·28	20·4	11·6	26·0	6·01	2·00	1·51	2·26	1·08	·62	4·59	3·06
2·26	*1·00*	*29·2*	*7·79*	*32·1*	*4·87*	*1·99*	*1·03*	*2·08*	*0·81*	*·35*	*7·13*	*2·77*
2·20	0·94	24·4	6·59	27·0	4·05	2·00	1·04	2·11	0·82	·35	5·89	2·30
2·13	0·88	18·7	5·10	20·7	3·10	2·03	1·06	2·13	0·82	·36	4·43	1·74
1·73	*1·10*	*15·5*	*7·37*	*18·8*	*4·15*	*1·55*	*1·07*	*1·71*	*0·80*	*·53*	*4·64*	*2·72*
1·66	1·03	12·7	6·04	15·4	3·32	1·57	1·09	1·73	0·81	·54	3·70	2·17
1·60	0·98	10·1	4·83	12·3	2·63	1·59	1·10	1·75	0·81	·54	2·89	1·70

3. Angles ordered to the standard thickness shall be practically accurate in profile; but if the thickness is above the Standards, the flanges will be longer than the Standards. The profile at the back of the toe will be slightly rounded when above the Standards, instead of square, but the radii at the root and toe will remain unchanged. In Unequal Sided Angles the flanges may differ in thickness, but the difference shall not exceed ·05 inch.
4. Angles may be ordered by width of flanges and thickness, or by width of flanges and weight per foot, but not by both thickness and weight per foot.



T-BARS

DIMENSIONS AND PROPERTIES

METRIC

Size	Weight		Width of Section **B**	Depth of Section **A**	Thickness *t*	Radius		Area of Section
	per foot	per metre				Root r_1	Toe r_2	
ins	*lbs*	*kg*	*mm*	*mm*	*mm*	*mm*	*mm*	*cm*2
6×6	24·23 19·62	36 29	152·4 152·4	152·4 152·4	15·87 12·70	12·19 12·19	8·63 8·63	46·00 37·23
6×4	19·99 16·22	30 24	152·4 152·4	101·6 101·6	15·87 12·70	10·67 10·67	7·36 7·36	37·94 30·78
6×3	14·52 11·08	22 16	152·4 152·4	76·2 76·2	12·70 9·52	9·91 9·91	6·85 6·85	27·55 21·02
5×4	14·50 11·06	22 16	127·0 127·0	101·6 101·6	12·70 9·52	9·91 9·91	6·85 6·85	27·55 20·96
5×3	12·80 9·79	19 15	127·0 127·0	76·2 76·2	12·70 9·52	9·14 9·14	6·35 6·35	24·32 18·58
4×4	12·79 9·77	19 15	101·6 101·6	101·6 101·6	12·70 9·52	9·14 9·14	6·35 6·35	24·25 18·51
4×3	11·09 8·49	16 13	101·6 101·6	76·2 76·2	12·70 9·52	8·38 8·38	5·84 5·84	21·02 16·13
3×3	7·20	11	76·2	76·2	9·52	7·62	5·33	13·67
2½×2½	5·92 4·07	9 6	63·5 63·5	63·5 63·5	9·52 6·35	6·85 6·85	4·82 4·82	11·22 7·74
2×2	3·21	5	50·8	50·8	6·35	6·09	4·32	6·06
1½×1½	2·36	4	38·1	38·1	6·35	5·33	3·81	4·45

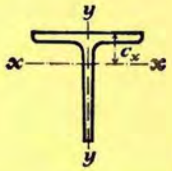
REMARKS

1. The dimensions, thickness and profile of Standard Tees shall be in accordance with the accompanying list and sketch. The Standard thickness of web shall be at a distance half-way between the extreme edge of the web and the farther side of the flange. The standard thickness of flange shall be measured at a distance half-way between the extreme edge of the flange and the nearer side of the web.
2. The tapers of the flange and web shall be such that the under side of the flange forms an angle of ½° with the horizontal upper side, whilst each side of the web forms an angle of ½° with vertical centre line as shown in the diagram.

T-BARS

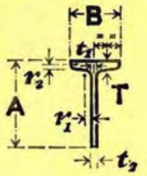
DIMENSIONS AND PROPERTIES

METRIC



Gravity Centre Distance *Cx*	Moment of Inertia		Radius of Gyration		Elastic Modulus	
	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*
cm	*cm*4	*cm*4	*cm*	*cm*	*cm*3	*cm*3
4·29 4·14	970·23 792·50	452·44 356·29	4·57 4·62	3·12 3·10	88·49 71·45	59·32 46·70
2·59 2·46	304·68 252·65	454·94 359·62	2·84 2·87	3·45 3·53	40·31 32·77	59·65 47·19
1·73 1·60	109·47 85·74	360·87 266·39	1·98 2·03	3·61 3·56	18·68 14·26	47·36 34·90
2·67 2·54	240·17 186·06	208·95 154·01	2·95 2·97	2·77 2·72	32·12 24·42	32·94 24·25
1·88 1·75	104·47 82·00	209·78 154·84	2·08 2·18	2·95 2·90	18·19 13·93	32·94 24·42
2·95 2·79	224·76 174·40	107·80 79·08	3·05 3·07	2·11 2·06	31·14 23·76	21·30 15·57
2·08 1·96	98·65 77·42	108·22 79·50	2·16 2·18	2·26 2·21	17·70 13·60	21·30 15·73
2·21	71·18	33·71	2·29	1·57	13·11	8·85
1·90 1·78	39·96 28·30	19·56 12·49	1·88 1·90	1·32 1·27	9·01 6·23	6·23 3·93
1·47	14·15	6·66	1·52	1·04	3·93	2·62
1·17	5·83	2·91	1·12	0·79	2·13	1·47

3. Tees ordered to the standard thickness shall be practically accurate in profile.
4. Tees may be ordered by width of flange, depth of section and thickness, or by width of flange, depth of section and weight per foot, but not by both thickness and weight per foot.



LONG STALK T-BARS

DIMENSIONS AND PROPERTIES

METRIC

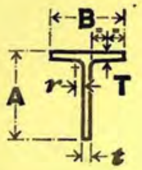
Size	Weight		Width of Section B	Depth of Section A	Thickness			Radius	
	per foot	per metre			T	t_1	t_2	Root r_1	Toe r_2
ins	*lbs*	*Kg*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*
5×10	23·80	35·42	127·0	254·0	18·29	9·40	8·89	13·46	6·60
4×8	16·81	25·02	101·6	203·2	16·26	8·38	7·87	12·19	7·62
3½×7	13·74	20·42	88·9	177·8	15·24	7·87	7·37	11·18	6·35
3×6	10·95	16·30	76·2	152·4	14·22	7·37	6·86	10·16	6·35
2½×5	8·48	12·62	63·5	127·0	13·36	6·86	6·35	8·89	5·08
1¾×4½	5·00	7·44	44·5	114·3	9·52	5·08	5·08	7·62	3·81
1×3	2·45	3·65	25·4	76·2	6·35	4·44	4·44	5·08	3·81

LONG STALK T-BARS

DIMENSIONS AND PROPERTIES

METRIC

Area of Section	Gravity Centre Distance *Cx*	Moment of Inertia		Radius of Gyration		Elastic Modulus	
		Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*
cm²	*cm*	*cm⁴*	*cm⁴*	*cm*	*cm*	*cm³*	*cm³*
45·35	6·93	2811·01	273·03	7·85	2·46	152·75	42·93
31·93	5·84	1289·39	124·86	6·38	1·98	88·98	24·58
26·06	5·18	804·93	79·49	5·56	1·75	63·74	17·86
20·90	4·44	468·23	46·61	4·72	1·50	43·42	12·29
16·13	3·76	248·47	25·80	3·94	1·27	27·86	8·19
9·48	3·66	126·11	7·80	3·63	·86	16·22	3·11
4·64	2·82	27·89	·83	2·44	·43	5·74	·66



STRUCTURAL TEES

Cut from Universal Beams

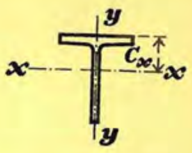
DIMENSIONS AND PROPERTIES

METRIC

Serial Size	Weight		Width of Section	Depth of Section	Thickness		Root Radius	Slope Inside Flange
	per foot	per metre	**B**	**A**	Web *t*	Flange **T**	*r*	
ins	*lbs*	*Kg*	*mm*	*mm*	*mm*	*mm*	*mm*	*per cent*
12 ×18	85	126	305	459	17·3	27·9	19·1	5·0
	75	112	304	455	15·9	23·9	19·1	5·0
	67·5	100	303	451	15·2	20·2	19·1	5·0
11½×16½	76	113	294	425	16·1	26·8	17·8	5·0
	65	97	292	420	14·7	21·7	17·8	5·0
	59	88	291·6	417	14·0	18·8	17·8	5·0
10½×15	66	98	268	385	15·6	25·4	16·5	5·0
	58	86	267	381	14·3	21·6	16·5	5·0
	49·5	74	265	377	12·9	17·5	16·5	5·0
10 ×13½	57	85	256	346	14·5	23·7	15·2	5·0
	51	76	254·5	344	13·2	21·0	15·2	5·0
	47	70	254	342	12·4	19·0	15·2	5·0
	42	63	253	339	11·7	16·2	15·2	5·0
12 ×12	80	119	312	316	18·6	31·4	16·5	5·0
	60	89	307	309	14·1	23·6	16·5	5·0
	50	74	305	305	11·9	19·7	16·5	5·0
9 ×12	47	70	230	308	13·1	22·1	12·7	5·0
	42	63	229	306	11·9	19·6	12·7	5·0
	38	57	228	304	11·2	17·3	12·7	5·0
	34	51	227·6	301	10·6	14·8	12·7	5·0
13 ×10½	71	106	334	273	16·7	27·8	16·5	5·0
	63·5	95	332	270	14·9	25·0	16·5	5·0
	56	83	330	267	13·4	22·0	16·5	5·0
8¼×10½	41	61	212	272	12·8	21·3	12·7	5·0
	36·5	54	211	270	11·6	18·8	12·7	5·0
	34	51	210	269	10·9	17·4	12·7	5·0
	31	46	209	267	10·2	15·6	12·7	5·0
	27·5	41	208·7	264	9·6	13·2	12·7	5·0
7½× 9	33	49	193	234	11·4	19·6	10·2	5·0
	30	45	192	232	10·6	17·7	10·2	5·0
	27·5	41	191	230	9·9	16·0	10·2	5·0
	25	37	190·5	229	9·1	14·5	10·2	5·0
	22·5	33	190	227	8·5	12·7	10·2	5·0
6 × 9	27·5	41	153·5	233	10·7	18·9	10·2	5·0
	25	37	152·7	231	9·9	17·0	10·2	5·0
	22·5	33	151·9	229	9·1	15·0	10·2	5·0

STRUCTURAL TEES

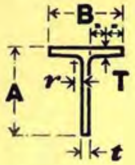
Cut from Universal Beams



DIMENSIONS AND PROPERTIES

METRIC

Area of Section	Gravity Centre Distance *Cx*	Moment of Inertia		Radius of Gyration		Elastic Modulus		Cut From Universal Beam
		Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	
cm²	*cm*	*cm⁴*	*cm⁴*	*cm*	*cm*	*cm³*	*cm³*	*ins × ins × lbs*
161·2	12·0	32665	6256	14·2	6·23	964	410	**36×12 ×170**
142·5	12·2	29000	5212	14·3	6·05	869	343	**150**
128·0	12·6	26399	4316	14·4	5·81	810	285	**135**
144·2	10·8	24635	5331	13·1	6·08	777	363	**33×11½×152**
123·4	11·1	21351	4193	13·2	5·83	690	287	**130**
111·9	11·4	19560	3555	13·2	5·64	644	244	**118**
125·3	9·91	17510	3850	11·8	5·54	613	288	**30×10½×132**
110·1	10·0	15477	3189	11·9	5·38	551	239	**116**
93·9	10·2	13308	2501	11·9	5·16	484	189	**99**
108·2	8·69	12025	3113	10·5	5·36	463	243	**27×10 ×114**
96·8	8·61	10727	2695	10·5	5·28	416	212	**102**
89·2	8·66	9926	2395	10·5	5·18	389	188	**94**
79·7	8·88	8983	1996	10·6	5·00	359	158	**84**
151·8	7·12	12283	7487	9·00	7·02	501	481	**24×12 ×160**
113·8	6·66	8939	5286	8·86	6·81	369	344	**120**
94·9	6·45	7355	4237	8·80	6·68	306	278	**100**
89·1	7·62	7739	2127	9·32	4·88	333	185	**24× 9 × 94**
79·7	7·56	6905	1838	9·31	4·80	300	161	**84**
72·2	7·62	6288	1592	9·33	4·70	276	139	**76**
64·5	7·82	5702	1329	9·40	4·54	256	117	**68**
134·8	5·56	7381	8032	7·40	7·71	340	482	**21×13 ×142**
120·6	5·36	6484	7046	7·33	7·64	300	425	**127**
106·4	5·23	5678	6029	7·31	7·53	265	365	**112**
77·8	6·68	5178	1604	8·16	4·54	252	151	**21× 8¼× 82**
69·2	6·61	4589	1377	8·14	4·46	225	131	**73**
64·6	6·58	4278	1256	8·14	4·41	211	120	**68**
58·8	6·58	3900	1106	8·14	4·34	194	106	**62**
52·1	6·75	3511	913	8·21	4·18	179	87·5	**55**
62·6	5·56	2976	1108	6·90	4·21	167	115	**18× 7½× 66**
56·9	5·50	2699	980	6·89	4·15	153	102	**60**
52·2	5·49	2479	873	6·89	4·09	141	91·3	**55**
47·5	5·43	2244	774	6·88	4·04	129	81·2	**50**
42·7	5·48	2034	664	6·90	3·95	118	70·0	**45**
52·2	6·03	2606	547	7·07	3·24	151·3	71·2	**18× 6 × 55**
47·4	5·99	2362	481	7·06	3·18	138·4	63·0	**50**
42·7	5·99	2126	414	7·06	3·12	126·0	54·6	**45**



STRUCTURAL TEES

Cut from Universal Beams

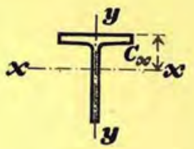
DIMENSIONS AND PROPERTIES

METRIC

Serial Size	Weight		Width of Section B	Depth of Section A	Thickness		Root Radius r	Slope Inside Flange
	per foot	per metre			Web t	Flange T		
ins	lbs	Kg	mm	mm	mm	mm	mm	per cent
7×8	25	37	180	207	9·7	16·0	10·2	5·0
	22·5	33	179	205	8·8	14·3	10·2	5·0
	20	30	178	203	7·8	12·8	10·2	5·0
	18	27	177·6	201	7·6	10·9	10·2	5·0
6×8	25	37	154	208	10·1	18·1	10·2	5·0
	22·5	33	153	206	9·3	16·0	10·2	5·0
	20	30	152	204	8·6	13·9	10·2	5·0
5½×8	15·5	23	142·4	201	6·9	11·2	10·2	5·0
	13	19	141·8	199	6·3	8·6	10·2	5·0
6×7½	22·5	33	154	194	9·7	16·3	10·2	5·0
	20	30	153	192	8·7	14·4	10·2	5·0
	17·5	26	152	191	7·8	12·4	10·2	5·0
6¾×7	22·5	33	173	182	9·1	15·7	10·2	5·0
	19	28	172	180	8·0	13·0	10·2	5·0
	17	25	171·5	178	7·3	11·5	10·2	5·0
	15	22	171	176	6·9	9·7	10·2	5·0
5×7	13	19	126	176	6·5	10·7	10·2	5·0
	11	16	125	174	5·9	8·5	10·2	5·0
6½×6	18	27	167	156	7·7	13·7	8·9	5·0
	15·5	23	166	154	6·7	11·8	8·9	5·0
	13·5	20	165	152	6·1	10·2	8·9	5·0
5×6	16	24	125	155	8·9	14·0	8·9	5·0
	14	21	124	153	8·0	12·1	8·9	5·0
	12·5	19	123·5	152	7·2	10·7	8·9	5·0
4×6	11	16	102·4	156	6·6	10·8	7·6	2·0
	9·5	14	101·9	154	6·1	8·9	7·6	2·0
	8·25	12	101·6	152	5·8	6·8	7·6	2·0
5¾×5	14·5	22	147	130	7·3	12·7	7·6	5·0
	12·5	19	146·4	128	6·4	10·9	7·6	5·0
	10·5	16	146	126	6·1	8·6	7·6	5·0
4×5	9·5	14	102·1	130	6·4	10·0	7·6	2·0
	8·5	13	101·9	129	6·1	8·4	7·6	2·0
	7·5	11	101·6	127	5·8	6·8	7·6	2·0
5¼×4	10	15	134	104	6·3	9·6	7·6	5·0
	8·5	13	133	102	5·8	7·8	7·6	5·0

STRUCTURAL TEES

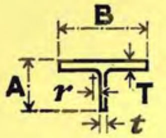
Cut from Universal Beams



DIMENSIONS AND PROPERTIES

METRIC

Area of Section	Gravity Centre Distance Cx	Moment of Inertia		Radius of Gyration		Elastic Modulus		Cut From Universal Beam
		Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	
cm^2	cm	cm^4	cm^4	cm	cm	cm^3	cm^3	ins × ins × lbs
47·5	4·81	1756	724	6·09	3·91	111	80·6	16×7 ×50
42·7	4·74	1572	634	6·07	3·86	99·9	71·0	45
38·0	4·63	1381	552	6·03	3·81	88·0	62·1	40
34·2	4·82	1280	461	6·12	3·67	83·6	51·9	36
47·4	5·14	1823	523	6·20	3·32	116·3	68·1	16×6 ×50
42·7	5·11	1638	454	6·20	3·26	105·6	59·4	45
37·9	5·12	1462	384	6·21	3·18	95·7	50·5	40
29·4	5·06	1129	250	6·19	2·91	75·0	35·1	16×5½×31
24·7	5·29	966	186	6·26	2·75	66·3	26·3	26
42·7	4·75	1427	473	5·78	3·33	97·2	61·4	15×6 ×45
38·0	4·67	1261	407	5·76	3·27	86·6	53·1	40
33·2	4·61	1097	343	5·75	3·21	76·0	45·0	35
42·7	4·01	1157	639	5·21	3·87	81·6	73·8	14×6¾×45
36·1	3·96	978	513	5·21	3·78	70·0	59·6	38
32·3	3·93	877	443	5·21	3·71	63·3	51·7	34
28·5	4·03	790	365	5·27	3·58	58·2	42·7	30
24·7	4·42	719	167	5·40	2·60	54·4	26·4	14×5 ×26
20·9	4·54	617	128	5·44	2·48	47·9	20·5	22
34·2	3·20	636	494	4·32	3·81	51·5	59·3	12×6½×36
29·4	3·09	540	412	4·28	3·73	44·1	49·8	31
25·7	3·07	475	346	4·30	3·66	39·2	41·9	27
30·4	3·92	653	219	4·64	2·68	56·3	35·0	12×5 ×32
26·6	3·86	567	183	4·62	2·63	49·4	29·5	28
23·7	3·81	504	158	4·61	2·58	44·3	25·6	25
20·9	4·15	487	95	4·83	2·13	42·4	18·5	12×4 ×22
18·1	4·23	426	76	4·85	2·05	38·0	15·0	19
15·7	4·48	375	58	4·89	1·92	34·9	11·4	16·5
27·5	2·67	349	317	3·56	3·40	33·8	43·0	10×5¾×29
23·7	2·58	296	264	3·54	3·33	29·0	36·1	25
20·0	2·69	263	203	3·63	3·18	26·6	27·8	21
18·1	3·27	283	87	3·96	2·19	29·1	17·1	10×4 ×19
16·1	3·37	257	72	4·00	2·11	27·1	14·1	17
14·2	3·51	231	58	4·04	2·02	25·1	11·4	15
19·0	2·10	152	177	2·83	3·05	18·5	26·5	8×5¼×20
16·2	2·13	133	140	2·88	2·95	16·6	21·0	17



STRUCTURAL TEES

Cut from Universal Columns

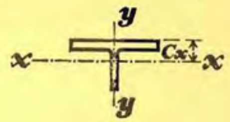
DIMENSIONS AND PROPERTIES

METRIC

Serial Size	Weight		Width of Section **B**	Depth of Section **A**	Thickness		Root Radius *r*	Slope Inside Flange
	per foot	per metre			Web *t*	Flange **T**		
ins	*lbs*	*Kg*	*mm*	*mm*	*mm*	*mm*	*mm*	*per cent*
16 ×7	79	118	395	191	18·5	30·2	15·2	0
14½×7	68	101	374	187	16·8	27·0	15·2	0
	59·5	89	372	184	14·5	23·8	15·2	0
	51·5	77	370	181	12·6	20·7	15·2	0
	43·5	65	368	178	10·7	17·5	15·2	0
12 ×6	53	79	311	164	15·7	25·0	15·2	0
	46	68	309	160	13·8	21·7	15·2	0
	39·5	59	307	157	11·9	18·7	15·2	0
	32·5	48	305	154	9·9	15·4	15·2	0
10 ×5	44·5	66	261	138	15·6	25·3	12·7	0
	36	54	258	133	13·0	20·5	12·7	0
	30	45	256	130	10·5	17·3	12·7	0
	24·5	36	254	127	8·6	14·2	12·7	0
8 ×4	29	43·2	209	111	13·0	20·5	10·2	0
	24	36	206	108	10·3	17·3	10·2	0
	20	30	205	105	9·3	14·2	10·2	0
	17·5	26	204	103	8·0	12·5	10·2	0
	15·5	23	203	102	7·3	11·0	10·2	0
6 ×3	12·5	19	154	81	8·1	11·5	7·6	0
	10	15	153	79	6·6	9·4	7·6	0
	7·85	12	152	76	6·1	6·8	7·6	0

STRUCTURAL TEES

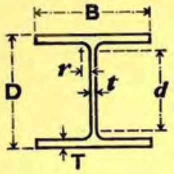
Cut from Universal Columns



DIMENSIONS AND PROPERTIES

METRIC

Area of Section	Gravity Centre Distance *Cx*	Moment of Inertia		Radius of Gyration		Elastic Modulus		Cut From Universal Column
		Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	
cm²	*cm*	*cm⁴*	*cm⁴*	*cm*	*cm*	*cm³*	*cm³*	*ins × ins × lbs*
149·9	3·41	2886	15504	4·39	10·2	185	785	**14× 16 × 158**
129·0	3·32	2500	11816	4·40	9·58	162	631	**14× 14½× 136**
112·9	3·10	2099	10235	4·31	9·53	137	550	**119**
97·6	2·92	1765	8735	4·25	9·45	116	472	**103**
82·5	2·73	1451	7278	4·19	9·40	96·4	395	**87**
100·6	3·04	1529	6262	3·90	7·90	115	403	**12× 12 × 106**
87·3	2·86	1291	5336	3·85	7·82	98·1	346	**92**
74·9	2·69	1075	4503	3·79	7·75	82·5	294	**79**
61·6	2·50	858	3634	3·73	7·67	66·6	238	**65**
84·5	2·72	887	3760	3·24	6·68	79·9	288	**10× 10 × 89**
68·3	2·47	683	2951	3·16	6·58	62·8	228	**72**
57·0	2·24	535	2424	3·06	6·53	49·6	189	**60**
46·4	2·05	416	1936	2·99	6·45	39·0	152	**49**
55·0	2·22	380	1560	2·63	5·33	42·7	149	**8× 8 × 58**
45·5	1·98	288	1268	2·52	5·28	32·7	123	**48**
37·9	1·88	241	1021	2·52	5·18	28·1	99·5	**40**
33·2	1·76	203	885	2·47	5·16	23·7	86·8	**35**
29·4	1·71	180	769	2·47	5·11	21·2	75·7	**31**
23·7	1·55	95	354	2·00	3·86	14·5	45·9	**6× 6 × 25**
19·1	1·41	73	279	1·95	3·81	11·3	36·5	**20**
14·9	1·43	61	202	2·03	3·68	9·9	26·5	**15·7**



UNIVERSAL BEARING PILES

Parallel Flanges

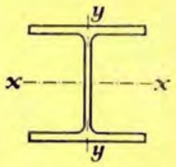
DIMENSIONS AND PROPERTIES

METRIC

Serial Size	Weight		Depth of Section **D**	Width of Section **B**	Thickness		Root Radius *r*	Depth between Fillets *d*
	per foot	per metre			Web *t*	Flange **T**		
ins	*lbs*	*Kg*	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*
14×14½	**117**	**174**	**362**	**378**	**20·4**	**20·4**	**15·2**	**290**
	102	**152**	**356**	**376**	**17·9**	**17·9**	**15·2**	**290**
	89	**133**	**352**	**373**	**15·6**	**15·6**	**15·2**	**290**
	73	**109**	**346**	**370**	**12·9**	**12·9**	**15·2**	**290**
12×12	**74**	**110**	**308**	**310**	**15·4**	**15·4**	**15·2**	**247**
	53	**79**	**299**	**306**	**11·1**	**11·1**	**15·2**	**247**
10×10	**57**	**85**	**254**	**260**	**14·3**	**14·3**	**12·7**	**200**
	42	**63**	**247**	**256**	**10·6**	**10·6**	**12·7**	**200**
8×8	**36**	**54**	**204**	**207**	**11·3**	**11·3**	**10·2**	**161**

UNIVERSAL BEARING PILES

Parallel Flanges



DIMENSIONS AND PROPERTIES

METRIC

Area of Section	Moment of Inertia		Radius of Gyration		Elastic Modulus		Serial Size
	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	
cm^2	cm^4	cm^4	cm	cm	cm^3	cm^3	*ins*
222·2	**51134**	**18444**	**15·2**	**9·11**	**2829**	976	**14×14½**
193·6	**43916**	**15799**	**15·1**	**9·03**	**2464**	**841**	
169·0	**37840**	**13576**	**15·0**	**8·96**	**2150**	**727**	
138·4	**30515**	**10901**	**14·8**	**8·87**	**1762**	**588**	
140·4	**23580**	**7689**	**13·0**	**7·40**	**1532**	**496**	**12×12**
100·4	**16400**	**5292**	**12·8**	**7·26**	**1096**	**346**	
108·1	12264	**4188**	**10·7**	**6·22**	**965**	**323**	**10×10**
79·7	**8775**	**2971**	**10·5**	**6·11**	**711**	**232**	
68·4	4987	**1683**	**8·54**	**4·96**	**489**	**162**	**8× 8**

The sections listed above are known all over the world and have been used in many varied types of structures; as foundations for bridges, buildings and heavy machinery; for wharves, steamship piers and mooring dolphins; and in numerous other situations.

Briefly, their advantages arise from the ability to withstand extremely hard driving and to develop a high bearing value.

The cost of driving is low, because no secondary operations are required and extremely long lengths can be pitched and driven as single pieces. Lengths up to 90 ft. are available from the mill, which reduces the number of splices required. Splicing by welding is quickly and easily carried out and develops the full strength of the section.

In special circumstances where minimum soil displacement is desirable, these sections are admirable and in normal conditions the life far exceeds requirements.

Standard tolerances and size extras as for Universal Beams and Columns are applicable.

PART IV

Safe Loads for and Properties of British Standard Sections

to B.S.4: Part 1: 1962 amended

and

Autofab Beams

for HIGH YIELD STRESS

(Welding Quality)

STRUCTURAL STEEL to B.S.968: 1962

UNIVERSAL BEAMS

BASED ON
B.S. 449
1959
AS AMENDED

WEB CAPACITIES IN TONS FOR HIGH YIELD STEEL

Serial Size inches	Weight per foot lbs	Web thickness *t* inches	Depth between fillets *d* inches	BUCKLING VALUE IN TONS FOR UNSTIFFENED WEB				
				Simply supported on End Bearing		Continuous over Intermediate Bearing		
				Beam Component	Stiff Bearing or Flange Pl. Component per inch	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness
36 × 16½	260	·845	31·16	161·34	8·90	322·67	8·90	17·81
	230	·765	31·16	131·93	7·35	263·86	7·35	14·71
36 × 12	194	·770	32·25	130·95	7·18	261·91	7·18	14·36
	170	·680	32·25	97·75	5·41	195·51	5·41	10·81
	150	·625	32·25	78·57	4·38	157·14	4·38	8·77
	135	·597	32·25	69·17	3·89	138·33	3·89	7·78
33 × 11½	152	·635	29·79	85·90	5·13	171·80	5·13	10·26
	130	·580	29·79	67·83	4·10	135·65	4·10	8·20
	118	·552	29·79	59·24	3·60	118·48	3·60	7·21
30 × 10½	132	·615	26·81	82·87	5·47	165·73	5·47	10·94
	116	·564	26·81	67·06	4·47	134·12	4·47	8·94
	99	·508	26·81	51·03	3·44	102·06	3·44	6·88
27 × 10	114	·570	24·04	71·93	5·27	143·86	5·27	10·55
	102	·518	24·04	57·46	4·25	114·93	4·25	8·49
	94	·490	24·04	49·93	3·71	99·86	3·71	7·42
	84	·462	24·04	42·70	3·20	85·39	3·20	6·40
24 × 12	160	·732	20·93	110·07	8·83	220·14	8·83	17·67
	120	·556	20·93	70·03	5·76	140·06	5·76	11·52
	100	·468	20·93	48·38	4·03	96·76	4·03	8·06
24 × 9	94	·516	21·38	59·13	4·87	118·26	4·87	9·74
	84	·470	21·38	47·67	3·96	95·35	3·96	7·92
	76	·440	21·38	40·39	3·38	80·79	3·38	6·76
	68	·416	21·38	34·81	2·94	69·61	2·94	5·87
21 × 13	142	·659	17·72	86·90	8·10	173·81	8·10	16·20
	127	·588	17·72	73·95	6·96	147·90	6·96	13·93
	112	·527	17·72	62·11	5·91	124·21	5·91	11·83
21 × 8¼	82	·502	18·61	56·47	5·27	112·94	5·27	10·53
	73	·455	18·61	46·25	4·36	92·51	4·36	8·71
	68	·430	18·61	40·77	3·86	81·54	3·86	7·72
	62	·400	18·61	34·29	3·27	68·58	3·27	6·53
	55	·376	18·61	29·23	2·81	58·46	2·81	5·62
18 × 7½	66	·450	15·92	44·99	4·89	89·98	4·89	9·78
	60	·416	15·92	38·76	4·25	77·51	4·25	8·49
	55	·390	15·92	33·89	3·74	67·79	3·74	7·48
	50	·358	15·92	27·96	3·11	55·92	3·11	6·21
	45	·334	15·92	23·56	2·64	47·11	2·64	5·28

For explanation of tables, see notes commencing page 168.
The web buckling and direct bearing values are applicable to end bearings, intermediate bearings and intermediate concentrated loads.

BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL BEAMS

WEB CAPACITIES IN TONS FOR HIGH YIELD STEEL

Serial Size inches	Weight per foot lbs	DIRECT BEARING VALUE IN TONS						Shear Value in Tons
		Simply supported on End Bearing			Continuous over Intermediate Bearing			
		Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	
36 × 16½	260	63·20	14·37	24·88	126·40	14·37	49·76	260·29
	230	53·16	13·01	22·53	106·32	13·01	45·05	233·31
36 × 12	194	47·95	13·09	22·67	95·90	13·09	45·35	238·76
	170	39·14	11·56	20·02	78·29	11·56	40·05	209·00
	150	33·03	10·63	18·40	66·07	10·63	36·81	190·40
	135	29·00	10·15	17·58	58·01	10·15	35·16	180·40
33 × 11½	152	34·78	10·80	18·70	69·55	10·80	37·40	180·82
	130	28·35	9·86	17·08	56·70	9·86	34·16	163·18
	118	25·11	9·38	16·25	50·22	9·38	32·51	154·23
30 × 10½	132	31·51	10·46	18·11	63·02	10·46	36·22	158·39
	116	26·40	9·59	16·61	52·81	9·59	33·21	143·82
	99	21·39	8·64	14·96	42·78	8·64	29·92	128·16
27 × 10	114	27·19	9·69	16·78	54·38	9·69	33·57	132·17
	102	23·11	8·81	15·25	46·21	8·81	30·50	119·19
	94	20·70	8·33	14·43	41·41	8·33	28·86	112·08
	84	18·02	7·85	13·60	36·05	7·85	27·21	104·81
24 × 12	160	43·00	12·44	21·55	86·00	12·44	43·11	155·05
	120	27·67	9·45	16·37	55·34	9·45	32·74	114·89
	100	21·15	7·96	13·78	42·31	7·96	27·56	95·47
24 × 9	94	22·11	8·77	15·19	44·21	8·77	30·39	106·54
	84	18·75	7·99	13·84	37·50	7·99	27·68	96·24
	76	16·39	7·48	12·96	32·78	7·48	25·91	89·42
	68	14·27	7·07	12·25	28·54	7·07	24·50	83·84
21 × 13	142	36·29	11·20	19·40	72·57	11·20	38·81	120·21
	127	30·47	10·00	17·31	60·94	10·00	34·63	106·16
	112	25·45	8·96	15·52	50·90	8·96	31·03	94·07
21 × 8¼	82	20·92	8·53	14·78	41·83	8·53	29·56	91·48
	73	17·62	7·74	13·40	35·24	7·74	26·79	82·15
	68	15·95	7·31	12·66	31·91	7·31	25·32	77·23
	62	14·02	6·80	11·78	28·03	6·80	23·56	71·37
	55	12·12	6·39	11·07	24·25	6·39	22·14	66·48
18 × 7½	66	16·43	7·65	13·25	32·86	7·65	26·50	70·38
	60	14·27	7·07	12·25	28·54	7·07	24·50	64·53
	55	12·63	6·63	11·48	25·26	6·63	22·97	60·07
	50	10·96	6·09	10·54	21·93	6·09	21·08	54·77
	45	9·54	5·68	9·83	19·08	5·68	19·67	50·70

Let W = web value in tons, Cj = beam component, Cp = flange plate component, Cb = stiff bearing component, tp = thickness, in inches, of flange plates between beam and bearing and lb = length, in inches, of stiff bearing; then, for web buckling or direct bearing, either at end or at intermediate bearings, $W = Cj + tp.Cp + lb.Cb$.

UNIVERSAL BEAMS

BASED ON
B.S. 449
1959
AS AMENDED

WEB CAPACITIES IN TONS FOR HIGH YIELD STEEL

				BUCKLING VALUE IN TONS FOR UNSTIFFENED WEB				
				Simply supported on End Bearing		Continuous over Intermediate Bearing		
Serial Size inches	Weight per foot lbs	Web thickness *t* inches	Depth between fillets *d* inches	Beam Component	Stiff Bearing or Flange Pl. Component per inch	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness
18×6	55	·420	15·92	39·60	4·33	79·20	4·33	8·65
	50	·389	15·92	33·79	3·72	67·58	3·72	7·44
	45	·360	15·92	28·31	3·15	56·62	3·15	6·29
16×7	50	·380	14·07	32·43	3·99	64·86	3·99	7·98
	45	·346	14·07	26·85	3·33	53·71	3·33	6·66
	40	·307	14·07	20·48	2·56	40·95	2·56	5·12
	36	·299	14·07	19·05	2·40	38·10	2·40	4·81
16×6	50	·399	14·07	35·61	4·35	71·22	4·35	8·69
	45	·368	14·07	30·52	3·76	61·03	3·76	7·52
	40	·340	14·07	25·80	3·21	51·60	3·21	6·43
16×5½	31	·272	14·07	15·06	1·90	30·11	1·90	3·80
	26	·249	14·07	11·79	1·51	23·57	1·51	3·01
15×6	45	·381	13·12	32·24	4·21	64·49	4·21	8·43
	40	·344	13·12	26·69	3·52	53·38	3·52	7·05
	35	·306	13·12	20·82	2·78	41·64	2·78	5·55
14×6¾	45	·357	12·17	28·48	3·98	56·96	3·98	7·95
	38	·313	12·17	22·23	3·15	44·47	3·15	6·30
	34	·287	12·17	18·47	2·64	36·94	2·64	5·28
	30	·270	12·17	15·96	2·30	31·92	2·30	4·61
14×5	26	·257	12·17	14·22	2·05	28·44	2·05	4·09
	22	·233	12·17	11·00	1·60	22·01	1·60	3·21
12×6½	36	·305	10·34	20·85	3·41	41·70	3·41	6·81
	31	·265	10·34	16·06	2·66	32·13	2·66	5·31
	27	·240	10·34	12·95	2·17	25·90	2·17	4·33
12×5	32	350	10·34	25·52	4·18	51·05	4·18	8·35
	28	·313	10·34	21·41	3·55	42·83	3·55	7·10
	25	·284	10·34	18·07	3·02	36·15	3·02	6·04
12×4	22	·260	10·84	14·99	2·44	29·99	2·44	4·87
	19	·240	10·84	12·41	2·04	24·82	2·04	4·08
	16·5	·230	10·84	11·07	1·84	22·14	1·84	3·69
10×5¾	29	·289	8·51	17·65	3·45	35·29	3·45	6·91
	25	·252	8·51	14·22	2·82	28·44	2·82	5·64
	21	·240	8·51	12·89	2·60	25·78	2·60	5·21
10×4	19	·250	8·84	13·93	2·72	27·86	2·72	5·44
	17	·240	8·84	12·81	2·53	25·61	2·53	5·06
	15	·230	8·84	11·70	2·34	23·39	2·34	4·68
8×5¼	20	·248	6·69	12·39	3·05	24·79	3·05	6·09
	17	·230	6·69	11·04	2·76	22·08	2·76	5·52

For explanation of tables, see notes commencing page 168.
The web buckling and direct bearing values are applicable to end bearings, intermediate bearings and intermediate concentrated loads.

BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL BEAMS

WEB CAPACITIES IN TONS FOR HIGH YIELD STEEL

		DIRECT BEARING VALUE IN TONS						
		Simply supported on End Bearing			Continuous over Intermediate Bearing			
Serial Size inches	Weight per foot lbs	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	Shear Value in Tons
18×6	55	14·78	7·14	12·37	29·56	7·14	24·73	65·37
	50	12·83	6·61	11·45	25·66	6·61	22·91	60·05
	45	11·02	6·12	10·60	22·05	6·12	21·20	55·08
16×7	50	12·20	6·46	11·19	24·39	6·46	22·38	52·49
	45	10·44	5·88	10·19	20·89	5·88	20·38	47·41
	40	8·72	5·22	9·04	17·45	5·22	18·08	41·75
	36	7·84	5·08	8·80	15·67	5·08	17·61	40·28
16×6	50	13·63	6·78	11·75	27·26	6·78	23·50	55·59
	45	11·70	6·26	10·84	23·41	6·26	21·67	50·77
	40	9·96	5·78	10·01	19·92	5·78	20·02	46·41
16×5½	31	7·09	4·62	8·01	14·18	4·62	16·02	36·62
	26	5·75	4·23	7·33	11·51	4·23	14·66	33·10
15×6	45	12·23	6·48	11·22	24·46	6·48	22·44	49·55
	40	10·28	5·85	10·13	20·56	5·85	20·26	44·30
	35	8·47	5·20	9·01	16·94	5·20	18·02	39·02
14×6¾	45	11·35	6·07	10·51	22·71	6·07	21·02	43·48
	38	8·99	5·32	9·22	17·97	5·32	18·43	37·57
	34	7·73	4·88	8·45	15·46	4·88	16·90	34·15
	30	6·72	4·59	7·95	13·44	4·59	15·90	31·81
14×5	26	6·51	4·37	7·57	13·02	4·37	15·13	30·34
	22	5·32	3·96	6·86	10·63	3·96	13·72	27·17
12×6½	36	8·53	5·19	8·98	17·06	5·19	17·96	31·73
	31	6·83	4·51	7·80	13·66	4·51	15·61	27·23
	27	5·72	4·08	7·07	11·45	4·08	14·13	24·40
12×5	32	9·69	5·95	10·31	19·37	5·95	20·61	36·35
	28	7·97	5·32	9·22	15·94	5·32	18·43	32·11
	25	6·77	4·83	8·36	13·55	4·83	16·72	28·87
12×4	22	5·63	4·42	7·66	11·25	4·42	15·31	27·20
	19	4·66	4·08	7·07	9·33	4·08	14·13	24·81
	16·5	3·93	3·91	6·77	7·86	3·91	13·54	23·46
10×5¾	29	7·28	4·91	8·51	14·55	4·91	17·02	25·11
	25	5·82	4·28	7·42	11·65	4·28	14·84	21·59
	21	4·91	4·08	7·07	9·82	4·08	14·13	20·20
10×4	19	5·19	4·25	7·36	10·38	4·25	14·72	21·78
	17	4·52	4·08	7·07	9·04	4·08	14·13	20·64
	15	3·93	3·91	6·77	7·86	3·91	13·54	19·55
8×5¼	20	5·29	4·22	7·30	10·59	4·22	14·60	17·16
	17	4·44	3·91	6·77	8·87	3·91	13·54	15·64

Let W = web value in tons, Cj = beam component, Cp = flange plate component, Cb = stiff bearing component, tp = thickness, in inches, of flange plates between beam and bearing and lb = length, in inches, of stiff bearing; then, for web buckling or direct bearing, either at end or at intermediate bearings, $W = Cj + tp.Cp + lb.Cb$.

UNIVERSAL COLUMNS AS BEAMS

BASED ON
B.S. 449
1959
AS AMENDED

WEB CAPACITIES IN TONS FOR HIGH YIELD STEEL

Serial Size	Weight per foot	Web Thickness *t*	Depth between fillets *d*	BUCKLING VALUE IN TONS FOR UNSTIFFENED WEB				
				Simply supported on End Bearing		Continuous over Intermediate Bearing		
				Beam Component	Stiff Bearing or Flange Pl. Component per inch	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness
inches	*lbs*	*inches*	*inches*					
14×16	264	1·205	11·42	133·37	16·17	266·74	16·17	32·33
	228	1·045	11·42	111·78	13·97	223·56	13·97	27·95
	193	·890	11·42	91·85	11·85	183·69	11·85	23·70
	158	·730	11·42	72·25	9·63	144·51	9·63	19·27
14×14½	136	·660	11·42	63·82	8·65	127·64	8·65	17·31
	119	·570	11·42	53·48	7·38	106·96	7·38	14·75
	103	·495	11·42	44·80	6·29	89·60	6·29	12·57
	87	·420	11·42	36·02	5·15	72·05	5·15	10·29
12×12	190	1·060	9·71	102·29	14·23	204·57	14·23	28·45
	161	·905	9·71	84·02	12·11	168·05	12·11	24·21
	133	·755	9·71	67·25	10·05	134·50	10·05	20·10
	106	·620	9·71	52·69	8·18	105·38	8·18	16·36
	92	·545	9·71	45·00	7·13	89·99	7·13	14·26
	79	·470	9·71	37·53	6·06	75·05	6·06	12·12
	65	·390	9·71	29·60	4·88	59·19	4·88	9·77
10×10	112	·755	7·88	57·51	10·11	115·03	10·11	20·22
	89	·615	7·88	44·55	8·19	89·10	8·19	16·38
	72	·510	7·88	35·36	6·74	70·72	6·74	13·47
	60	·415	7·88	27·68	5·40	55·35	5·40	10·80
	49	·340	7·88	21·57	4·31	43·15	4·31	8·63
8× 8	58	·510	6·33	29·74	6·80	59·49	6·80	13·60
	48	·405	6·33	22·72	5·35	45·43	5·35	10·69
	40	·365	6·33	19·74	4·78	39·47	4·78	9·57
	35	·315	6·33	16·55	4·08	33·09	4·08	8·15
	31	·288	6·33	14·74	3·69	29·48	3·69	7·37
6× 6	25	·320	4·86	13·47	4·23	26·95	4·23	8·46
	20	·258	4·86	10·41	3·36	20·83	3·36	6·72
	15·7	·240	4·86	9·31	3·10	18·61	3·10	6·20

For explanation of tables, see notes commencing page 167.
The web buckling and direct bearing values are applicable to end bearings, intermediate bearings and intermediate concentrated loads.

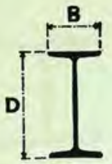
BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL COLUMNS AS BEAMS

WEB CAPACITIES IN TONS FOR HIGH YIELD STEEL

Serial Size	Weight per foot	DIRECT BEARING VALUE IN TONS						Shear Value in Tons
		Simply supported on End Bearing			Continuous over Intermediate Bearing			
		Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	
inches	*lbs*							
14×16	264	90·05	20·48	35·48	180·10	20·48	70·96	169·00
	228	70·40	17·76	30·77	140·80	17·76	61·54	142·12
	193	53·41	15·13	26·21	106·82	15·13	52·41	117·26
	158	38·43	12·41	21·49	76·86	12·41	42·99	93·07
14×14½	136	32·32	11·22	19·43	64·64	11·22	38·87	82·75
	119	25·81	9·69	16·78	51·63	9·69	33·57	70·25
	103	20·59	8·41	14·58	41·19	8·41	29·15	59·96
	87	15·93	7·14	12·37	31·86	7·14	24·73	49·98
12×12	190	72·91	18·02	31·21	145·82	18·02	62·42	129·56
	161	55·59	15·38	26·65	111·17	15·38	53·30	106·77
	133	40·82	12·83	22·23	81·63	12·83	44·46	85·87
	106	28·95	10·54	18·26	57·91	10·54	36·51	67·88
	92	23·36	9·26	16·05	46·73	9·26	32·09	58·46
	79	18·49	7·99	13·84	36·98	7·99	27·68	49·46
	65	13·85	6·63	11·48	27·70	6·63	22·97	40·18
10×10	112	38·86	12·83	22·23	77·72	12·83	44·46	73·03
	89	27·13	10·45	18·11	54·25	10·45	36·22	56·88
	72	19·64	8·67	15·02	39·28	8·67	30·03	45·52
	60	14·46	7·05	12·22	28·91	7·05	24·44	36·16
	49	10·59	5·78	10·01	21·18	5·78	20·02	28·90
8× 8	58	18·14	8·67	15·02	36·28	8·67	30·03	37·93
	48	12·91	6·88	11·93	25·83	6·88	23·85	29·26
	40	10·30	6·20	10·75	20·59	6·20	21·49	25·60
	35	8·28	5·35	9·28	16·57	5·35	18·55	21·74
	31	7·06	4·90	8·48	14·13	4·90	16·96	19·58
6× 6	25	7·10	5·44	9·42	14·21	5·44	18·84	17·33
	20	5·08	4·39	7·60	10·16	4·39	15·19	13·60
	15·7	4·02	4·08	7·07	8·04	4·08	14·13	12·24

Let W=web value in tons, Cj=beam component, Cp=flange plate component, Cb=stiff bearing component, tp=thickness, in inches, of flange plates between beam and bearing and lb=length, in inches, of stiff bearing; then, for web buckling or direct bearing, either at end or at intermediate bearings, $W=Cj+tp.Cp+lb.Cb$.



JOISTS

BASED ON
B.S. 449
1959
AS AMENDED

WEB CAPACITIES IN TONS FOR HIGH YIELD STEEL

Size D×B	Weight per foot	Web thickness *t*	Depth between fillets *d*	BUCKLING VALUE IN TONS FOR UNSTIFFENED WEB				
				Simply supported on End Bearing		Continuous over Intermediate Bearing		
				Joist Component	Stiff Bearing or Flange Pl. Component per inch	Joist Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness
inches	lbs	inches	inches					
8×4	17	·230	6·34	11·23	2·81	22·46	2·81	5·62
7×4	14·5	·210	5·44	9·12	2·61	18·24	2·61	5·21
6×3½	11·5	·194	4·64	7·34	2·45	14·69	2·45	4·90
5×3	9	·178	3·71	5·73	2·29	11·47	2·29	4·59
4×2½	6·5	·161	2·88	4·21	2·11	8·42	2·11	4·21
3×2	4·5	·150	1·98	2·99	2·00	5·99	2·00	3·99

CHANNELS

BASED ON
B.S. 449
1959
AS AMENDED

WEB CAPACITIES IN TONS FOR HIGH YIELD STEEL

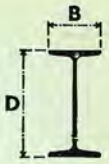
Size D×B	Weight per foot	Web thickness *t*	Depth between fillets *d*	BUCKLING VALUE IN TONS FOR UNSTIFFENED WEB				
				Simply supported on End Bearing		Continuous over Intermediate Bearing		
				Channel Component	Stiff Bearing or Flange Pl. Component per inch	Channel Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness
inches	lbs	inches	inches					
17×4	44	·48	14·27	48·58	5·71	97·15	5·71	11·43
15×4	37	·41	12·30	36·48	4·86	72·96	4·86	9·73
12×4	31	·40	9·42	30·37	5·06	60·73	5·06	10·12
12×3½	28	·40	9·66	30·24	5·04	60·48	5·04	10·08
10×3½	24	·36	7·67	23·12	4·62	46·24	4·62	9·25
10×3	19	·32	8·02	20·01	4·00	40·02	4·00	8·00
9×3½	22	·34	6·69	19·84	4·41	39·68	4·41	8·82
9×3	17·5	·30	7·01	17·11	3·80	34·21	3·80	7·60
8×3½	20	·32	5·72	16·74	4·19	33·49	4·19	8·37
8×3	16	·28	6·00	14·38	3·59	28·75	3·59	7·19
7×3½	18	·30	4·76	13·85	3·96	27·69	3·96	7·91
7×3	14	·26	5·07	11·81	3·37	23·62	3·37	6·75
6×3½	16	·28	3·82	11·16	3·72	22·31	3·72	7·44
6×3	12	·25	4·17	9·86	3·29	19·71	3·29	6·57
5×2½	10	·25	3·31	8·31	3·33	16·63	3·33	6·65
4×2	7	·24	2·59	6·42	3·21	12·84	3·21	6·42
3×1½	4·5	·20	1·80	4·03	2·68	8·05	2·68	5·37

For explanation of tables, see notes commencing page 168.
The web buckling and direct bearing values are applicable to end bearings, intermediate bearings and intermediate concentrated loads.

BASED ON
B.S. 449
1959
AS AMENDED
1962

JOISTS

WEB CAPACITIES IN TONS FOR HIGH YIELD STEEL



Size D×B	Weight per foot	DIRECT BEARING VALUE IN TONS						Shear Value in Tons
		Simply supported on End Bearing			Continuous over Intermediate Bearing			
		Joist Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	Joist Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	
inches	*lbs*							
8×4	17	5·62	3·91	6·77	11·24	3·91	13·54	15·64
7×4	14·5	4·82	3·57	6·18	9·65	3·57	12·37	12·50
6×3½	11·5	3·88	3·30	5·71	7·77	3·30	11·42	9·89
5×3	9	3·38	3·03	5·24	6·76	3·03	10·48	7·57
4×2½	6·5	2·65	2·74	4·74	5·31	2·74	9·48	5·47
3×2	4·5	2·25	2·55	4·42	4·51	2·55	8·83	3·83

BASED ON
B.S. 449
1959
AS AMENDED
1962

CHANNELS

WEB CAPACITIES IN TONS FOR HIGH YIELD STEEL

Size D×B	Weight per foot	DIRECT BEARING VALUE IN TONS						Shear Value in Tons
		Simply supported on End Bearing			Continuous over Intermediate Bearing			
		Channel Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	Channel Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	
inches	*lbs*							
17×4	44	19·29	8·16	14·13	38·58	8·16	28·27	65·28
15×4	37	16·30	6·97	12·07	32·59	6·97	24·14	49·20
12×4	31	15·19	6·80	11·78	30·39	6·80	23·56	38·40
12×3½	28	13·78	6·80	11·78	27·56	6·80	23·56	38·40
10×3½	24	12·35	6·12	10·60	24·70	6·12	21·20	28·80
10×3	19	9·33	5·44	9·42	18·66	5·44	18·84	25·60
9×3½	22	11·56	5·78	10·01	23·13	5·78	20·02	24·48
9×3	17·5	8·79	5·10	8·83	17·58	5·10	17·67	21·60
8×3½	20	10·74	5·44	9·42	21·48	5·44	18·84	20·48
8×3	16	8·24	4·76	8·24	16·49	4·76	16·49	17·92
7×3½	18	9·89	5·10	8·83	19·79	5·10	17·67	16·80
7×3	14	7·39	4·42	7·66	14·77	4·42	15·31	14·56
6×3½	16	8·99	4·76	8·24	17·97	4·76	16·49	13·44
6×3	12	6·74	4·25	7·36	13·47	4·25	14·72	12·00
5×2½	10	6·22	4·25	7·36	12·44	4·25	14·72	10·00
4×2	7	4·98	4·08	7·07	9·96	4·08	14·13	7·68
3×1½	4·5	3·53	3·40	5·89	7·07	3·40	11·78	4·80

Let W = web value in tons, C = joist or channel component, Cp = flange plate component, Cb = stiff bearing component, tp = thickness, in inches, of flange plates between beam and bearing and lb = length, in inches, of stiff bearing; then, for web buckling or direct bearing either at end or at intermediate bearings, $W = C + tp.Cp + lb.Cb$.

UNIVERSAL BEAMS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Serial Size inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS															
		14 ·0983	**16** ·0752	**18** ·0594	**20** ·0481	**22** ·0398	**24** ·0334	**26** ·0285	**28** ·0246	**32** ·0188	**36** ·0149	**40** ·0120	**44** ·0099	**48** ·0084	**56** ·0061	**64** ·0047	**72** ·0037
36×16½	260			**511**	**460**	**418**	**383**	**354**	**328**	*287*	*255*	230	209	192	164	144	128
	230			**449**	**404**	**367**	**337**	**311**	**288**	*252*	224	202	184	168	144	126	112
36×12	194	**458**	**401**	**356**	**321**	**292**	**267**	*247*	*229*	*200*	*178*	160	146	134	115	100	89·1
	170	**400**	**350**	**311**	**280**	**254**	**233**	**215**	**200**	*175*	*155*	140	127	117	100	87·5	77·7
	150	**347**	**304**	**270**	**243**	**221**	**203**	**187**	**174**	*152*	135	122	110	101	86·8	76·0	67·5
	135	**303**	**265**	**236**	**212**	**193**	**177**	**163**	**152**	*133*	118	106	96·4	88·4	75·8	66·3	58·9
33×11½	152	**336**	**294**	**261**	**235**	**214**	**196**	**181**	*168*	*147*	131	118	107	98·0	84·0	73·5	65·3
	130	**280**	**245**	**217**	**196**	**178**	**163**	**151**	**140**	*122*	109	97·8	88·9	81·5	69·9	61·1	54·3
	118	**248**	**217**	**193**	**173**	**158**	**144**	**133**	**124**	*108*	96·3	86·7	78·8	72·2	61·9	54·2	48·2
30×10½	132	**262**	**229**	**204**	**184**	**167**	*153*	*141*	*131*	115	102	91·8	83·4	76·5	65·5	57·4	
	116	**226**	**198**	**176**	**158**	**144**	*132*	*122*	*113*	99·1	88·0	79·2	72·0	66·0	56·6	49·5	
	99	**188**	**165**	**146**	**132**	**120**	**110**	*101*	*94·2*	82·4	73·3	65·9	59·9	54·9	47·1	41·2	
27×10	114	**207**	**181**	**161**	**145**	*131*	*121*	*111*	103	90·4	80·3	72·3	65·7	60·3	51·6	45·2	
	102	**184**	**161**	**143**	**129**	**117**	*107*	*99·0*	91·9	80·4	71·5	64·4	58·5	53·6	46·0	40·2	
	94	**168**	**147**	**130**	**117**	**107**	*97·8*	*90·3*	83·8	73·3	65·2	58·7	53·3	48·9	41·9	36·7	
	84	**146**	**128**	**114**	**102**	**93·1**	*85·3*	*78·8*	73·2	64·0	56·9	51·2	46·6	42·7	36·6	32·0	
24×12	160	**276**	**241**	*215*	*193*	*176*	*161*	149	138	121	107	96·6	87·8	80·5	69·0		
	120	**207**	**181**	**161**	**145**	*131*	*120*	111	103	90·4	80·3	72·3	65·7	60·2	51·6		
	100	**172**	**150**	**134**	**120**	**109**	100‡	92·5	85·9	75·2	66·8	60·2	54·7	50·1	43·0		
24×9	94	**153**	**133**	**119**	*107*	*97·1*	*89·0*	82·1	76·3	66·7	59·3	53·4	48·5	44·5	38·1		
	84	**136**	**119**	**105**	*94·9*	*86·3*	79·1	73·0	67·8	59·3	52·7	47·4	45·1	39·5	33·9		
	76	**121**	**106**	**94·2**	**84·8**	*77·1*	70·6	65·2	60·6	53·0	47·1	42·4	38·5	35·3	30·3		
	68	**106**	**92·5**	**82·2**	**74·0**	*67·3*	61·7	56·9	52·9	46·2	41·1	37·0	33·6	30·8	26·4		
21×13	142	**219**	**192**	*170*	*153*	139	128	118	110	95·8	85·2	76·7	69·7	63·9			
	127	**196**	**172**	**153**	*137*	125	114	106	98·1	85·9	76·3	68·7	62·4	57·2			
	112	**172**	**151**	**134**	*121*	110	101	92·8	86·2	75·4	67·0	60·3	54·9	50·3			
21×8¼	82	**118**	*103*	*91·6*	*82·4*	74·9	68·7	63·4	58·9	51·5	45·8	41·2	37·5	34·3			
	73	**104**	*91·0*	*80·9*	*72·8*	66·2	60·7	56·0	52·0	45·5	40·5	36·4	33·1	30·3			
	68	**96·6**	**84·5**	*75·1*	*67·6*	61·5	56·3	52·0	48·3	42·3	37·6	33·8	30·7	28·2			
	62	**87·3**	**76·4**	*67·9*	*61·1*	55·5	50·9	47·0	43·6	38·2	33·9	30·5	27·8	25·5			
	55	**75·5**	**66·1**	**58·8**	*52·9*	48·1	44·1	40·7	37·8	33·0	29·4	26·4	24·0	22·0			
18×7½	66	*82·3*	*72·0*	*64·0*	57·6	52·4	48·0	44·3	41·2	36·0	32·0	28·8					
	60	*74·4*	*65·1*	*57·9*	52·1	47·4	43·4	40·1	37·2	32·6	28·9	26·1					
	55	*67·8*	*59·3*	*52·7*	47·5	43·1	39·6	36·5	33·9	29·7	26·4	23·7					
	50	**61·5**	*53·8*	47·8	43·0	39·1	35·8	33·1	30·7	26·9	23·9	21·5					
	45	**54·5**	**47·7**	42·4	38·1	34·7	31·8	29·3	27·2	23·8	21·2	19·1					

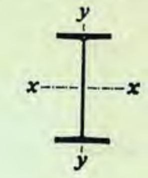
Generally, tabular loads are based on a flexural stress of 14.5 tons/inch^2, assuming adequate lateral support. Beams without adequate lateral support must not exceed the critical span *Lc*, unless the allowable compressive stress is reduced in accordance with clause 19.*a*.(ii) of B.S. 449 : 1959 as amended.

Tabular loads printed in bold face type exceed the load buckling capacity of the unstiffened web without allowance for actual length of bearing; the load bearing capacity should be checked, see page 168.

BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL BEAMS

DIMENSIONS AND PROPERTIES



Critical Span *Lc* feet	Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Ratio **D**/**T**	Serial Size inches
		Axis *x-x*	Axis *y-y*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
15·21	76·56	17234	1021	3·65	951·1	123·3	25·2	**36×16½**
14·96	67·73	14988	870·9	3·59	835·5	105·7	28·5	
10·37	57·11	12103	355·4	2·49	663·6	58·7	29·0	**36×12**
10·21	49·98	10470	300·6	2·45	579·1	50·0	32·9	
9·92	44·16	9012·1	250·4	2·38	502·9	41·8	38·1	
9·54	39·69	7801·3	207·4	2·29	438·9	34·7	44·7	
9·96	44·71	8147·6	256·1	2·39	486·4	44·3	31·8	**33×11½**
9·54	38·26	6699·0	201·4	2·29	404·8	35·0	38·7	
9·25	34·69	5896·0	170·8	2·22	358·7	29·8	44·4	
9·08	38·83	5753·1	185·0	2·18	379·7	35·1	30·3	**30×10½**
8·83	34·13	4919·1	153·2	2·12	327·9	29·2	35·3	
8·46	29·11	4049·1	120·2	2·03	272·8	23·0	43·0	
8·79	33·53	4080·5	149·6	2·11	299·2	29·7	29·3	**27×10**
8·67	30·01	3604·1	129·5	2·08	266·3	25·9	32·7	
8·50	27·65	3266·8	115·1	2·04	242·8	23·0	36·0	
8·21	24·71	2827·7	95·9	1·97	211·9	19·3	41·9	
13·76	47·05	4979·2	359·7	2·77	399·6	58·7	20·2	**24×12**
11·17	35·29	3635·3	254·0	2·68	299·1	42·0	26·1	
10·96	29·43	2987·3	203·6	2·63	248·9	33·9	31·0	
8·00	27·63	2683·0	102·2	1·92	220·9	22·6	27·9	**24×9**
7·87	24·71	2364·3	88·3	1·89	196·3	19·6	31·2	
7·71	22·37	2096·4	76·5	1·85	175·4	17·0	35·1	
7·46	20·00	1815·1	63·9	1·79	153·1	14·3	40·7	
15·40	41·78	3403·9	386·0	3·04	317·2	58·8	19·6	**21×13**
14·25	37·38	3018·0	338·6	3·01	284·2	51·8	21·6	
12·68	32·97	2621·4	289·7	2·96	249·7	44·6	24·3	
7·46	24·12	1827·8	77·1	1·79	170·5	18·5	25·5	**21×8¼**
7·33	21·46	1600·3	66·2	1·76	150·7	16·0	28·7	
7·25	20·02	1478·3	60·4	1·74	139·9	14·6	30·8	
7·12	18·23	1326·8	53·1	1·71	126·4	12·9	34·1	
6·87	16·17	1137·9	43·9	1·65	109·4	10·7	40·0	
7·22	19·40	1096·8	53·2	1·66	119·2	14·0	23·9	**18×7½**
6·79	17·64	984·0	47·1	1·63	107·8	12·5	26·3	
6·71	16·19	889·9	42·0	1·61	98·2	11·1	28·8	
6·62	14·71	800·6	37·2	1·59	89·0	9·91	31·6	
6·46	13·23	704·8	31·9	1·55	78·9	8·54	35·7	

Tabular loads printed in italic type are within the web buckling capacity of the unstiffened web and produce a total deflection not exceeding 1/360th of the span.
Tabular loads printed in ordinary type should be checked for deflection, see page 169.
For explanation of tables, see notes commencing pages 162 and 167.
‡This load exceeds the web buckling capacity of the unstiffened web.

UNIVERSAL BEAMS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Serial Size inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS															
		7 ·3930	**8** ·3009	**9** ·2378	**10** ·1926	**12** ·1337	**14** ·0983	**16** ·0752	**18** ·0594	**20** ·0481	**22** ·0398	**24** ·0334	**26** ·0285	**28** ·0246	**30** ·0214	**32** ·0188	**36** ·0149
18×6	55		**115**	**102**	**91·7**	*76·4*	*65·5*	*57·3*	*51·0*	45·9	41·7	38·2	35·3	32·8	30·6	28·7	25·5
	50		**104**	**92·0**	**82·8**	**69·0**	*59·2*	*51·8*	*46·0*	41·4	37·7	34·5	31·9	29·6	27·6	25·9	23·0
	45		**92·0**	**81·7**	**73·6**	**61·3**	*52·5*	*46·0*	40·9	36·8	33·4	30·7	28·3	26·3	24·5	23·0	20·4
16×7	50		**97·5**	**86·7**	**78·0**	**65·0**	*55·7*	*48·8*	43·3	39·0	35·5	32·5	30·0	27·9	26·0	24·4	21·7
	45		**87·5**	**77·8**	**70·0**	**58·3**	*50·0*	*43·7*	38·9	35·0	31·8	29·2	26·9	25·0	23·3	21·9	19·4
	40		**77·8**	**69·2**	**62·3**	**51·9**	**44·5**	38·9	34·6	31·1	28·3	25·9	23·9	22·2	20·8	19·5	17·3
	36		**68·0**	**60·5**	**54·4**	**45·4**	**38·9**	34·0	30·2	27·2	24·7	22·7	20·9	19·4	18·1	17·0	15·1
16×6	50		**95·5**	**84·9**	**76·4**	*63·6*	*54·5*	*47·7*	42·4	38·2	34·7	31·8	29·4	27·3	25·5	23·9	21·2
	45		**85·2**	**75·7**	**68·2**	*56·8*	*48·7*	*42·6*	37·9	34·1	31·0	28·4	26·2	24·3	22·7	21·3	18·9
	40		**74·6**	**66·3**	**59·6**	*49·7*	*42·6*	37·3	33·1	29·8	27·1	24·9	22·9	21·3	19·9	18·6	16·6
16×5½	31		**57·2**	**50·8**	**45·7**	**38·1**	**32·7**	28·6	25·4	22·9	20·8	19·1	17·6	16·3	15·2	14·3	12·7
	26		**46·0**	**40·9**	**36·8**	**30·7**	**26·3**	23·0	20·5	18·4	16·7	15·3	14·2	13·2	12·3	11·5	10·2
15×6	45		**80·7**	**71·7**	**64·6**	*53·8*	*46·1*	40·4	35·9	32·3	29·4	26·9	24·8	23·1	21·5	20·2	
	40		**71·4**	**63·5**	**57·1**	*47·6*	*40·8*	35·7	31·7	28·6	26·0	23·8	22·0	20·4	19·0	17·9	
	35		**62·1**	**55·2**	**49·7**	*41·4*	*35·5*	31·1	27·6	24·8	22·6	20·7	19·1	17·7	16·6	15·5	
14×6¾	45		**78·9**	**70·1**	**63·1**	*52·6*	*45·1*	39·5	35·1	31·6	28·7	26·3	24·3	22·5	21·0	19·7	
	38		**66·0**	**58·6**	**52·8**	*44·0*	*37·7*	33·0	29·3	26·4	24·0	22·0	20·3	18·8	17·6	16·5	
	34		**58·6**	**52·1**	**46·9**	**39·1**	33·5	29·3	26·0	23·4	21·3	19·5	18·0	16·7	15·6	14·7	
	30		**50·5**	**44·9**	**40·4**	**33·7**	28·9	25·3	22·4	20·2	18·4	16·8	15·5	14·4	13·5	12·6	
14×5	26		**42·1**	**37·4**	**33·6**	*28·0*	24·0	21·0	18·7	16·8	15·3	14·0	12·9	12·0	11·2	10·5	
	22		**34·6**	**30·7**	**27·6**	**23·0**	19·7	17·3	15·4	13·8	12·6	11·5	10·6	9·8	9·2	8·6	
12×6½	36	**63·4**	**55·5**	**49·3**	**44·4**	*37·0*	31·7	27·7	24·6	22·2	20·2	18·5	17·1	15·8			
	31	**54·4**	**47·6**	**42·3**	**38·1**	*31·7*	27·2	23·8	21·2	19·0	17·3	15·9	14·6	13·6			
	27	**47·1**	**41·2**	**36·6**	**33·0**	27·5‡	23·5	20·6	18·3	16·5	15·0	13·7	12·7	11·8			
12×5	32	**51·5**	*45·1*	*40·1*	*36·1*	*30·0*	25·8	22·5	20·0	18·0	16·4	15·0	13·9	12·9			
	28	**44·6**	*39·0*	*34·7*	*31·2*	*26·0*	22·3	19·5	17·3	15·6	14·2	13·0	12·0	11·2			
	25	**39·6**	*34·7*	*30·8*	*27·7*	23·1	19·8	17·3	15·4	13·9	12·6	11·6	10·7	9·9			
12×4	22	**34·9**	**30·6**	*27·2*	*24·5*	*20·4*	17·5	15·3	13·6	12·2	11·1	10·2	9·4	8·7			
	19	**29·6**	**25·9**	*23·0*	*20·7*	*17·2*	14·8	12·9	11·5	10·3	9·4	8·6	7·9	7·3			
	16·5	**24·2**	*21·1*	*18·8*	*16·9*	14·1	12·1	10·6	9·3	8·4	7·6	7·0	6·5	6·0			
10×5¾	29	**42·5**	**37·2**	*33·1*	*29·8*	24·8	21·3	18·6	16·5	14·9	13·5	12·4					
	25	**36·5**	**31·9**	*28·4*	*25·5*	21·3	18·2	15·9	14·2	12·8	11·6	10·6					
	21	**29·7**	**26·0**	*23·1*	20·8	17·3	14·8	13·0	11·5	10·4	9·4	8·6					
10×4	19	*26·0*	*22·7*	*20·2*	*18·2*	15·1	13·0	11·4	10·1	9·0	8·2	7·5					
	17	*22·4*	*19·6*	*17·4*	*15·7*	13·0	11·2	9·7	8·7	7·8	7·1	6·5					
	15	*19·1*	*16·7*	*14·8*	13·3	11·1	9·5	8·3	7·4	6·6	6·0	5·5					
8×5¼	20	*23·5*	*20·5*	18·3	16·4	13·7	11·7	10·3	9·1	8·2							
	17	*19·5*	17·0	15·1	13·6	11·4	9·7	8·5	7·5	6·8							

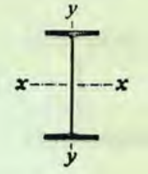
Generally, tabular loads are based on a flexural stress of 14.5 tons/inch^2, assuming adequate lateral support. Beams without adequate lateral support must not exceed the critical span *Lc*, unless the allowable compressive stress is reduced in accordance with clause 19.*a*.(ii) of B.S. 449 : 1959, as amended.

Tabular loads printed in bold face type exceed the load buckling capacity of the unstiffened web without allowance for actual length of bearing; the load bearing capacity should be checked, see page 168.

BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL BEAMS

DIMENSIONS AND PROPERTIES



Critical Span *Lc* feet	Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Ratio $\frac{D}{T}$	Serial Size inches
		Axis *x-x*	Axis *y-y*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
5·38	16·18	868·7	26·3	1·27	94·9	8·70	24·6	**18×6**
5·21	14·71	777·9	23·1	1·25	85·7	7·69	27·1	
5·12	13·22	685·2	19·9	1·23	76·1	6·66	30·6	
6·42	14·70	655·4	34·8	1·54	80·7	9·84	25·9	**16×7**
6·33	13·24	583·3	30·5	1·52	72·4	8·66	28·6	
6·25	11·77	515·5	26·5	1·50	64·4	7·58	31·8	
6·04	10·59	446·3	22·1	1·45	56·3	6·34	37·0	
5·87	14·70	647·2	25·1	1·31	79·0	8·31	23·1	**16×6**
5·33	13·23	571·8	21·8	1·28	70·5	7·25	25·7	
5·21	11·76	495·4	18·5	1·25	61·7	6·16	29·4	
4·79	9·12	374·9	12·0	1·15	47·3	4·29	36·0	**16×5½**
4·50	7·64	298·1	8·96	1·08	38·1	3·21	46·0	
5·70	13·24	511·2	22·7	1·31	66·8	7·49	23·9	**15×6**
5·37	11·77	447·6	19·6	1·29	59·1	6·48	26·8	
5·25	10·29	385·5	16·5	1·26	51·4	5·49	30·6	
6·79	13·23	468·1	30·7	1·52	65·3	9·01	23·2	**14×6¾**
6·21	11·17	385·3	24·6	1·49	54·6	7·28	27·5	
6·08	10·00	339·2	21·3	1·46	48·5	6·30	30·9	
5·87	8·81	289·6	17·5	1·41	41·8	5·21	36·2	
4·25	7·64	241·6	8·00	1·02	34·8	3·23	33·1	**14×5**
4·08	6·47	196·2	6·17	·98	28·6	2·50	41·0	
6·82	10·59	280·8	23·7	1·50	45·9	7·23	22·7	**12×6½**
6·12	9·12	238·4	19·8	1·47	39·4	6·07	26·0	
6·00	7·97	204·2	16·6	1·44	34·1	5·11	29·9	
4·91	9·42	227·9	10·52	1·06	37·3	4·27	22·2	**12×5**
4·29	8·23	195·2	8·81	1·03	32·3	3·60	25·4	
4·25	7·35	171·6	7·59	1·02	28·7	3·12	28·4	
3·50	6·47	155·7	4·55	·84	25·3	2·26	29·0	**12×4**
3·37	5·62	130·1	3·67	·81	21·4	1·83	34·8	
3·17	4·86	105·3	2·79	·76	17·5	1·39	44·6	
6·61	8·53	157·3	15·2	1·34	30·8	5·25	20·4	**10×5¾**
5·81	7·35	133·2	12·7	1·31	26·4	4·40	23·4	
5·21	6·19	106·3	9·74	1·25	21·5	3·39	29·1	
3·58	5·61	96·2	4·19	·86	18·8	2·08	26·0	**10×4**
3·46	4·98	81·8	3·45	·83	16·2	1·72	30·8	
3·33	4·40	68·8	2·79	·80	13·8	1·39	37·2	
5·70	5·88	69·2	8·50	1·20	17·0	3·23	21·5	**8×5¼**
4·83	5·00	56·4	6·72	1·16	14·1	2·56	26·0	

Tabular loads printed in italic type are within the web buckling capacity of the unstiffened web and produce a total deflection not exceeding 1/360th of the span.

Tabular loads printed in ordinary type should be checked for deflection, see page 169.

For explanation of tables, see notes commencing pages 162 and 167.

‡This load exceeds the web buckling capacity of the unstiffened web.

UNIVERSAL COLUMNS AS BEAMS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Serial Size inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS															
		7 ·3930	**8** ·3009	**10** ·1926	**12** ·1337	**14** ·0983	**16** ·0752	**18** ·0594	**20** ·0481	**22** ·0398	**24** ·0334	**26** ·0285	**28** ·0246	**30** ·0214	**32** ·0188	**36** ·0149	**40** ·0120
14×16	264				**338†**	**295**	*258*	230	207	188	172	159	148	138	129	115	103
	228				**284†**	**254**	222	198	178	162	148	137	127	119	111	98·8	88·9
	193				**234†**	**214**	*187**	166	150	136	125	115	107	99·9	93·6	83·2	74·9
	158				**186†**	**175**	*153**	136	122	111	102	94·2	87·5	81·7	76·5	68·0	61·2
14×14½	136				**165†**	**149**	*130**	116	104	94·9	87·0	80·3	74·6	69·6	65·2	58·0	
	119				**140†**	**131**	*114**	102	91·5	83·2	76·3	70·4	65·4	61·0	57·2	50·9	
	103				**120†**	**113**	*98·8**	87·9	79·1	71·9	65·9	60·8	56·5	52·7	49·4	43·9	
	87				**100†**	*95·4**	*83·4**	*74·2**	66·7	60·7	55·6	51·3	47·7	44·5	41·7	37·1	
12×12	190		**259†**	**254**	**212**	*182*	159	141	127	116	106	97·9	90·9	84·8	79·5		
	161			**213†**	**179**	153	134	119	107	97·6	89·5	82·6	76·7	71·6	67·1		
	133			**172†**	**147**	126	110	98·0	88·2	80·2	73·5	67·9	63·0	58·8	55·1		
	106			**136†**	**116**	99·8	87·3	77·6	69·8	63·5	58·2	53·7	49·9	46·6	43·7		
	92			**117†**	**101**	86·3	75·5	67·1	60·4	54·9	50·3	46·5	43·2	40·3	37·8		
	79			**98·9†**	**86·3**	73·9	64·7	57·5	51·8	47·1	43·1	39·8	37·0	34·5	32·4		
	65			**80·4†**	**70·9**	*60·8**	53·2	47·3	42·5	38·7	35·4	32·7	30·4	28·4	26·6		
10×10	112		**146†**	**122**	102	87·2	76·3	67·8	61·0	55·5	50·9	47·0	43·6				
	89		**114†**	**96·4**	80·3	68·8	60·2	53·5	48·2	43·8	40·2	37·1	34·4				
	72		**91·0†**	**77·4**	64·5	55·3	48·4	43·0	38·7	35·2	32·3	29·8	27·7				
	60		**72·3†**	**64·9**	54·1	46·3	40·5	36·0	32·4	29·5	27·0	24·9	23·2				
	49		**57·8†**	*52·8**	*44·0**	37·7	33·0	29·3	26·4	24·0	22·0	20·3	18·8				
8×8	58	**71·8**	**62·8**	50·3	41·9	35·9	31·4	27·9	25·1	22·8							
	48	**58·5†**	**52·2**	41·8	34·8	29·8	26·1	23·2	20·9	19·0							
	40	**49·0**	**42·9**	34·3	28·6	24·5	21·4	19·1	17·2	15·6							
	35	**42·9**	**37·6**	30·1	25·1	21·5	18·8	16·7	15·0	13·7							
	31	**37·8**	*33·1**	26·5	22·1	18·9	16·6	14·7	13·2	12·0							
6×6	25	23·1	20·2	16·1	13·5	11·5	10·1										
	20	18·6	16·3	13·0	10·9	9·3	8·1										
	15·7	13·9	12·2	9·7	8·1	6·9	6·1										

Generally, tabular loads are based on a flexural stress of 14·5 tons/inch², assuming adequate lateral support. Beams without adequate lateral support must not exceed the critical span *Lc*, unless the allowable compressive stress is reduced in accordance with clause 19.*a*.(ii) of B.S. 449 : 1959, amended.
Tabular loads with asterisk or printed in prominent type exceed the load buckling capacity of the unstiffened web without allowance for actual length of bearing; the load bearing capacity should be checked, see page 168.

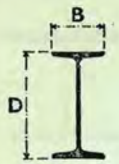
BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL COLUMNS AS BEAMS

DIMENSIONS AND PROPERTIES

Critical Span *Lc* feet	Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Ratio $\frac{D}{T}$	Serial Size inches
		Axis *x-x*	Axis *y-y*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
28·63	77·63	3526·0	1331·2	4·14	427·4	166·1	8·5	**14×16**
27·67	67·06	2942·4	1124·8	4·10	367·8	141·8	9·5	
26·46	56·73	2402·4	930·1	4·05	310·0	118·4	10·8	
24·93	46·47	1900·6	745·0	4·00	253·4	95·8	12·6	
22·68	39·98	1593·0	567·8	3·77	216·0	77·0	13·9	**14×14½**
21·56	34·99	1373·1	491·8	3·75	189·4	67·1	15·5	
20·15	30·26	1165·8	419·7	3·72	163·6	57·6	17·5	
18·31	25·56	966·9	349·7	3·70	138·1	48·2	20·3	
22·59	55·86	1892·6	589·7	3·25	263·2	93·1	8·3	**12×12**
21·71	47·38	1541·9	486·3	3·20	222·2	77·7	9·3	
20·64	39·11	1221·3	389·9	3·16	182·5	63·1	10·8	
19·13	31·19	930·7	300·9	3·11	144·5	49·2	13·1	
18·12	27·06	788·9	256·4	3·08	125·0	42·2	14·7	
16·88	23·22	663·1	216·4	3·05	107·1	35·8	16·8	
15·10	19·11	533·4	174·6	3·02	88·0	29·1	20·0	
18·20	32·92	718·7	235·4	2·67	126·3	45·2	9·1	**10×10**
17·14	26·19	542·4	180·6	2·63	99·7	35·2	10·9	
15·97	21·18	420·7	141·8	2·59	80·1	27·9	13·0	
14·99	17·66	343·7	116·5	2·57	67·1	23·1	15·0	
13·59	14·40	272·9	93·0	2·54	54·6	18·6	17·9	
13·72	17·06	227·3	74·9	2·10	52·0	18·2	10·8	**8×8**
13·03	14·11	183·7	60·9	2·08	43·2	15·0	12·4	
11·97	11·76	146·3	49·0	2·04	35·5	12·1	14·8	
11·33	10·30	126·5	42·5	2·03	31·1	10·6	16·5	
10·55	9·12	109·7	37·0	2·01	27·4	9·24	18·5	
9·12	7·35	53·3	17·0	1·52	16·7	5·60	14·0	**6×6**
8·30	5·93	41·9	13·4	1·50	13·5	4·46	16·8	
6·69	4·62	30·3	9·69	1·45	10·1	3·23	22·3	

Tabular loads marked † are based on the maximum shear value of the web and are less than the permissible flexural load.
Tabular loads printed in italic type without asterisk are within the buckling capacity of the unstiffened web and produce a total deflection not exceeding 1/360th of the span.
Tabular loads printed in italic type with asterisk and in ordinary type produce a deflection exceeding 1/360th of the span.
Loads producing a deflection of 1/360th span may be obtained from $W = CI_x$, where C is the coefficient given below the appropriate span and I_x is the inertia of the beam.
For explanation of tables, see notes commencing pages 163 and 167.



JOISTS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Size D×B inches	Weight per foot lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS													
		3 2·140	4 1·204	5 ·7704	6 ·5350	7 ·3930	8 ·3009	9 ·2378	10 ·1926	11 ·1592	12 ·1337	14 ·0983	16 ·0752	18 ·0594	20 ·0481
8×4	17		**†31·3**	**26·6**	*22·2*	*19·0*	16·7	14·8	13·3	12·1	11·1	9·5	8·3	7·4	6·6
7×4	14·5		**†25·0**	**20·2**	*16·8*	14·4	12·6	11·2	10·1	9·1	8·4	7·2	6·3		
6×3½	11·5	**†19·8**	**17·1**	*13·7*	11·4	9·7	8·5	7·5	6·8	6·2	5·6				
5×3	9	**14·8**	*11·1*	8·8	7·3	6·3	5·5	4·9	4·4	4·0					
4×2½	6·5	**8·4**	6·3	5·0	4·2	3·6	3·1	2·8	2·5						
3×2	4·5	4·2	3·2	2·5	2·1	1·8	1·6								

CHANNELS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

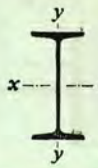
Size D×B inches	Weight per foot lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS													
		4 1·204	6 ·5350	8 ·3009	10 ·1926	12 ·1337	14 ·0983	16 ·0752	18 ·0594	20 ·0481	22 ·0398	24 ·0334	26 ·0285	28 ·0246	32 ·0188	36 ·0149
17×4	44	**†131**	**97·4**	*73·1*	*58·5*	*48·7*	*41·8*	*36·5*	32·5	29·2	26·6	24·4	22·5	20·9	18·3	16·2
15×4	37	**†98·4**	**76·9**	*57·7*	*46·1*	*38·4*	*32·9*	28·8	25·6	23·1	21·0	19·2	17·7	16·5	14·4	
12×4	31	**†76·8**	*53·0*	*39·7*	*31·8*	26·5	22·7	19·9	17·7	15·9	14·5	13·2	12·2	11·4		
12×3½	28	**68·3**	*45·5*	*34·2*	*27·3*	22·8	19·5	17·1	15·2	13·7	12·4	11·4	10·5	9·7		
10×3½	24	**51·6**	*34·4*	*25·8*	20·7	17·2	14·8	12·9	11·5	10·3	9·3	8·6				
10×3	19	*39·1*	*26·1*	*19·6*	15·6	13·0	11·2	9·7	8·6	7·8	7·1	6·5				
9×3½	22	**43·7**	*29·1*	*21·8*	17·5	14·6	12·5	10·9	9·7	8·7	7·9					
9×3	17·5	*33·7*	*22·4*	*16·8*	13·5	11·2	9·6	8·4	7·4	6·7	6·1					
8×3½	20	**36·2**	*24·1*	18·1	14·5	12·1	10·3	9·0	8·0							
8×3	16	*28·3*	*18·9*	14·1	11·3	9·4	8·0	7·0	6·2							
7×3½	18	**29·1**	*19·4*	14·5	11·6	9·6	8·3									
7×3	14	*22·2*	*14·8*	*11·1*	8·8	7·3	6·3									
6×3½	16	**22·6**	15·0	11·3	9·0	7·5	6·4									
6×3	12	*16·5*	11·0	8·2	6·5	5·4	4·7									
5×2½	10	*11·2*	7·4	5·6	4·4	3·7										
4×2	7	6·0	4·0	3·0	2·4	2·0										
3×1½	4·5	2·8	1·9	1·4	1·1											

Generally, tabular loads are based on a flexural stress of 14·5 tons/inch², assuming adequate lateral support. Beams without adequate lateral support must not exceed the critical span *Lc*, unless the allowable compressive stress is reduced in accordance with clause 19.*a*.(ii) of B.S. 449 : 1959 as amended.

Tabular loads printed in bold face type exceed the load buckling capacity of the unstiffened web without allowance for actual length of bearing; the load bearing capacity should be checked, see page 169.

BASED ON
B.S. 449
1959
AS AMENDED

JOISTS

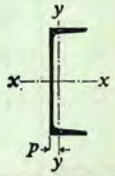


DIMENSIONS AND PROPERTIES

Size D×B inches	Weight per foot in lbs	Critical Span *Lc* feet	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T	Area in square inches
			Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
8×4	17	4·46	55·11	3·91	3·32	·88	13·78	1·95	19·6	5·00
7×4	14·5	4·51	36·57	3·36	2·93	·89	10·45	1·68	19·6	4·26
6×3½	11·5	4·11	21·22	2·07	2·51	·78	7·07	1·18	18·4	3·38
5×3	9	3·77	11·46	1·21	2·08	·68	4·58	·81	16·7	2·64
4×2½	6·5	3·30	5·24	·61	1·66	·57	2·62	·49	15·3	1·91
3×2	4·5	2·75	2·00	·27	1·23	·45	1·33	·27	13·4	1·32

BASED ON
B.S. 449
1959
AS AMENDED

CHANNELS



DIMENSIONS AND PROPERTIES

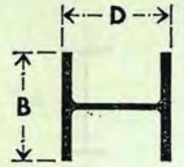
Size D×B inches	Weight per foot in lbs	Dimension *p*	Critical Span *Lc* feet	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T	Area in square inches
				Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
17×4	44	·91	4·50	514·11	15·10	6·30	1·08	60·48	4·89	25·6	12·94
15×4	37	·99	5·03	357·82	13·93	5·73	1·13	47·71	4·63	23·3	10·88
12×4	31	1·05	5·65	197·34	12·00	4·65	1·15	32·89	4·06	20·5	9·12
12×3½	28	·86	4·48	169·64	7·82	4·54	·97	28·27	2·96	22·3	8·23
10×3½	24	·95	5·27	106·86	7·27	3·89	1·01	21·37	2·85	18·7	7·06
10×3	19	·73	3·75	80·88	3·91	3·81	·84	16·18	1·72	23·2	5·59
9×3½	22	1·00	5·63	81·38	6·85	3·55	1·03	18·08	2·74	17·2	6·47
9×3	17·5	·79	4·23	62·70	3·81	3·49	·86	13·93	1·72	20·5	5·15
8×3½	20	1·04	5·93	59·85	6·35	3·19	1·04	14·96	2·58	15·8	5·88
8×3	16	·84	4·66	46·86	3·64	3·16	·88	11·71	1·68	18·2	4·70
7×3½	18	1·09	6·21	42·12	5·79	2·82	1·05	12·03	2·40	14·5	5·29
7×3	14	·87	4·80	32·13	3·22	2·79	·88	9·18	1·51	17·3	4·11
6×3½	16	1·13	6·44	28·01	5·17	2·44	1·05	9·34	2·18	13·2	4·71
6×3	12	·87	4·85	20·46	2·73	2·41	·88	6·82	1·28	16·9	3·53
5×2½	10	·76	4·46	11·59	1·62	1·99	·74	4·64	·93	13·8	2·94
4×2	7	·60	3·55	4·99	·70	1·56	·58	2·50	·50	13·3	2·06
3×1½	4·5	·47	2·85	1·78	·26	1·16	·44	1·19	·25	11·2	1·32

Tabular loads marked thus † are based on the maximum shear value of the web and are less than the permissible flexural load.

Tabular loads printed in italic type are within the web buckling capacity of the unstiffened web and produce a total deflection not exceeding 1/360th of the span.

Tabular loads printed in ordinary type should be checked for deflection, see page 169.

For explanation of tables, see notes commencing pages 162 and 167.



UNIVERSAL COLUMNS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

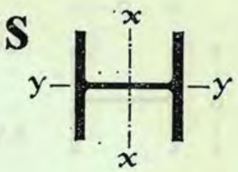
Serial Size in inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		10	12	14	16	20	24	28	32	36	40	44	48	52	56	60
14×16	426	*1579*	*1558*	*1530*	*1494*	*1389*	*1236*	*1052*	*875*	*725*	*604*	*509*	*434*	*373*	*324*	*283*
	370	*1370*	*1351*	*1326*	*1293*	*1198*	*1059*	*895*	*742*	*613*	*510*	*429*	*365*	*314*	*273*	*238*
	314	*1161*	*1144*	*1122*	*1093*	*1008*	*885*	*744*	*613*	*505*	*420*	*353*	*300*	*258*	*224*	*196*
	264	1020	1004	983	955	874	757	628	513	421	349	292	248	213	185	162
	228	881	867	848	823	750	646	535	436	357	296	248	211	181	156	137
	193	744	732	716	694	630	541	445	362	296	245	205	174	149	129	113
	158	609	599	585	566	512	437	358	290	237	196	164	139	119	104	90·6
Column Core	320	*1184*	*1166*	*1143*	*1112*	*1024*	*896*	*752*	*618*	*509*	*423*	*355*	*302*	*259*	*225*	*197*
14×14½	136	522	511	497	478	422	350	282	226	183	151	126	107	91·7	79·4	
	119	456	447	434	418	368	305	245	196	159	131	109	92·6	79·4	68·8	
	103	394	386	375	360	316	261	209	167	136	112	93·3	78·8	67·6		
	87	333	326	316	303	266	219	175	140	113	93·2	78·0	65·9	56·5		
12×12	190	717	695	664	622	510	397	308	242	195	159	133	112			
	161	607	588	560	522	425	329	254	200	161	131	109	92·4			
	133	501	483	460	427	345	266	205	161	129	106	87·9				
	106	398	384	364	337	270	207	159	125	100	81·7	68·1				
	92	345	332	314	291	231	177	136	106	85·2	69·7	57·9				
	79	296	284	268	247	196	149	114	89·5	71·9	58·7	48·7				
	65	243	233	220	202	159	121	92·5	72·4	58·1	47·4	39·4				

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 180. Safe loads printed in ordinary type are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended. Safe loads printed in italics are based on a yield stress of 22 tons/ins.^{2}; yield stress for sections over 2 ins. thick to be agreed with the manufacturer.

BASED ON
B.S. 449
1959
AS AMENDED
1962

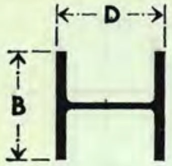
UNIVERSAL COLUMNS

DIMENSIONS AND PROPERTIES



Serial Size in inches	Depth of Section D	Width of Section B	Area of Section in square inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T
				Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	
14×16	18·69	16·695	125·25	2359·5	6610·3	**4·34**	7·26	282·7	707·4	6·2
	17·94	16·475	108·78	1986·0	5454·2	**4·27**	7·08	241·1	608·1	6·7
	17·19	16·235	92·30	1631·4	4399·4	**4·20**	6·90	201·0	511·9	7·5
	16·50	16·025	77·63	1331·2	3526·0	**4·14**	6·74	166·1	427·4	8·5
	16·00	15·865	67·06	1124·8	2942·4	**4·10**	6·62	141·8	367·8	9·5
	15·50	15·710	56·73	930·1	2402·4	**4·05**	6·51	118·4	310·0	10·8
	15·00	15·550	46·47	745·0	1900·6	**4·00**	6·40	95·8	253·4	12·6
Column Core	16·81	16·710	94·12	1635·1	4141·7	**4·17**	6·63	195·7	492·8	8·0
14×14½	14·75	14·740	39·93	567·8	1593·0	**3·77**	6·31	77·0	216·0	13·9
	14·50	14·650	34·99	491·8	1373·1	**3·75**	6·26	67·1	189·4	15·5
	14·25	14·575	30·26	419·7	1165·8	**3·72**	6·21	57·6	163·6	17·5
	14·00	14·500	25·56	349·7	966·9	**3·70**	6·15	48·2	138·1	20·3
12×12	14·38	12·670	55·86	589·7	1892·6	**3·25**	5·82	93·1	263·2	8·3
	13·88	12·515	47·38	486·3	1541·9	**3·20**	5·70	77·7	222·2	9·3
	13·38	12·365	39·11	389·9	1221·3	**3·16**	5·59	63·1	182·5	10·8
	12·88	12·230	31·19	300·9	930·7	**3·11**	5·46	49·2	144·5	13·1
	12·62	12·155	27·06	256·4	788·9	**3·08**	5·40	42·2	125·0	14·7
	12·38	12·080	23·22	216·4	663·1	**3·05**	5·34	35·8	107·1	16·8
	12·12	12·000	19·11	174·6	533·4	**3·02**	5·28	29·1	88·0	20·0

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

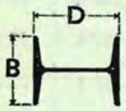


UNIVERSAL COLUMNS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Serial Size in inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		4	6	8	10	12	14	16	18	20	22	24	26	28	32	36
10×10	112	441	435	424	408	384	351	310	267	229	196	168	146	127	99·0	78·9
	89	351	345	337	324	304	276	243	208	178	152	130	113	98·3	76·5	60·9
	72	283	279	272	261	244	220	193	165	140	120	103	88·7	77·2	60·0	47·8
	60	236	233	227	217	202	183	159	136	115	98·3	84·3	72·9	63·5	49·3	39·3
	49	193	189	184	176	164	147	128	109	92·4	78·6	67·3	58·2	50·6	39·4	31·4
8×8	58	227	221	211	194	169	141	115	94·8	78·6	66·0	56·0	48·2	41·8		
	48	188	183	174	159	138	115	94·0	77·1	64·0	53·7	45·5	39·1	33·9		
	40	156	152	144	131	113	93·2	75·9	62·1	51·4	43·1	36·6	31·4	27·2		
	35	137	133	126	115	98·5	81·1	66·0	53·9	44·6	37·4	31·8	27·2	23·6		
	31	121	118	111	101	86·2	70·8	57·5	47·0	38·8	32·5	27·6	23·7	20·5		
6×6	25	96·0	89·9	78·1	61·7	47·0	36·0	28·2	22·6	18·5	15·3					
	20	77·3	72·3	62·4	48·9	37·1	28·3	22·2	17·8	14·5	12·1					
	15·7	60·1	55·7	47·2	36·4	27·3	20·8	16·2	13·0	10·6						



JOIST STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

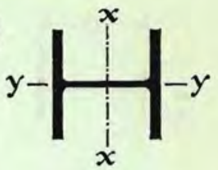
SAFE LOADS FOR HIGH YIELD STEEL

Size D×B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		3	4	5	6	7	8	9	10	11	12	13				
8×4	17	63·2	58·1	49·7	40·0	31·6	25·1	20·2	16·6	13·8	11·7	10·0				
7×4	14·5	54·0	49·7	42·8	34·6	27·4	21·8	17·6	14·5	12·1	10·2	8·7				
6×3½	11·5	41·6	36·6	29·4	22·5	17·3	13·6	10·9	8·9	7·4						
5×3	9	31·1	25·4	18·9	13·9	10·6	8·2	6·5	5·3							
4×2½	6·5	20·3	14·7	10·2	7·3	5·4	4·2									
3×2	4·5	10·9	6·8	4·5	3·2											

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 180. Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959
AS AMENDED
1962

UNIVERSAL COLUMNS

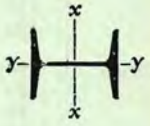


DIMENSIONS AND PROPERTIES

Serial Size in inches	Depth of Section D	Width of Section B	Area of Section square ins	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T
				Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	
10×10	11·38	10·415	32·92	235·4	718·7	**2·67**	4·67	45·2	126·3	9·1
	10·88	10·275	26·19	180·6	542·4	**2·63**	4·55	35·2	99·7	10·9
	10·50	10·170	21·18	141·8	420·7	**2·59**	4·46	27·9	80·1	13·0
	10·25	10·075	17·66	116·5	343·7	**2·57**	4·41	23·1	67·1	15·0
	10·00	10·000	14·40	93·0	272·9	**2·54**	4·35	18·6	54·6	17·9
8×8	8·75	8·222	17·06	74·9	227·3	**2·10**	3·65	18·2	52·0	10·8
	8·50	8·117	14·11	60·9	183·7	**2·08**	3·61	15·0	43·2	12·4
	8·25	8·077	11·76	49·0	146·3	**2·04**	3·53	12·1	35·5	14·8
	8·12	8·027	10·30	42·5	126·5	**2·03**	3·50	10·6	31·1	16·5
	8·00	8·000	9·12	37·0	109·7	**2·01**	3·47	9·24	27·4	18·5
6×6	6·37	6·080	7·35	17·0	53·3	**1·52**	2·69	5·60	16·7	14·0
	6·20	6·018	5·93	13·4	41·9	**1·50**	2·66	4·46	13·5	16·8
	6·00	6·000	4·62	9·69	30·3	**1·45**	2·56	3·23	10·1	22·3

BASED ON
B.S. 449
1959
AS AMENDED
1962

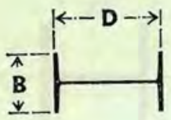
JOIST STANCHIONS



DIMENSIONS AND PROPERTIES

Size D × B inches	Weight per foot in lbs	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T	Area in square ins
		Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x		
8×4	17	3·91	55·1	**·88**	3·32	1·95	13·8	19·6	5·00
7×4	14·5	3·36	36·6	**·89**	2·93	1·68	10·4	19·6	4·26
6×3½	11·5	2·07	21·2	**·78**	2·51	1·18	7·07	18·4	3·38
5×3	9	1·21	11·5	**·68**	2·08	·81	4·58	16·7	2·64
4×2½	6·5	·61	5·24	**·57**	1·66	·49	2·62	15·3	1·91
3×2	4·5	·27	2·00	**·45**	1·23	·27	1·33	13·4	1·32

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



UNIVERSAL BEAMS AS STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

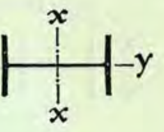
SAFE LOADS FOR HIGH YIELD STEEL

Serial Size in inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		10	12	14	16	18	20	22	24	28	32	36	40	44	48	54
36 × 16½	260				904	851	787	716	643	512	409	331	272	228	193	153
	230				794	745	686	622	557	441	352	284	233	195	165	
36 × 12	194		644	574	495	419	355	301	258	194	150	119				
	170		558	494	424	358	302	256	219	164	127	101				
	150	530	484	424	360	302	254	215	183	137	106					
	135	469	423	365	306	255	213	180	153	115	88·8					
33 × 11½	152	537	491	431	367	308	259	219	187	140	109					
	130	452	408	352	295	246	206	174	148	111	85·6					
	118	405	361	308	256	212	177	149	126	94·6	72·9					
30 × 10½	132	449	398	337	278	230	192	161	137	102	79·0					
	116	389	341	285	235	193	160	134	114	85·2						
	99	324	278	229	186	152	126	106	89·8	66·8						
27 × 10	114	381	333	278	229	188	156	131	111	82·9						
	102	339	294	244	200	164	136	114	96·8	72·1						
	94	309	266	219	179	146	121	101	86·1	64·0						
	84	270	228	186	151	123	101	84·7	72·0	53·5						
24 × 12	160		558	515	460	402	346	298	257	194	151	121	98·5			
	120		413	377	334	288	247	211	182	137	107	85·2	69·4			
	100		341	310	273	234	200	170	147	110	85·9	68·4				
24 × 9	94	296	248	200	161	131	108	90·4	76·5	56·9						
	84	262	217	175	140	114	93·9	78·4	66·4	49·3						
	76	233	192	153	122	99·3	81·6	68·3	57·7							
	68	202	164	130	103	83·5	68·5	57·2	48·5							
21 × 13	142		511	482	444	399	351	306	267	205	160	129	105	87·2		
	127		456	429	394	353	310	270	235	180	141	113	92·2	76·7		
	112		400	375	343	305	267	232	201	154	120	96·3	78·6	65·4		
21 × 8¼	82	244	197	156	125	101	82·7	69·0	58·4							
	73	213	172	135	108	86·8	71·3	59·4	50·2							
	68	197	158	124	98·3	79·3	65·1	54·3	45·9							
	62	176	140	110	86·7	69·9	57·4	47·7	40·4							
	55	150	118	91·5	72·2	58·0	47·6	39·6	33·5							
18 × 7½	66	182	142	111	87·6	70·3	57·8	48·1	40·5							
	60	162	126	97·6	77·0	61·8	50·6	42·2	35·6							
	55	146	113	87·7	69·0	55·4	45·4	37·7	31·9							
	50	131	101	78·0	61·3	49·2	40·3	33·5								
	45	114	87·2	67·1	52·6	42·1	34·5	28·7								

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 180. Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959
AS AMENDED

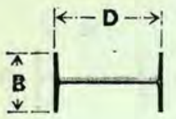
UNIVERSAL BEAMS AS STANCHIONS



DIMENSIONS AND PROPERTIES

Serial Size in inches	Depth of Section D	Width of Section B	Area in square inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T
				Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	
36 × 16½	36·24	16·555	76·56	1021	17234	**3·65**	15·00	123·3	951·1	25·2
	35·88	16·475	67·73	870·9	14988	**3·59**	14·88	105·7	835·5	28·5
36 × 12	36·48	12·117	57·11	355·4	12103	**2·49**	14·56	58·7	663·6	29·0
	36·16	12·027	49·98	300·6	10470	**2·45**	14·47	50·0	579·1	32·9
	35·84	11·972	44·16	250·4	9012·1	**2·38**	14·29	41·8	502·9	38·1
	35·55	11·944	39·69	207·4	7801·3	**2·29**	14·02	34·7	438·9	44·7
33 × 11½	33·50	11·565	44·71	256·1	8147·6	**2·39**	13·50	44·3	486·4	31·8
	33·10	11·510	38·26	201·4	6699·0	**2·29**	13·23	35·0	404·8	38·7
	32·87	11·482	34·69	170·8	5896·0	**2·22**	13·04	29·8	358·7	44·4
30 × 10½	30·30	10·551	38·83	185·0	5753·1	**2·18**	12·17	35·1	379·7	30·3
	30·00	10·500	34·13	153·2	4919·1	**2·12**	12·00	29·2	327·9	35·3
	29·68	10·444	29·11	120·2	4049·1	**2·03**	11·79	23·0	272·8	43·0
27 × 10	27·28	10·070	33·53	149·6	4080·5	**2·11**	11·03	29·7	299·2	29·3
	27·07	10·018	30·01	129·5	3604·1	**2·08**	10·96	25·9	266·3	32·7
	26·91	9·990	27·65	115·1	3266·8	**2·04**	10·87	23·0	242·8	36·0
	26·69	9·962	24·71	95·9	2827·7	**1·97**	10·70	19·3	211·9	41·9
24 × 12	24·92	12·264	47·05	359·7	4979·2	**2·77**	10·29	58·7	399·6	20·2
	24·31	12·088	35·29	254·0	3635·3	**2·68**	10·15	42·0	299·1	26·1
	24·00	12·000	29·43	203·6	2987·3	**2·63**	10·08	33·9	248·9	31·0
24 × 9	24·29	9·061	27·63	102·2	2683·0	**1·92**	9·85	22·6	220·9	27·9
	24·09	9·015	24·71	88·3	2364·3	**1·89**	9·78	19·6	196·3	31·2
	23·91	8·985	22·37	76·5	2096·4	**1·85**	9·68	17·0	175·4	35·1
	23·71	8·961	20·00	63·9	1815·1	**1·79**	9·53	14·3	153·1	40·7
21 × 13	21·46	13·132	41·78	386·0	3403·9	**3·04**	9·03	58·8	317·2	19·6
	21·24	13·061	37·38	338·6	3018·0	**3·01**	8·99	51·8	284·2	21·6
	21·00	13·000	32·97	289·7	2621·4	**2·96**	8·92	44·6	249·7	24·3
21 × 8¼	21·44	8·342	24·12	77·1	1827·8	**1·79**	8·70	18·5	170·5	25·5
	21·24	8·295	21·46	66·2	1600·3	**1·76**	8·64	16·0	150·7	28·7
	21·13	8·270	20·02	60·4	1478·3	**1·74**	8·59	14·6	139·9	30·8
	20·99	8·240	18·23	53·1	1326·8	**1·71**	8·53	12·9	126·4	34·1
	20·80	8·216	16·17	43·9	1137·9	**1·65**	8·39	10·7	109·4	40·0
18 × 7½	18·40	7·592	19·40	53·2	1096·8	**1·66**	7·52	14·0	119·2	23·9
	18·25	7·558	17·64	47·1	984·0	**1·63**	7·47	12·5	107·8	26·3
	18·12	7·532	16·19	42·0	889·9	**1·61**	7·41	11·1	98·2	28·8
	18·00	7·500	14·71	37·2	800·6	**1·59**	7·38	9·91	89·0	31·6
	17·86	7·476	13·23	31·9	704·8	**1·55**	7·30	8·54	78·9	35·7

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



UNIVERSAL BEAMS AS STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

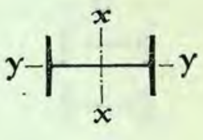
SAFE LOADS FOR HIGH YIELD STEEL

Serial Size in inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		5	6	7	8	9	10	11	12	13	14	15	16	18	20	22
18×6	55		184	166	144	122	104	88·3	75·6	65·4	56·9	50·0	44·2	35·2		
	50		166	148	128	109	91·9	78·1	66·9	57·7	50·2	44·1	38·9	31·0		
	45		148	131	113	95·3	80·4	68·2	58·4	50·3	43·8	38·4	33·9	27·1		
16×7	50			171	158	142	126	110	95·9	83·8	73·7	65·1	57·8	46·3	37·8	31·5
	45			153	141	126	111	97·1	84·6	73·8	64·8	57·2	50·8	40·7	33·3	27·6
	40			135	124	111	97·1	84·5	73·6	64·1	56·3	49·7	44·0	35·3	28·8	24·0
	36			119	108	95·8	83·4	72·2	62·5	54·4	47·7	42·0	37·2	29·8	24·3	
16×6	50		170	154	135	116	99·2	84·6	72·7	62·8	54·8	48·1	42·6	34·0		
	45		151	136	119	101	86·0	73·1	62·7	54·2	47·2	41·5	36·6	29·2		
	40		133	119	102	86·9	73·5	62·4	53·5	46·1	40·1	35·3	31·1	24·8		
16×5½	31	108	97·6	84·4	70·9	59·1	49·4	41·7	35·5	30·6	26·6	23·3	20·5			
	26	88·0	77·6	65·5	54·0	44·5	37·1	31·1	26·5	22·8	19·7	17·3	15·2			
15×6	45		153	139	122	105	89·3	76·2	65·5	56·6	49·4	43·3	38·4	30·6		
	40		135	122	107	91·1	77·4	66·0	56·6	48·9	42·6	37·4	33·1	26·4		
	35		117	105	90·5	76·9	65·2	55·4	47·4	41·0	35·6	31·3	27·7	22·0		
14×6¾	45			153	141	126	111	97·0	84·5	73·8	64·8	57·2	50·7	40·7	33·2	27·6
	38			128	117	104	91·3	79·4	69·0	60·2	52·7	46·5	41·3	33·1	27·0	22·4
	34			113	103	91·1	79·5	68·9	59·7	52·0	45·6	40·1	35·5	28·4	23·2	
	30		105	97·5	87·7	77·0	66·6	57·4	49·6	43·1	37·6	33·1	29·4	23·5	19·1	
14×5	26	85·3	73·4	60·5	49·3	40·3	33·4	28·0	23·8	20·4	17·7	15·5				
	22	70·3	59·5	48·4	39·1	31·9	26·3	22·0	18·6	16·0	13·9					
12×6½	36			121	111	99·5	87·4	76·0	66·2	57·7	50·6	44·7	39·6	31·8	25·9	21·6
	31			103	94·4	83·8	73·2	63·5	55·1	48·0	42·0	37·1	32·8	26·3	21·5	17·9
	27		95·9	89·4	80·9	71·5	62·1	53·7	46·5	40·4	35·4	31·2	27·6	22·1	18·0	
12×5	32	107	94·0	78·7	64·7	53·2	44·1	37·1	31·5	27·1	23·5	20·6				
	28	92·4	79·9	66·1	54·0	44·2	36·7	30·7	26·1	22·4	19·4	17·0				
	25	82·0	70·6	58·2	47·5	38·8	32·2	26·9	22·9	19·6	17·0	14·9				
12×4	22	61·4	48·4	37·7	29·8	24·0	19·7	16·4	13·9							
	19	51·1	39·8	30·8	24·2	19·5	15·9	13·3	11·2							
	16·5	40·8	31·1	23·8	18·6	14·9	12·2	10·1								
10×5¾	29		99·8	91·2	80·6	69·7	59·7	51·0	43·9	38·1	33·2	29·1	25·8	20·6	16·8	
	25		85·1	77·2	67·7	58·2	49·6	42·3	36·4	31·4	27·4	24·1	21·3	17·0		
	21		69·9	62·4	53·9	45·7	38·7	32·8	28·1	24·3	21·1	18·6	16·4	13·0		
10×4	19	54·5	43·4	34·1	27·0	21·7	17·8	14·9	12·6							
	17	46·6	36·6	28·4	22·5	18·0	14·8	12·3	10·4							
	15	39·5	30·5	23·6	18·6	14·9	12·2	10·2	8·5							
8×5¼	20	70·7	64·8	57·0	48·5	40·8	34·3	29·0	24·8	21·3	18·6	16·3	14·4	11·5		
	17	59·4	53·9	46·7	39·4	32·8	27·5	23·2	19·8	17·1	14·8	13·0	11·5			

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 180. Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959
AS AMENDED

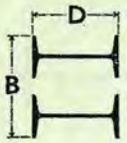
UNIVERSAL BEAMS AS STANCHIONS



DIMENSIONS AND PROPERTIES

Serial Size in inches	Depth of Section D	Width of Section B	Area in square inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T
				Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	
18×6	18·31	6·042	16·18	26·3	868·7	1·27	7·33	8·70	94·9	24·6
	18·16	6·011	14·71	23·1	777·9	1·25	7·27	7·69	85·7	27·1
	18·00	5·982	13·22	19·9	685·2	1·23	7·20	6·66	76·1	30·6
16×7	16·25	7·073	14·70	34·8	655·4	1·54	6·68	9·84	80·7	25·9
	16·12	7·039	13·24	30·5	583·3	1·52	6·64	8·66	72·4	28·6
	16·00	7·000	11·77	26·5	515·5	1·50	6·62	7·58	64·4	31·8
	15·85	6·992	10·59	22·1	446·3	1·45	6·49	6·34	56·3	37·0
16×6	16·39	6·052	14·70	25·1	647·2	1·31	6·64	8·31	79·0	23·1
	16·23	6·021	13·23	21·8	571·8	1·28	6·57	7·25	70·5	25·7
	16·06	5·993	11·76	18·5	495·4	1·25	6·49	6·16	61·7	29·4
16×5½	15·84	5·605	9·12	12·0	374·9	1·15	6·41	4·29	47·3	36·0
	15·64	5·582	7·64	8·96	298·1	1·08	6·25	3·21	38·1	46·0
15×6	15·30	6·075	13·24	22·7	511·2	1·31	6·21	7·49	66·8	23·9
	15·15	6·038	11·77	19·6	447·6	1·29	6·17	6·48	59·1	26·8
	15·00	6·000	10·29	16·5	385·5	1·26	6·12	5·49	51·4	30·6
14×6¾	14·33	6·820	13·23	30·7	468·1	1·52	5·95	9·01	65·3	23·2
	14·12	6·776	11·17	24·6	385·3	1·49	5·87	7·28	54·6	27·5
	14·00	6·750	10·00	21·3	339·2	1·46	5·83	6·30	48·5	30·9
	13·86	6·733	8·81	17·5	289·6	1·41	5·73	5·21	41·8	36·2
14×5	13·89	4·960	7·64	8·00	241·6	1·02	5·62	3·23	34·8	33·1
	13·72	4·936	6·47	6·17	196·2	·98	5·51	2·50	28·6	41·0
12×6½	12·24	6·565	10·59	23·7	280·8	1·50	5·15	7·23	45·9	22·7
	12·09	6·525	9·12	19·8	238·4	1·47	5·11	6·07	39·4	26·0
	11·96	6·500	7·97	16·6	204·2	1·44	5·06	5·11	34·1	29·9
12×5	12·22	4·930	9·42	10·5	227·9	1·06	4·92	4·27	37·3	22·2
	12·07	4·893	8·23	8·81	195·2	1·03	4·87	3·60	32·3	25·4
	11·96	4·864	7·35	7·59	171·6	1·02	4·83	3·12	28·7	28·4
12×4	12·31	4·030	6·47	4·55	155·7	·84	4·91	2·26	25·3	29·0
	12·16	4·010	5·62	3·67	130·1	·81	4·81	1·83	21·4	34·8
	12·00	4·000	4·86	2·79	105·3	·76	4·65	1·39	17·5	44·6
10×5¾	10·22	5·799	8·53	15·2	157·3	1·34	4·29	5·25	30·8	20·4
	10·08	5·762	7·35	12·7	133·2	1·31	4·26	4·40	26·4	23·4
	9·90	5·750	6·19	9·74	106·3	1·25	4·14	3·39	21·5	29·1
10×4	10·25	4·020	5·61	4·19	96·2	·86	4·14	2·08	18·8	26·0
	10·12	4·010	4·98	3·45	81·8	·83	4·05	1·72	16·2	30·8
	10·00	4·000	4·40	2·79	68·8	·80	3·95	1·39	13·8	37·2
8×5¼	8·14	5·268	5·88	8·50	69·2	1·20	3·43	3·23	17·0	21·5
	8·00	5·250	5·00	6·72	56·4	1·16	3·36	2·56	14·1	26·0

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

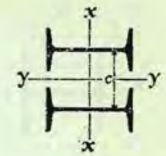
SAFE LOADS FOR HIGH YIELD STEEL

Size D×B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET													
		16	**18**	**20**	**22**	**24**	**26**	**28**	**32**	**36**	**40**	**45**	**50**	**55**	**60**
$21\frac{7}{16} \times 25\frac{5}{16}$	164										557	519	474	426	379
$21\frac{1}{4} \times 25\frac{5}{16}$	146										494	460	419	376	334
$21\frac{1}{8} \times 25\frac{1}{4}$	136									481	460	427	389	348	309
$21 \times 25\frac{1}{4}$	124									437	417	387	352	315	279
$18\frac{3}{8} \times 22\frac{1}{16}$	132								462	436	406	362	317	275	239
$18\frac{1}{4} \times 22\frac{1}{16}$	120								419	396	368	328	287	250	217
$18\frac{1}{8} \times 22\frac{1}{16}$	110								385	363	337	300	263	228	198
18×22	100								349	329	306	272	237	206	179
$18\frac{5}{16} \times 20\frac{9}{16}$	110								383	361	334	296	259	224	195
$18\frac{3}{16} \times 20\frac{1}{2}$	100								347	326	301	267	232	201	174
$18 \times 20\frac{1}{2}$	90								310	291	269	237	206	178	154
$16\frac{1}{4} \times 20\frac{1}{16}$	100							353	332	307	277	239	205	175	151
$16\frac{1}{8} \times 20\frac{1}{16}$	90							317	298	275	248	214	183	156	134
16×20	80							282	265	244	220	189	162	138	119
$15\frac{7}{8} \times 20$	72							252	236	215	193	165	141	120	103
$16\frac{3}{8} \times 19\frac{1}{16}$	100							352	331	305	275	237	202	173	149
$16\frac{1}{4} \times 19$	90							316	296	272	245	210	179	153	132
$16\frac{1}{16} \times 19$	80							279	262	239	214	184	156	133	114
$15\frac{5}{16} \times 18\frac{1}{16}$	90						317	307	284	255	225	190	161	136	117
$15\frac{1}{8} \times 18\frac{1}{16}$	80						282	273	252	227	200	169	143	121	104
15×18	70						246	238	220	198	174	147	124	105	90·0
$14\frac{5}{16} \times 18\frac{5}{16}$	90						313	302	277	246	216	181	152	129	110
$14\frac{1}{8} \times 18\frac{1}{4}$	76						263	253	231	205	179	150	126	106	90·5
$14 \times 18\frac{1}{4}$	68						234	226	205	182	159	133	111	93·7	80·0
$13\frac{7}{8} \times 18\frac{1}{4}$	60					212	205	197	178	157	136	114	94·9	80·1	68·2
$12\frac{1}{4} \times 16\frac{9}{16}$	72				253	243	232	219	191	163	139	114	94·3	79·0	67·1
$12\frac{1}{16} \times 16\frac{1}{2}$	62				217	208	199	188	163	139	118	96·7	80·1	67·1	57·0
$11\frac{15}{16} \times 16\frac{1}{2}$	54				189	181	172	162	141	120	102	83·1	68·7	57·5	48·9
$12\frac{1}{4} \times 14\frac{7}{16}$	64				219	210	198	185	158	134	113	91·7	75·7	63·4	53·6
$12\frac{1}{16} \times 14\frac{3}{8}$	56				192	183	173	161	138	116	98·0	79·8	65·9	55·1	46·7
$11\frac{15}{16} \times 14\frac{3}{8}$	50				171	163	154	143	122	103	86·6	70·5	58·2	48·6	41·3
$10\frac{1}{4} \times 13\frac{13}{16}$	58		204	194	183	169	156	142	116	95·6	79·3	63·8	52·4	43·6	36·9
$10\frac{1}{16} \times 13\frac{3}{4}$	50		175	167	157	146	134	122	99·9	82·0	68·0	54·8	45·0	37·4	31·6
$9\frac{7}{8} \times 13\frac{3}{4}$	42		147	139	131	121	110	100	81·8	67·1	55·6	44·7	36·7	30·5	25·8
$8\frac{1}{8} \times 11\frac{3}{4}$	40	135	125	114	102	90·6	80·3	71·1	56·3	45·3	37·2	29·7	24·2		
$8 \times 11\frac{3}{4}$	34	113	105	94·9	84·5	74·8	66·0	58·3	46·1	37·1	30·5	24·3	19·8		

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 180. Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959
AS AMENDED
1962

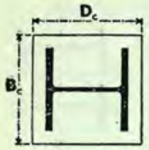
COMPOUND STANCHIONS



COMPOSITION AND PROPERTIES

Composed of Two Universal Beams Latticed	Area in square inches	Centres of Beam Webs *c* inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T
			Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	
21 × 8¼ @ 82	48·24	17·0	3655·6	3639·5	8·70	**8·69**	341·0	287·2	25·5
73	42·92	17·0	3200·6	3233·4	**8·64**	8·68	301·4	255·7	28·7
68	40·04	17·0	2956·6	3013·7	**8·59**	8·68	279·8	238·5	30·8
62	36·46	17·0	2653·6	2740·4	**8·53**	8·67	252·8	217·2	34·1
18 × 7½ @ 66	38·80	14·5	2193·6	2145·8	7·52	**7·44**	238·4	194·3	23·9
60	35·28	14·5	1958·0	1943·6	7·47	**7·43**	215·6	176·7	26·3
55	32·38	14·5	1779·8	1786·0	**7·41**	7·43	195·4	162·1	28·8
50	29·42	14·5	1601·2	1620·8	**7·38**	7·42	178·0	147·3	31·6
18 × 6 @ 55	32·36	14·5	1737·4	1753·5	**7·33**	7·36	139·8	170·7	24·6
50	29·42	14·5	1555·8	1592·6	**7·27**	7·36	171·4	155·3	27·1
45	26·44	14·5	1370·4	1429·6	**7·20**	7·35	152·3	139·6	30·6
16 × 7 @ 50	29·40	13·0	1310·8	1311·8	**6·68**	6·68	161·4	130·7	25·9
45	26·48	13·0	1166·6	1179·8	**6·64**	6·67	144·8	117·7	28·6
40	23·54	13·0	1031·0	1047·6	**6·62**	6·67	123·8	104·8	31·8
36	21·18	13·0	892·6	939·1	**6·49**	6·66	112·6	93·9	37·0
16 × 6 @ 59	29·40	13·0	1294·4	1292·4	6·64	**6·63**	157·9	135·7	23·1
45	26·46	13·0	1143·6	1161·5	**6·57**	6·63	140·9	122·1	25·7
40	23·52	13·0	990·8	1030·7	**6·49**	6·62	123·4	108·5	29·4
15 × 6 @ 45	26·48	12·0	1022·4	998·7	6·21	**6·14**	133·6	110·5	23·9
40	23·54	12·0	895·2	886·6	6·17	**6·14**	118·2	98·3	26·8
35	20·58	12·0	771·0	773·9	**6·12**	6·13	102·8	86·0	30·6
14 × 6¾ @ 45	26·46	11·5	936·2	936·2	5·95	**5·95**	130·6	102·2	23·2
38	22·34	11·5	770·6	787·8	**5·87**	5·94	109·2	86·2	27·5
34	20·00	11·5	678·4	703·9	**5·83**	5·93	97·0	77·1	30·9
30	17·62	11·5	579·2	617·6	**5·73**	5·92	83·6	67·7	36·2
12 × 6½ @ 36	21·18	10·0	561·6	576·9	**5·15**	5·22	91·8	69·7	22·7
31	18·24	10·0	476·8	495·6	**5·11**	5·21	78·8	60·0	26·0
27	15·94	10·0	408·4	431·7	**5·06**	5·20	68·2	52·3	29·9
12 × 5 @ 32	18·84	9·5	455·8	446·1	4·92	**4·87**	74·6	61·8	22·2
28	16·46	9·5	390·4	389·0	4·87	**4·86**	64·7	54·1	25·4
25	14·70	9·5	343·2	346·8	**4·83**	4·86	57·4	48·3	28·4
10 × 5¾ @ 29	17·06	8·0	314·6	303·4	4·29	**4·22**	61·6	44·0	20·4
25	14·70	8·0	266·4	260·6	4·26	**4·21**	52·8	37·9	23·4
21	12·38	8·0	212·6	217·6	**4·14**	4·19	43·0	31·6	29·1
8 × 5¼ @ 20	11·76	6·5	138·4	141·2	**3·43**	3·47	34·0	24·0	21·5
17	10·00	6·5	112·8	119·1	**3·36**	3·45	28·2	20·7	26·0

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



UNIVERSAL COLUMNS CASED

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Minimum Size Dc × Bc inches	Core Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET													
		8	12	16	20	24	28	32	36	40	44	48	52	56	64
22¾×20¾	426	**1734**	**1694**	**1623**	**1510**	**1343**	**1144**	**950**	**788**	**656**	**553**	**471**	**405**	**352**	**272**
22 ×20½	370	**1517**	**1480**	**1416**	**1312**	**1160**	**981**	**812**	**671**	**559**	**470**	**400**	**344**	**299**	**230**
21¼×20¼	314	**1300**	**1267**	**1210**	**1116**	**980**	**824**	**679**	**559**	**465**	**391**	**332**	**286**	**248**	
20½×20¼	264	1159	1128	1073	981	850	705	576	472	392	328	278	240	208	
20 ×20	228	1013	986	936	853	736	608	496	406	337	282	239	205	178	
19½×19¾	193	871	847	802	729	625	514	418	342	283	237	201	172	150	
19 ×19¾	158	731	710	672	607	518	424	344	281	233	194	165	142	123	
21 ×20¾	320	**1325**	**1290**	**1231**	**1133**	**992**	**832**	**684**	**563**	**468**	**393**	**334**	**287**	**250**	
18¾×18¾	136	636	615	575	508	421	339	272	221	182	152	129	110	95·4	
18½×18¾	119	569	549	513	452	374	300	241	195	161	134	114	97·4	84·5	
18¼×18¾	103	505	487	454	399	329	263	210	171	141	118				
18 ×18½	87	439	424	394	346	284	227	182	147	121	101				
18½×16¾	190	828	788	711	591	465	362	286	230	189	157	132			
18 ×16¾	161	713	678	610	505	395	307	242	195	160	133	112			
17½×16½	133	601	570	511	421	328	255	201	161	132	110	93·1			
17 ×16¼	106	493	467	418	343	267	207	163	131	107	89·2	75·3			
16¾×16¼	92	437	414	369	302	235	182	143	115	94·0	78·2	66·1			
16½×16¼	79	385	365	325	265	206	159	125	101	82·5					
16¼×16	65	329	311	276	225	174	134	106	85·0						
15½×14½	112	495	458	387	297	222	169	132	106	86·1					
15 ×14½	89	405	374	315	241	180	137	107	85·4	69·7					
14½×14¼	72	336	310	259	197	147	111	87·0	69·5	56·7					
14¼×14¼	60	290	267	222	169	126	95·4	74·4	59·4						
14 ×14	49	245	225	187	141	105	79·8	62·1							
12¾×12¼	53	263	230	174	124	89·8	67·4	52·2	41·5						
12½×12¼	48	224	195	147	104	75·4	56·6	43·9							
12¼×12¼	40	193	169	127	89·9	65·1	48·8								
12¼×12¼	35	175	152	114	80·7	58·4	43·8	34·0	27·0						
12 ×12	31	158	137	103	72·5	52·5	39·3	30·5	24·2						
10½×10¼	25	120	93·4	*56·4*	*36·9*	*25·9*	*19·1*								
10¼×10¼	20	102	*74·1*	*44·4*	*29·1*	*20·4*	*15·1*								
10 ×10	15·7	84·3	*54·5*	*32·4*	*21·2*	*14·9*	*11·0*								

The above safe loads are calculated for effective slenderness ratios not exceeding 180 for the cased section and the term "effective length" at the head of the table is applicable only to the cased section.

The maximum permissible length of the uncased section should be checked in accordance with clause 30.*b*, B.S. 449 : 1959, as amended.

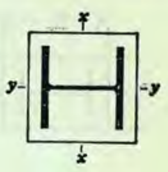
Tabular loads printed in italics are based on loads restricted to 100% in excess of those permitted on the uncased section.

Tabular loads printed in ordinary type are based on stresses given in Table 17 of B.S. 449 : 1959, as amended.

Tabular loads printed in prominent type are based on a yield stress of 22 tons/inch^2; yield stress for sections over 2 inches thick to be agreed with the manufacturer.

BASED ON
B.S. 449
1959
AS AMENDED
1962

UNIVERSAL COLUMNS CASED



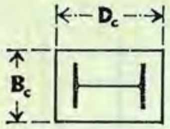
DIMENSIONS AND PROPERTIES

Core Composed of One Universal Column	Core Area in square inches	Cased Section Area in square inches	Radius of Gyration			Elastic Modulus	
			Axis *y-y*		Axis *x-x* Core only	Axis *y-y*	Axis *x-x*
			Cased Section	Core Only			
14×16 @ 426	125·25	472·06	4·34	4·34	7·26	282·7	707·4
370	108·78	451·00	4·27	4·27	7·08	241·1	608·1
314	92·30	430·31	4·20	4·20	6·90	201·0	511·9
264	77·63	415·13	4·14	4·14	6·74	166·1	427·4
228	67·06	400·00	4·10	4·10	6·62	141·8	367·8
193	56·73	385·13	4·05	4·05	6·51	118·4	310·0
158	46·47	375·25	4·00	4·00	6·40	95·8	253·4
Column Core @ 320	94·12	435·75	4·17	4·17	6·63	195·7	492·8
14×14½ @ 136	39·98	351·56	3·77	3·77	6·31	77·0	216·0
119	34·99	346·88	3·75	3·75	6·26	67·1	189·4
103	30·26	342·19	3·72	3·72	6·21	57·6	163·6
87	25·56	333·00	3·70	3·70	6·15	48·2	138·1
12×12 @ 190	55·86	309·88	3·33	3·25	5·82	93·1	263·2
161	47·38	301·50	3·30	3·20	5·70	77·7	222·2
133	39·11	288·75	3·27	3·16	5·59	63·1	182·5
106	31·19	276·25	3·25	3·11	5·46	49·2	144·5
92	27·06	272·19	3·23	3·08	5·40	42·2	125·0
79	23·22	268·13	3·22	3·05	5·34	35·8	107·1
65	19·11	260·00	3·20	3·02	5·28	29·1	88·0
10×10 @ 112	32·92	224·75	2·88	2·67	4·67	45·2	126·3
89	26·19	217·50	2·86	2·63	4·55	35·2	99·7
72	21·18	206·63	2·83	2·59	4·46	27·9	80·1
60	17·66	203·06	2·82	2·57	4·41	23·1	67·1
49	14·40	196·00	2·80	2·54	4·35	18·6	54·6
8×8 @ 58	17·06	156·19	2·44	2·10	3·65	18·2	52·0
48	14·11	153·13	2·42	2·08	3·61	15·0	43·2
40	11·76	150·06	2·42	2·04	3·53	12·1	35·5
35	10·30	150·06	2·41	2·03	3·50	10·6	31·1
31	9·12	144·00	2·40	2·01	3·47	9·24	27·4
6×6 @ 25	7·35	107·63	2·02	1·52	2·69	5·60	16·7
20	5·93	105·06	2·00	1·50	2·66	4·46	13·5
15·7	4·62	100·00	2·00	1·45	2·56	3·23	10·1

The weights per foot are for the main steel shaft only. Weights of bases and connections are to be added and suitable allowances made where necessary for binding wire and casing.

The stanchions must be constructed to comply with the requirements of Clause 30.*b* of B.S. 449 : 1959, as amended 1962.

For explanation of tables, see notes commencing pages 162 and 181.



UNIVERSAL BEAMS AS CASED STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Minimum Size D_c × B_c inches	Core Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET													
		8	10	12	14	16	18	20	24	28	32	36	40	44	48
34½ × 14¾	132	657	638	610	570	518	459	*383*	*274*	*204*	*158*	*126*	*102*		
34 × 14½	116	591	574	548	512	465	*386*	*320*	*229*	*170*	*132*	*105*	*85·0*		
33¾ × 14½	99	525	509	486	453	*373*	*305*	*252*	*180*	*134*	*103*	*81·6*	*66·7*		
31½ × 14¼	114	568	550	523	484	435	*376*	*312*	*222*	*166*	*128*	*102*	*82·8*		
31¼ × 14¼	102	522	505	479	444	398	*328*	*272*	*194*	*144*	*111*	*88·4*	*72·2*		
31 × 14	94	488	472	448	415	*357*	*292*	*242*	*172*	*128*	*98·7*	*78·2*	*64·0*		
30¾ × 14	84	448	434	412	*372*	*301*	*246*	*203*	*144*	*107*	*82·6*	*65·6*	*53·0*		
29 × 16½	160	762	746	723	690	646	591	530	413	320	252	202	166	138	116
28½ × 16¼	120	602	589	571	544	508	464	415	322	249	196	157	129	107	90·6
28 × 16	100	521	509	493	469	438	399	356	276	213	168	135	110	91·8	77·5
28½ × 13¼	94	467	448	419	380	*322*	*262*	*216*	*153*	*114*	*87·9*	*69·6*			
28¼ × 13¼	84	428	410	384	348	*281*	*228*	*188*	*133*	*98·6*	*76·0*	*60·5*			
28 × 13	76	395	379	354	*306*	*245*	*199*	*163*	*115*	*85·8*	*66·0*	*52·3*			
27¾ × 13	68	363	348	326	*259*	*207*	*167*	*137*	*96·9*	*71·8*	*55·4*	*43·9*			
25½ × 17¼	142	683	671	653	628	595	553	503	400	314	248	200	164	137	116
25¼ × 17¼	127	624	612	596	573	542	503	457	362	283	224	181	148		
25 × 17	112	563	552	537	516	488	452	411	325	254	201	162	133		
25½ × 12½	82	401	382	353	*313*	*249*	*201*	*165*	*117*	*86·6*	*66·8*	*52·9*			
25¼ × 12½	73	366	348	321	*271*	*215*	*174*	*143*	*100*	*74·7*	*57·4*	*45·5*			
25¼ × 12½	68	348	330	305	*248*	*197*	*159*	*130*	*91·9*	*68·0*	*52·3*	*41·5*			
25 × 12¼	62	322	306	*280*	*219*	*173*	*140*	*115*	*80·8*	*59·8*	*46·1*				
25 × 12¼	55	296	281	*235*	*183*	*144*	*116*	*95·1*	*66·9*	*49·6*	*37·9*				
22½ × 11¾	66	322	303	274	*222*	*175*	*141*	*116*	*81·1*	*60·2*	*46·3*				
22¼ × 11¾	60	298	281	*252*	*195*	*154*	*124*	*101*	*71·2*	*52·8*	*40·7*				
22¼ × 11¾	55	280	263	*227*	*175*	*138*	*111*	*90·9*	*63·9*	*47·1*	*36·4*				
22 × 11½	50	259	243	*202*	*156*	*123*	*98·5*	*80·7*	*56·7*	*41·9*	*32·2*				
22 × 11½	45	240	226	*174*	*134*	*105*	*84·3*	*68·9*	*48·5*	*35·8*	*27·6*				
22½ × 10¼	55	262	*208*	*151*	*114*	*88·4*	*70·5*	*57·3*	*40·2*						
22¼ × 10¼	50	243	*184*	*134*	*100*	*77·8*	*62·0*	*50·6*	*35·5*						
22 × 10	45	223	*161*	*117*	*87·5*	*67·9*	*54·1*	*44·1*	*30·9*						
20¼ × 11¼	50	249	232	*192*	*147*	*116*	*92·6*	*75·7*	*53·2*	*39·3*	*30·2*				
20¼ × 11¼	45	231	215	*169*	*130*	*102*	*81·4*	*66·5*	*46·6*	*34·4*					
20 × 11	40	210	*194*	*147*	*113*	*88·0*	*70·6*	*57·7*	*40·5*	*29·9*					
20 × 11	36	195	*167*	*125*	*95·3*	*74·3*	*59·5*	*48·6*	*34·0*	*25·1*					
20½ × 10¼	50	238	*198*	*145*	*110*	*85·2*	*68·0*	*55·4*	*38·9*						
20¼ × 10¼	45	219	*172*	*125*	*94·4*	*73·3*	*58·4*	*47·6*	*33·3*						
20¼ × 10	40	200	*147*	*107*	*80·3*	*62·2*	*49·5*	*40·5*	*28·4*						
20 × 9¾	31	*142*	*98·8*	*71·1*	*53·2*	*41·1*	*32·7*	*26·6*							
19¾ × 9¾	26	*108*	*74·1*	*52·9*	*39·5*	*30·5*	*24·3*	*19·7*							
19½ × 10¼	45	218	*179*	*131*	*98·7*	*76·7*	*61·2*	*49·9*	*35·0*						
19¼ × 10¼	40	199	*155*	*113*	*85·2*	*66·3*	*52·8*	*43·1*	*30·1*						
19 × 10	35	179	*130*	*94·9*	*71·3*	*55·3*	*44·1*	*35·9*	*25·2*						

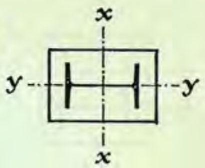
The above safe loads are calculated for effective slenderness ratios not exceeding 180 for the cased section, and the term "effective length" at the head of the table is applicable only to the cased section.

The maximum permissible length of the uncased section should be checked in accordance with clause 30.*b*, B.S. 449 : 1959, as amended.

Tabular loads printed in italics are based on loads restricted to 100% in excess of those permitted on the uncased section.

BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL BEAMS AS CASED STANCHIONS



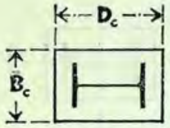
DIMENSIONS AND PROPERTIES

Core Composed of One Universal Beam	Core Area in square inches	Cased Section Area in square inches	Radius of Gyration			Elastic Modulus	
			Axis *y-y*		Axis *x-x* Core only	Axis *y-y*	Axis *x-x*
			Cased Section	Core Only			
30 × 10½ @ 132	38·83	508·88	2·91	2·18	12·17	35·1	379·7
116	34·13	493·00	2·90	2·12	12·00	29·2	327·9
99	29·11	489·38	2·89	2·03	11·79	23·0	272·8
27 × 10 @ 114	33·53	448·88	2·81	2·11	11·03	29·7	299·2
102	30·01	445·31	2·80	2·08	10·96	25·9	266·3
94	27·65	434·00	2·80	2·04	10·87	23·0	242·8
84	24·71	430·50	2·79	1·97	10·70	19·3	211·9
24 × 12 @ 160	47·05	478·50	3·25	2·77	10·29	58·7	399·6
120	35·29	463·13	3·22	2·68	10·15	42·0	299·1
100	29·43	448·00	3·20	2·63	10·08	33·9	248·9
24 × 9 @ 94	27·63	377·63	2·61	1·92	9·85	22·6	220·9
84	24·71	374·31	2·60	1·89	9·78	19·6	196·3
76	22·37	364·00	2·60	1·85	9·68	17·0	175·4
68	20·00	360·75	2·59	1·79	9·53	14·3	153·1
21 × 13 @ 142	41·78	439·88	3·43	3·04	9·03	58·8	317·2
127	37·38	435·56	3·41	3·01	8·99	51·8	284·2
112	32·97	425·00	3·40	2·96	8·92	44·6	249·7
21 × 8¼ @ 82	24·12	318·75	2·47	1·79	8·70	18·5	170·5
73	21·46	315·63	2·46	1·76	8·64	16·0	150·7
68	20·02	315·63	2·45	1·74	8·59	14·6	139·9
62	18·23	306·25	2·45	1·71	8·53	12·9	126·4
55	16·17	306·25	2·44	1·65	8·39	10·7	109·4
18 × 7½ @ 66	19·40	264·38	2·32	1·66	7·52	14·0	119·2
60	17·64	261·44	2·31	1·63	7·47	12·5	107·8
55	16·19	261·44	2·31	1·61	7·41	11·1	98·2
50	14·71	253·00	2·30	1·59	7·38	9·91	89·0
45	13·23	253·00	2·30	1·55	7·30	8·54	78·9
18 × 6 @ 55	16·18	230·63	2·01	1·27	7·33	8·70	94·9
50	14·71	228·06	2·00	1·25	7·27	7·69	85·7
45	13·22	220·00	2·00	1·23	7·20	6·66	76·1
16 × 7 @ 50	14·70	227·81	2·21	1·54	6·68	9·84	80·7
45	13·24	227·81	2·21	1·52	6·64	8·66	72·4
40	11·77	220·00	2·20	1·50	6·62	7·58	64·4
36	10·59	220·00	2·20	1·45	6·49	6·34	56·3
16 × 6 @ 50	14·70	210·13	2·01	1·31	6·64	8·31	79·0
45	13·23	207·56	2·00	1·28	6·57	7·25	70·5
40	11·76	202·50	2·00	1·25	6·49	6·16	61·7
16 × 5½ @ 31	9·12	195·00	1·92	1·15	6·41	4·29	47·3
26	7·64	192·56	1·92	1·08	6·25	3·21	3·81
15 × 6 @ 45	13·24	199·88	2·02	1·31	6·21	7·49	66·8
40	11·77	197·31	2·01	1·29	6·17	6·48	59·1
35	10·29	190·00	2·00	1·26	6·12	5·49	51·4

The weights per foot are for the main steel shaft only. Weights of bases and connections are to be added and suitable allowances made where necessary for binding wire and casing.

The stanchions must be constructed to comply with the requirements of Clause 30.*b* of B.S. 449 : 1959, as amended.

For explanation of tables, see notes commencing pages 162 and 181.



UNIVERSAL BEAMS AND JOISTS AS CASED STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

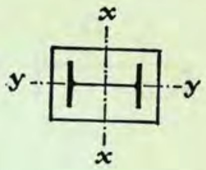
SAFE LOADS FOR HIGH YIELD STEEL

Minimum Size Dc × Bc inches	Core Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET													
		4	6	8	10	12	14	16	18	20	22	24	26	28	30
UNIVERSAL BEAMS															
18½×11	45	238	233	223	206	*169*	*130*	*101*	*81·4*	*66·5*	*55·2*	*46·6*	*39·9*	*34·4*	*30·2*
18¼×11	38	210	205	196	182	*138*	*105*	*82·6*	*66·2*	*54·0*	*44·8*	*37·8*	*32·3*	*28·0*	*24·4*
18 ×10¾	34	192	188	180	*159*	*119*	*91·1*	*71·1*	*56·8*	*46·4*	*38·7*	*32·5*	*27·9*	*24·2*	*21·1*
18 ×10¾	30	177	172	165	*133*	*99·2*	*75·3*	*58·7*	*46·9*	*38·3*	*31·8*	*26·9*	*22·9*	*19·9*	
18 × 9	26	150	144	*98·7*	*66·8*	*47·6*	*35·4*	*27·3*	*21·6*	*17·7*					
17¾× 9	22	134	*119*	*78·2*	*52·6*	*37·3*	*27·7*	*21·4*	*17·0*	*13·7*					
16¼×10¾	36	194	189	181	166	*132*	*101*	*79·2*	*63·5*	*51·9*	*43·2*	*36·4*	*31·1*	*26·9*	*23·5*
16¼×10¾	31	175	170	162	*146*	*110*	*84·1*	*65·7*	*52·6*	*42·9*	*35·7*	*30·1*	*25·7*	*22·3*	*19·4*
16 ×10½	27	157	153	146	*124*	*92·9*	*70·8*	*55·2*	*44·2*	*36·0*	*30·0*	*25·3*	*21·6*	*18·6*	*16·3*
16¼× 9	32	169	162	*129*	*88·3*	*63·1*	*47·0*	*36·3*	*28·9*	*23·5*	*19·4*				
16¼× 9	28	153	147	*108*	*73·3*	*52·1*	*38·8*	*30·0*	*23·8*	*19·3*					
16 × 9	25	141	135	*94·9*	*64·3*	*45·8*	*34·0*	*26·2*	*20·8*	*17·0*					
16½× 8¼	22	126	*96·8*	*59·7*	*39·4*	*27·7*	*20·6*	*15·8*							
16¼× 8¼	19	114	*79·5*	*48·5*	*31·9*	*22·4*	*16·6*	*12·8*							
16 × 8	16·5	102	*62·1*	*37·3*	*24·4*	*17·1*	*12·6*								
14¼×10	29	157	152	143	*119*	*87·8*	*66·3*	*51·7*	*41·2*	*33·6*	*27·8*	*23·6*	*20·0*		
14¼×10	25	141	136	128	*99·2*	*72·7*	*54·8*	*42·6*	*34·0*	*27·7*	*23·0*	*19·4*	*16·6*		
14 × 9¾	21	124	120	*108*	*77·4*	*56·3*	*42·3*	*32·8*	*26·1*	*21·3*	*17·7*	*14·9*	*12·7*		
14¼× 8¼	19	109	*86·8*	*54·0*	*35·7*	*25·1*	*18·7*	*14·3*							
14¼× 8¼	17	101	*73·1*	*45·0*	*29·6*	*20·8*	*15·5*	*11·9*							
14 × 8	15	91·4	*61·1*	*37·1*	*24·4*	*17·2*	*12·7*	*9·7*							
12¼× 9½	20	113	109	*97·0*	*68·6*	*49·6*	*37·2*	*28·8*	*22·9*	*18·7*	*15·5*	*13·1*			
12 × 9¼	17	99·9	96·3	*78·7*	*55·0*	*39·6*	*29·7*	*22·9*	*18·3*	*14·8*	*12·3*	*10·4*			
JOISTS															
12×8	17	94·5	*80·0*	*50·1*	*33·2*	*23·4*	*17·4*	*13·4*	*10·6*						
11×8	14·5	82·4	*69·2*	*43·6*	*28·9*	*20·4*	*15·1*	*11·6*	*9·2*						
10×7½	11·5	66·6	*45·0*	*27·2*	*17·8*	*12·6*	*9·2*	*7·1*							
9×7	9	*50·7*	*27·9*	*16·4*	*10·7*	*7·4*	*5·5*								
8×6½	6·5	*29·3*	*14·6*	*8·4*	*5·4*										
7×6	4·5	*13·8*	*6·4*	*3·6*											

The above safe loads are calculated for effective slenderness ratios not exceeding 180 for the cased section, and the term "effective length" at the head of the table is applicable only to the cased section.
The maximum permissible length of the uncased section should be checked in accordance with clause 30.*b*, B.S. 449 : 1959, as amended.
Tabular loads printed in italics are based on loads restricted to 100% in excess of those permitted on the uncased section.

BASED ON
B.S. 449
1959
AS AMENDED

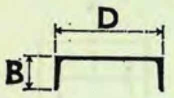
UNIVERSAL BEAMS AND JOISTS AS CASED STANCHIONS



DIMENSIONS AND PROPERTIES

Core Composed of One Universal Beam or Joist	Core Area in square inches	Cased Section Area in square inches	Radius of Gyration			Elastic Modulus	
			Axis *y-y*		Axis *x-x* Core only	Axis *y-y*	Axis *x-x*
			Cased Section	Core Only			
UNIVERSAL BEAMS							
14×6¾ @ 45	13·23	203·50	2·16	1·52	5·95	9·01	65·3
38	11·17	200·75	2·16	1·49	5·87	7·28	54·6
34	10·00	193·50	2·15	1·46	5·83	6·30	48·5
30	8·81	193·50	2·15	1·41	5·73	5·21	41·8
14×5 @ 26	7·64	162·00	1·79	1·02	5·62	3·23	34·8
22	6·47	159·75	1·79	·98	5·51	2·50	28·6
12×6½ @ 36	10·59	174·69	2·11	1·50	5·15	7·23	45·9
31	9·12	174·69	2·10	1·47	5·11	6·07	39·4
27	7·97	168·00	2·10	1·44	5·06	5·11	34·1
12×5 @ 32	9·42	146·25	1·79	1·06	4·92	4·27	37·3
28	8·23	146·25	1·78	1·03	4·87	3·60	32·3
25	7·35	144·00	1·77	1·02	4·83	3·12	28·7
12×4 @ 22	6·47	136·13	1·61	·84	4·91	2·26	25·3
19	5·62	134·06	1·60	·81	4·81	1·83	21·4
16·5	4·86	128·00	1·60	·76	4·65	1·39	17·5
10×5¾ @ 29	8·53	142·50	1·96	1·34	4·29	5·25	30·8
25	7·35	142·50	1·95	1·31	4·26	4·40	26·4
21	6·19	136·50	1·95	1·25	4·14	3·39	21·5
10×4 @ 19	5·61	117·56	1·60	·86	4·14	2·08	18·8
17	4·98	117·56	1·60	·83	4·05	1·72	16·2
15	4·40	112·00	1·60	·80	3·95	1·39	13·8
8×5¼ @ 20	5·88	116·38	1·85	1·20	3·43	3·23	17·0
17	5·00	111·00	1·85	1·16	3·36	2·56	14·1
JOISTS							
8×4 @ 17	5·00	96·00	1·60	·88	3·32	1·95	13·78
7×4 @ 14·5	4·26	88·00	1·60	·89	2·93	1·68	10·45
6×3½ @ 11·5	3·38	75·00	1·50	·78	2·51	1·18	7·07
5×3 @ 9	2·64	63·00	1·40	·68	2·08	·81	4·58
4×2½ @ 6·5	1·91	52·00	1·30	·57	1·66	·49	2·62
3×2 @ 4·5	1·32	42·00	1·20	·45	1·23	·27	1·33

The weights per foot are for the main steel shaft only. Weights of bases and connections are to be added and suitable allowances made where necessary for binding wire and casing.
The stanchions must be constructed to comply with the requirements of Clause 30.*b* of B.S. 449 : 1959, as amended.
For explanation of tables, see notes commencing pages 162 and 181.



CHANNEL STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

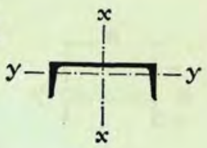
SAFE LOADS FOR HIGH YIELD STEEL

Size D×B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
17×4	44			149	131	111	91·5	75·4	62·8	52·8	44·8	38·6	33·4	29·2	25·8	
15×4	37			128	115	98·6	82·4	68·5	57·2	48·2	41·1	35·3	30·7	26·9	23·7	
12×4	31			108	97·6	84·4	70·9	59·1	49·4	41·7	35·5	30·6	26·6	23·3	20·5	18·3
12×3½	28			88·9	74·7	60·6	48·8	39·8	32·8	27·5	23·3	20·0	17·3			
10×3½	24			78·3	67·1	55·2	44·9	36·7	30·3	25·4	21·6	18·5	16·0	14·0		
10×3	19		63·4	53·0	41·8	32·6	25·8	20·7	17·0	14·2	12·0					
9×3½	22			72·6	62·8	52·0	42·4	34·8	28·8	24·1	20·5	17·6	15·2	13·4		
9×3	17·5		59·2	50·1	39·9	31·3	24·8	20·0	16·4	13·6	11·5					
8×3½	20			66·3	57·6	47·9	39·2	32·1	26·7	22·4	19·0	16·3	14·1	12·3		
8×3	16		54·6	46·7	37·6	29·7	23·6	19·0	15·6	13·0	11·0	9·4				
7×3½	18			60·0	52·3	43·6	35·8	29·4	24·4	20·5	17·4	14·9	13·0	11·3		
7×3	14		47·7	40·9	32·9	25·9	20·6	16·6	13·7	11·4	9·6	8·2				
6×3½	16			53·4	46·6	38·9	31·9	26·2	21·7	18·2	15·5	13·3	11·5	10·1		
6×3	12		41·0	35·1	28·2	22·3	17·7	14·3	11·7	9·7	8·2	7·0				
5×2½	10		30·6	23·8	18·0	13·7	10·7	8·5	7·0	5·8						
4×2	7	22·2	16·2	11·3	8·1	6·1	4·7									
3×1½	4·5	10·6	6·6	4·3	3·0											

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 180. Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959
AS AMENDED
1962

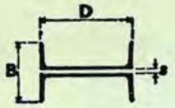
CHANNEL STANCHIONS



DIMENSIONS AND PROPERTIES

Size D×B inches	Area of Section in square inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T
		Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	
17×4	12·94	15·10	514·11	1·08	6·30	4·89	60·48	25·6
15×4	10·88	13·93	357·82	1·13	5·73	4·63	47·71	23·3
12×4	9·12	12·00	197·34	1·15	4·65	4·06	32·89	20·5
12×3½	8·23	7·82	169·64	·97	4·54	2·96	28·27	22·3
10×3½	7·06	7·27	106·86	1·01	3·89	2·85	21·37	18·7
10×3	5·59	3·91	80·88	·84	3·81	1·72	16·18	23·2
9×3½	6·47	6·85	81·38	1·03	3·55	2·74	18·08	17·2
9×3	5·15	3·81	62·70	·86	3·49	1·72	13·93	20·5
8×3½	5·88	6·35	59·85	1·04	3·19	2·58	14·96	15·8
8×3	4·70	3·64	46·86	·88	3·16	1·68	11·71	18·2
7×3½	5·29	5·79	42·12	1·05	2·82	2·40	12·03	14·5
7×3	4·11	3·22	32·13	·88	2·79	1·51	9·18	17·3
6×3½	4·71	5·17	28·01	1·05	2·44	2·18	9·34	13·2
6×3	3·53	2·73	20·46	·88	2·41	1·28	6·82	16·9
5×2½	2·94	1·62	11·59	·74	1·99	·93	4·64	13·8
4×2	2·06	·70	4·99	·58	1·56	·50	2·50	13·3
3×1½	1·32	·26	1·78	·44	1·16	·25	1·19	11·2

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STRUTS

Two channels back to back

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Size D×B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		4	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**32**	**36**
17×8⅝	88			289	237	185	143	113	90·7	74·3	61·9	52·3	*55·9*	*48·5*	*37·3*	
15×8⅝	74			251	213	170	133	106	85·3	69·9	58·4	49·3	*52·9*	*45·6*	*35·1*	*27·8*
12×8⅝	62			213	183	148	117	93·2	75·3	62·0	51·6	43·7	37·5	*40·4*	*31·1*	*24·7*
12×7⅝	56			175	138	105	80·6	63·1	50·6	41·4	34·3	*36·2*	*31·0*	*26·7*		
10×7⅝	48			157	128	99·8	77·3	60·9	48·9	40·0	33·3	28·1	*30·1*	*26·0*	*20·1*	
10×6½	38		128	101	73·5	53·7	40·4	31·4	25·0	*25·6*	*21·2*	*17·8*	*15·2*			
9×7½	44			144	118	91·5	70·9	55·8	44·8	36·7	30·6	25·8	*27·6*	*23·9*	*18·4*	
9×6½	35		121	98·1	72·8	53·7	40·6	31·6	25·2	20·5	*21·3*	*18·0*	*15·4*	*13·3*		
8×7½	40			133	110	86·4	67·2	53·1	42·6	35·0	29·2	24·6	*26·3*	*22·8*	*17·6*	
8×6½	32		112	93·1	70·4	52·3	39·7	30·9	24·7	20·2	*20·9*	*17·7*	*15·1*	*13·1*		
7×7½	36			121	102	80·6	63·0	49·8	40·2	33·0	27·4	23·2	*24·9*	*21·5*	*16·6*	
7×6⅜	28		97·5	80·2	60·2	44·6	33·8	26·3	21·0	17·1	*17·8*	*15·0*	*12·8*	*11·1*		
6×7⅜	32			107	89·3	70·4	54·9	43·4	34·9	28·7	23·9	20·2	*21·6*	*18·7*	*14·4*	
6×6⅜	24		83·6	68·8	51·6	38·3	29·0	22·6	18·0	14·7	*15·3*	*12·8*	*11·0*	*9·4*		
5×5⅜	20		65·1	49·1	34·8	25·2	18·9	14·6	11·6	*11·9*	*9·8*	*8·3*				
4×4⅜	14		37·9	24·9	16·7	11·9	8·8	*8·5*	*6·7*	*5·4*						
3×3⅜	9	29·0	18·0	10·9	7·1	*6·3*	*4·6*	*3·5*								

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the "effective lengths" of struts in accordance with Table 17 and clause 33 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959
AS AMENDED
1962

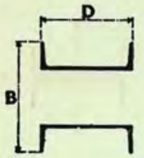
COMPOUND STRUTS

Two channels back to back

COMPOSITION AND PROPERTIES

Composed of Two Channels	Area in square inches	Space between Webs *s* inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T
			Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	
17×4 @ 44	25·88	·625	69·0	1028·2	**1·63**	6·30	16·01	121·0	25·6
15×4 @ 37	21·76	·625	64·8	715·6	**1·73**	5·73	15·04	95·4	23·3
12×4 @ 31	18·24	·625	57·7	394·7	**1·78**	4·65	13·38	65·8	20·5
12×3½ @ 28	16·46	·625	38·2	339·3	**1·52**	4·54	10·02	56·5	22·3
10×3½ @ 24	14·11	·625	37·1	213·7	**1·62**	3·89	9·72	42·7	18·7
10×3 @ 19	11·17	·500	18·6	161·8	**1·29**	3·81	5·71	32·4	23·2
9×3½ @ 22	12·94	·500	33·8	162·8	**1·62**	3·55	9·01	36·2	17·2
9×3 @ 17·5	10·29	·500	18·7	125·4	**1·35**	3·49	5·75	27·9	20·5
8×3½ @ 20	11·76	·500	32·3	119·7	**1·66**	3·19	8·62	29·9	15·8
8×3 @ 16	9·41	·500	18·4	93·7	**1·40**	3·16	5·68	23·4	18·2
7×3½ @ 18	10·59	·500	30·5	84·2	**1·70**	2·82	8·12	24·1	14·5
7×3 @ 14	8·23	·375	15·6	64·3	**1·38**	2·79	4·89	18·4	17·3
6×3½ @ 16	9·41	·375	26·6	56·0	**1·68**	2·44	7·22	18·7	13·2
6×3 @ 12	7·06	·375	13·4	40·9	**1·38**	2·41	4·20	13·6	16·9
5×2½ @ 10	5·88	·375	8·56	23·2	**1·21**	1·99	3·19	9·27	13·8
4×2 @ 7	4·12	·375	3·92	9·98	**·98**	1·56	1·79	4·99	13·3
3×1½ @ 4·5	2·65	·375	1·66	3·56	**·79**	1·16	·98	2·38	11·2

Each weight per foot is for the shaft only, weight of connections, etc., to be added.
D/T ratios are tabulated to facilitate the design of struts subject to bending.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

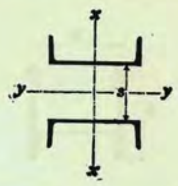
SAFE LOADS FOR HIGH YIELD STEEL

Size D×B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		12	14	16	18	20	22	24	26	28	30	32	36	40	44	48
17×18½	88								312	303	293	281	254	226	198	173
15×17½	74							261	253	243	232	220	194	168	145	126
12×15	62					217	208	197	184	171	157	144	120	101	85·0	72·6
12×14	56					193	183	172	160	147	135	123	102	84·9	71·5	60·9
10×12½	48			170	161	151	139	127	114	102	91·7	82·3	66·9	55·2	46·1	39·1
10×12	38			134	127	119	109	99·2	89·2	79·9	71·7	64·2	52·2	43·0	36·0	30·5
9×12	44			151	141	130	117	105	93·1	82·8	73·7	65·8	53·2	43·7	36·5	30·8
9×11½	35			119	111	101	91·3	81·3	72·2	64·0	56·9	50·8	41·0	33·6	28·1	23·8
8×11	40		139	129	118	105	92·6	81·2	71·3	62·7	55·4	49·3	39·6	32·4	27·0	
8×10½	32		111	103	93·4	83·1	73·1	64·0	56·1	49·3	43·6	38·8	31·1	25·4	21·2	
7×10	36	126	116	104	91·3	78·8	67·8	58·5	50·8	44·4	39·1	34·6	27·6	22·5		
7×9½	28	97·5	89·8	80·2	70·0	60·2	51·8	44·6	38·7	33·8	29·7	26·3	21·0	17·1		

The above safe loads are tabulated for ratios of slenderness not exceeding 180.
Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959
AS AMENDED
1962

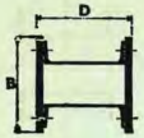
COMPOUND STANCHIONS



COMPOSITION AND PROPERTIES

Composed of Two Steel Channels Latticed	Area in square inches	Space between Webs *s* inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T
			Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	
17×4 @44	25·88	10·5	1013·0	1028·2	**6·26**	6·30	109·5	121·0	25·6
15×4 @37	21·76	9·5	745·1	715·6	5·85	**5·73**	85·2	95·4	23·3
12×4 @31	18·24	7·0	401·1	394·7	4·69	**4·65**	53·5	65·8	20·5
12×3½@28	16·46	7·0	328·3	339·3	**4·47**	4·54	46·9	56·5	22·3
10×3½@24	14·11	5·5	207·8	213·7	**3·84**	3·89	33·3	42·7	18·7
10×3 @19	11·17	6·0	163·3	161·8	3·82	**3·81**	27·2	32·4	23·2
9×3½@22	12·94	5·0	171·8	162·8	3·64	**3·55**	28·6	36·2	17·2
9×3 @17.5	10·29	5·5	136·3	125·4	3·64	**3·49**	23·7	27·9	20·5
8×3½@20	11·76	4·0	121·5	119·7	3·21	**3·19**	22·1	29·9	15·8
8×3 @16	9·41	4·5	97·1	93·7	3·21	**3·16**	18·5	23·4	18·2
7×3½@18	10·59	3·0	82·3	84·2	**2·79**	2·82	16·5	24·1	14·5
7×3 @14	8·23	3·5	62·8	64·3	**2·76**	2·79	13·2	18·4	17·3

Each weight per foot is for the shaft only, weight of base, etc., to be added.
D/T ratios are tabulated to facilitate the design of stanchions subject to bending.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Size D × B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		14	15	16	18	20	22	24	26	28	30	32	36	40	44	48
20 × 18	274·6						952	916	874	826	774	720	615	522	445	381
19½ × 18	244·0						845	813	775	733	686	639	545	463	395	338
19 × 18	213·4						737	709	676	639	598	556	475	403	343	294
18¾ × 18	198·1						683	657	626	591	554	515	439	373	317	272
18½ × 18	182·8						629	605	577	545	510	474	405	344	292	251
							Rivets ⅞-in. dia.									
18 × 16	240·2					817	778	731	679	626	572	522	433	361	304	259
17½ × 16	213·0					722	687	645	599	551	503	459	380	317	267	227
17 × 16	185·8					626	595	558	518	475	434	395	327	273	229	195
16¾ × 16	172·2					579	550	516	478	439	400	365	302	251	212	180
16½ × 16	158·6					532	504	473	438	401	366	333	275	229	193	164
							Rivets ⅞-in. dia.									
15 × 14	207·8			723	687	643	591	537	483	433	388	348	283	233	195	165
14½ × 14	184·0			638	605	565	518	470	422	378	339	304	247	203	170	144
14 × 14	160·2			552	522	486	445	403	361	323	289	259	210	173	145	122
13¾ × 14	148·3			509	481	448	409	370	331	296	265	237	192	158	132	112
13½ × 14	136·4			466	440	408	373	336	300	269	240	215	174	143	120	101
							Rivets ⅞-in. dia.									
15 × 14	201·8				674	633	585	534	482	434	390	350	285	235	197	167
14½ × 14	178·0				592	556	513	467	422	379	340	305	249	205	172	145
14 × 14	154·2				509	477	440	400	360	323	290	260	212	175	146	124
13¾ × 14	142·3			492	468	438	403	366	330	296	265	238	193	159	133	113
13½ × 14	130·4			449	427	399	367	333	299	268	240	215	175	144	121	102
							Rivets ⅞-in. dia.									
13 × 12	173·4		588	569	527	477	425	376	332	294	261	232	187	153	128	108
12½ × 12	153·0	531	517	500	462	418	373	330	291	257	228	203	164	134	112	94·5
12 × 12	132·6	458	445	431	398	359	320	282	249	220	195	174	140	115	95·6	80·7
11¾ × 12	122·4	421	410	396	365	330	293	259	228	202	179	159	128	105	87·5	73·8
11½ × 12	112·2	385	374	362	333	301	267	236	208	183	163	145	116	95·6	79·6	67·1
							Rivets ⅞-in. dia.									

The above safe loads are tabulated for ratios of slenderness not exceeding 180.
Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.
Approximate safe loads for stanchions with plates of intermediate thicknesses can be obtained by interpolation.

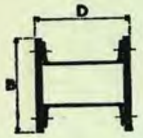
BASED ON
B.S. 449
1959
AS AMENDED
1962

COMPOUND STANCHIONS

COMPOSITION AND PROPERTIES

Composed of		Area in square inches	Space between Webs *s* inches	Moment of Inertia		Radius of Gyration		Elastic Modulus	
Two Steel Channels	Plates each Flange to form			Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
17×4 @ 44	18×1½	79·88	8·0	2112·7	5658·7	**5·14**	8·42	234·7	565·9
	18×1¼	70·88	8·0	1869·7	4781·0	**5·14**	8·21	207·7	490·4
	18×1	61·88	8·0	1626·7	3947·3	**5·13**	7·99	180·7	415·5
	18×⅞	57·38	8·0	1505·2	3546·4	**5·12**	7·86	167·2	378·3
	18×¾	52·88	8·0	1383·7	3156·2	**5·12**	7·73	153·7	341·2
15×4 @ 37	16×1½	69·76	6·0	1398·5	3991·6	**4·48**	7·56	174·8	443·5
	16×1¼	61·76	6·0	1227·8	3361·5	**4·46**	7·38	153·5	384·2
	16×1	53 76	6·0	1057·2	2766·4	**4·43**	7·17	132·1	325·5
	16×⅞	49·76	6·0	971·8	2481·6	**4·42**	7·06	121·5	296·3
	16×¾	45·76	6·0	886·5	2205·1	**4·40**	6·94	110·8	267·3
12×4 @ 31	14×1½	60·24	4·0	879·3	2316·2	**3·82**	6·20	125·6	308·8
	14×1¼	53·24	4·0	765·0	1935·4	**3·79**	6·03	109·3	266·9
	14×1	46·24	4·0	650·7	1580·1	**3·75**	5·85	93·0	225·7
	14×⅞	42·74	4·0	593·5	1411·5	**3·73**	5·75	84·8	205·3
	14×¾	39·24	4·0	536·3	1249·1	**3·70**	5·64	76·6	185·1
12×3½ @ 28	14×1½	58·46	5·0	887·3	2260·8	**3·90**	6·22	126·8	301·4
	14×1¼	51·46	5·0	773·0	1880·0	**3·88**	6·04	110·4	259·3
	14×1	44·46	5·0	658·6	1524·7	**3·85**	5·86	94·1	217·8
	14×⅞	40·96	5·0	601·5	1356·1	**3·83**	5·75	85·9	197·3
	14×¾	37·46	5·0	544·3	1193·7	**3·81**	5·64	77·8	176·8
10×3½ @ 24	12×1½	50·11	4·0	569·4	1410·7	**3·37**	5·31	94·9	217·0
	12×1¼	44·11	4·0	497·4	1166·8	**3·36**	5·14	82·9	186·7
	12×1	38·11	4·0	425·4	941·7	**3·34**	4·97	70·9	157·0
	12×⅞	35·11	4·0	389·4	835·9	**3·33**	4·88	64·9	142·3
	12×¾	32·11	4·0	353·4	734·6	**3·32**	4·78	58·9	127·8

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

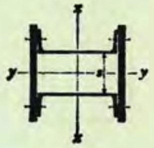
SAFE LOADS FOR HIGH YIELD STEEL

Size D×B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET													
		12	14	16	18	20	22	24	26	28	30	32	36	40	44	48
13 ×12	162·4			541	503	457	410	363	322	285	253	226	182	149	124	105
12½×12	142·0			472	439	399	358	317	281	249	221	197	159	130	108	91·9
12 ×12	121·6			403	374	340	304	270	239	211	188	167	135	111	92·1	78·0
11¾×12	111·4			368	342	311	278	247	219	193	172	153	123	101	84·2	71·3
11½×12	101·2			334	310	282	252	224	198	175	156	139	112	91·8	76·4	64·7
								Rivets ¾-in. dia.								
12 ×12	169·4			558	517	469	419	371	328	290	257	229	185	152	126	107
11½×12	149·0			489	452	410	366	324	286	253	225	200	161	132	110	93·1
11 ×12	128·6		444	419	387	350	312	276	244	215	191	170	137	113	93·7	79·1
10¾×12	118·4		408	384	355	321	286	253	223	197	175	156	125	103	85·6	72·3
10½×12	108·2		371	350	323	292	259	229	202	179	158	141	114	93·2	77·6	65·5
								Rivets ⅞-in. dia.								
12 ×12	159·4			533	495	451	405	360	319	282	251	224	180	148	124	104
11½×12	139·0			464	431	393	352	313	278	246	218	195	157	129	108	90·7
11 ×12	118·6			394	366	333	299	265	235	208	185	165	133	109	90·9	76·8
10¾×12	108·4			359	334	304	273	242	215	190	169	150	121	99·5	82·9	70·1
10½×12	98·2			325	302	275	247	219	194	172	153	136	110	89·9	75·0	63·4
								Rivets ¾-in. dia.								
10 ×10	111·0	371	340	300	259	222	190	164	142	123	109	96·2	76·7	62·5		
9¾×10	102·5	341	311	274	236	202	173	149	129	112	98·7	87·4	69·6			
9½×10	94·0	311	283	249	214	183	156	134	116	101	88·9	78·7	62·6			
9¼×10	85·5	280	254	223	191	163	139	119	103	89·8	78·9	69·7	55·7			
9 ×10	77·0	250	226	197	168	143	122	105	90·4	78·7	69·2	61·3	48·8			
								Rivets ⅞-in. dia.								
10 ×10	102·0	349	322	288	251	216	186	160	139	122	107	94·7	75·6	61·6		
9¾×10	93·5	319	294	262	229	197	169	146	126	110	97·1	86·0	68·7	56·0		
9½×10	85·0	288	265	236	205	177	152	131	113	98·9	86·9	77·0	61·5	50·2		
9¼×10	76·5	258	237	211	183	158	135	116	101	88·2	77·5	68·7	54·8	44·8		
9 ×10	68·0	228	209	186	161	138	118	102	88·3	77·1	67·7	60·0	47·9	39·0		
								Rivets ¾-in. dia.								

The above safe loads are tabulated for ratios of slenderness not exceeding 180.
Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.
Approximate safe loads for stanchions with plates of intermediate thicknesses can be obtained by interpolation.

BASED ON
B.S. 449
1959
AS AMENDED
1962

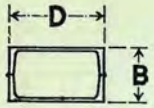
COMPOUND STANCHIONS



COMPOSITION AND PROPERTIES

Composed of		Area in square inches	Space between Webs *s* inches	Moment of Inertia		Radius of Gyration		Elastic Modulus	
Two Steel Channels	Plates each Flange to form			Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
10×3 @ 19	12×1½	47·17	5·0	556·4	1358·8	**3·43**	5·37	92·7	209·0
	12×1¼	41·17	5·0	484·4	1114·9	**3·43**	5·20	80·7	178·4
	12×1	35·17	5·0	412·4	889·8	**3·42**	5·03	68·7	148·3
	12×⅞	32·17	5·0	376·4	784·0	**3·42**	4·94	62·7	133·4
	12×¾	29·17	5·0	340·4	682·6	**3·42**	4·84	56·7	118·7
9×3½ @ 22	12×1½	48·94	4·0	561·8	1161·8	**3·39**	4·87	93·6	193·6
	12×1¼	42·94	4·0	489·8	954·6	**3·38**	4·72	81·6	166·0
	12×1	36·94	4·0	417·8	764·8	**3·36**	4·55	69·6	139·0
	12×⅞	33·94	4·0	381·8	676·1	**3·35**	4·46	63·6	125·8
	12×¾	30·94	4·0	345·8	591·4	**3·34**	4·37	57·6	112·6
9×3 @ 17·5	12×1½	46·29	5·0	550·8	1124·4	**3·45**	4·93	91·8	187·4
	12×1¼	40·29	5·0	478·8	917·3	**3·45**	4·77	79·8	159·5
	12×1	34·29	5·0	406·8	727·4	**3·44**	4·61	67·8	132·3
	12×⅞	31·29	5·0	370·8	638·7	**3·44**	4·52	61·8	118·8
	12×¾	28·29	5·0	334·8	554·0	**3·44**	4·43	55·8	105·5
8×3½ @ 20	10×1	31·76	2·0	228·4	526·4	**2·68**	4·07	45·7	105·3
	10×⅞	29·26	2·0	207·6	465·4	**2·66**	3·99	41·5	95·5
	10×¾	26·76	2·0	186·7	407·5	**2·64**	3·90	37·3	85·8
	10×⅝	24·26	2·0	165·9	352·6	**2·61**	3·81	33·2	76·2
	10×½	21·76	2·0	145·1	300·5	**2·58**	3·72	29·0	66·8
8×3 @ 16	10×1	29·41	3·0	225·4	500·4	**2·77**	4·13	45·1	100·1
	10×⅞	26·91	3·0	204·6	439·4	**2·76**	4·04	40·9	90·1
	10×¾	24·41	3·0	183·8	381·5	**2·74**	3·95	36·8	80·3
	10×⅝	21·91	3·0	162·9	326·6	**2·73**	3·86	32·6	70·6
	10×½	19·41	3·0	142·1	274·5	**2·71**	3·76	28·4	61·0

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

Two channels welded toe to toe

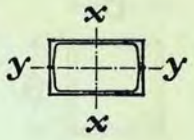
SAFE LOADS FOR HIGH YIELD STEEL

Size D×B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		8	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**28**	**32**	**36**	**40**	**44**	**48**
17×8	88				308	289	265	238	211	186	144	114	91·2	74·8	62·3	52·7
15×8	74				257	240	219	196	173	152	117	92·3	74·1	60·7	50·5	42·7
12×8	62				215	200	181	162	142	125	96·1	75·5	60·7	49·7	41·3	
12×7	56			197	182	164	144	124	107	92·6	70·3	54·8	43·8	35·8		
10×7	48			167	153	137	119	102	87·6	75·5	57·2	44·5	35·6	29·0		
10×6	38			124	109	93·2	78·5	66·0	56·0	47·8	35·8	27·8	22·1			
9×7	44			152	140	124	107	92·0	78·9	67·9	51·4	40·0	31·9	26·0		
9×6	35		123	113	98·9	83·9	70·5	59·1	50·1	42·7	32·0	24·8				
8×7	40			137	125	111	95·5	81·8	69·9	60·1	45·4	35·4	28·2	23·0		
8×6	32		112	102	88·3	74·5	62·3	52·1	44·0	37·6	28·2	21·8				
7×7	36			123	112	98·1	84·2	71·9	61·3	52·7	39·8	30·9	24·6			
7×6	28		97·6	88·4	76·5	64·4	53·7	44·9	37·9	32·3	24·2	18·7				
6×7	32			105	92·7	79·4	67·0	56·5	47·8	40·9	30·7	23·8	18·9			
6×6	24		83·6	75·5	65·3	54·9	45·7	38·3	32·3	27·5	20·6	15·9				
5×5	20	70·4	62·2	51·7	41·6	33·4	27·1	22·3	18·7	15·8	11·7					
4×4	14	43·8	34·6	26·3	20·2	15·8	12·7	10·4	8·5							
3×3	9	19·8	13·7	9·8	7·3	5·6										

The above safe loads are tabulated for ratios of slenderness not exceeding 180.
Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959
AS AMENDED
1962

COMPOUND STANCHIONS

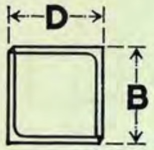


Two channels welded toe to toe

COMPOSITION AND PROPERTIES

Composed of Two Steel Channels	Area in square inches	Moment of Inertia		Radius of Gyration		Elastic Modulus	
		Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
17×4 @ 44	25·88	277·0	1028·2	**3·27**	6·30	69·2	121·0
15×4 @ 37	21·76	224·9	715·6	**3·21**	5·73	56·2	95·4
12×4 @ 31	18·24	183·0	394·7	**3·17**	4·65	45·8	65·8
12×3½ @ 28	16·46	130·6	339·3	**2·82**	4·54	37·3	56·5
10×3½ @ 24	14·11	106·2	213·7	**2·74**	3·89	30·4	42·7
10×3 @ 19	11·17	65·3	161·8	**2·42**	3·81	21·8	32·4
9×3½ @ 22	12·94	94·8	162·8	**2·71**	3·55	27·1	36·2
9×3 @ 17·5	10·29	58·1	125·4	**2·38**	3·49	19·4	27·9
8×3½ @ 20	11·76	83·8	119·7	**2·67**	3·19	23·9	29·9
8×3 @ 16	9·41	51·2	93·7	**2·33**	3·16	17·1	23·4
7×3½ @ 18	10·59	73·3	84·2	**2·63**	2·82	20·9	24·1
7×3 @ 14	8·23	43·9	64·3	**2·31**	2·79	14·6	18·4
6×3½ @ 16	9·41	63·3	56·0	2·59	**2·44**	18·1	18·7
6×3 @ 12	7·06	37·5	40·9	**2·30**	2·41	12·5	13·6
5×2½ @ 10	5·88	21·0	23·2	**1·89**	1·99	8·38	9·27
4×2 @ 7	4·12	9·51	9·98	**1·52**	1·56	4·76	4·99
3×1½ @ 4·5	2·65	3·32	3·56	**1·12**	1·16	2·21	2·38

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



TWO ANGLES AS STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

Welded toe to toe

SAFE LOADS FOR HIGH YIELD STEEL

Size $D \times B$ inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		8	10	12	14	16	18	20	22	24	26	28	30	32	36	40
$8\frac{7}{8} \times 8\frac{7}{8}$	102				348	321	288	254	222	194	169	149	131	116	93·4	76·3
$8\frac{3}{4} \times 8\frac{3}{4}$	90·0				308	284	256	226	198	173	151	133	117	104	83·4	68·2
$8\frac{5}{8} \times 8\frac{5}{8}$	77·8				267	247	223	197	173	151	132	116	103	91·0	72·9	59·6
$8\frac{1}{2} \times 8\frac{1}{2}$	65·4				225	208	188	167	147	128	112	98·6	87·2	77·4	62·1	50·7
$6\frac{3}{4} \times 6\frac{3}{4}$	66·2		230	206	177	149	124	103	87·1	74·1	63·7	55·3	48·5	42·8		
$6\frac{5}{8} \times 6\frac{5}{8}$	57·4		200	180	155	130	109	90·8	76·6	65·2	56·2	48·8	42·8	37·7		
$6\frac{1}{2} \times 6\frac{1}{2}$	48·4		169	153	132	111	92·9	77·7	65·6	56·0	48·2	41·9	36·7	32·4		
$6\frac{3}{8} \times 6\frac{3}{8}$	39·0		137	124	108	90·9	75·9	63·6	53·7	45·8	39·4	34·3	30·0	26·6		
$6\frac{1}{4} \times 6\frac{1}{4}$	29·6		104	94·5	82·4	69·7	58·4	49·0	41·3	35·3	30·4	26·5	23·2	20·4		
$5\frac{5}{8} \times 5\frac{5}{8}$	47·2	166	147	122	98·2	78·9	64·0	52·8	44·1	37·3	32·1	27·7				
$5\frac{1}{2} \times 5\frac{1}{2}$	39·8	141	125	104	84·1	67·7	55·0	45·3	37·9	32·2	27·5	23·9				
$5\frac{3}{8} \times 5\frac{3}{8}$	32·2		102	85·5	69·2	55·7	45·3	37·4	31·3	26·5	22·7	19·7				
$5\frac{1}{4} \times 5\frac{1}{4}$	24·6		78·3	66·0	53·6	43·3	35·3	29·1	24·4	20·6	17·7	15·3				
$4\frac{5}{8} \times 4\frac{5}{8}$	37·0	113	88·2	66·5	50·8	39·7	31·8	26·0	21·6							
$4\frac{1}{2} \times 4\frac{1}{2}$	31·4	97·1	76·1	57·7	44·1	34·5	27·7	22·6	18·8							
$4\frac{3}{8} \times 4\frac{3}{8}$	25·4	79·4	62·7	47·7	36·6	28·6	23·0	18·8	15·6							
$4\frac{1}{4} \times 4\frac{1}{4}$	19·4	61·2	48·7	37·2	28·6	22·4	18·0	14·7	12·2							
4×4	27·0	72·5	52·9	38·7	29·2	22·6	18·1									
$3\frac{7}{8} \times 3\frac{7}{8}$	22·0	60·2	44·2	32·4	24·5	19·0	15·1									
$3\frac{3}{4} \times 3\frac{3}{4}$	16·8	46·7	34·5	25·4	19·2	15·0	11·9	9·7								
$3\frac{11}{16} \times 3\frac{11}{16}$	14·2	39·8	29·6	21·8	16·5	12·8	10·2	8·3								
$3\frac{3}{8} \times 3\frac{3}{8}$	18·6	40·9	28·3	20·3	15·2	11·7										
$3\frac{1}{4} \times 3\frac{1}{4}$	14·2	32·0	22·3	16·0	11·9	9·2										
$3\frac{3}{16} \times 3\frac{3}{16}$	12·0	27·4	19·1	13·8	10·3	7·9										
$3\frac{1}{8} \times 3\frac{1}{8}$	9·6	22·3	15·6	11·2	8·3	6·4										
$2\frac{15}{16} \times 2\frac{15}{16}$	15·2	24·2	16·1	11·4												
$2\frac{13}{16} \times 2\frac{13}{16}$	11·8	19·5	13·0	9·2	6·8											
$2\frac{3}{4} \times 2\frac{3}{4}$	10·0	16·8	11·3	7·9	5·9											
$2\frac{11}{16} \times 2\frac{11}{16}$	8·0	13·7	9·1	6·5	4·8											

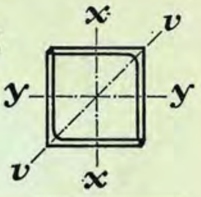
The above safe loads are tabulated for ratios of slenderness not exceeding 180.
Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TWO ANGLES AS STANCHIONS

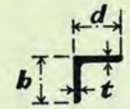
Welded toe to toe

COMPOSITION AND PROPERTIES



Composed of Two Equal Angles	Actual Thickness	Area in square inches	Moment of Inertia		Radius of Gyration		Elastic Modulus	
			Axis v-v	Axis x-x or y-y	Axis v-v	Axis x-x or y-y	Axis v-v	Axis x-x or y-y
$8 \times 8 \times 1$	·996	30·01	280·8	307·7	**3·06**	3·20	49·65	69·26
$8 \times 8 \times \frac{7}{8}$	·871	26·48	251·4	271·8	**3·08**	3·20	44·44	62·04
$8 \times 8 \times \frac{3}{4}$	·746	22·88	220·4	235·2	**3·10**	3·21	38·96	54·48
$8 \times 8 \times \frac{5}{8}$	·621	19·23	187·7	198·1	**3·12**	3·21	33·18	46·54
$6 \times 6 \times \frac{7}{8}$	·872	19·48	100·4	111·4	**2·27**	2·39	23·65	32·95
$6 \times 6 \times \frac{3}{4}$	·747	16·88	88·7	96·6	**2·29**	2·39	20·90	29·12
$6 \times 6 \times \frac{5}{8}$	·623	14·24	76·2	81·7	**2·31**	2·39	17·97	25·08
$6 \times 6 \times \frac{1}{2}$	·496	11·48	62·6	66·0	**2·33**	2·40	14·75	20·66
$6 \times 6 \times \frac{3}{8}$	·371	8·70	48·2	50·2	**2·35**	2·40	11·36	16·02
$5 \times 5 \times \frac{3}{4}$	·748	13·89	49·4	54·8	**1·89**	1·99	13·98	19·45
$5 \times 5 \times \frac{5}{8}$	·622	11·71	42·6	46·3	**1·91**	1·99	12·06	16·79
$5 \times 5 \times \frac{1}{2}$	·496	9·47	35·3	37·5	**1·93**	1·99	9·98	13·93
$5 \times 5 \times \frac{3}{8}$	·373	7·23	27·5	28·7	**1·95**	1·99	7·76	10·91
$4 \times 4 \times \frac{3}{4}$	·749	10·89	23·9	27·3	**1·48**	1·58	8·45	11·77
$4 \times 4 \times \frac{5}{8}$	·624	9·23	20·8	23·1	**1·50**	1·58	7·37	10·24
$4 \times 4 \times \frac{1}{2}$	·496	7·47	17·4	18·7	**1·52**	1·58	6·14	8·53
$4 \times 4 \times \frac{3}{8}$	·372	5·70	13·6	14·3	**1·54**	1·58	4·81	6·72
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{8}$	·621	7·94	13·4	15·1	**1·30**	1·38	5·43	7·54
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$	·496	6·47	11·3	12·3	**1·32**	1·38	4·57	6·34
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$	·371	4·94	8·89	9·42	**1·34**	1·38	3·59	5·01
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$	·311	4·18	7·62	7·98	**1·35**	1·38	3·08	4·31
$3 \times 3 \times \frac{1}{2}$	·496	5·47	6·85	7·58	**1·12**	1·18	3·23	4·48
$3 \times 3 \times \frac{3}{8}$	·370	4·17	5·42	5·79	**1·14**	1·18	2·56	3·55
$3 \times 3 \times \frac{5}{16}$	·309	3·53	4·65	4·90	**1·15**	1·18	2·19	3·06
$3 \times 3 \times \frac{1}{4}$	·245	2·83	3·78	3·94	**1·16**	1·18	1·78	2·51
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{2}$	·493	4·47	3·79	4·42	**·92**	·99	2·14	3·01
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	·372	3·47	3·08	3·42	**·94**	·99	1·74	2·43
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	·311	2·94	2·67	2·90	**·95**	·99	1·51	2·11
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	·245	2·35	2·18	2·33	**·96**	1·00	1·23	1·73

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



STRUTS

Equal Angles

BASED ON
B.S. 449
1959
AS AMENDED

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR HIGH YIELD STEEL

Size d×b×t inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	3	4	5	6	8	10	12	14	16	18	20	24	28	32	36
8 ×8 ×1					178	155	127	101	81·0	65·6	53·9	38·2	*35·4*	*27·2*	*21·7*
8 ×8 ×⅞					157	138	113	90·4	72·2	58·6	48·1	34·1	*31·6*	*24·3*	*19·4*
8 ×8 ×¾					136	120	98·5	78·9	63·1	51·2	42·1	29·8	*27·7*	*21·3*	*16·8*
8 ×8 ×⅝					114	100	82·8	66·3	53·0	43·0	35·4	25·0	*23·2*	*17·9*	*14·1*
6 ×6 ×⅞				115	94·7	71·0	52·5	39·8	31·0	24·8	20·2	*17·6*	*13·0*		
6 ×6 ×¾				99·9	82·1	61·5	45·5	34·5	26·8	21·5	17·5	*15·3*	*11·3*		
6 ×6 ×⅝				84·5	69·8	52·6	39·0	29·5	23·0	18·4	15·0	*13·1*	*9·7*		
6 ×6 ×½				68·1	56·3	42·4	31·4	23·8	18·6	14·8	12·1	*10·6*	*7·8*		
6 ×6 ×⅜				51·8	43·0	32·5	24·2	18·4	14·3	11·4	9·3	*8·1*	*6·0*		
5 ×5 ×¾			81·9	73·8	53·3	37·1	26·7	19·9	15·4	*15·3*	*12·5*				
5 ×5 ×⅝			69·5	62·8	45·7	31·9	22·9	17·2	13·3	*13·2*	*10·7*	*7·4*			
5 ×5 ×½			56·2	50·8	37·0	25·8	18·6	13·9	10·7	*10·7*	*8·6*	*6·0*			
5 ×5 ×⅜			43·0	39·0	28·6	20·0	14·4	10·8	8·3	*8·3*	*6·7*	*4·7*			
4 ×4 ×¾		64·0	55·6	45·3	28·7	19·1	13·5	*12·5*	*9·6*	*7·6*					
4 ×4 ×⅝		54·7	47·8	39·1	24·9	16·6	11·7	*10·9*	*8·3*	*6·6*					
4 ×4 ×½		44·1	38·6	31·6	20·1	13·4	9·4	*8·8*	*6·7*	*5·3*					
4 ×4 ×⅜		33·7	29·5	24·1	15·4	10·2	7·2	*6·7*	*5·1*	*4·1*					
3½×3½×⅝		43·7	35·6	27·6	16·8	11·0	7·7	*7·1*	*5·5*						
3½×3½×½		35·6	29·0	22·4	13·6	8·9	6·2	*5·8*	*4·4*						
3½×3½×⅜		27·2	22·2	17·1	10·4	6·8	4·8	*4·4*	*3·4*						
3½×3½×5/16		23·2	19·1	14·8	9·0	5·9	4·1	*3·8*	*2·9*						
3 ×3 ×½	32·2	26·3	19·6	14·5	8·5	5·5	*4·8*	*3·6*							
3 ×3 ×⅜	24·6	20·2	15·0	11·1	6·5	4·2	*3·7*	*2·7*							
3 ×3 ×5/16	20·8	17·0	12·7	9·3	5·5	3·5	*3·1*	*2·3*							
3 ×3 ×¼	16·7	13·8	10·4	7·7	4·5	2·9	*2·5*	*1·9*							
2½×2½×⅜	18·5	13·5	9·4	6·7	3·9	*3·1*	*2·2*								
2½×2½×5/16	15·8	11·5	8·0	5·7	3·3	*2·6*	*1·8*								
2½×2½×¼	12·7	9·2	6·4	4·6	2·6	*2·1*	*1·5*								
2¼×2¼×⅜	14·9	10·1	6·8	4·8	*3·5*	*2·2*									
2¼×2¼×5/16	12·6	8·5	5·8	4·1	*2·9*	*1·9*									
2¼×2¼×¼	10·3	7·0	4·7	3·3	*2·4*	*1·5*									
2¼×2¼×3/16	7·7	5·2	3·5	2·5	*1·8*	*1·1*									
2 ×2 ×5/16	9·7	6·2	4·1	2·9	*2·0*										
2 ×2 ×¼	7·9	5·0	3·3	2·3	*1·7*										
2 ×2 ×3/16	6·0	3·8	2·5	1·8	*1·2*										

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut centre to centre of intersections in accordance with clause 30.*c*.(i) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

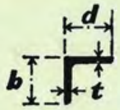
STRUTS

Equal Angles

DIMENSIONS AND PROPERTIES

Size d×b×t inches	Actual Thickness inches	Weight per foot in lbs	Distance in inches			Radius of Gyration		Elastic Modulus	Area in square inches
			nx or *ny*	*nv*	*nu*	Axis *v-v*	Axis *u-u*	*x-x* or *y-y*	
8 ×8 ×1	·996	51·0	5·64	3·33	5·66	**1·56**	3·06	15·69	15·01
8 ×8 ×⅞	·871	45·0	5·69	3·27	5·66	**1·57**	3·08	13·91	13·24
8 ×8 ×¾	·746	38·9	5·74	3·20	5·66	**1·58**	3·10	12·08	11·44
8 ×8 ×⅝	·621	32·7	5·79	3·13	5·66	**1·58**	3·12	10·20	9·61
6 ×6 ×⅞	·872	33·1	4·19	2·56	4·24	**1·17**	2·27	7·58	9·74
6 ×6 ×¾	·747	28·7	4·23	2·50	4·24	**1·17**	2·29	6·60	8·44
6 ×6 ×⅝	·623	24·2	4·28	2·43	4·24	**1·18**	2·31	5·61	7·12
6 ×6 ×½	·496	19·5	4·33	2·36	4·24	**1·18**	2·33	4·54	5·74
6 ×6 ×⅜	·371	14·8	4·38	2·29	4·24	**1·19**	2·35	3·46	4·35
5 ×5 ×¾	·748	23·6	3·48	2·14	3·54	**·97**	1·89	4·49	6·94
5 ×5 ×⅝	·622	19·9	3·53	2·08	3·54	**·98**	1·91	3·81	5·86
5 ×5 ×½	·496	16·1	3·58	2·01	3·54	**·98**	1·93	3·10	4·74
5 ×5 ×⅜	·373	12·3	3·63	1·94	3·54	**·99**	1·95	2·38	3·61
4 ×4 ×¾	·749	18·5	2·73	1·79	2·83	**·77**	1·48	2·78	5·44
4 ×4 ×⅝	·624	15·7	2·78	1·73	2·83	**·78**	1·50	2·37	4·62
4 ×4 ×½	·496	12·7	2·83	1·66	2·83	**·78**	1·52	1·94	3·73
4 ×4 ×⅜	·372	9·7	2·87	1·59	2·83	**·78**	1·54	1·49	2·85
3½×3½×⅝	·621	13·5	2·41	1·55	2·47	**·68**	1·30	1·77	3·97
3½×3½×½	·496	11·0	2·45	1·48	2·47	**·68**	1·32	1·46	3·23
3½×3½×⅜	·371	8·4	2·50	1·42	2·47	**·68**	1·34	1·12	2·47
3½×3½×5/16	·311	7·1	2·52	1·38	2·47	**·69**	1·35	·95	2·09
3 ×3 ×½	·496	9·3	2·08	1·31	2·12	**·58**	1·12	1·05	2·73
3 ×3 ×⅜	·370	7·1	2·12	1·24	2·12	**·58**	1·14	·80	2·09
3 ×3 ×5/16	·309	6·0	2·15	1·20	2·12	**·58**	1·15	·68	1·76
3 ×3 ×¼	·245	4·8	2·17	1·17	2·12	**·59**	1·16	·55	1·41
2½×2½×⅜	·372	5·9	1·74	1·07	1·77	**·49**	·94	·56	1·73
2½×2½×5/16	·311	5·0	1·77	1·04	1·77	**·49**	·95	·48	1·47
2½×2½×¼	·245	4·0	1·79	1·00	1·77	**·49**	·96	·38	1·18
2¼×2¼×⅜	·367	5·2	1·56	·98	1·59	**·44**	·84	·44	1·53
2¼×2¼×5/16	·306	4·4	1·58	·95	1·59	**·44**	·85	·38	1·29
2¼×2¼×¼	·246	3·6	1·60	·91	1·59	**·44**	·86	·31	1·06
2¼×2¼×3/16	·181	2·7	1·63	·88	1·59	**·44**	·87	·23	·79
2 ×2 ×5/16	·308	3·9	1·39	·86	1·41	**·39**	·75	·29	1·15
2 ×2 ×¼	·249	3·2	1·41	·83	1·41	**·39**	·76	·24	·94
2 ×2 ×3/16	·183	2·4	1·44	·79	1·41	**·39**	·77	·18	·71

Each weight per foot is for the shaft only. Weight of connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



STRUTS

Equal Angles

Single-bolted or single-riveted at ends

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Size $d \times b \times t$ inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS													
	2	3	4	5	6	7	8	9	10					
$3 \times 3 \times \frac{1}{2}$							*5·0*							
$3 \times 3 \times \frac{3}{8}$						*4·9*	*3·8*							
$3 \times 3 \times \frac{5}{16}$					*5·5*	*4·1*	*3·2*							
$3 \times 3 \times \frac{1}{4}$					*4·6*	*3·4*	*2·6*							
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$				*5·6*	*3·9*	*2·9*								
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$				*4·7*	*3·3*	*2·5*								
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$			*5·7*	*3·8*	*2·7*	*2·0*								
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{8}$				*4·0*	*2·8*									
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{5}{16}$				*3·4*	*2·4*									
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{1}{4}$			*4·2*	*2·8*	*1·9*									
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{16}$			*3·1*	*2·0*	*1·4*									
$2 \times 2 \times \frac{5}{16}$			*3·7*	*2·4*										
$2 \times 2 \times \frac{1}{4}$		*5·0*	*3·0*	*1·9*										
$2 \times 2 \times \frac{3}{16}$		*3·7*	*2·2*	*1·4*										

The above safe loads are calculated in accordance with Clause 30.*c*.(i) B.S. 449 : 1959, as amended.
In all cases the values represent the capacity of the angle; all loads are printed in italics as they all exceed the H.Y. Steel black bolt value.
Safe loads are tabulated for L/r values not exceeding 180, where L is the length centre to centre of intersections.

BASED ON
B.S. 449
1959
AS AMENDED
1962

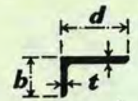
STRUTS

Equal Angles

DIMENSIONS AND PROPERTIES

Size $d \times b \times t$ inches	Actual Thick-ness inches	Weight per foot in lbs	Distance in inches			Radius of Gyration		Elastic Modulus	Area in square inches
			nx or *ny*	*nv*	*nu*	Axis *v-v*	Axis *u-u*	*x-x* or *y-y*	
$3 \times 3 \times \frac{1}{2}$	·496	9·3	2·08	1·31	2·12	·58	1·12	1·05	2·73
$3 \times 3 \times \frac{3}{8}$	·370	7·1	2·12	1·24	2·12	·58	1·14	·80	2·09
$3 \times 3 \times \frac{5}{16}$	·309	6·0	2·15	1·20	2·12	·58	1·15	·68	1·76
$3 \times 3 \times \frac{1}{4}$	·245	4·8	2·17	1·17	2·12	·59	1·16	·55	1·41
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	·372	5·9	1·74	1·07	1·77	·49	·94	·56	1·73
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	·311	5·0	1·77	1·04	1·77	·49	·95	·48	1·47
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	·245	4·0	1·79	1·00	1·77	·49	·96	·38	1·18
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{8}$	·367	5·2	1·56	·98	1·59	·44	·84	·44	1·53
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{5}{16}$	·306	4·4	1·58	·95	1·59	·44	·85	·38	1·29
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{1}{4}$	·246	3·6	1·60	·91	1·59	·44	·86	·31	1·06
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{16}$	·181	2·7	1·63	·88	1·59	·44	·87	·23	·79
$2 \times 2 \times \frac{5}{16}$	·308	3·9	1·39	·86	1·41	·39	·75	·29	1·15
$2 \times 2 \times \frac{1}{4}$	·249	3·2	1·41	·83	1·41	·39	·76	·24	·94
$2 \times 2 \times \frac{3}{16}$	·183	2·4	1·44	·79	1·41	·39	·77	·18	·71

Each weight per foot is for the shaft only. Weight of connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



STRUTS

Unequal Angles

BASED ON
B.S. 449
1959
AS AMENDED

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR HIGH YIELD STEEL

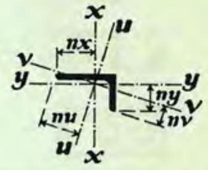
Size d×b×t inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30
9×4 ×⅞		115	97·2	63·8	42·9	30·4	22·6	*21·7*	*17·2*	*14·1*					
9×4 ×¾		100	85·1	56·2	37·8	26·9	20·0	*19·2*	*15·3*	*12·4*					
9×4 ×⅝		84·6	71·8	47·4	31·9	22·7	16·9	*16·2*	*12·9*	*10·5*					
9×4 ×½		68·7	58·6	38·9	26·3	18·7	13·9	*13·4*	*10·6*	*8·6*					
8×6 ×⅞				121	95·1	72·2	55·2	43·2	34·7	28·3	23·6	*24·9*	*21·2*	*18·3*	*16·0*
8×6 ×¾				105	83·2	63·3	48·5	38·0	30·5	24·9	20·7	*21·8*	*18·7*	*16·1*	*14·1*
8×6 ×⅝				88·8	70·1	53·3	40·8	32·0	25·6	20·9	17·4	*18·3*	*15·7*	*13·5*	*11·9*
8×6 ×½				71·9	57·0	43·4	33·3	26·1	20·9	17·1	14·2	*15·0*	*12·9*	*11·1*	*9·7*
8×4 ×¾		93·0	79·3	52·7	35·6	25·3	18·8	*18·1*	*14·3*	*11·7*					
8×4 ×⅝		78·5	66·9	44·5	30·0	21·4	15·9	*15·3*	*12·1*	*9·8*					
8×4 ×½		63·7	54·7	36·6	24·7	17·6	13·1	*12·6*	*10·0*	*8·1*					
7×3½×⅝	71·4	60·8	48·7	30·4	20·1	14·2	*13·1*	*10·1*	*8·0*						
7×3½×½	58·1	49·8	40·1	25·2	16·7	11·8	*10·9*	*8·4*	*6·6*						
7×3½×⅜	44·3	38·3	31·0	19·5	13·0	9·1	*8·4*	*6·5*	*5·1*						
6×4 ×¾		77·1	66·1	44·2	29·9	21·3	15·8	*15·2*	*12·1*	*9·8*					
6×4 ×⅝		65·1	55·8	37·3	25·2	18·0	13·4	*12·9*	*10·2*	*8·3*					
6×4 ×½		53·0	45·7	30·8	20·9	14·8	11·0	*10·7*	*8·4*	*6·9*					
6×3½×⅝	64·3	55·1	44·4	27·8	18·5	13·0	*12·1*	*9·2*	*7·3*						
6×3½×½	52·7	45·4	36·8	23·2	15·4	10·9	*10·1*	*7·7*	*6·1*						
6×3½×⅜	39·9	34·4	27·9	17·6	11·7	8·2	*7·6*	*5·8*	*4·6*						
6×3 ×⅝	54·6	42·5	32·1	19·2	12·5	*11·0*	*8·1*								
6×3 ×½	44·7	35·2	26·7	16·0	10·5	*9·1*	*6·7*								
6×3 ×⅜	34·2	26·9	20·4	12·2	7·9	*7·0*	*5·1*								
5×3½×⅝	57·1	49·0	39·4	24·7	16·4	11·6	*10·7*	*8·2*	*6·5*						
5×3½×½	46·5	39·9	32·1	20·1	13·4	9·4	*8·7*	*6·7*	*5·3*						
5×3½×⅜	35·5	30·6	24·8	15·6	10·4	7·3	*6·7*	*5·2*	*4·1*						
5×3 ×½	39·4	30·9	23·5	14·1	9·2	*8·0*	*5·9*								
5×3 ×⅜	30·4	24·1	18·4	11·1	7·2	*6·3*	*4·7*								
5×3 ×5/16	25·4	20·2	15·4	9·2	6·0	*5·3*	*3·9*								

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut centre to centre of intersections in accordance with clause 30.*c*.(i) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

STRUTS

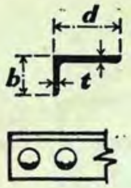
Unequal Angles



DIMENSIONS AND PROPERTIES

Size d×b×t inches	Actual Thickness inches	Weight per foot in lbs	Distance in inches				Radius of Gyration		Elastic Modulus		Area in square inches
			nx	*ny*	*nv*	*nu*	Axis *v-v*	Axis *u-u*	Axis *x-x*	Axis *y-y*	
9×4 ×⅞	·872	36·1	5·56	3·05	2·43	5·64	**·83**	2·91	15·57	3·52	10·62
9×4 ×¾	·745	31·2	5·61	3·10	2·45	5·68	**·84**	2·93	13·50	3·07	9·17
9×4 ×⅝	·622	26·3	5·66	3·15	2·47	5·72	**·84**	2·95	11·43	2·61	7·74
9×4 ×½	·495	21·2	5·72	3·20	2·50	5·76	**·85**	2·97	9·23	2·12	6·23
8×6 ×⅞	·870	39·0	5·40	4·40	2·97	5·51	**1·28**	2·76	13·30	7·86	11·47
8×6 ×¾	·746	33·8	5·45	4·44	2·96	5·53	**1·29**	2·79	11·57	6·85	9·93
8×6 ×⅝	·621	28·4	5·50	4·49	2·96	5·54	**1·29**	2·81	9·77	5·80	8·36
8×6 ×½	·495	22·9	5·55	4·54	2·96	5·56	**1·30**	2·83	7·90	4·71	6·73
8×4 ×¾	·747	28·7	5·06	3·05	2·37	5·14	**·85**	2·62	10·80	3·04	8·44
8×4 ×⅝	·623	24·2	5·11	3·10	2·39	5·17	**·85**	2·64	9·15	2·58	7·12
8×4 ×½	·496	19·5	5·17	3·15	2·41	5·21	**·86**	2·66	7·40	2·10	5·74
7×3½×⅝	·623	21·0	4·44	2·68	2·08	4·51	**·74**	2·30	6·92	1·94	6·18
7×3½×½	·497	17·0	4·50	2·73	2·09	4·54	**·75**	2·32	5·62	1·59	5·00
7×3½×⅜	·372	12·9	4·55	2·78	2·11	4·58	**·76**	2·33	4·28	1·22	3·79
6×4 ×¾	·748	23·6	3·93	2·93	2·12	4·04	**·86**	2·00	6·20	2·94	6·94
6×4 ×⅝	·622	19·9	3·98	2·97	2·12	4·06	**·86**	2·03	5·26	2·50	5·86
6×4 ×½	·496	16·1	4·03	3·02	2·12	4·08	**·87**	2·05	4·27	2·04	4·74
6×3½×⅝	·620	18·8	3·88	2·63	1·96	3·96	**·75**	1·99	5·12	1·90	5·53
6×3½×½	·497	15·3	3·93	2·67	1·97	3·99	**·76**	2·00	4·18	1·56	4·50
6×3½×⅜	·371	11·6	3·99	2·72	1·99	4·02	**·76**	2·02	3·18	1·20	3·41
6×3 ×⅝	·623	17·8	3·78	2·27	1·76	3·84	**·63**	1·95	5·00	1·40	5·24
6×3 ×½	·496	14·4	3·83	2·31	1·78	3·88	**·64**	1·97	4·06	1·14	4·24
6×3 ×⅜	·373	11·0	3·88	2·36	1·80	3·91	**·64**	1·99	3·11	·88	3·24
5×3½×⅝	·621	16·7	3·31	2·55	1·80	3·40	**·75**	1·69	3·60	1·86	4·91
5×3½×½	·498	13·6	3·36	2·60	1·79	3·42	**·75**	1·70	2·95	1·53	4·00
5×3½×⅜	·371	10·3	3·41	2·65	1·80	3·44	**·76**	1·72	2·24	1·17	3·03
5×3 ×½	·496	12·7	3·26	2·26	1·66	3·32	**·64**	1·66	2·86	1·12	3·73
5×3 ×⅜	·372	9·7	3·31	2·30	1·67	3·35	**·65**	1·68	2·19	·86	2·85
5×3 ×5/16	·308	8·1	3·34	2·33	1·68	3·37	**·65**	1·69	1·83	·72	2·38

Each weight per foot is for the shaft only. Weight of connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



STRUTS

Unequal Angles

BASED ON
B.S. 449
1959
AS AMENDED

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR HIGH YIELD STEEL

Size d×b×t inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17
4 × 3½ × ⅝			49·0	41·2	32·6	25·4	20·1	16·2	13·3	11·1	9·3	*10·0*	*8·6*	*7·5*	*5·9*
4 × 3½ × ½			39·9	33·5	26·5	20·7	16·4	13·2	10·8	9·0	7·6	*8·1*	*7·0*	*6·1*	*4·8*
4 × 3½ × ⅜			30·5	25·7	20·3	15·8	12·5	10·1	8·2	6·9	5·8	*6·2*	*5·4*	*4·7*	*3·6*
4 × 3½ × 5/16			25·6	21·7	17·2	13·5	10·7	8·6	7·0	5·8	4·9	*5·3*	*4·6*	*4·0*	*3·1*
4 × 3 × ½			33·7	26·2	19·8	15·1	11·8	9·4	7·7	6·4	*6·7*	*5·7*	*5·0*	*4·3*	
4 × 3 × ⅜			26·1	20·5	15·5	11·9	9·3	7·4	6·0	5·0	*5·3*	*4·5*	*3·9*	*3·4*	
4 × 3 × 5/16			22·1	17·3	13·1	10·1	7·8	6·3	5·1	4·2	*4·5*	*3·8*	*3·3*	*2·9*	
4 × 2½ × ⅜		26·1	20·4	14·7	10·7	8·0	6·2	4·9	*5·0*	*4·2*	*3·5*	*3·0*			
4 × 2½ × 5/16		21·8	17·0	12·3	8·9	6·7	5·2	4·1	*4·2*	*3·5*	*2·9*	*2·5*			
4 × 2½ × ¼		17·8	13·9	10·0	7·2	5·4	4·2	3·4	*3·4*	*2·8*	*2·4*	*2·0*			
3½ × 3 × ½			30·8	23·8	17·9	13·6	10·6	8·5	6·9	*7·2*	*6·0*	*5·2*	*4·5*	*3·9*	
3½ × 3 × ⅜			23·5	18·2	13·7	10·4	8·1	6·4	5·3	*5·5*	*4·6*	*3·9*	*3·4*	*3·0*	
3½ × 3 × 5/16			19·6	15·2	11·4	8·6	6·7	5·4	4·4	*4·6*	*3·8*	*3·3*	*2·8*	*2·5*	
3½ × 2½ × ⅜		23·6	18·1	13·0	9·4	7·1	5·4	4·3	*4·4*	*3·6*	*3·1*				
3½ × 2½ × 5/16		19·9	15·3	11·0	7·9	5·9	4·6	3·6	*3·7*	*3·1*	*2·6*				
3½ × 2½ × ¼		16·1	12·5	9·0	6·5	4·9	3·8	3·0	*3·1*	*2·5*	*2·1*	*1·8*			
3 × 2½ × ⅜		21·3	16·2	11·5	8·3	6·2	4·8	3·8	*3·9*	*3·2*	*2·7*				
3 × 2½ × 5/16		18·1	13·7	9·7	7·0	5·3	4·1	3·2	*3·3*	*2·7*	*2·3*				
3 × 2½ × ¼		14·5	11·0	7·8	5·6	4·2	3·3	2·6	*2·6*	*2·2*	*1·8*				
3 × 2 × ⅜		16·5	11·0	7·4	5·3	3·9	*3·7*	*3·0*	*2·4*						
3 × 2 × 5/16		14·0	9·3	6·3	4·5	3·3	*3·2*	*2·5*	*2·0*						
3 × 2 × ¼		11·2	7·5	5·0	3·6	2·6	*2·5*	*2·0*	*1·6*						
2½ × 2 × ⅜		14·2	9·3	6·3	4·4	3·3	*3·2*	*2·5*	*2·0*						
2½ × 2 × 5/16		12·0	7·9	5·3	3·7	2·8	*2·7*	*2·1*	*1·7*						
2½ × 2 × ¼		9·8	6·4	4·3	3·1	2·3	*2·2*	*1·7*	*1·4*						
2½ × 2 × 3/16		7·5	5·0	3·4	2·4	1·8	*1·7*	*1·3*	*1·1*						
2½ × 1½ × ¼	9·9	5·9	3·5	2·3	*2·0*	*1·5*									
2½ × 1½ × 3/16	7·4	4·4	2·6	1·7	*1·5*	*1·1*									
2 × 1½ × ¼	8·3	4·9	2·9	1·9	*1·7*	*1·2*									
2 × 1½ × 3/16	6·5	3·9	2·3	1·5	*1·1*	*0·99*									

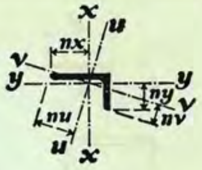
The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut centre to centre of intersections in accordance with clause 30.*c*.(i) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

STRUTS

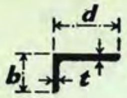
Unequal Angles

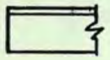
DIMENSIONS AND PROPERTIES



Size d×b×t inches	Actual Thick-ness inches	Weight per foot in lbs	Distance in inches				Radius of Gyration		Elastic Modulus		Area in square inches
			nx	*ny*	*nv*	*nu*	Axis *v-v*	Axis *u-u*	Axis *x-x*	Axis *y-y*	
4 × 3½ × ⅝	·623	14·6	2·71	2·46	1·51	2·80	**·72**	1·41	2·32	1·81	4·30
4 × 3½ × ½	·498	11·9	2·76	2·51	1·49	2·80	**·72**	1·43	1·90	1·49	3·50
4 × 3½ × ⅜	·374	9·1	2·81	2·56	1·48	2·81	**·72**	1·45	1·47	1·15	2·68
4 × 3½ × 5/16	·309	7·6	2·83	2·58	1·47	2·82	**·73**	1·46	1·23	·96	2·23
4 × 3 × ½	·496	11·0	2·68	2·18	1·46	2·75	**·63**	1·37	1·85	1·09	3·23
4 × 3 × ⅜	·371	8·4	2·73	2·23	1·46	2·77	**·64**	1·39	1·42	·84	2·47
4 × 3 × 5/16	·311	7·1	2·76	2·25	1·46	2·78	**·64**	1·40	1·20	·71	2·09
4 × 2½ × ⅜	·373	7·8	2·64	1·89	1·35	2·69	**·54**	1·34	1·39	·58	2·29
4 × 2½ × 5/16	·308	6·5	2·67	1·91	1·36	2·70	**·54**	1·35	1·16	·49	1·91
4 × 2½ × ¼	·248	5·3	2·70	1·94	1·37	2·72	**·54**	1·35	·94	·40	1·56
3½ × 3 × ½	·499	10·2	2·38	2·13	1·30	2·45	**·62**	1·23	1·43	1·08	3·00
3½ × 3 × ⅜	·373	7·8	2·43	2·18	1·29	2·45	**·62**	1·25	1·10	·83	2·29
3½ × 3 × 5/16	·308	6·5	2·46	2·21	1·29	2·46	**·62**	1·26	·92	·69	1·91
3½ × 2½ × ⅜	·370	7·1	2·35	1·85	1·25	2·40	**·53**	1·19	1·06	·57	2·09
3½ × 2½ × 5/16	·309	6·0	2·38	1·87	1·25	2·41	**·53**	1·20	·90	·48	1·76
3½ × 2½ × ¼	·245	4·8	2·41	1·90	1·26	2·42	**·54**	1·21	·72	·39	1·41
3 × 2½ × ⅜	·372	6·5	2·06	1·80	1·10	2·09	**·52**	1·05	·79	·56	1·91
3 × 2½ × 5/16	·311	5·5	2·08	1·83	1·10	2·10	**·52**	1·06	·67	·48	1·62
3 × 2½ × ¼	·246	4·4	2·11	1·85	1·10	2·11	**·52**	1·07	·54	·38	1·30
3 × 2 × ⅜	·372	5·9	1·97	1·46	1·06	2·02	**·43**	1·00	·77	·37	1·73
3 × 2 × 5/16	·311	5·0	1·99	1·49	1·06	2·03	**·43**	1·01	·66	·31	1·47
3 × 2 × ¼	·245	4·0	2·02	1·51	1·06	2·05	**·43**	1·02	·53	·25	1·18
2½ × 2 × ⅜	·367	5·2	1·68	1·42	·94	1·73	**·42**	·86	·53	·35	1·53
2½ × 2 × 5/16	·306	4·4	1·70	1·45	·94	1·74	**·42**	·87	·45	·30	1·29
2½ × 2 × ¼	·246	3·6	1·72	1·47	·93	1·74	**·42**	·88	·37	·25	1·06
2½ × 2 × 3/16	·181	2·7	1·75	1·50	·93	1·75	**·43**	·89	·28	·19	·79
2½ × 1½ × ¼	·249	3·2	1·63	1·13	·83	1·67	**·32**	·83	·36	·14	·94
2½ × 1½ × 3/16	·183	2·4	1·66	1·15	·84	1·68	**·32**	·84	·27	·11	·71
2 × 1½ × ¼	·241	2·7	1·35	1·09	·73	1·38	**·32**	·68	·23	·13	·79
2 × 1½ × 3/16	·184	2·1	1·37	1·12	·73	1·39	**·32**	·69	·18	·10	·62

Each weight per foot is for the shaft only. Weight of connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.





STRUTS

Unequal Angles

BASED ON
B.S. 449
1959
AS AMENDED

Single-bolted or single-riveted at ends

SAFE LOADS FOR HIGH YIELD STEEL

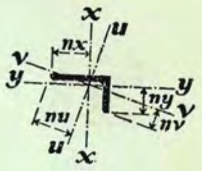
Size $d\times b\times t$ inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS													
	2	3	4	5	6	7	8	9	10					
3½×2½×⅜				*7·8*	*5·5*	*4·1*								
3½×2½×5/16				*6·5*	*4·7*	*3·5*								
3½×2½×¼				*5·4*	*3·9*	*2·9*	*2·2*							
3 ×2½×⅜					*4·9*	*3·6*								
3 ×2½×5/16				*5·8*	*4·1*	*3·1*								
3 ×2½×¼				*4·7*	*3·3*	*2·5*								
3 ×2 ×⅜			*6·6*	*4·3*	*3·1*									
3 ×2 ×5/16			*5·6*	*3·7*	*2·6*									
3 ×2 ×¼			*4·5*	*3·0*	*2·1*									
2½×2 ×⅜			*5·6*	*3·7*	2·6									
2½×2 ×5/16			*4·7*	*3·1*	2·2									
2½×2 ×¼		*6·3*	*3·9*	*2·5*	1·8									
2½×2 ×3/16		*4·8*	*3·0*	*2·0*	1·4									
2½×1½×¼	*6·7*	*3·5*	*2·0*											
2½×1½×3/16	*5·0*	*2·6*	*1·5*											
2 ×1½×¼	*5·6*	*2·9*	*1·7*											
2 ×1½×3/16	*4·4*	*2·3*	*1·3*											

The above safe loads are calculated in accordance with Clause 30.*c*.(i) B.S. 449 : 1959, as amended.
In all cases the values represent the capacity of the angle; loads printed in italics exceed the H.Y. Steel black bolt value.
Safe loads are tabulated for *L*/*r* values not exceeding 180, where *L* is the length centre to centre of intersections.

BASED ON
B.S. 449
1959
AS AMENDED
1962

STRUTS

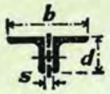
Unequal Angles



DIMENSIONS AND PROPERTIES

Size $d\times b\times t$ inches	Actual Thickness inches	Weight per foot in lbs	Distance in inches				Radius of Gyration		Elastic Modulus		Area in square inches
			nx	*ny*	*nv*	*nu*	Axis *v-v*	Axis *u-u*	Axis *x-x*	Axis *y-y*	
3½×2½×⅜	·370	7·1	2·35	1·85	1·25	2·40	**·53**	1·19	1·06	·57	2·09
3½×2½×5/16	·309	6·0	2·38	1·87	1·25	2·41	**·53**	1·20	·90	·48	1·76
3½×2½×¼	·245	4·8	2·41	1·90	1·26	2·42	**·54**	1·21	·72	·39	1·41
3 ×2½×⅜	·372	6·5	2·06	1·80	1·10	2·09	**·52**	1·05	·79	·56	1·91
3 ×2½×5/16	·311	5·5	2·08	1·83	1·10	2·10	**·52**	1·06	·67	·48	1·62
3 ×2½×¼	·246	4·4	2·11	1·85	1·10	2·11	**·52**	1·07	·54	·38	1·30
3 ×2 ×⅜	·372	5·9	1·97	1·46	1·06	2·02	**·43**	1·00	·77	·37	1·73
3 ×2 ×5/16	·311	5·0	1·99	1·49	1·06	2·03	**·43**	1·01	·66	·31	1·47
3 ×2 ×¼	·245	4·0	2·02	1·51	1·06	2·05	**·43**	1·02	·53	·25	1·18
2½×2 ×⅜	·367	5·2	1·68	1·42	·94	1·73	**·42**	·86	·53	·35	1·53
2½×2 ×5/16	·306	4·4	1·70	1·45	·94	1·74	**·42**	·87	·45	·30	1·29
2½×2 ×¼	·246	3·6	1·72	1·47	·93	1·74	**·42**	·88	·37	·25	1·06
2½×2 ×3/16	·181	2·7	1·75	1·50	·93	1·75	**·43**	·89	·28	·19	·79
2½×1½×¼	·249	3·2	1·63	1·13	·83	1·67	**·32**	·83	·36	·14	·94
2½×1½×3/16	·183	2·4	1·66	1·15	·84	1·68	**·32**	·84	·27	·11	·71
2 ×1½×¼	·241	2·7	1·35	1·09	·73	1·38	**·32**	·68	·23	·13	·79
2 ×1½×3/16	·184	2·1	1·37	1·12	·73	1·39	**·32**	·69	·18	·10	·62

Each weight per foot is for the shaft only. Weight of connections etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STRUTS

BASED ON
B.S. 449
1959
AS AMENDED

Two Equal Angles back to back
Gusset between Angles
Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR HIGH YIELD STEEL

Size $d \times b$ inches	SAFE LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
	4	6	8	10	12	14	16	18	20	24	28	32	36	40	44
$8 \times 16\frac{5}{8}$					333	294	252	212	179	129	97·1	75·3	59·9	*61·0*	*50·5*
$8 \times 16\frac{5}{8}$					296	262	225	190	160	116	87·0	67·5	53·8	*54·7*	*45·3*
$8 \times 16\frac{5}{8}$					256	227	195	165	139	101	75·7	58·7	46·9	*47·7*	*39·6*
$8 \times 16\frac{5}{8}$					216	192	166	140	119	86·2	64·7	50·1	39·9	*40·6*	*33·7*
$6 \times 12\frac{1}{2}$			229	199	162	129	103	83·0	68·2	48·2	*44·8*	*34·3*	*27·3*		
$6 \times 12\frac{1}{2}$			199	173	141	112	89·7	72·6	59·7	42·2	*39·2*	*30·2*	*24·0*		
$6 \times 12\frac{1}{2}$			169	148	121	96·6	77·2	62·6	51·4	36·4	*33·8*	*25·9*	*20·7*		
$6 \times 12\frac{1}{2}$			136	119	98·3	78·6	62·8	50·9	41·9	29·6	*27·5*	*21·2*	*16·8*		
$6 \times 12\frac{1}{2}$			104	91·3	75·5	60·5	48·5	39·4	32·4	22·9	17·0	*16·4*	*13·0*		
$5 \times 10\frac{1}{2}$			146	115	86·8	66·4	51·9	41·7	34·0	*29·9*	*22·1*				
$5 \times 10\frac{1}{2}$			124	98·3	74·8	57·4	44·9	36·0	29·4	*25·8*	*19·0*				
$5 \times 10\frac{1}{2}$			101	80·3	61·1	46·9	36·7	29·5	24·1	*21·1*	*15·7*				
$5 \times 10\frac{1}{2}$			78·0	62·3	47·7	36·6	28·8	23·0	18·8	*16·6*	*12·2*	*9·4*			
$4 \times 8\frac{3}{8}$		119	87·8	61·7	44·5	33·4	25·8	*25·7*	*20·9*	*14·6*					
$4 \times 8\frac{3}{8}$		102	76·1	53·8	39·0	29·2	22·6	18·0	*18·3*	*12·8*					
$4 \times 8\frac{3}{8}$		82·8	62·3	44·2	32·0	24·0	18·6	14·8	*15·1*	*10·6*					
$4 \times 8\frac{3}{8}$		63·5	48·1	34·2	24·8	18·6	14·4	11·5	*11·7*	*8·1*					
$3\frac{1}{2} \times 7\frac{3}{8}$		77·8	52·9	36·0	25·6	19·1	*18·4*	*14·6*	*11·9*						
$3\frac{1}{2} \times 7\frac{3}{8}$		64·0	43·8	29·8	21·2	15·9	*15·3*	*12·2*	*9·8*						
$3\frac{1}{2} \times 7\frac{3}{8}$		49·3	33·9	23·1	16·5	12·3	*11·9*	*9·4*	*7·6*						
$3\frac{1}{2} \times 7\frac{3}{8}$		42·1	29·1	19·9	14·2	10·6	8·1	*8·1*	*6·6*						
$3 \times 6\frac{5}{16}$	63·9	44·4	28·0	18·6	13·1	*12·1*	*9·3*	*7·4*							
$3 \times 6\frac{5}{16}$	48·9	34·4	21·8	14·4	10·2	*9·4*	*7·2*	*5·7*							
$3 \times 6\frac{5}{16}$	41·6	29·6	18·8	12·5	8·8	*8·1*	*6·3*	*5·0*							
$3 \times 6\frac{5}{16}$	33·5	24·1	15·3	10·2	7·2	*6·7*	*5·1*	*4·1*							
$2\frac{1}{2} \times 5\frac{5}{16}$	36·5	21·7	13·0	8·5	*7·4*	*5·5*									
$2\frac{1}{2} \times 5\frac{5}{16}$	31·3	18·8	11·3	7·3	*6·4*	*4·7*									
$2\frac{1}{2} \times 5\frac{5}{16}$	25·0	15·0	9·0	5·9	*5·1*	*3·8*									
$2\frac{1}{4} \times 4\frac{13}{16}$	28·9	15·8	9·2	6·0	*5·2*										
$2\frac{1}{4} \times 4\frac{13}{16}$	24·9	13·7	8·0	5·2	*4·5*	*3·3*									
$2\frac{1}{4} \times 4\frac{13}{16}$	20·3	11·1	6·5	4·2	*3·7*	*2·7*									
$2\frac{1}{4} \times 4\frac{13}{16}$	15·4	8·5	5·0	3·2	*2·8*	*2·1*									
$2 \times 4\frac{5}{16}$	18·9	9·6	5·6	*4·5*	*3·1*										
$2 \times 4\frac{5}{16}$	15·6	7·9	4·6	*3·7*	*2·6*										
$2 \times 4\frac{5}{16}$	11·9	6·1	3·5	*2·8*	*2·0*										

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the "effective length" of the strut in accordance with clause 30.*c.*(ii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

COMPOUND STRUTS

Two Equal Angles back to back

COMPOSITION AND PROPERTIES

Composed of Two Equal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
$8 \times 8 \times 1$	·996	102·0	$\frac{5}{8}$	5·64	30·01	3·61	**2·43**	47·03	31·38
$8 \times 8 \times \frac{7}{8}$	·871	90·0	$\frac{5}{8}$	5·69	25·48	3·59	**2·45**	40·96	27·82
$8 \times 8 \times \frac{3}{4}$	·746	77·8	$\frac{5}{8}$	5·74	22·88	3·56	**2·46**	34·94	24·16
$8 \times 8 \times \frac{5}{8}$	·621	65·4	$\frac{5}{8}$	5·79	19·23	3·54	**2·48**	28·96	20·39
$6 \times 6 \times \frac{7}{8}$	·872	66·2	$\frac{1}{2}$	4·19	19·48	2·74	**1·81**	23·40	15·15
$6 \times 6 \times \frac{3}{4}$	·747	57·4	$\frac{1}{2}$	4·23	16·88	2·72	**1·82**	19·92	13·21
$6 \times 6 \times \frac{5}{8}$	·623	48·4	$\frac{1}{2}$	4·28	14·24	2·69	**1·84**	16·52	11·21
$6 \times 6 \times \frac{1}{2}$	·496	39·0	$\frac{1}{2}$	4·33	11·48	2·67	**1·85**	13·07	9·09
$6 \times 6 \times \frac{3}{8}$	·371	29·6	$\frac{1}{2}$	4·38	8·70	2·64	**1·87**	9·71	6·92
$5 \times 5 \times \frac{3}{4}$	·748	47·2	$\frac{1}{2}$	3·48	13·89	2·32	**1·50**	14·21	8·97
$5 \times 5 \times \frac{5}{8}$	·622	39·8	$\frac{1}{2}$	3·53	11·71	2·29	**1·52**	11·72	7·62
$5 \times 5 \times \frac{1}{2}$	·496	32·2	$\frac{1}{2}$	3·58	9·47	2·27	**1·53**	9·27	6·20
$5 \times 5 \times \frac{3}{8}$	·373	24·6	$\frac{1}{2}$	3·63	7·23	2·24	**1·55**	6·91	4·76
$4 \times 4 \times \frac{3}{4}$	·749	37·0	$\frac{3}{8}$	2·73	10·89	1·87	**1·18**	9·13	5·56
$4 \times 4 \times \frac{5}{8}$	·624	31·4	$\frac{3}{8}$	2·78	9·23	1·85	**1·20**	7·52	4·75
$4 \times 4 \times \frac{1}{2}$	·496	25·4	$\frac{3}{8}$	2·83	7·47	1·82	**1·21**	5·92	3·87
$4 \times 4 \times \frac{3}{8}$	·372	19·4	$\frac{3}{8}$	2·87	5·70	1·80	**1·22**	4·39	2·97
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{8}$	·621	27·0	$\frac{3}{8}$	2·41	7·94	1·65	**1·04**	5·85	3·55
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$	·496	22·0	$\frac{3}{8}$	2·45	6·47	1·62	**1·05**	4·62	2·91
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$	·371	16·8	$\frac{3}{8}$	2·50	4·94	1·60	**1·06**	3·41	2·24
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$	·311	14·2	$\frac{3}{8}$	2·52	4·18	1·58	**1·07**	2·84	1·90
$3 \times 3 \times \frac{1}{2}$	·496	18·6	$\frac{5}{16}$	2·08	5·47	1·40	**·89**	3·40	2·09
$3 \times 3 \times \frac{3}{8}$	·370	14·2	$\frac{5}{16}$	2·12	4·17	1·37	**·90**	2·49	1·61
$3 \times 3 \times \frac{5}{16}$	·309	12·0	$\frac{5}{16}$	2·15	3·53	1·36	**·91**	2·06	1·36
$3 \times 3 \times \frac{1}{4}$	·245	9·6	$\frac{5}{16}$	2·17	2·83	1·34	**·92**	1·62	1·10
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	·372	11·8	$\frac{5}{16}$	1·74	3·47	1·18	**·75**	1·82	1·12
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·77	2·94	1·17	**·76**	1·51	·95
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	·245	8·0	$\frac{5}{16}$	1·79	2·35	1·15	**·76**	1·18	·77
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{8}$	·367	10·4	$\frac{5}{16}$	1·56	3·06	1·08	**·67**	1·48	·88
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·58	2·59	1·07	**·68**	1·23	·75
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{1}{4}$	·246	7·2	$\frac{5}{16}$	1·60	2·11	1·05	**·68**	·98	·62
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·63	1·58	1·04	**·69**	·71	·46
$2 \times 2 \times \frac{5}{16}$	·308	7·8	$\frac{5}{16}$	1·39	2·29	·97	**·60**	1·00	·59
$2 \times 2 \times \frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·41	1·89	·96	**·60**	·80	·49
$2 \times 2 \times \frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·44	1·41	·94	**·61**	·58	·37

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

COMPOUND STRUTS

BASED ON
B.S. 449
1959
AS AMENDED

Two Unequal Angles long legs back to back
Gusset between Angles

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR HIGH YIELD STEEL

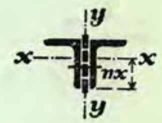
Size *d*×*b* inches	SAFE LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
	6	8	10	12	14	16	18	20	22	24	28	32	36	40	44
9× 8⅝		235	192	149	115	90·5	72·7	59·6	49·5	41·9	*38·6*	*29·9*			
9× 8⅝		200	162	125	96·2	75·5	60·6	49·6	41·2	*43·6*	*32·2*	*24·8*			
9× 8⅝		168	135	103	79·4	62·3	50·0	40·8	34·0	*36·0*	*26·5*	*20·5*			
9× 8⅝		133	106	80·5	61·7	48·4	38·8	31·7	26·3	*27·8*	*20·6*				
8×12⅝				259	231	200	169	143	122	104	78·3	60·7	48·3	*49·3*	*40·9*
8×12⅝				225	202	175	149	126	107	91·6	68·8	53·4	42·6	*43·3*	*35·9*
8×12⅝				190	171	148	126	107	91·2	78·1	58·7	45·7	36·4	*37·0*	*30·7*
8×12⅝				152	136	118	100	84·7	71·9	61·6	46·3	35·9	28·6	*29·2*	*24·2*
8× 8⅝		189	156	122	94·5	74·5	59·8	49·1	40·9	34·6	*31·9*	*24·7*			
8× 8⅝		158	129	99·8	77·2	60·7	48·8	40·0	33·2	28·1	*25·9*	*20·0*			
8× 8⅝		125	101	78·1	60·2	47·3	37·9	31·0	25·8	*27·3*	*20·1*	*15·5*			
7× 7⅝		127	98·2	73·8	56·3	43·9	35·1	28·7	*29·9*	*25·1*	*18·7*				
7× 7⅝		101	77·1	57·6	43·9	34·2	27·4	22·3	*23·2*	*19·6*	*14·5*				
7× 7⅝	90·4	75·1	56·8	42·2	32·0	24·9	19·9	16·3	*16·9*	*14·3*	*10·5*				
6× 8½		160	136	108	85·1	67·5	54·4	44·6	37·3	31·5	*29·1*	*22·4*	*17·8*		
6× 8½		134	113	89·1	69·7	55·1	44·5	36·5	30·3	25·7	*23·8*	*18·3*			
6× 8½		107	89·8	70·8	55·2	43·7	35·1	28·8	24·0	20·3	*18·8*	*14·5*			
6× 7½		114	88·6	66·8	50·9	39·8	31·9	26·0	21·6	*22·8*	*16·9*				
6× 7½		91·9	70·8	53·0	40·5	31·5	25·3	20·6	*21·4*	*18·1*	*13·3*				
6× 7½		68·4	52·1	38·8	29·5	23·0	18·4	15·0	*15·6*	*13·2*	*9·7*				
6× 6½	118	91·2	65·4	47·6	35·7	27·7	22·0	*22·5*	*18·7*	*15·8*					
6× 6½	94·3	71·5	50·8	36·8	27·6	21·4	17·0	*17·3*	*14·4*	*12·2*					
6× 6½	71·3	53·4	37·7	27·3	20·4	15·9	12·6	*12·9*	*10·7*	*8·9*					
5× 7½		106	84·7	64·7	49·8	39·1	31·3	25·6	21·3	*22·5*	*16·6*	*12·8*			
5× 7½		85·0	67·2	51·1	39·2	30·7	24·6	20·1	16·7	*17·6*	*13·0*				
5× 7½		63·4	49·5	37·4	28·6	22·4	17·9	14·7	12·2	*12·8*	*9·5*				
5× 6½	85·8	67·6	49·1	35·9	27·0	21·0	16·7	*17·1*	*14·2*	*11·9*					
5× 6½	64·7	50·1	36·1	26·3	19·7	15·3	12·2	*12·4*	*10·3*	*8·7*					
5× 6½	53·8	41·5	29·7	21·6	16·3	12·6	10·0	*10·2*	*8·4*	*7·1*					

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the "effective length" of the strut in accordance with clause 30.*c*.(ii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

COMPOUND STRUTS

Two Unequal Angles
Long Legs back to back



COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
9×4 × ⅞	·872	72·2	⅝	5·56	21·23	**1·61**	2·86	12·83	31·15
9×4 × ¾	·745	62·4	⅝	5·61	18·34	**1·58**	2·88	10·67	27·00
9×4 × ⅝	·622	52·6	⅝	5·66	15·48	**1·56**	2·89	8·69	22·86
9×4 × ½	·495	42·4	⅝	5·72	12·46	**1·53**	2·91	6·74	18·46
8×6 × ⅞	·870	78·0	⅝	5·40	22·94	2·58	**2·50**	24·27	26·60
8×6 × ¾	·746	67·6	⅝	5·45	19·87	2·56	**2·52**	20·63	23·14
8×6 × ⅝	·621	56·8	⅝	5·50	16·71	2·54	**2·54**	17·03	19·54
8×6 × ½	·495	45·8	⅝	5·55	13·46	**2·51**	2·55	13·46	15·80
8×4 × ¾	·747	57·4	⅝	5·06	16·88	**1·64**	2·55	10·52	21·60
8×4 × ⅝	·623	48·4	⅝	5·11	14·24	**1·61**	2·56	8·58	18·30
8×4 × ½	·496	39·0	⅝	5·17	11·48	**1·58**	2·58	6·68	14·80
7×3½× ⅝	·623	42·0	⅝	4·44	12·36	**1·46**	2·23	6·88	13·84
7×3½× ½	·497	34·0	⅝	4·50	10·00	**1·43**	2·25	5·34	11·23
7×3½× ⅜	·372	25·8	⅝	4·55	7·59	**1·40**	2·27	3·89	8·55
6×4 × ¾	·748	47·2	½	3·93	13·89	**1·73**	1·87	9·77	12·40
6×4 × ⅝	·622	39·8	½	3·98	11·71	**1·70**	1·89	7·99	10·51
6×4 × ½	·496	32·2	½	4·03	9·47	**1·68**	1·91	6·26	8·54
6×3½× ⅝	·620	37·6	½	3·88	11·05	**1·47**	1·90	6·39	10·24
6×3½× ½	·497	30·6	½	3·93	8·99	**1·45**	1·91	5·01	8·37
6×3½× ⅜	·371	23·2	½	3·99	6·82	**1·42**	1·93	3·65	6·36
6×3 × ⅝	·623	35·6	½	3·78	10·47	**1·25**	1·90	5·07	10·00
6×3 × ½	·496	28·8	½	3·83	8·47	**1·22**	1·92	3·91	8·12
6×3 × ⅜	·373	22·0	½	3·88	6·47	**1·20**	1·93	2·85	6·23
5×3½× ⅝	·621	33·4	½	3·31	9·82	**1·55**	1·56	6·28	7·19
5×3½× ½	·498	27·2	½	3·36	8·00	**1·52**	1·57	4·94	5·89
5×3½× ⅜	·371	20·6	½	3·41	6·06	**1·49**	1·59	3·61	4·49
5×3 × ½	·496	25·4	½	3·26	7·47	**1·29**	1·58	3·82	5·72
5×3 × ⅜	·372	19·4	½	3·31	5·70	**1·26**	1·60	2·79	4·38
5×3 × 5/16	·308	16·2	½	3·34	4·76	**1·25**	1·60	2·28	3·67

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

COMPOUND STRUTS

Two Unequal Angles long legs back to back
Gusset between Angles
Two or more rivets or bolts in line, or welded, at ends

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Size $d \times b$ inches	SAFE LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
$4 \times 7\frac{3}{8}$				95·2	83·9	71·7	60·4	50·8	36·8	27·6	21·4	17·0	*17·3*	*14·4*	*12·1*
$4 \times 7\frac{3}{8}$				78·3	69·5	59·7	50·4	42·6	30·9	23·2	18·0	14·3	*14·6*	*12·1*	*10·2*
$4 \times 7\frac{3}{8}$				60·1	53·5	46·1	39·0	33·0	24·0	18·0	13·9	11·1	*11·3*	*9·3*	*7·8*
$4 \times 7\frac{3}{8}$				50·5	45·1	38·9	33·0	27·9	20·3	15·3	11·8	9·4	*9·6*	*7·9*	*6·7*
$4 \times 6\frac{3}{8}$				72·7	64·7	55·8	47·2	39·9	29·0	21·8	16·9	13·4	*13·7*	*11·3*	*9·5*
$4 \times 6\frac{3}{8}$				55·8	49·8	43·0	36·5	30·9	22·5	16·9	13·1	10·4	*10·6*	*8·8*	*7·4*
$4 \times 6\frac{3}{8}$				47·4	42·5	36·8	31·3	26·5	19·3	14·5	11·2	8·9	*9·1*	*7·5*	*6·3*
$4 \times 5\frac{3}{8}$			52·2	45·7	38·3	31·5	25·9	21·5	15·3	11·4	*11·0*	*8·7*	*7·1*	*5·8*	
$4 \times 5\frac{3}{8}$			43·2	37·5	31·2	25·5	20·9	17·4	12·4	9·2	*8·8*	*7·0*	*5·7*		
$4 \times 5\frac{3}{8}$			34·9	30·2	25·0	20·4	16·7	13·9	9·8	7·3	*7·0*	*5·6*	*4·5*		
$3\frac{1}{2} \times 6\frac{3}{8}$			68·8	60·4	50·8	41·8	34·4	28·6	20·4	15·2	11·8	*11·7*	*9·5*	*7·8*	
$3\frac{1}{2} \times 6\frac{3}{8}$			52·7	46·5	39·3	32·4	26·7	22·2	15·9	11·8	9·1	*9·1*	*7·3*	*6·1*	
$3\frac{1}{2} \times 6\frac{3}{8}$			44·3	39·2	33·2	27·5	22·7	18·9	13·5	10·1	7·7	*7·7*	*6·3*	*5·2*	
$3\frac{1}{2} \times 5\frac{3}{8}$			48·2	42·7	36·2	29·9	24·7	20·6	14·7	11·0	8·4	*8·4*	*6·8*	*5·6*	
$3\frac{1}{2} \times 5\frac{3}{8}$			40·6	35·9	30·3	25·0	20·6	17·1	12·2	9·1	7·0	*7·0*	*5·6*	*4·7*	
$3\frac{1}{2} \times 5\frac{3}{8}$			32·4	28·5	24·0	19·7	16·2	13·5	9·6	7·1	5·5	*5·5*	*4·4*	*3·7*	
$3 \times 5\frac{5}{16}$		45·2	39·6	32·5	25·9	20·7	16·8	13·8	9·7	*9·0*	*6·9*	*5·5*			
$3 \times 5\frac{5}{16}$		38·4	33·8	27·8	22·3	17·8	14·5	11·9	8·4	*7·8*	*6·0*	*4·7*			
$3 \times 5\frac{5}{16}$		30·8	27·1	22·3	17·9	14·3	11·6	9·5	6·7	*6·2*	*4·8*	*3·8*			
$3 \times 4\frac{5}{16}$		40·5	34·9	28·2	22·3	17·7	14·3	11·8	8·3	*7·6*	*5·9*	*4·6*			
$3 \times 4\frac{5}{16}$		34·0	28·9	23·1	18·2	14·4	11·6	9·5	6·7	*6·2*	*4·7*	*3·8*			
$3 \times 4\frac{5}{16}$		27·0	22·8	18·2	14·3	11·3	9·1	7·4	5·2	*4·8*	*3·7*				
$2\frac{1}{2} \times 4\frac{5}{16}$		32·5	25·7	19·6	15·0	11·7	9·4	7·6	*6·7*	*4·9*					
$2\frac{1}{2} \times 4\frac{5}{16}$		27·8	22·1	16·9	13·0	10·2	8·1	6·6	*5·8*	*4·3*	*3·3*				
$2\frac{1}{2} \times 4\frac{5}{16}$		22·9	18·3	14·1	10·8	8·4	6·8	5·5	*4·9*	*3·6*	*2·7*				
$2\frac{1}{2} \times 4\frac{5}{16}$		17·3	13·9	10·7	8·2	6·5	5·2	4·2	*3·7*	*2·7*	*2·1*				
$2\frac{1}{2} \times 3\frac{5}{16}$	22·1	17·9	13·2	9·7	7·3	5·7	4·5	3·7	*3·2*						
$2\frac{1}{2} \times 3\frac{5}{16}$	16·3	12·9	9·3	6·8	5·1	4·0	3·2	*3·2*	*2·2*						
$2 \times 3\frac{5}{16}$	17·9	13·7	9·8	7·1	5·3	4·1	3·3	*3·3*	*2·3*						
$2 \times 3\frac{5}{16}$	14·1	10·9	7·8	5·7	4·2	3·3	2·6	*2·7*	*1·8*						

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the "effective length" of the strut in accordance with clause 30.*c*.(ii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

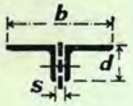
COMPOUND STRUTS

Two Unequal Angles
Long Legs back to back

COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thick-ness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
$4 \times 3\frac{1}{2} \times \frac{5}{8}$	·623	29·2	$\frac{3}{8}$	2·71	8·59	1·59	**1·21**	5·92	4·65
$4 \times 3\frac{1}{2} \times \frac{1}{2}$	·498	23·8	$\frac{3}{8}$	2·76	7·00	1·57	**1·23**	4·67	3·81
$4 \times 3\frac{1}{2} \times \frac{3}{8}$	·374	18·2	$\frac{3}{8}$	2·81	5·35	1·54	**1·24**	3·45	2·93
$4 \times 3\frac{1}{2} \times \frac{5}{16}$	·309	15·2	$\frac{3}{8}$	2·83	4·47	1·53	**1·25**	2·83	2·45
$4 \times 3 \times \frac{1}{2}$	·496	22·0	$\frac{3}{8}$	2·68	6·47	1·32	**1·24**	3·55	3·70
$4 \times 3 \times \frac{3}{8}$	·371	16·8	$\frac{3}{8}$	2·73	4·94	1·30	**1·25**	2·60	2·84
$4 \times 3 \times \frac{5}{16}$	·311	14·2	$\frac{3}{8}$	2·76	4·18	1·28	**1·26**	2·15	2·41
$4 \times 2\frac{1}{2} \times \frac{3}{8}$	·373	15·6	$\frac{3}{8}$	2·64	4·58	**1·06**	1·26	1·91	2·77
$4 \times 2\frac{1}{2} \times \frac{5}{16}$	·308	13·0	$\frac{3}{8}$	2·67	3·83	**1·04**	1·27	1·55	2·32
$4 \times 2\frac{1}{2} \times \frac{1}{4}$	·248	10·6	$\frac{3}{8}$	2·70	3·11	**1·03**	1·28	1·23	1·89
$3\frac{1}{2} \times 3 \times \frac{1}{2}$	·499	20·4	$\frac{3}{8}$	2·38	6·00	1·37	**1·07**	3·54	2·86
$3\frac{1}{2} \times 3 \times \frac{3}{8}$	·373	15·6	$\frac{3}{8}$	2·43	4·58	1·34	**1·08**	2·59	2·20
$3\frac{1}{2} \times 3 \times \frac{5}{16}$	·308	13·0	$\frac{3}{8}$	2·46	3·83	1·33	**1·09**	2·12	1·84
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	·370	14·2	$\frac{3}{8}$	2·35	4·17	1·10	**1·09**	1·88	2·12
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	·309	12·0	$\frac{3}{8}$	2·38	3·53	**1·08**	1·10	1·54	1·79
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	·245	9·6	$\frac{3}{8}$	2·41	2·83	**1·07**	1·11	1·20	1·44
$3 \times 2\frac{1}{2} \times \frac{3}{8}$	·372	13·0	$\frac{5}{16}$	2·06	3·82	1·12	**·92**	1·81	1·57
$3 \times 2\frac{1}{2} \times \frac{5}{16}$	·311	11·0	$\frac{5}{16}$	2·08	3·23	1·11	**·93**	1·49	1·33
$3 \times 2\frac{1}{2} \times \frac{1}{4}$	·246	8·8	$\frac{5}{16}$	2·11	2·59	1·09	**·93**	1·16	1·07
$3 \times 2 \times \frac{3}{8}$	·372	11·8	$\frac{5}{16}$	1·97	3·47	**·89**	·94	1·27	1·54
$3 \times 2 \times \frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·99	2·94	**·87**	·94	1·04	1·31
$3 \times 2 \times \frac{1}{4}$	·245	8·0	$\frac{5}{16}$	2·02	2·35	**·86**	·95	·81	1·06
$2\frac{1}{2} \times 2 \times \frac{3}{8}$	·367	10·4	$\frac{5}{16}$	1·68	3·06	·93	**·76**	1·23	1·07
$2\frac{1}{2} \times 2 \times \frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·70	2·59	·92	**·77**	1·01	·91
$2\frac{1}{2} \times 2 \times \frac{1}{4}$	·246	7·2	$\frac{5}{16}$	1·72	2·11	·90	**·78**	·80	·74
$2\frac{1}{2} \times 2 \times \frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·75	1·58	·89	**·79**	·58	·56
$2\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·63	1·89	**·67**	·79	·51	·72
$2\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·66	1·41	**·65**	·80	·36	·54
$2 \times 1\frac{1}{2} \times \frac{1}{4}$	·241	5·4	$\frac{5}{16}$	1·35	1·59	·71	**·62**	·48	·45
$2 \times 1\frac{1}{2} \times \frac{3}{16}$	·184	4·2	$\frac{5}{16}$	1·37	1·24	·69	**·63**	·36	·35

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STRUTS

Two Unequal Angles short legs back to back
Gusset between Angles
Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR HIGH YIELD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Size $d \times b$ inches	SAFE LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET													
	4	5	6	7	8	9	10	11	12	13	14	16	20	24	28
4 × 18⅝		235	202	166	135	110	91·1	76·3	64·9	55·5	48·2	*46·4*	*30·1*		
4 × 18⅝		205	176	145	118	96·8	80·2	67·2	57·1	49·0	42·5	*40·9*	*26·5*		
4 × 18⅝		174	150	124	102	83·2	69·0	57·8	49·0	42·1	36·5	*35·3*	*22·6*		
4 × 18⅝		141	122	101	83·0	68·1	56·5	47·4	40·2	34·5	30·0	*28·9*	*18·7*		
6 × 16⅝					265	247	226	203	181	160	142	113	74·6	52·6	*48·7*
6 × 16⅝					230	215	197	177	158	140	124	98·6	65·3	46·1	*42·7*
6 × 16⅝					195	182	167	151	135	120	106	84·6	56·2	39·6	*36·6*
6 × 16⅝					157	147	135	122	109	97·3	86·5	68·8	45·7	32·3	*29·8*
4 × 16⅝		191	167	139	114	93·8	77·8	65·3	55·4	47·6	41·4	*39·9*	*25·8*		
4 × 16⅝		162	142	119	97·9	80·5	66·7	56·1	47·7	40·9	35·5	*34·3*	*22·2*		
4 × 16⅝		132	116	97·2	80·1	65·9	54·7	46·0	39·1	33·6	29·2	22·5	*18·2*		
3½ × 14⅝	146	128	105	83·8	67·0	54·3	44·6	37·3	31·6	27·1	*29·3*	*22·5*			
3½ × 14⅝	119	105	86·2	69·0	55·2	44·8	36·9	30·8	26·0	22·4	*24·2*	*18·6*			
3½ × 14⅝	90·7	80·0	66·3	53·3	42·7	34·7	28·5	23·9	20·2	17·3	15·0	*14·5*			
4 × 12½		162	145	123	102	84·9	70·7	59·5	50·6	43·6	37·9	29·2	*23·6*		
4 × 12½		138	124	106	88·7	73·7	61·5	51·9	44·2	38·0	33·0	25·5	*20·6*		
4 × 12½		112	101	86·7	72·7	60·5	50·5	42·7	36·3	31·2	27·1	21·0	*17·0*		
3½ × 12½		117	97·8	78·8	63·3	51·4	42·4	35·4	30·0	25·7	22·3	*21·5*			
3½ × 12½		96·3	80·6	65·1	52·4	42·6	35·2	29·4	24·9	21·4	18·5	*17·9*	*11·5*		
3½ × 12½		74·2	62·7	51·0	41·2	33·6	27·7	23·2	19·7	16·9	14·6	*14·1*	*9·0*		
3 × 12½	113	91·0	69·8	53·7	42·1	33·8	27·6	23·0	*24·3*	*20·8*	*18·0*	*13·8*			
3 × 12½	92·6	74·8	57·6	44·4	34·9	28·0	22·9	19·0	*20·2*	*17·2*	*14·9*	*11·4*			
3 × 12½	71·3	58·0	44·9	34·7	27·3	21·9	17·9	14·9	12·6	*13·5*	*11·6*	*8·9*			
3½ × 10½		108	91·3	74·5	60·3	49·2	40·6	34·0	28·9	24·8	21·5	*20·6*	*13·3*		
3½ × 10½		88·2	75·2	61·6	50·0	40·8	33·8	28·2	24·0	20·6	17·8	*17·2*	*11·1*		
3½ × 10½		67·2	57·6	47·4	38·5	31·5	26·0	21·8	18·5	15·9	13·8	*13·2*	*8·5*		
3 × 10½	83·6	69·0	53·8	41·8	33·0	26·5	21·7	18·1	15·3	*16·3*	*14·1*	*10·9*			
3 × 10½	64·7	54·1	42·6	33·2	26·3	21·2	17·4	14·5	12·2	*13·1*	*11·3*	*8·7*			
3 × 10½	54·0	45·2	35·6	27·8	21·9	17·7	14·5	12·1	10·2	*10·9*	*9·4*	*7·2*			

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the "effective length" of the strut in accordance with clause 30.*c*.(ii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

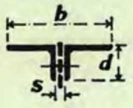
COMPOUND STRUTS

Two Unequal Angles
Short Legs back to back

COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
9×4 × ⅞	·872	72·2	⅝	3·05	21·23	4·71	**1·01**	50·66	7·05
9×4 × ¾	·745	62·4	⅝	3·10	18·34	4·68	**1·02**	43·21	6·13
9×4 × ⅝	·622	52·6	⅝	3·15	15·48	4·66	**1·03**	36·02	5·22
9×4 × ½	·495	42·4	⅝	3·20	12·46	4·62	**1·04**	28·61	4·25
8×6 × ⅞	·870	78·0	⅝	4·40	22·94	3·84	**1·74**	40·64	15·72
8×6 × ¾	·746	67·6	⅝	4·44	19·87	3·81	**1·75**	34·74	13·71
8×6 × ⅝	·621	56·8	⅝	4·49	16·71	3·79	**1·77**	28·83	11·61
8×6 × ½	·495	45·8	⅝	4·54	13·46	3·76	**1·78**	22·91	9·41
8×4 × ¾	·747	57·4	⅝	3·05	16·88	4·13	**1·05**	34·60	6·07
8×4 × ⅝	·623	48·4	⅝	3·10	14·24	4·10	**1·06**	28·80	5·17
8×4 × ½	·496	39·0	⅝	3·15	11·48	4·07	**1·07**	22·87	4·21
7×3½× ⅝	·623	42·0	⅝	2·68	12·36	3·63	**·92**	22·32	3·89
7×3½× ½	·497	34·0	⅝	2·73	10·00	3·60	**·93**	17·75	3·18
7×3½× ⅜	·372	25·8	⅝	2·78	7·59	3·57	**·94**	13·24	2·44
6×4 × ¾	·748	47·2	½	2·93	13·89	2·98	**1·11**	19·74	5·88
6×4 × ⅝	·622	39·8	½	2·97	11·71	2·95	**1·13**	16·35	5·00
6×4 × ½	·496	32·2	½	3·02	9·47	2·93	**1·14**	12·98	4·08
6×3½× ⅝	·620	37·6	½	2·63	11·05	3·03	**·95**	16·26	3·81
6×3½× ½	·497	30·6	½	2·67	8·99	3·00	**·96**	12·98	3·13
6×3½× ⅜	·371	23·2	½	2·72	6·82	2·97	**·98**	9·65	2·39
6×3 × ⅝	·623	35·6	½	2·27	10·47	3·12	**·78**	16·30	2·80
6×3 × ½	·496	28·8	½	2·31	8·47	3·09	**·79**	12·94	2·28
6×3 × ⅜	·373	22·0	½	2·36	6·47	3·06	**·80**	9·69	1·76
5×3½× ⅝	·621	33·4	½	2·55	9·82	2·49	**·99**	11·58	3·73
5×3½× ½	·498	27·2	½	2·60	8·00	2·46	**1·00**	9·23	3·07
5×3½× ⅜	·371	20·6	½	2·65	6·06	2·43	**1·01**	6·83	2·34
5×3 × ½	·496	25·4	½	2·26	7·47	2·54	**·82**	9·17	2·24
5×3 × ⅜	·372	19·4	½	2·30	5·70	2·51	**·84**	6·84	1·73
5×3 × $\frac{5}{16}$	·308	16·2	½	2·33	4·76	2·49	**·84**	5·64	1·45

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STRUTS

Two Unequal Angles short legs back to back
Gusset between Angles
Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR HIGH YIELD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Size $d\times b$ inches	SAFE LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**14**	**16**	**18**	**20**
$3\frac{1}{2}\times8\frac{3}{8}$				95·9	82·5	68·1	55·5	45·4	37·6	31·5	26·7	19·9	*19·2*	*15·2*	*12·4*
$3\frac{1}{2}\times8\frac{3}{8}$				78·6	67·9	56·2	45·9	37·6	31·2	26·1	22·2	16·5	*15·9*	*12·6*	*10·2*
$3\frac{1}{2}\times8\frac{3}{8}$				60·7	52·9	44·1	36·2	29·7	24·7	20·7	17·6	13·1	*12·7*	*10·1*	*8·1*
$3\frac{1}{2}\times8\frac{3}{8}$				50·7	44·2	36·9	30·3	24·8	20·6	17·3	14·7	11·0	*10·6*	*8·3*	*6·8*
$3\ \times8\frac{3}{8}$			74·3	62·9	50·1	39·3	31·1	25·1	20·6	17·1	14·5	*13·5*	*10·3*		
$3\ \times8\frac{3}{8}$			57·1	48·6	38·9	30·6	24·3	19·6	16·1	13·4	11·3	*10·5*	*8·0*	*6·4*	
$3\ \times8\frac{3}{8}$			48·6	41·6	33·4	26·4	21·0	16·9	13·9	11·6	9·7	*9·0*	*6·9*	*5·5*	
$2\frac{1}{2}\times8\frac{3}{8}$		54·2	44·7	33·5	24·8	18·8	14·6	11·7	9·5	*9·9*	*8·3*	*6·1*			
$2\frac{1}{2}\times8\frac{3}{8}$		45·6	37·9	28·6	21·3	16·2	12·6	10·0	8·2	*8·5*	*7·1*	*5·3*			
$2\frac{1}{2}\times8\frac{3}{8}$		37·0	30·8	23·3	17·3	13·1	10·2	8·1	6·6	*6·9*	*5·8*	*4·3*			
$3\ \times7\frac{3}{8}$			69·3	59·0	47·2	37·1	29·5	23·8	19·5	16·3	13·8	*12·7*	*9·7*	*7·7*	
$3\ \times7\frac{3}{8}$			53·5	46·0	37·2	29·4	23·4	18·9	15·6	13·0	11·0	*10·2*	*7·8*	*6·2*	
$3\ \times7\frac{3}{8}$			44·7	38·5	31·1	24·6	19·6	15·8	13·0	10·8	9·1	*8·4*	*6·5*	*5·1*	
$2\frac{1}{2}\times7\frac{3}{8}$			41·8	31·8	23·7	18·0	14·1	11·2	9·1	*9·5*	*8·0*	*5·9*			
$2\frac{1}{2}\times7\frac{3}{8}$			35·9	27·5	20·6	15·7	12·2	9·7	7·9	*8·3*	*7·0*	*5·1*			
$2\frac{1}{2}\times7\frac{3}{8}$			28·7	22·1	16·5	12·6	9·8	7·8	6·3	*6·6*	*5·6*	*4·1*			
$2\frac{1}{2}\times6\frac{5}{16}$			39·3	30·4	22·8	17·4	13·6	10·9	8·8	*9·2*	*7·7*	*5·7*			
$2\frac{1}{2}\times6\frac{5}{16}$			33·2	25·7	19·3	14·7	11·5	9·1	7·5	*7·8*	*6·5*	*4·8*			
$2\frac{1}{2}\times6\frac{5}{16}$			27·0	21·0	15·8	12·1	9·4	7·5	6·1	5·1	*5·4*	*4·0*			
$2\ \times6\frac{5}{16}$		36·4	25·9	18·0	12·9	9·6	7·4	*7·3*	*6·0*	*5·0*					
$2\ \times6\frac{5}{16}$		30·8	22·0	15·2	10·9	8·1	6·2	*6·2*	*5·0*	*4·2*					
$2\ \times6\frac{5}{16}$		25·0	18·0	12·5	9·0	6·7	5·2	*5·1*	*4·2*	*3·4*					
$2\ \times5\frac{5}{16}$		32·5	23·5	16·3	11·7	8·7	6·7	*6·7*	*5·4*	*4·5*					
$2\ \times5\frac{5}{16}$		27·9	20·4	14·2	10·3	7·6	5·9	*5·9*	*4·7*	*3·9*	*3·3*				
$2\ \times5\frac{5}{16}$		23·0	17·0	12·0	8·6	6·4	4·9	*4·9*	*4·0*	*3·3*	*2·8*				
$2\ \times5\frac{5}{16}$		17·2	12·7	8·9	6·4	4·8	3·7	*3·7*	*3·0*	*2·5*	*2·1*				
$1\frac{1}{2}\times5\frac{5}{16}$	21·2	13·6	8·3	5·4	3·8	*3·5*	*2·7*								
$1\frac{1}{2}\times5\frac{5}{16}$	16·0	10·5	6·5	4·2	3·0	*2·8*	*2·1*								
$1\frac{1}{2}\times4\frac{5}{16}$	18·3	12·3	7·6	5·0	3·5	*3·3*	*2·5*								
$1\frac{1}{2}\times4\frac{5}{16}$	14·2	9·5	5·9	3·9	2·7	*2·5*	*1·9*								

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.

Safe loads are calculated for the "effective length" of the strut in accordance with clause 30.*c*.(ii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.

These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

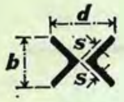
COMPOUND STRUTS

Two Unequal Angles
Short Legs back to back

COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
$4\ \times3\frac{1}{2}\times\frac{5}{8}$	·623	29·2	$\frac{3}{8}$	2·46	8·59	1·91	**1·02**	7·47	3·63
$4\ \times3\frac{1}{2}\times\frac{1}{2}$	·498	23·8	$\frac{3}{8}$	2·51	7·00	1·88	**1·03**	5·92	2·98
$4\ \times3\frac{1}{2}\times\frac{3}{8}$	·374	18·2	$\frac{3}{8}$	2·56	5·35	1·86	**1·05**	4·40	2·30
$4\ \times3\frac{1}{2}\times\frac{5}{16}$	·309	15·2	$\frac{3}{8}$	2·58	4·47	1·84	**1·05**	3·61	1·92
$4\ \times3\ \times\frac{1}{2}$	·496	22·0	$\frac{3}{8}$	2·18	6·47	1·95	**·86**	5·87	2·18
$4\ \times3\ \times\frac{3}{8}$	·371	16·8	$\frac{3}{8}$	2·23	4·94	1·92	**·87**	4·35	1·68
$4\ \times3\ \times\frac{5}{16}$	·311	14·2	$\frac{3}{8}$	2·25	4·18	1·91	**·88**	3·63	1·42
$4\ \times2\frac{1}{2}\times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	1·89	4·58	2·00	**·69**	4·36	1·17
$4\ \times2\frac{1}{2}\times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	1·91	3·83	1·98	**·70**	3·58	·98
$4\ \times2\frac{1}{2}\times\frac{1}{4}$	·248	10·6	$\frac{3}{8}$	1·94	3·11	1·96	**·70**	2·87	·80
$3\frac{1}{2}\times3\ \times\frac{1}{2}$	·499	20·4	$\frac{3}{8}$	2·13	6·00	1·68	**·87**	4·62	2·15
$3\frac{1}{2}\times3\ \times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	2·18	4·58	1·66	**·89**	3·41	1·66
$3\frac{1}{2}\times3\ \times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	2·21	3·83	1·64	**·89**	2·80	1·39
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·370	14·2	$\frac{3}{8}$	1·85	4·17	1·72	**·71**	3·37	1·14
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·309	12·0	$\frac{3}{8}$	1·87	3·53	1·71	**·72**	2·79	·97
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	9·6	$\frac{3}{8}$	1·90	2·83	1·69	**·72**	2·20	·78
$3\ \times2\frac{1}{2}\times\frac{3}{8}$	·372	13·0	$\frac{5}{16}$	1·80	3·82	1·43	**·73**	2·49	1·12
$3\ \times2\frac{1}{2}\times\frac{5}{16}$	·311	11·0	$\frac{5}{16}$	1·83	3·23	1·42	**·73**	2·07	·95
$3\ \times2\frac{1}{2}\times\frac{1}{4}$	·246	8·8	$\frac{5}{16}$	1·85	2·59	1·40	**·74**	1·62	·77
$3\ \times2\ \times\frac{3}{8}$	·372	11·8	$\frac{5}{16}$	1·46	3·47	1·51	**·56**	2·51	·73
$3\ \times2\ \times\frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·49	2·94	1·50	**·56**	2·09	·62
$3\ \times2\ \times\frac{1}{4}$	·245	8·0	$\frac{5}{16}$	1·51	2·35	1·48	**·57**	1·64	·50
$2\frac{1}{2}\times2\ \times\frac{3}{8}$	·367	10·4	$\frac{5}{16}$	1·42	3·06	1·24	**·57**	1·78	·71
$2\frac{1}{2}\times2\ \times\frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·45	2·59	1·23	**·58**	1·47	·60
$2\frac{1}{2}\times2\ \times\frac{1}{4}$	·246	7·2	$\frac{5}{16}$	1·47	2·11	1·22	**·59**	1·18	·50
$2\frac{1}{2}\times2\ \times\frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·50	1·58	1·20	**·59**	·86	·37
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·13	1·89	1·29	**·41**	1·18	·28
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·15	1·41	1·27	**·42**	·86	·21
$2\ \times1\frac{1}{2}\times\frac{1}{4}$	·241	5·4	$\frac{5}{16}$	1·09	1·59	1·02	**·43**	·76	·27
$2\ \times1\frac{1}{2}\times\frac{3}{16}$	·184	4·2	$\frac{5}{16}$	1·12	1·24	1·00	**·43**	·58	·21

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STRUTS

Two Equal Angles Battened

Two or more rivets or bolts in line, or welded, at ends

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Size $d \times b$ inches	SAFE LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
	4	6	8	10	12	14	16	20	24	28	32	36	40	45	50
$13\frac{7}{16} \times 11\frac{5}{16}$						348	321	254	194	149	116	93·4	76·3	60·8	*61·8*
$13\frac{1}{4} \times 11\frac{5}{16}$						308	284	226	173	133	104	83·4	68·2	54·4	*55·3*
$13\frac{1}{8} \times 11\frac{5}{16}$						267	247	197	151	116	91·0	72·9	59·6	47·5	*48·3*
$12\frac{15}{16} \times 11\frac{5}{16}$						225	208	167	128	98·6	77·4	62·1	50·7	40·4	*41·2*
$10\frac{1}{4} \times 8\frac{1}{2}$				230	206	177	149	103	74·1	55·3	42·8	*42·5*	*34·6*	*27·5*	
$10\frac{1}{16} \times 8\frac{1}{2}$				200	180	155	130	90·8	65·2	48·8	37·7	*37·5*	*30·5*	*24·3*	
$9\frac{15}{16} \times 8\frac{1}{2}$				169	153	132	111	77·7	56·0	41·9	32·4	*32·2*	*26·2*	*20·8*	
$9\frac{3}{4} \times 8\frac{1}{2}$				137	124	108	90·9	63·6	45·8	34·3	26·6	*26·4*	*21·5*	*17·0*	
$9\frac{9}{16} \times 8\frac{1}{2}$				104	94·5	82·4	69·7	49·0	35·3	26·5	20·4	*20·4*	*16·6*	*13·2*	
$8\frac{11}{16} \times 7\frac{1}{16}$				147	122	98·2	78·9	52·8	37·3	27·7	*26·7*	*21·3*			
$8\frac{1}{2} \times 7\frac{1}{16}$				125	104	84·1	67·7	45·3	32·2	23·9	*23·0*	*18·3*			
$8\frac{5}{16} \times 7\frac{1}{16}$				102	85·5	69·2	55·7	37·4	26·5	19·7	*18·9*	*15·1*	*12·2*		
$8\frac{1}{8} \times 7\frac{1}{16}$				78·3	66·0	53·6	43·3	29·1	20·6	15·3	*14·7*	*11·7*	*9·5*		
$7\frac{1}{16} \times 5\frac{11}{16}$			113	88·2	66·5	50·8	39·7	26·0	*22·8*	*16·9*					
$6\frac{15}{16} \times 5\frac{11}{16}$			97·1	76·1	57·7	44·1	34·5	22·6	*19·8*	*14·7*					
$6\frac{3}{4} \times 5\frac{11}{16}$			79·4	62·7	47·7	36·6	28·6	18·8	*16·4*	*12·1*					
$6\frac{9}{16} \times 5\frac{11}{16}$			61·2	48·7	37·2	28·6	22·4	14·7	*12·9*	*9·5*	*7·3*				
$6\frac{3}{16} \times 4\frac{15}{16}$		91·6	72·5	52·9	38·7	29·2	22·6	*18·4*	*12·9*						
$6 \times 4\frac{15}{16}$		75·2	60·2	44·2	32·4	24·5	19·0	*15·5*	*10·8*						
$5\frac{7}{8} \times 4\frac{15}{16}$		57·8	46·7	34·5	25·4	19·2	15·0	9·7	*8·5*						
$5\frac{3}{4} \times 4\frac{15}{16}$		49·1	39·8	29·6	21·8	16·5	12·8	8·3	*7·2*	*5·3*					
$5\frac{1}{4} \times 4\frac{1}{4}$		57·3	40·9	28·3	20·3	15·2	11·7	*9·4*							
$5\frac{1}{16} \times 4\frac{1}{4}$		44·3	32·0	22·3	16·0	11·9	9·2	*7·4*							
$4\frac{15}{16} \times 4\frac{1}{4}$		37·8	27·4	19·1	13·8	10·3	7·9	*6·4*							
$4\frac{7}{8} \times 4\frac{1}{4}$		30·5	22·3	15·6	11·2	8·3	6·4	*5·2*	*3·6*						
$4\frac{7}{16} \times 3\frac{9}{16}$	41·4	30·3	19·5	13·0	9·2	6·8	*6·6*								
$4\frac{5}{16} \times 3\frac{9}{16}$		26·0	16·8	11·3	7·9	5·9	*5·7*								
$4\frac{1}{4} \times 3\frac{9}{16}$		21·1	13·7	9·1	6·5	4·8	*4·6*	*2·9*							
$4\frac{1}{16} \times 3\frac{3}{16}$	34·7	22·9	14·1	9·3	6·5	*6·0*	*4·6*								
$4 \times 3\frac{3}{16}$	29·6	19·7	12·2	8·0	5·6	*5·2*	*4·0*								
$3\frac{7}{8} \times 3\frac{3}{16}$	24·2	16·3	10·1	6·7	4·7	*4·3*	*3·3*								
$3\frac{13}{16} \times 3\frac{3}{16}$	18·3	12·4	7·7	5·1	3·6	*3·3*	*2·5*								
$3\frac{5}{8} \times 2\frac{13}{16}$	24·1	14·3	8·5	5·6	*4·9*	*3·6*									
$3\frac{9}{16} \times 2\frac{13}{16}$	20·1	12·1	7·2	4·7	*4·1*	*3·0*									
$3\frac{7}{16} \times 2\frac{13}{16}$	15·1	9·1	5·5	3·6	*3·1*	*2·3*	*1·8*								

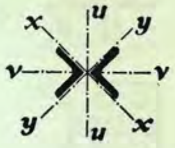
The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the "effective length" of the strut in accordance with clause 30.c. (ii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line in each angle, or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

COMPOUND STRUTS

Two Equal Angles Battened

COMPOSITION AND PROPERTIES



Composed of Two Equal Angles	Actual Thickness inches	Weight per foot in lbs	Thickness of Batten Plate *s* inches	Area in square inches	Radius of Gyration			Elastic Modulus		
					Axis *v-v*	Axis *u-u*	Axis *x-x or y-y*	Axis *v-v*	Axis *u-u*	Axis *x-x or y-y*
$8 \times 8 \times 1$	·996	102	$\frac{5}{8}$	30·01	3·06	4·09	3·61	49·65	74·50	47·03
$8 \times 8 \times \frac{7}{8}$	·871	90·0	$\frac{5}{8}$	26·48	3·08	4·03	3·59	44·44	64·71	40·96
$8 \times 8 \times \frac{3}{4}$	·746	77·8	$\frac{5}{8}$	22·88	3·10	3·97	3·56	38·96	55·04	34·94
$8 \times 8 \times \frac{5}{8}$	·621	65·4	$\frac{5}{8}$	19·23	3·12	3·91	3·54	33·18	45·48	28·96
$6 \times 6 \times \frac{7}{8}$	·872	66·2	$\frac{1}{2}$	19·48	2·27	3·14	2·74	23·65	37·42	23·40
$6 \times 6 \times \frac{3}{4}$	·747	57·4	$\frac{1}{2}$	16·88	2·29	3·08	2·72	21·90	31·77	19·92
$6 \times 6 \times \frac{5}{8}$	·623	48·4	$\frac{1}{2}$	14·24	2·31	3·02	2·69	17·97	26·26	16·52
$6 \times 6 \times \frac{1}{2}$	·496	39·0	$\frac{1}{2}$	11·48	2·33	2·96	2·67	14·75	20·69	13·07
$6 \times 6 \times \frac{3}{8}$	·371	29·6	$\frac{1}{2}$	8·70	2·35	2·90	2·64	11·36	15·31	9·71
$5 \times 5 \times \frac{3}{4}$	·748	47·2	$\frac{1}{2}$	13·89	1·89	2·68	2·32	13·98	22·99	14·21
$5 \times 5 \times \frac{5}{8}$	·622	39·8	$\frac{1}{2}$	11·71	1·91	2·62	2·29	12·06	18·92	11·72
$5 \times 5 \times \frac{1}{2}$	·496	32·2	$\frac{1}{2}$	9·47	1·93	2·56	2·27	9·98	14·92	9·27
$5 \times 5 \times \frac{3}{8}$	·373	24·6	$\frac{1}{2}$	7·23	1·95	2·50	2·24	7·76	11·08	6·91
$4 \times 4 \times \frac{3}{4}$	·749	37·0	$\frac{3}{8}$	10·89	1·48	2·20	1·87	8·45	14·82	9·13
$4 \times 4 \times \frac{5}{8}$	·624	31·4	$\frac{3}{8}$	9·23	1·50	2·14	1·85	7·37	12·20	7·52
$4 \times 4 \times \frac{1}{2}$	·496	25·4	$\frac{3}{8}$	7·47	1·52	2·08	1·82	6·14	9·56	5·92
$4 \times 4 \times \frac{3}{8}$	·372	19·4	$\frac{3}{8}$	5·70	1·54	2·02	1·80	4·81	7·06	4·39
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{8}$	·621	27·0	$\frac{3}{8}$	7·94	1·30	1·94	1·65	5·43	9·59	5·85
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$	·496	22·0	$\frac{3}{8}$	6·47	1·32	1·88	1·62	4·57	7·55	4·62
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$	·371	16·8	$\frac{3}{8}$	4·94	1·34	1·81	1·60	3·59	5·55	3·41
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$	·311	14·2	$\frac{3}{8}$	4·18	1·35	1·78	1·58	3·08	4·61	2·84
$3 \times 3 \times \frac{1}{2}$	·496	18·6	$\frac{5}{16}$	5·47	1·12	1·63	1·40	3·23	5·58	3·40
$3 \times 3 \times \frac{3}{8}$	·370	14·2	$\frac{5}{16}$	4·17	1·14	1·57	1·37	2·56	4·08	2·49
$3 \times 3 \times \frac{5}{16}$	·309	12·0	$\frac{5}{16}$	3·53	1·15	1·54	1·36	2·19	3·37	2·06
$3 \times 3 \times \frac{1}{4}$	·245	9·6	$\frac{5}{16}$	2·83	1·16	1·51	1·34	1·78	2·64	1·62
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	·372	11·8	$\frac{5}{16}$	3·47	·94	1·38	1·18	1·74	2·98	1·82
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	·311	10·0	$\frac{5}{16}$	2·94	·95	1·35	1·17	1·51	2·47	1·51
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	·245	8·0	$\frac{5}{16}$	2·35	·96	1·32	1·15	1·23	1·92	1·18
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{8}$	·367	10·4	$\frac{5}{16}$	3·06	·84	1·28	1·08	1·36	2·45	1·48
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{5}{16}$	·306	8·8	$\frac{5}{16}$	2·59	·85	1·25	1·07	1·18	2·02	1·23
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{1}{4}$	·246	7·2	$\frac{5}{16}$	2·11	·86	1·22	1·05	·99	1·61	·98
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·58	·87	1·18	1·04	·76	1·17	·71
$2 \times 2 \times \frac{5}{16}$	·308	7·8	$\frac{5}{16}$	2·29	·75	1·15	·97	·91	1·66	1·00
$2 \times 2 \times \frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·89	·76	1·12	·96	·77	1·33	·80
$2 \times 2 \times \frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·41	·77	1·09	·94	·59	·97	·58

Each weight per foot is for the shaft only. Weight of batten plates, connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

COMPOUND STRUTS

Two Equal Angles back to back
Gusset on back of Angles

BASED ON
B.S. 449
1959
AS AMENDED

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR HIGH YIELD STEEL

Size $d \times b$ inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	4	6	8	10	12	14	16	20	24	28	32	36	40	44	48
$8\times16\frac{5}{8}$					360	335	303	231	173	132	103	82·1	67·0	*69·6*	*58·7*
$8\times16\frac{5}{8}$						297	269	207	155	118	91·9	73·5	60·0	*62·4*	*52·7*
$8\times16\frac{5}{8}$						257	233	180	135	103	80·0	64·0	52·3	*54·4*	*45·8*
$8\times16\frac{5}{8}$						217	198	153	115	87·5	66·3	54·6	44·6	*46·4*	*39·1*
$6\times12\frac{1}{2}$				223	195	164	135	92·0	65·8	49·0	*47·3*	*37·5*	*30·6*	*25·3*	
$6\times12\frac{1}{2}$				194	170	143	118	80·6	57·6	42·9	33·1	*33·0*	*26·8*	*22·2*	
$6\times12\frac{1}{2}$				164	145	122	101	69·4	49·5	36·9	28·5	*28·4*	*23·0*	*19·1*	
$6\times12\frac{1}{2}$				133	117	99·3	82·1	56·5	40·3	30·1	23·3	*23·1*	*18·8*	*15·6*	
$6\times12\frac{1}{2}$				101	89·8	76·3	63·3	43·6	31·2	23·3	18·0	*17·9*	*14·6*	*12·1*	
$5\times10\frac{1}{2}$			162	138	111	88·0	70·0	46·4	32·7	*30·3*	*23·3*	*18·4*			
$5\times10\frac{1}{2}$			137	118	95·7	75·8	60·4	40·1	28·3	*26·2*	*20·2*	*16·0*			
$5\times10\frac{1}{2}$			111	96·2	78·1	62·0	49·4	32·8	23·2	*21·5*	*16·5*	*13·1*			
$5\times10\frac{1}{2}$			85·3	74·3	60·7	48·3	38·6	25·7	18·2	*16·8*	*13·0*	*10·3*			
$4\times8\frac{3}{8}$		129	107	80·4	59·6	45·2	35·2	22·9	*20·1*	*14·8*					
$4\times8\frac{3}{8}$		110	92·0	69·9	52·1	39·5	30·8	20·1	*17·7*	*13·0*					
$4\times8\frac{3}{8}$		89·5	75·1	57·2	42·7	32·5	25·4	16·5	*14·5*	*10·7*					
$4\times8\frac{3}{8}$		68·5	57·7	44·2	33·0	25·2	19·6	12·8	*11·2*	*8·3*					
$3\frac{1}{2}\times7\frac{3}{8}$		88·6	67·3	47·9	34·7	26·0	20·2	*16·3*	*11·5*						
$3\frac{1}{2}\times7\frac{3}{8}$		72·6	55·5	39·6	28·8	21·6	16·7	*13·6*	*9·4*						
$3\frac{1}{2}\times7\frac{3}{8}$		55·7	42·9	30·8	22·4	16·8	13·0	*10·6*	*7·4*						
$3\frac{1}{2}\times7\frac{3}{8}$		47·4	36·7	26·4	19·2	14·5	11·2	*9·1*	*6·3*						
$3\times6\frac{5}{16}$		54·0	36·9	25·1	17·9	13·3	*12·9*	*8·3*							
$3\times6\frac{5}{16}$		41·6	28·6	19·5	13·9	10·4	*10·0*	*6·4*							
$3\times6\frac{5}{16}$		35·6	24·6	16·8	12·0	8·9	6·9	*5·5*							
$3\times6\frac{5}{16}$		28·8	20·1	13·8	9·8	7·3	5·6	*4·5*							
$2\frac{1}{2}\times5\frac{5}{16}$	40·4	27·9	17·5	11·6	8·1	*7·5*	*5·8*								
$2\frac{1}{2}\times5\frac{5}{16}$	34·4	24·0	15·2	10·1	7·1	*6·5*	*5·0*								
$2\frac{1}{2}\times5\frac{5}{16}$	27·5	19·2	12·1	8·0	5·6	*5·2*	*4·0*								
$2\frac{1}{4}\times4\frac{13}{16}$	33·4	20·7	12·6	8·2	*7·2*	*5·3*	*4·1*								
$2\frac{1}{4}\times4\frac{13}{16}$	28·5	18·0	10·9	7·1	5·0	*4·6*	*3·5*								
$2\frac{1}{4}\times4\frac{13}{16}$	23·3	14·6	8·9	5·8	4·1	*3·7*	*2·9*								
$2\frac{1}{4}\times4\frac{13}{16}$	17·6	11·2	6·8	4·4	3·1	*2·9*	*2·2*								
$2\times4\frac{5}{16}$	22·8	12·9	7·6	4·9	*4·3*	*3·2*									
$2\times4\frac{5}{16}$	18·8	10·7	6·3	4·1	*3·6*	*2·6*									
$2\times4\frac{5}{16}$	14·3	8·1	4·8	3·1	*2·7*	*2·0*									

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut, centre to centre of intersections, in accordance with clause 30.*c*.(iii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line in each angle or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

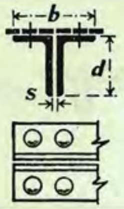
COMPOUND STRUTS

Two Equal Angles back to back

COMPOSITION AND PROPERTIES

Composed of Two Equal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
$8\times8\times1$	·996	102·0	$\frac{5}{8}$	5·64	30·01	3·61	**2·43**	47·03	31·38
$8\times8\times\frac{7}{8}$	·871	90·0	$\frac{5}{8}$	5·69	26·48	3·59	**2·45**	40·96	27·82
$8\times8\times\frac{3}{4}$	·746	77·8	$\frac{5}{8}$	5·74	22·88	3·56	**2·46**	34·94	24·16
$8\times8\times\frac{5}{8}$	·621	65·4	$\frac{5}{8}$	5·79	19·23	3·54	**2·48**	28·96	20·39
$6\times6\times\frac{7}{8}$	·872	66·2	$\frac{1}{2}$	4·19	19·48	2·74	**1·81**	23·40	15·15
$6\times6\times\frac{3}{4}$	·747	57·4	$\frac{1}{2}$	4·23	16·88	2·72	**1·82**	19·92	13·21
$6\times6\times\frac{5}{8}$	·623	48·4	$\frac{1}{2}$	4·28	14·24	2·69	**1·84**	16·52	11·21
$6\times6\times\frac{1}{2}$	·496	39·0	$\frac{1}{2}$	4·33	11·48	2·67	**1·85**	13·07	9·09
$6\times6\times\frac{3}{8}$	·371	29·6	$\frac{1}{2}$	4·38	8·70	2·64	**1·87**	9·71	6·92
$5\times5\times\frac{3}{4}$	·748	47·2	$\frac{1}{2}$	3·48	13·89	2·32	**1·50**	14·21	8·97
$5\times5\times\frac{5}{8}$	·622	39·8	$\frac{1}{2}$	3·53	11·71	2·29	**1·52**	11·72	7·62
$5\times5\times\frac{1}{2}$	·496	32·2	$\frac{1}{2}$	3·58	9·47	2·27	**1·53**	9·27	6·20
$5\times5\times\frac{3}{8}$	·373	24·6	$\frac{1}{2}$	3·63	7·23	2·24	**1·55**	6·91	4·76
$4\times4\times\frac{3}{4}$	·749	37·0	$\frac{3}{8}$	2·73	10·89	1·87	**1·18**	9·13	5·56
$4\times4\times\frac{5}{8}$	·624	31·4	$\frac{3}{8}$	2·78	9·23	1·85	**1·20**	7·52	4·75
$4\times4\times\frac{1}{2}$	·496	25·4	$\frac{3}{8}$	2·83	7·47	1·82	**1·21**	5·92	3·87
$4\times4\times\frac{3}{8}$	·372	19·4	$\frac{3}{8}$	2·87	5·70	1·80	**1·22**	4·39	2·97
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{5}{8}$	·621	27·0	$\frac{3}{8}$	2·41	7·94	1·65	**1·04**	5·85	3·55
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{1}{2}$	·496	22·0	$\frac{3}{8}$	2·45	6·47	1·62	**1·05**	4·62	2·91
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{3}{8}$	·371	16·8	$\frac{3}{8}$	2·50	4·94	1·60	**1·06**	3·41	2·24
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{5}{16}$	·311	14·2	$\frac{3}{8}$	2·52	4·18	1·58	**1·07**	2·84	1·90
$3\times3\times\frac{1}{2}$	·496	18·6	$\frac{5}{16}$	2·08	5·47	1·40	**·89**	3·40	2·09
$3\times3\times\frac{3}{8}$	·370	14·2	$\frac{5}{16}$	2·12	4·17	1·37	**·90**	2·49	1·61
$3\times3\times\frac{5}{16}$	·309	12·0	$\frac{5}{16}$	2·15	3·53	1·36	**·91**	2·06	1·36
$3\times3\times\frac{1}{4}$	·245	9·6	$\frac{5}{16}$	2·17	2·83	1·34	**·92**	1·62	1·10
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·372	11·8	$\frac{5}{16}$	1·74	3·47	1·18	**·75**	1·82	1·12
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·77	2·94	1·17	**·76**	1·51	·95
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	8·0	$\frac{5}{16}$	1·79	2·35	1·15	**·76**	1·18	·77
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{3}{8}$	·367	10·4	$\frac{5}{16}$	1·56	3·06	1·08	**·67**	1·48	·88
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·58	2·59	1·07	**·68**	1·23	·75
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{1}{4}$	·246	7·2	$\frac{5}{16}$	1·60	2·11	1·05	**·68**	·98	·62
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·63	1·58	1·04	**·69**	·71	·46
$2\times2\times\frac{5}{16}$	·308	7·8	$\frac{5}{16}$	1·39	2·29	·97	**·60**	1·00	·59
$2\times2\times\frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·41	1·89	·96	**·60**	·80	·49
$2\times2\times\frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·44	1·41	·94	**·61**	·58	·37

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages, 162 and 176.



COMPOUND STRUTS

Two Unequal Angles long legs back to back
Gusset on back of Angles

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR HIGH YIELD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Size d × b inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	8	9	10	12	14	16	18	20	24	28	32	36	40	50	60
9×8⅝		241	225	187	151	121	98·2	81·0	57·3	42·5	*41·0*	*32·6*			
9×8⅝	218	206	192	158	126	101	82·1	67·5	47·7	*44·3*	*34·1*	*27·0*			
9×8⅝	183	173	160	131	105	83·5	67·7	55·6	39·4	*36·5*	*28·0*	*22·4*			
9×8⅝	146	137	127	103	81·5	65·0	52·6	43·2	30·5	*28·3*	*21·8*	*17·3*			
8×12⅝					260	237	211	184	139	106	82·6	66·2	54·0	*43·9*	*30·5*
8×12⅝					226	207	184	161	122	92·9	72·7	58·2	47·5	*38·5*	*26·8*
8×12⅝					191	175	156	137	104	79·3	62·1	49·8	40·6	*32·9*	*23·0*
8×12⅝					153	140	124	109	81·9	62·5	48·8	39·1	31·9	*25·9*	*18·0*
8×8⅝		194	182	152	123	99·2	80·8	66·6	47·3	35·1	*33·8*	*26·8*	*21·8*		
8×8⅝		162	151	126	101	81·1	65·9	54·3	38·4	28·5	*27·5*	*21·9*			
8×8⅝	137	129	120	98·9	79·1	63·3	51·4	42·3	29·9	*27·8*	*21·4*	*16·9*			
7×7⅝	142	132	120	95·5	74·9	59·3	47·8	39·2	27·6	*25·6*	*19·7*				
7×7⅝	114	105	95·0	74·9	58·4	46·2	37·2	30·5	21·5	*19·9*	*15·3*				
7×7⅝	85·1	78·3	70·4	55·1	42·8	33·8	27·1	22·2	15·7	*14·5*	*11·1*				
6×8½		163	155	133	110	89·4	73·1	60·5	43·1	32·0	*30·8*	*24·4*	*20·0*		
6×8½		137	129	110	90·2	73·2	59·7	49·4	35·1	26·1	*25·2*	*19·9*	*16·2*		
6×8½		110	104	87·9	71·7	58·0	47·3	39·1	27·8	20·6	*19·9*	*15·8*	*12·8*		
6×7½	127	118	108	86·2	67·7	53·7	43·3	35·5	25·0	*23·2*	*17·8*	*14·1*			
6×7½	103	95·4	86·7	68·7	53·8	42·6	34·3	28·2	19·8	*18·3*	*14·1*				
6×7½	77·1	71·2	64·3	50·6	39·4	31·1	25·0	20·6	14·4	*13·4*	*10·3*				
6×6½	108	96·3	84·0	63·3	48·3	37·7	30·2	24·6	*21·6*	*16·0*					
6×6½	85·8	75·7	65·7	49·1	37·4	29·1	23·3	19·0	*16·7*	*12·4*					
6×6½	64·5	56·6	49·0	36·5	27·7	21·6	17·3	14·1	*12·4*	*9·1*					
5×7½	116	109	101	82·4	65·6	52·4	42·4	34·9	24·7	*22·9*	*17·6*	*14·0*			
5×7½	93·6	87·8	80·8	65·4	51·8	41·3	33·3	27·4	19·3	*17·9*	*13·8*	*10·9*			
5×7½	70·3	65·6	60·0	48·2	38·0	30·2	24·3	20·0	14·1	*13·1*	*10·1*	*7·9*			
5×6½	79·3	71·2	62·6	47·6	36·5	28·6	22·9	18·7	*16·4*	*12·1*					
5×6½	59·4	52·9	46·3	34·9	26·7	20·9	16·7	13·6	*11·9*	*8·8*					
5×6½	49·3	43·8	38·2	28·8	22·0	17·1	13·7	11·2	*9·8*	*7·2*					

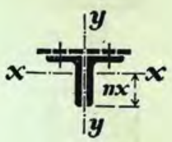
The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut, centre to centre of intersections, in accordance with clause 30.*c*.(iii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line in each angle or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

COMPOUND STRUTS

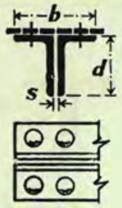
Two Unequal Angles
Long Legs back to back

COMPOSITION AND PROPERTIES



Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
9×4×⅞	·872	72·2	⅝	5·56	21·23	**1·61**	2·86	12·83	31·15
9×4×¾	·745	62·4	⅝	5·61	18·34	**1·58**	2·88	10·67	27·00
9×4×⅝	·622	52·6	⅝	5·66	15·48	**1·56**	2·89	8·69	22·86
9×4×½	·495	42·4	⅝	5·72	12·46	**1·53**	2·91	6·74	18·46
8×6×⅞	·870	78·0	⅝	5·40	22·94	2·58	**2·50**	24·27	26·60
8×6×¾	·746	67·6	⅝	5·45	19·87	2·56	**2·52**	20·63	23·14
8×6×⅝	·621	56·8	⅝	5·50	16·71	**2·54**	**2·54**	17·03	19·54
8×6×½	·495	45·8	⅝	5·55	13·46	**2·51**	2·55	13·46	15·80
8×4×¾	·747	57·4	⅝	5·06	16·88	**1·64**	2·55	10·52	21·60
8×4×⅝	·623	48·4	⅝	5·11	14·24	**1·61**	2·56	8·58	18·30
8×4×½	·496	39·0	⅝	5·17	11·48	**1·58**	2·58	6·68	14·80
7×3½×⅝	·623	42·0	⅝	4·44	12·36	**1·46**	2·23	6·88	13·84
7×3½×½	·497	34·0	⅝	4·50	10·00	**1·43**	2·25	5·34	11·23
7×3½×⅜	·372	25·8	⅝	4·55	7·59	**1·40**	2·27	3·89	8·55
6×4×¾	·748	47·2	½	3·93	13·89	**1·73**	1·87	9·77	12·40
6×4×⅝	·622	39·8	½	3·98	11·71	**1·70**	1·89	7·99	10·51
6×4×½	·496	32·2	½	4·03	9·47	**1·68**	1·91	6·26	8·54
6×3½×⅝	·620	37·6	½	3·88	11·05	**1·47**	1·90	6·39	10·24
6×3½×½	·497	30·6	½	3·93	8·99	**1·45**	1·91	5·01	8·37
6×3½×⅜	·371	23·2	½	3·99	6·82	**1·42**	1·93	3·65	6·36
6×3×⅝	·623	35·6	½	3·78	10·47	**1·25**	1·90	5·07	10·00
6×3×½	·496	28·8	½	3·83	8·47	**1·22**	1·92	3·91	8·12
6×3×⅜	·373	22·0	½	3·88	6·47	**1·20**	1·93	2·85	6·23
5×3½×⅝	·621	33·4	½	3·31	9·82	**1·55**	1·56	6·28	7·19
5×3½×½	·498	27·2	½	3·36	8·00	**1·52**	1·57	4·94	5·89
5×3½×⅜	·371	20·6	½	3·41	6·06	**1·49**	1·59	3·61	4·49
5×3×½	·496	25·4	½	3·26	7·47	**1·29**	1·58	3·82	5·72
5×3×⅜	·372	19·4	½	3·31	5·70	**1·26**	1·60	2·79	4·38
5×3×5⁄16	·308	16·2	½	3·34	4·76	**1·25**	1·60	2·28	3·67

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STRUTS

Two Unequal Angles long legs back to back
Gusset on back of Angles

BASED ON
B.S. 449
1959
AS AMENDED

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR HIGH YIELD STEEL

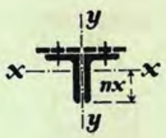
Size $d \times b$ inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30
$4\times7\frac{3}{8}$				86·3	65·8	49·1	37·4	29·2	23·3	19·0	*19·8*	*16·7*	*14·3*	*12·3*	
$4\times7\frac{3}{8}$				71·4	54·9	41·2	31·4	24·5	19·6	16·0	*16·6*	*14·0*	*12·0*	*10·3*	*9·0*
$4\times7\frac{3}{8}$				55·0	42·5	31·9	24·3	19·0	15·2	12·4	*12·9*	*10·9*	*9·3*	*8·0*	*7·0*
$4\times7\frac{3}{8}$				46·3	35·9	27·0	20·6	16·1	12·9	10·5	8·7	*9·2*	*7·8*	*6·8*	*5·9*
$4\times6\frac{3}{8}$				66·5	51·3	38·6	29·4	23·0	18·4	15·0	*15·6*	*13·2*	*11·2*	*9·7*	*8·5*
$4\times6\frac{3}{8}$				51·1	39·6	29·9	22·8	17·8	14·3	11·6	9·6	*10·2*	*8·6*	*7·5*	*6·5*
$4\times6\frac{3}{8}$				43·6	33·9	25·6	19·5	15·3	12·3	10·0	8·3	*8·7*	*7·4*	*6·4*	*5·6*
$4\times5\frac{3}{8}$			51·7	39·8	28·5	20·7	15·6	12·1	9·5	*9·7*	*8·1*	*6·8*			
$4\times5\frac{3}{8}$			42·7	32·4	23·1	16·7	12·6	9·7	7·7	*7·8*	*6·5*	*5·5*			
$4\times5\frac{3}{8}$			34·5	26·0	18·4	13·3	10·0	7·7	6·1	*6·2*	*5·2*	*4·4*			
$3\frac{1}{2}\times6\frac{3}{8}$			68·0	52·7	37·9	27·6	20·7	16·1	12·8	*13·1*	*10·8*	*9·1*	*7·8*		
$3\frac{1}{2}\times6\frac{3}{8}$			52·2	40·7	29·4	21·4	16·1	12·5	9·9	*10·1*	*8·4*	*7·1*	*6·0*		
$3\frac{1}{2}\times6\frac{3}{8}$			43·9	34·4	25·0	18·2	13·7	10·7	8·4	*8·6*	*7·1*	*6·0*	*5·1*		
$3\frac{1}{2}\times5\frac{3}{8}$			47·8	37·5	27·2	19·8	14·9	11·6	9·2	*9·4*	*7·8*	*6·5*	*5·6*		
$3\frac{1}{2}\times5\frac{3}{8}$			40·2	31·4	22·7	16·5	12·4	9·6	7·6	*7·8*	*6·4*	*5·4*	*4·6*		
$3\frac{1}{2}\times5\frac{3}{8}$			32·1	24·9	17·9	13·0	9·7	7·5	6·0	*6·1*	*5·1*	*4·3*	*3·6*		
$3\times5\frac{5}{16}$		44·0	38·9	27·1	18·6	13·3	9·9	7·6	*7·6*	*6·1*	*5·1*				
$3\times5\frac{5}{16}$		37·4	33·2	23·3	16·0	11·5	8·5	6·6	*6·5*	*5·3*	*4·4*				
$3\times5\frac{5}{16}$		30·0	26·6	18·7	12·9	9·1	6·8	5·3	*5·2*	*4·2*	*3·5*				
$3\times4\frac{5}{16}$		39·3	34·2	23·4	15·9	11·3	8·4	*8·1*	*6·4*	*5·2*					
$3\times4\frac{5}{16}$		32·9	28·3	19·1	12·9	9·2	6·8	*6·6*	*5·2*	*4·2*					
$3\times4\frac{5}{16}$		26·1	22·4	15·0	10·1	7·2	5·3	*5·1*	*4·0*	*3·3*					
$2\frac{1}{2}\times4\frac{5}{16}$	35·8	30·9	25·0	15·8	10·5	7·4	*6·8*	*5·2*	*4·1*						
$2\frac{1}{2}\times4\frac{5}{16}$	30·5	26·5	21·6	13·7	9·0	6·4	*5·9*	*4·5*	*3·6*						
$2\frac{1}{2}\times4\frac{5}{16}$	25·0	21·8	17·9	11·4	7·5	5·3	*4·9*	*3·8*	*3·0*						
$2\frac{1}{2}\times4\frac{5}{16}$	18·8	16·5	13·6	8·7	5·8	4·1	*3·8*	*2·9*	*2·3*						
$2\frac{1}{2}\times3\frac{5}{16}$	20·6	16·6	12·8	7·7	5·0	*4·4*	*3·3*	*2·5*							
$2\frac{1}{2}\times3\frac{5}{16}$	15·1	11·9	9·0	5·4	3·5	*3·1*	*2·3*								
$2\times3\frac{5}{16}$	16·3	12·6	9·4	5·6	3·6	*3·2*	*2·3*								
$2\times3\frac{5}{16}$	12·9	10·1	7·5	4·5	2·9	*2·5*	*1·9*								

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut, centre to centre of intersections, in accordance with clause 30.*c*.(iii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line in each angle or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

COMPOUND STRUTS

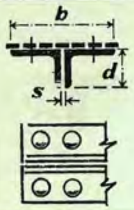
Two Unequal Angles
Long Legs back to back



COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
$4\times3\frac{1}{2}\times\frac{5}{8}$	·623	29·2	$\frac{3}{8}$	2·71	8·59	1·59	**1·21**	5·92	4·65
$4\times3\frac{1}{2}\times\frac{1}{2}$	·498	23·8	$\frac{3}{8}$	2·76	7·00	1·57	**1·23**	4·67	3·81
$4\times3\frac{1}{2}\times\frac{3}{8}$	·374	18·2	$\frac{3}{8}$	2·81	5·35	1·54	**1·24**	3·45	2·93
$4\times3\frac{1}{2}\times\frac{5}{16}$	·309	15·2	$\frac{3}{8}$	2·83	4·47	1·53	**1·25**	2·83	2·45
$4\times3\times\frac{1}{2}$	·496	22·0	$\frac{3}{8}$	2·68	6·47	1·32	**1·24**	3·55	3·70
$4\times3\times\frac{3}{8}$	·371	16·8	$\frac{3}{8}$	2·73	4·94	1·30	**1·25**	2·60	2·84
$4\times3\times\frac{5}{16}$	·311	14·2	$\frac{3}{8}$	2·76	4·18	1·28	**1·26**	2·15	2·41
$4\times2\frac{1}{2}\times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	2·64	4·58	**1·06**	1·26	1·91	2·77
$4\times2\frac{1}{2}\times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	2·67	3·83	**1·04**	1·27	1·55	2·32
$4\times2\frac{1}{2}\times\frac{1}{4}$	·248	10·6	$\frac{3}{8}$	2·70	3·11	**1·03**	1·28	1·23	1·89
$3\frac{1}{2}\times3\times\frac{1}{2}$	·499	20·4	$\frac{3}{8}$	2·38	6·00	1·37	**1·07**	3·54	2·86
$3\frac{1}{2}\times3\times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	2·43	4·58	1·34	**1·08**	2·59	2·20
$3\frac{1}{2}\times3\times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	2·46	3·83	1·33	**1·09**	2·12	1·84
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·370	14·2	$\frac{3}{8}$	2·35	4·17	1·10	**1·09**	1·88	2·12
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·309	12·0	$\frac{3}{8}$	2·38	3·53	**1·08**	1·10	1·54	1·79
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	9·6	$\frac{3}{8}$	2·41	2·83	**1·07**	1·11	1·20	1·44
$3\times2\frac{1}{2}\times\frac{3}{8}$	·372	13·0	$\frac{5}{16}$	2·06	3·82	1·12	**·92**	1·81	1·57
$3\times2\frac{1}{2}\times\frac{5}{16}$	·311	11·0	$\frac{5}{16}$	2·08	3·23	1·11	**·93**	1·49	1·33
$3\times2\frac{1}{2}\times\frac{1}{4}$	·246	8·8	$\frac{5}{16}$	2·11	2·59	1·09	**·93**	1·16	1·07
$3\times2\times\frac{3}{8}$	·372	11·8	$\frac{5}{16}$	1·97	3·47	**·89**	·94	1·27	1·54
$3\times2\times\frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·99	2·94	**·87**	·94	1·04	1·31
$3\times2\times\frac{1}{4}$	·245	8·0	$\frac{5}{16}$	2·02	2·35	**·86**	·95	·81	1·06
$2\frac{1}{2}\times2\times\frac{3}{8}$	·367	10·4	$\frac{5}{16}$	1·68	3·06	·93	**·76**	1·23	1·07
$2\frac{1}{2}\times2\times\frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·70	2·59	·92	**·77**	1·01	·91
$2\frac{1}{2}\times2\times\frac{1}{4}$	·246	7·2	$\frac{5}{16}$	1·72	2·11	·90	**·78**	·80	·74
$2\frac{1}{2}\times2\times\frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·75	1·58	·89	**·79**	·58	·56
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·63	1·89	**·67**	·79	·51	·72
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·66	1·41	**·65**	·80	·36	·54
$2\times1\frac{1}{2}\times\frac{1}{4}$	·241	5·4	$\frac{5}{16}$	1·35	1·59	·71	**·62**	·48	·45
$2\times1\frac{1}{2}\times\frac{3}{16}$	·184	4·2	$\frac{5}{16}$	1·37	1·24	·69	**·63**	·36	·35

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STRUTS

Two Unequa! Angles short legs back to back
Gusset on back of Angles

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR HIGH YIELD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Size *d* × *b* inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	5	6	8	10	12	14	16	18	20	22	24	26	28	32	40
4×18⅝		232	173	122	87·9	65·9	51·0	*50·8*	*41·4*	*34·2*	*28·8*				
4×18⅝		202	151	107	77·4	58·0	44·9	35·8	*36·5*	*30·3*	*25·4*				
4×18⅝		172	129	91·8	66·4	49·8	38·6	30·7	*31·3*	*25·9*	*21·9*				
4×18⅝		139	106	75·2	54·5	40·8	31·7	25·2	*25·6*	*21·2*	*18·0*				
6×16⅝				257	221	183	149	122	101	84·7	71·9	61·7	53·4	*51·6*	*33·4*
6×16⅝				223	193	159	130	107	88·4	74·1	62·9	54·0	46·8	*45·2*	*29·1*
6×16⅝				189	164	136	112	91·5	75·9	63·7	54·1	46·4	40·3	*38·9*	*25·2*
6×16⅝				152	133	111	90·7	74·4	61·7	51·8	44·0	37·8	32·8	*31·7*	*20·5*
4×16⅝		189	145	103	75·1	56·4	43·7	34·8	*35·4*	*29·4*	*24·7*				
4×16⅝		161	124	88·6	64·5	48·4	37·5	29·8	*30·4*	*25·2*	*21·4*				
4×16⅝		130	101	72·6	52·8	39·7	30·8	24·5	*25·0*	*20·7*	*17·5*	*14·9*			
3½×14⅝	142	126	87·7	60·2	43·0	32·1	24·7	*24·6*	*20·0*	*16·5*					
3½×14⅝	116	103	72·1	49·7	35·5	26·5	20·5	*20·3*	*16·6*	*13·7*					
3½×14⅝	88·4	78·7	55·7	38·4	27·5	20·5	15·8	*15·8*	*12·8*	*10·7*					
4×12½		161	128	93·2	68·3	51·5	40·0	31·9	*32·5*	*27·0*	*22·7*	*19·5*			
4×12½		136	110	80·9	59·4	44·9	34·9	27·8	*28·4*	*23·5*	*19·8*	*17·0*			
4×12½		111	89·6	66·3	48·8	36·9	28·7	22·9	18·7	*19·3*	*16·4*	*13·9*			
3½×12½	129	116	82·4	57·0	40·9	30·5	23·6	*23·4*	*19·1*	*15·9*					
3½×12½	106	94·9	68·1	47·2	33·9	25·3	19·6	*19·5*	*15·8*	*13·1*					
3½×12½	80·9	73·1	53·2	37·1	26·7	20·0	15·4	*15·4*	*12·5*	*10·4*	*8·7*				
3×12½	108	88·7	56·5	37·6	26·6	*24·7*	*19·0*	*15·1*							
3×12½	88·5	73·0	46·7	31·2	22·0	*20·5*	*15·8*	*12·5*							
3×12½	68·3	56·6	36·5	24·4	17·3	12·8	*12·4*	*9·8*							
3½×10½	117	106	77·7	54·4	39·2	29·4	22·7	*22·6*	*18·4*	*15·3*	*12·9*				
3½×10½		87·0	64·2	45·1	32·5	24·4	18·8	*18·8*	*15·3*	*12·7*	*10·6*				
3½×10½		66·3	49·3	34·7	25·1	18·8	14·6	*14·5*	*11·8*	*9·7*	*8·2*				
3×10½	80·3	67·4	43·9	29·5	20·9	15·5	*14·9*	*11·9*	*9·6*						
3×10½	62·3	52·9	34·9	23·5	16·7	12·4	*11·9*	*9·5*	*7·7*						
3×10½	52·0	44·2	29·2	19·6	14·0	10·4	*9·9*	*7·9*	*6·4*						

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut, centre to centre of intersections, in accordance with clause 30.*c*.(iii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line in each angle or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

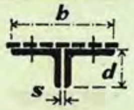
COMPOUND STRUTS

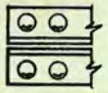
Two Unequal Angles
Short Legs back to back

COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
9×4×⅞	·872	72·2	⅝	3·05	21·23	4·71	**1·01**	50·66	7·05
9×4×¾	·745	62·4	⅝	3·10	18·34	4·68	**1·02**	43·21	6·13
9×4×⅝	·622	52·6	⅝	3·15	15·48	4·66	**1·03**	36·02	5·22
9×4×½	·495	42·4	⅝	3·20	12·46	4·62	**1·04**	28·61	4·25
8×6×⅞	·870	78·0	⅝	4·40	22·94	3·84	**1·74**	40·64	15·72
8×6×¾	·746	67·6	⅝	4·44	19·87	3·81	**1·75**	34·74	13·71
8×6×⅝	·621	56·8	⅝	4·49	16·71	3·79	**1·77**	28·83	11·61
8×6×½	·495	45·8	⅝	4·54	13·46	3·76	**1·78**	22·91	9·41
8×4×¾	·747	57·4	⅝	3·05	16·88	4·13	**1·05**	34·60	6·07
8×4×⅝	·623	48·4	⅝	3·10	14·24	4·10	**1·06**	28·80	5·17
8×4×½	·496	39·0	⅝	3·15	11·48	4·07	**1·07**	22·87	4·21
7×3½×⅝	·623	42·0	⅝	2·68	12·36	3·63	**·92**	22·32	3·89
7×3½×½	·497	34·0	⅝	2·73	10·00	3·60	**·93**	17·75	3·18
7×3½×⅜	·372	25·8	⅝	2·78	7·59	3·57	**·94**	13·24	2·44
6×4×¾	·748	47·2	½	2·93	13·89	2·98	**1·11**	19·74	5·88
6×4×⅝	·622	39·8	½	2·97	11·71	2·95	**1·13**	16·35	5·00
6×4×½	·496	32·2	½	3·02	9·47	2·93	**1·14**	12·98	4·08
6×3½×⅝	·620	37·6	½	2·63	11·05	3·03	**·95**	16·26	3·81
6×3½×½	·497	30·6	½	2·67	8·99	3·00	**·96**	12·98	3·13
6×3½×⅜	·371	23·2	½	2·72	6·82	2·97	**·98**	9·65	2·39
6×3×⅝	·623	35·6	½	2·27	10·47	3·12	**·78**	16·30	2·80
6×3×½	·496	28·8	½	2·31	8·47	3·09	**·79**	12·94	2·28
6×3×⅜	·373	22·0	½	2·36	6·47	3·06	**·80**	9·69	1·76
5×3½×⅝	·621	33·4	½	2·55	9·82	2·49	**·99**	11·58	3·73
5×3½×½	·498	27·2	½	2·60	8·00	2·46	**1·00**	9·23	3·07
5×3½×⅜	·371	20·6	½	2·65	6·06	2·43	**1·01**	6·83	2·34
5×3×½	·496	25·4	½	2·26	7·47	2·54	**·82**	9·17	2·24
5×3×⅜	·372	19·4	½	2·30	5·70	2·51	**·84**	6·84	1·73
5×3×5/16	·308	16·2	½	2·33	4·76	2·49	**·84**	5·64	1·45

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.





COMPOUND STRUTS

Two Unequal Angles short legs back to back
Gusset on back of Angles

BASED ON
B.S. 449
1959
AS AMENDED

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR HIGH YIELD STEEL

Size d × b inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24
3½×8⅜		103	94·7	83·2	70·9	59·6	50·1	42·4	36·2	27·1	21·0	16·8	*17·1*	*14·2*	*11·9*
3½×8⅜			77·6	68·5	58·5	49·3	41·5	35·2	30·0	22·5	17·5	13·9	*14·2*	*11·7*	*9·9*
3½×8⅜			60·0	53·3	45·9	38·8	32·8	27·8	23·8	17·9	13·8	11·0	*11·2*	*9·3*	*7·8*
3½×8⅜			50·1	44·6	38·4	32·4	27·4	23·3	19·9	14·9	11·6	9·2	*9·3*	*7·7*	*6·5*
3×8⅜		71·8	61·6	50·7	41·2	33·7	27·9	23·3	19·8	14·7	*14·2*	*11·3*	*9·2*		
3×8⅜		55·2	47·6	39·3	32·1	26·2	21·8	18·2	15·5	11·5	*11·1*	*8·8*	*7·1*		
3×8⅜		47·0	40·8	33·8	27·6	22·7	18·8	15·8	13·4	9·9	*9·6*	*7·6*	*6·1*		
2½×8⅜	50·9	41·8	32·5	25·2	19·8	15·9	13·0	10·9	9·1	*8·4*	*6·5*				
2½×8⅜	43·0	35·5	27·8	21·6	17·0	13·7	11·2	9·3	7·9	*7·3*	*5·6*				
2½×8⅜	34·9	28·9	22·6	17·5	13·8	11·1	9·1	7·5	6·4	*5·9*	*4·5*				
3×7⅜		67·1	57·9	47·8	39·0	31·9	26·4	22·2	18·8	14·0	*13·5*	*10·7*	*8·7*		
3×7⅜		51·9	45·2	37·6	30·9	25·3	21·0	17·6	15·0	11·2	*10·8*	*8·5*	*6·9*		
3×7⅜		43·4	37·8	31·5	25·8	21·2	17·6	14·7	12·5	9·3	*9·0*	*7·1*	*5·8*		
2½×7⅜	47·2	39·3	30·9	24·1	19·0	15·3	12·6	10·5	8·8	*8·1*	*6·3*				
2½×7⅜	40·2	33·8	26·7	20·9	16·5	13·3	10·9	9·0	7·6	*7·1*	*5·4*				
2½×7⅜	32·3	27·1	21·4	16·7	13·2	10·7	8·7	7·2	6·1	*5·7*	*4·3*				
2½×6 5/16	43·9	37·1	29·5	23·1	18·3	14·8	12·1	10·1	8·5	*7·9*	*6·0*				
2½×6 5/16	37·1	31·4	24·9	19·6	15·5	12·5	10·2	8·5	7·2	*6·6*	*5·1*				
2½×6 5/16	29·9	25·5	20·4	16·0	12·7	10·3	8·4	7·0	5·9	*5·5*	*4·2*	*3·3*			
2×6 5/16	32·2	23·6	17·3	13·1	10·2	8·0	*8·2*	*6·8*	*5·7*						
2×6 5/16	27·3	20·0	14·7	11·1	8·6	6·8	*7·0*	*5·8*	*4·9*						
2×6 5/16	22·2	16·5	12·1	9·1	7·1	5·6	4·6	*4·7*	*4·0*						
2×5 5/16	29·0	21·4	15·8	11·9	9·2	7·4	6·0	*6·2*	*5·2*						
2×5 5/16	25·0	18·6	13·8	10·4	8·1	6·4	5·2	*5·4*	*4·6*	*3·4*					
2×5 5/16	20·7	15·6	11·6	8·7	6·8	5·4	4·4	*4·6*	*3·8*	*2·8*					
2×5 5/16	15·5	11·7	8·6	6·5	5·1	4·0	3·3	*3·4*	*2·9*	*2·1*					
1½×5 5/16	11·1	7·4	5·2	3·9	*3·7*	*3·0*	*2·4*								
1½×5 5/16	8·6	5·8	4·1	3·0	*2·9*	*2·3*	*1·9*								
1½×4 5/16	10·1	6·8	4·8	3·6	*3·4*	*2·7*	*2·2*								
1½×4 5/16	7·9	5·3	3·8	2·8	*2·7*	*2·1*	*1·7*								

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut, centre to centre of intersections, in accordance with clause 30.*c*.(iii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line in each angle or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

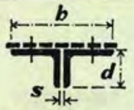
COMPOUND STRUTS

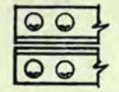
Two Unequal Angles
Short Legs back to back

COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
4×3½×⅝	·623	29·2	⅜	2·46	8·59	1·91	**1·02**	7·47	3·63
4×3½×½	·498	23·8	⅜	2·51	7·00	1·88	**1·03**	5·92	2·98
4×3½×⅜	·374	18·2	⅜	2·56	5·35	1·86	**1·05**	4·40	2·30
4×3½×5/16	·309	15·2	⅜	2·58	4·47	1·84	**1·05**	3·61	1·92
4×3×½	·496	22·0	⅜	2·18	6·47	1·95	**·86**	5·87	2·18
4×3×⅜	·371	16·8	⅜	2·23	4·94	1·92	**·87**	4·35	1·68
4×3×5/16	·311	14·2	⅜	2·25	4·18	1·91	**·88**	3·63	1·42
4×2½×⅜	·373	15·6	⅜	1·89	4·58	2·00	**·69**	4·36	1·17
4×2½×5/16	·308	13·0	⅜	1·91	3·83	1·98	**·70**	3·58	·98
4×2½×¼	·248	10·6	⅜	1·94	3·11	1·96	**·70**	2·87	·80
3½×3×½	·499	20·4	⅜	2·13	6·00	1·68	**·87**	4·62	2·15
3½×3×⅜	·373	15·6	⅜	2·18	4·58	1·66	**·89**	3·41	1·66
3½×3×5/16	·308	13·0	⅜	2·21	3·83	1·64	**·89**	2·80	1·39
3½×2½×⅜	·370	14·2	⅜	1·85	4·17	1·72	**·71**	3·37	1·14
3½×2½×5/16	·309	12·0	⅜	1·87	3·53	1·71	**·72**	2·79	·97
3½×2½×¼	·245	9·6	⅜	1·90	2·83	1·69	**·72**	2·20	·78
3×2½×⅜	·372	13·0	5/16	1·80	3·82	1·43	**·73**	2·49	1·12
3×2½×5/16	·311	11·0	5/16	1·83	3·23	1·42	**·73**	2·07	·95
3×2½×¼	·246	8·8	5/16	1·85	2·59	1·40	**·74**	1·62	·77
3×2×⅜	·372	11·8	5/16	1·46	3·47	1·51	**·56**	2·51	·73
3×2×5/16	·311	10·0	5/16	1·49	2·94	1·50	**·56**	2·09	·62
3×2×¼	·245	8·0	5/16	1·51	2·35	1·48	**·57**	1·64	·50
2½×2×⅜	·367	10·4	5/16	1·42	3·06	1·24	**·57**	1·78	·71
2½×2×5/16	·306	8·8	5/16	1·45	2·59	1·23	**·58**	1·47	·60
2½×2×¼	·246	7·2	5/16	1·47	2·11	1·22	**·59**	1·18	·50
2½×2×3/16	·181	5·4	5/16	1·50	1·58	1·20	**·59**	·86	·37
2½×1½×¼	·249	6·4	5/16	1·13	1·89	1·29	**·41**	1·18	·28
2½×1½×3/16	·183	4·8	5/16	1·15	1·41	1·27	**·42**	·86	·21
2×1½×¼	·241	5·4	5/16	1·09	1·59	1·02	**·43**	·76	·27
2×1½×3/16	·184	4·2	5/16	1·12	1·24	1·00	**·43**	·58	·21

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.





COMPOUND STRUTS

Two Unequal Angles short legs back to back
Gusset on back of Angles

BASED ON
B.S. 449
1959
AS AMENDED

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR HIGH YIELD STEEL

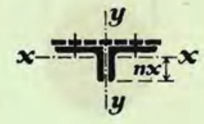
Size $d\times b$ inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
$3\frac{1}{2}\times8\frac{3}{8}$		103	94·7	83·2	70·9	59·6	50·1	42·4	36·2	27·1	21·0	16·8	*17·1*	*14·2*	*11·9*
$3\frac{1}{2}\times8\frac{3}{8}$			77·6	68·5	58·5	49·3	41·5	35·2	30·0	22·5	17·5	13·9	*14·2*	*11·7*	*9·9*
$3\frac{1}{2}\times8\frac{3}{8}$			60·0	53·3	45·9	38·8	32·8	27·8	23·8	17·9	13·8	11·0	*11·2*	*9·3*	*7·8*
$3\frac{1}{2}\times8\frac{3}{8}$			50·1	44·6	38·4	32·4	27·4	23·3	19·9	14·9	11·6	9·2	*9·3*	*7·7*	*6·5*
$3\times8\frac{3}{8}$		71·8	61·6	50·7	41·2	33·7	27·9	23·3	19·8	14·7	*14·2*	*11·3*	*9·2*		
$3\times8\frac{3}{8}$		55·2	47·6	39·3	32·1	26·2	21·8	18·2	15·5	11·5	*11·1*	*8·8*	*7·1*		
$3\times8\frac{3}{8}$		47·0	40·8	33·8	27·6	22·7	18·8	15·8	13·4	9·9	*9·6*	*7·6*	*6·1*		
$2\frac{1}{2}\times8\frac{3}{8}$	50·9	41·8	32·5	25·2	19·8	15·9	13·0	10·9	9·1	*8·4*	*6·5*				
$2\frac{1}{2}\times8\frac{3}{8}$	43·0	35·5	27·8	21·6	17·0	13·7	11·2	9·3	7·9	*7·3*	*5·6*				
$2\frac{1}{2}\times8\frac{3}{8}$	34·9	28·9	22·6	17·5	13·8	11·1	9·1	7·5	6·4	*5·9*	*4·5*				
$3\times7\frac{3}{8}$		67·1	57·9	47·8	39·0	31·9	26·4	22·2	18·8	14·0	*13·5*	*10·7*	*8·7*		
$3\times7\frac{3}{8}$		51·9	45·2	37·6	30·9	25·3	21·0	17·6	15·0	11·2	*10·8*	*8·5*	*6·9*		
$3\times7\frac{3}{8}$		43·4	37·8	31·5	25·8	21·2	17·6	14·7	12·5	9·3	*9·0*	*7·1*	*5·8*		
$2\frac{1}{2}\times7\frac{3}{8}$	47·2	39·3	30·9	24·1	19·0	15·3	12·6	10·5	8·8	*8·1*	*6·3*				
$2\frac{1}{2}\times7\frac{3}{8}$	40·2	33·8	26·7	20·9	16·5	13·3	10·9	9·0	7·6	*7·1*	*5·4*				
$2\frac{1}{2}\times7\frac{3}{8}$	32·3	27·1	21·4	16·7	13·2	10·7	8·7	7·2	6·1	*5·7*	*4·3*				
$2\frac{1}{2}\times6\frac{5}{16}$	43·9	37·1	29·5	23·1	18·3	14·8	12·1	10·1	8·5	*7·9*	*6·0*				
$2\frac{1}{2}\times6\frac{5}{16}$	37·1	31·4	24·9	19·6	15·5	12·5	10·2	8·5	7·2	*6·6*	*5·1*				
$2\frac{1}{2}\times6\frac{5}{16}$	29·9	25·5	20·4	16·0	12·7	10·3	8·4	7·0	5·9	*5·5*	*4·2*	*3·3*			
$2\times6\frac{5}{16}$	32·2	23·6	17·3	13·1	10·2	8·0	*8·2*	*6·8*	*5·7*						
$2\times6\frac{5}{16}$	27·3	20·0	14·7	11·1	8·6	6·8	*7·0*	*5·8*	*4·9*						
$2\times6\frac{5}{16}$	22·2	16·5	12·1	9·1	7·1	5·6	4·6	*4·7*	*4·0*						
$2\times5\frac{5}{16}$	29·0	21·4	15·8	11·9	9·2	7·4	6·0	*6·2*	*5·2*						
$2\times5\frac{5}{16}$	25·0	18·6	13·8	10·4	8·1	6·4	5·2	*5·4*	*4·6*	*3·4*					
$2\times5\frac{5}{16}$	20·7	15·6	11·6	8·7	6·8	5·4	4·4	*4·6*	*3·8*	*2·8*					
$2\times5\frac{5}{16}$	15·5	11·7	8·6	6·5	5·1	4·0	3·3	*3·4*	*2·9*	*2·1*					
$1\frac{1}{2}\times5\frac{5}{16}$	11·1	7·4	5·2	3·9	*3·7*	*3·0*	*2·4*								
$1\frac{1}{2}\times5\frac{5}{16}$	8·6	5·8	4·1	3·0	*2·9*	*2·3*	*1·9*								
$1\frac{1}{2}\times4\frac{5}{16}$	10·1	6·8	4·8	3·6	*3·4*	*2·7*	*2·2*								
$1\frac{1}{2}\times4\frac{5}{16}$	7·9	5·3	3·8	2·8	*2·7*	*2·1*	*1·7*								

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut, centre to centre of intersections, in accordance with clause 30.*c*.(iii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line in each angle or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959
AS AMENDED
1962

COMPOUND STRUTS

Two Unequal Angles
Short Legs back to back



COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
$4\times3\frac{1}{2}\times\frac{5}{8}$	·623	29·2	$\frac{3}{8}$	2·46	8·59	1·91	**1·02**	7·47	3·63
$4\times3\frac{1}{2}\times\frac{1}{2}$	·498	23·8	$\frac{3}{8}$	2·51	7·00	1·88	**1·03**	5·92	2·98
$4\times3\frac{1}{2}\times\frac{3}{8}$	·374	18·2	$\frac{3}{8}$	2·56	5·35	1·86	**1·05**	4·40	2·30
$4\times3\frac{1}{2}\times\frac{5}{16}$	·309	15·2	$\frac{3}{8}$	2·58	4·47	1·84	**1·05**	3·61	1·92
$4\times3\times\frac{1}{2}$	·496	22·0	$\frac{3}{8}$	2·18	6·47	1·95	**·86**	5·87	2·18
$4\times3\times\frac{3}{8}$	·371	16·8	$\frac{3}{8}$	2·23	4·94	1·92	**·87**	4·35	1·68
$4\times3\times\frac{5}{16}$	·311	14·2	$\frac{3}{8}$	2·25	4·18	1·91	**·88**	3·63	1·42
$4\times2\frac{1}{2}\times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	1·89	4·58	2·00	**·69**	4·36	1·17
$4\times2\frac{1}{2}\times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	1·91	3·83	1·98	**·70**	3·58	·98
$4\times2\frac{1}{2}\times\frac{1}{4}$	·248	10·6	$\frac{3}{8}$	1·94	3·11	1·96	**·70**	2·87	·80
$3\frac{1}{2}\times3\times\frac{1}{2}$	·499	20·4	$\frac{3}{8}$	2·13	6·00	1·68	**·87**	4·62	2·15
$3\frac{1}{2}\times3\times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	2·18	4·58	1·66	**·89**	3·41	1·66
$3\frac{1}{2}\times3\times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	2·21	3·83	1·64	**·89**	2·80	1·39
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·370	14·2	$\frac{3}{8}$	1·85	4·17	1·72	**·71**	3·37	1·14
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·309	12·0	$\frac{3}{8}$	1·87	3·53	1·71	**·72**	2·79	·97
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	9·6	$\frac{3}{8}$	1·90	2·83	1·69	**·72**	2·20	·78
$3\times2\frac{1}{2}\times\frac{3}{8}$	·372	13·0	$\frac{5}{16}$	1·80	3·82	1·43	**·73**	2·49	1·12
$3\times2\frac{1}{2}\times\frac{5}{16}$	·311	11·0	$\frac{5}{16}$	1·83	3·23	1·42	**·73**	2·07	·95
$3\times2\frac{1}{2}\times\frac{1}{4}$	·246	8·8	$\frac{5}{16}$	1·85	2·59	1·40	**·74**	1·62	·77
$3\times2\times\frac{3}{8}$	·372	11·8	$\frac{5}{16}$	1·46	3·47	1·51	**·56**	2·51	·73
$3\times2\times\frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·49	2·94	1·50	**·56**	2·09	·62
$3\times2\times\frac{1}{4}$	·245	8·0	$\frac{5}{16}$	1·51	2·35	1·48	**·57**	1·64	·50
$2\frac{1}{2}\times2\times\frac{3}{8}$	·367	10·4	$\frac{5}{16}$	1·42	3·06	1·24	**·57**	1·78	·71
$2\frac{1}{2}\times2\times\frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·45	2·59	1·23	**·58**	1·47	·60
$2\frac{1}{2}\times2\times\frac{1}{4}$	·246	7·2	$\frac{5}{16}$	1·47	2·11	1·22	**·59**	1·18	·50
$2\frac{1}{2}\times2\times\frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·50	1·58	1·20	**·59**	·86	·37
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·13	1·89	1·29	**·41**	1·18	·28
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·15	1·41	1·27	**·42**	·86	·21
$2\times1\frac{1}{2}\times\frac{1}{4}$	·241	5·4	$\frac{5}{16}$	1·09	1·59	1·02	**·43**	·76	·27
$2\times1\frac{1}{2}\times\frac{3}{16}$	·184	4·2	$\frac{5}{16}$	1·12	1·24	1·00	**·43**	·58	·21

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

COLUMNS

SOLID ROUND STEEL

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Diameter D inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET													
		8	10	12	14	16	18	20	22	24	26	28	32	36	40
12	385				1297	1190	1063	933	812	707	616	541	423	339	277
11½	353·5			1249	1164	1053	930	807	698	604	525	460	359	287	234
11	323·5			1124	1035	923	804	691	594	512	444	388	302	241	197
10½	294·5			1003	911	800	687	586	500	430	371	324	252	201	
10	267·5			887	792	684	580	491	417	357	308	268	208	165	
9½	241		850	776	680	576	484	406	344	293	252	220	170		
9	216·5		747	669	574	479	398	332	280	238	205	178	137		
8½	193		648	568	476	391	322	267	224	191	164	142			
8	171		554	472	387	314	256	212	177	151	129	112			
7½	150·5	527	465	385	309	247	201	165	138	117	100	86·9			

Diameter D inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET													
		6	8	9	10	11	12	13	14	16	18	20	22	24	26
7	131		446	416	381	343	305	271	241	191	154	126	106	89·2	76·4
6½	113		369	338	303	268	236	207	183	144	116	94·6	78·8	66·5	
6	96·5		297	266	233	203	177	154	135	106	84·8	69·3	57·7		
5½	81	281	231	201	173	148	128	111	96·9	75·4	60·3	49·2			
5	67	222	171	145	123	104	89·3	77·0	67·0	52·0	41·4				
4½	54·5	167	120	99·4	83·0	69·9	59·5	51·2	44·5	34·4					
4	43	118	78·5	64·1	53·0	44·4	37·7	32·3	28·0						
3½	33	76·3	47·7	38·5	31·6	26·4	22·3	19·1							
3	24·5	44·2	26·4	21·2	17·3	14·4									

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 180. Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959
AS AMENDED
1962

COLUMNS

SOLID ROUND STEEL

DIMENSIONS AND PROPERTIES

Diameter D	Area	Moment of Inertia	Radius of Gyration	Elastic Modulus
ins	*ins*^{2}	*ins*^{4}	*ins*	*ins*^{3}
12	113·100	1017·9	3·000	169·6
11½	103·870	858·5	2·875	149·3
11	95·033	718·7	2·750	130·6
10½	86·590	596·7	2·625	113·6
10	78·540	490·9	2·500	98·1
9½	70·882	399·8	2·375	84·1
9	63·617	322·1	2·250	71·5
8½	56·745	256·2	2·125	60·2
8	50·265	201·1	2·000	50·2
7½	44·179	155·3	1·875	41·4
7	38·485	117·9	1·750	33·6
6½	33·183	87·6	1·625	26·9
6	28·274	63·6	1·500	21·2
5½	23·758	44·9	1·375	16·3
5	19·635	30·7	1·250	12·2
4½	15·904	20·1	1·125	8·94
4	12·566	12·57	1·000	6·28
3½	9·621	7·37	·875	4·20
3	7·069	3·98	·750	2·65

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

TIES

BASED ON
B.S. 449
1959
AS AMENDED
1962

Equal Angles

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of One Equal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
8×8×1	·996	51·0	1·56	15·01	0	—	13·08	177	—	—
					1	$\frac{15}{16}$	11·95	161	14·07	190
					2	$\frac{15}{16}$	10·78	145	13·14	177
					3	$\frac{15}{16}$	—	—	12·20	165
8×8×$\frac{7}{8}$	·871	45·0	1·57	13·24	0	—	11·53	156	—	—
					1	$\frac{15}{16}$	10·54	142	12·42	168
					2	$\frac{15}{16}$	9·52	129	11·61	157
					3	$\frac{15}{16}$	—	—	10·79	146
8×8×$\frac{3}{4}$	·746	38·9	1·58	11·44	0	—	9·96	134	—	—
					1	$\frac{15}{16}$	9·11	123	10·74	145
					2	$\frac{15}{16}$	8·24	111	10·04	136
					3	$\frac{15}{16}$	—	—	9·34	126
8×8×$\frac{5}{8}$	·621	32·7	1·58	9·61	0	—	8·36	113	—	—
					1	$\frac{15}{16}$	7·65	103	9·03	122
					2	$\frac{15}{16}$	6·93	93	8·45	114
					3	$\frac{15}{16}$	—	—	7·87	106

The above safe loads are calculated for an axial stress of 13·5 tons/inch^2 on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Equal Angles

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of One Equal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
6×6×$\frac{7}{8}$	·872	33·1	1·17	9·74	0	—	8·49	115	—	—
					1	$\frac{15}{16}$	7·50	101	8·92	120
					2	$\frac{15}{16}$	—	—	8·10	109
6×6×$\frac{3}{4}$	·747	28·7	1·17	8·44	0	—	7·36	99·3	—	—
					1	$\frac{15}{16}$	6·50	87·8	7·74	104
					2	$\frac{15}{16}$	—	—	7·04	95·0
6×6×$\frac{5}{8}$	·623	24·2	1·18	7·12	0	—	6·20	83·7	—	—
					1	$\frac{15}{16}$	5·49	74·2	6·54	88·3
					2	$\frac{15}{16}$	—	—	5·95	80·4
6×6×$\frac{1}{2}$	·496	19·5	1·18	5·74	0	—	4·99	67·4	—	—
					1	$\frac{15}{16}$	4·43	59·8	5·28	71·2
					2	$\frac{15}{16}$	—	—	4·81	64·9
6×6×$\frac{3}{8}$	·371	14·8	1·19	4·35	0	—	3·78	51·0	—	—
					1	$\frac{15}{16}$	3·35	45·3	4·00	54·0
					2	$\frac{15}{16}$	—	—	3·65	49·3
5×5×$\frac{3}{4}$	·748	23·6	·97	6·94	0	—	6·06	81·7	—	—
					1	$\frac{15}{16}$	5·20	70·2	6·24	84·3
					2	$\frac{15}{16}$	—	—	5·54	74·8
5×5×$\frac{5}{8}$	·622	19·9	·98	5·86	0	—	5·10	68·9	—	—
					1	$\frac{15}{16}$	4·39	59·3	5·27	71·2
					2	$\frac{15}{16}$	—	—	4·69	63·3
5×5×$\frac{1}{2}$	·496	16·1	·98	4·74	0	—	4·12	55·7	—	—
					1	$\frac{15}{16}$	3·56	48·0	4·27	57·7
					2	$\frac{15}{16}$	—	—	3·81	51·4
5×5×$\frac{3}{8}$	·373	12·3	·99	3·61	0	—	3·14	42·4	—	—
					1	$\frac{15}{16}$	2·72	36·7	3·26	44·1
					2	$\frac{15}{16}$	—	—	2·91	39·3

Each weight per foot is for angle only. Weights of end connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

TIES

Equal Angles

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

BASED ON
B.S. 449
1959
AS AMENDED
1962

Composed of One Equal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
4 × 4 × ¾	·749	18·5	·77	5·44	0	—	4·75	64·2	—	—
					1	15/16	3·89	52·5	4·74	64·0
					2	15/16	—	—	4·04	54·5
4 × 4 × ⅝	·624	15·7	·78	4·62	0	—	4·03	54·4	—	—
					1	15/16	3·31	44·6	4·03	54·4
					2	15/16	—	—	3·45	46·5
4 × 4 × ½	·496	12·7	·78	3·73	0	—	3·26	44·0	—	—
					1	15/16	2·68	36·2	3·27	44·1
					2	15/16	—	—	2·80	37·9
4 × 4 × ⅜	·372	9·7	·78	2·85	0	—	2·48	33·5	—	—
					1	15/16	2·05	27·7	2·50	33·8
					2	15/16	—	—	2·15	29·1
3½ × 3½ × ⅝	·621	13·5	·68	3·97	0	—	3·47	46·8	—	—
					1	15/16	2·74	37·0	3·39	45·7
3½ × 3½ × ½	·496	11·0	·68	3·23	0	—	2·82	38·1	—	—
					1	15/16	2·25	30·3	2·77	37·4
3½ × 3½ × ⅜	·371	8·4	·68	2·47	0	—	2·15	29·1	—	—
					1	13/16	1·78	24·0	2·17	29·2
3½ × 3½ × 5/16	·311	7·1	·69	2·09	0	—	1·82	24·6	—	—
					1	13/16	1·51	20·4	1·84	24·8
3 × 3 × ½	·496	9·3	·58	2·73	0	—	2·39	32·2	—	—
					1	13/16	1·89	25·5	2·33	31·5
3 × 3 × ⅜	·370	7·1	·58	2·09	0	—	1·82	24·6	—	—
					1	13/16	1·45	19·6	1·79	24·1
3 × 3 × 5/16	·309	6·0	·58	1·76	0	—	1·54	20·8	—	—
					1	13/16	1·23	16·6	1·51	20·4
3 × 3 × ¼	·245	4·8	·59	1·41	0	—	1·23	16·7	—	—
					1	13/16	·99	13·3	1·22	16·4

The above safe loads are calculated for an axial stress of 13·5 tons/inch² on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Equal Angles

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of One Equal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
2½ × 2½ × ⅜	·372	5·9	·49	1·73	0	—	1·51	20·3	—	—
					1	13/16	1·13	15·2	1·43	19·3
2½ × 2½ × 5/16	·311	5·0	·49	1·47	0	—	1·28	17·2	—	—
					1	13/16	·96	13·0	1·22	16·4
2½ × 2½ × ¼	·245	4·0	·49	1·18	0	—	1·02	13·8	—	—
					1	11/16	·81	10·9	1·01	13·6
					1	13/16	·77	10·4	·98	13·2
2¼ × 2¼ × ⅜	·367	5·2	·44	1·53	0	—	1·33	17·9	—	—
					1	11/16	1·01	13·7	1·28	17·2
2¼ × 2¼ × 5/16	·306	4·4	·44	1·29	0	—	1·12	15·2	—	—
					1	11/16	·86	11·6	1·08	14·6
2¼ × 2¼ × ¼	·246	3·6	·44	1·06	0	—	·92	12·4	—	—
					1	11/16	·70	9·5	·89	12·0
2¼ × 2¼ × 3/16	·181	2·7	·44	·79	0	—	·68	9·2	—	—
					1	11/16	·53	7·1	·67	9·0
2 × 2 × 5/16	·308	3·9	·39	1·15	0	—	·99	13·4	—	—
					1	11/16	·73	9·8	·93	12·6
2 × 2 × ¼	·249	3·2	·39	·94	0	—	·82	11·0	—	—
					1	11/16	·60	8·1	·77	10·4
2 × 2 × 3/16	·183	2·4	·39	·71	0	—	·61	8·2	—	—
					1	11/16	·45	6·1	·58	7·8

Each weight per foot is for angle only. Weights of end connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

TIES

Unequal Angles

LONG LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

BASED ON
B.S. 449
1959
AS AMENDED
1962

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
9×4×$\frac{7}{8}$	·872	36·1	·83	10·62	0	—	10·20	138	—	—
					1	$\frac{15}{16}$	9·34	126	9·80	132
					2	$\frac{15}{16}$	8·47	114	8·98	121
					3	$\frac{15}{16}$	—	—	8·16	110
9×4×$\frac{3}{4}$	·745	31·2	·84	9·17	0	—	8·80	119	—	—
					1	$\frac{15}{16}$	8·06	109	8·47	114
					2	$\frac{15}{16}$	7·32	98·9	7·77	105
					3	$\frac{15}{16}$	—	—	7·08	95·5
9×4×$\frac{5}{8}$	·622	26·3	·84	7·74	0	—	7·41	100	—	—
					1	$\frac{15}{16}$	6·80	91·8	7·16	96·6
					2	$\frac{15}{16}$	6·18	83·5	6·57	88·7
					3	$\frac{15}{16}$	—	—	5·99	80·9
9×4×$\frac{1}{2}$	·495	21·2	·85	6·23	0	—	5·96	80·4	—	—
					1	$\frac{15}{16}$	5·47	73·8	5·77	77·8
					2	$\frac{15}{16}$	4·98	67·2	5·30	71·6
					3	$\frac{15}{16}$	—	—	4·84	65·3
8×6×$\frac{7}{8}$	·870	39·0	1·28	11·47	0	—	10·47	141	—	—
					1	$\frac{15}{16}$	9·55	129	10·65	144
					2	$\frac{15}{16}$	8·60	116	9·84	133
					3	$\frac{15}{16}$	—	—	9·02	122
8×6×$\frac{3}{4}$	·746	33·8	1·29	9·93	0	—	9·06	122	—	—
					1	$\frac{15}{16}$	8·27	112	9·24	125
					2	$\frac{15}{16}$	7·46	101	8·54	115
					3	$\frac{15}{16}$	—	—	7·84	106
8×6×$\frac{5}{8}$	·621	28·4	1·29	8·36	0	—	7·61	103	—	—
					1	$\frac{15}{16}$	6·95	93·8	7·77	105
					2	$\frac{15}{16}$	6·28	84·7	7·19	97·1
					3	$\frac{15}{16}$	—	—	6·61	89·2
8×6×$\frac{1}{2}$	·495	22·9	1·30	6·73	0	—	6·12	82·6	—	—
					1	$\frac{15}{16}$	5·60	75·5	6·27	84·6
					2	$\frac{15}{16}$	5·06	68·3	5·80	78·4
					3	$\frac{15}{16}$	—	—	5·34	72·1

The above safe loads are calculated for an axial stress of 13·5 tons/inch² on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Unequal Angles

LONG LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
8×4 ×$\frac{3}{4}$	·747	28·7	·85	8·44	0	—	8·04	108	—	—
					1	$\frac{15}{16}$	7·29	98·4	7·74	104
					2	$\frac{15}{16}$	6·53	88·2	7·04	95·0
					3	$\frac{15}{16}$	—	—	6·34	85·6
8×4 ×$\frac{5}{8}$	·623	24·2	·85	7·12	0	—	6·77	91·4	—	—
					1	$\frac{15}{16}$	6·15	83·0	6·54	88·3
					2	$\frac{15}{16}$	5·52	74·5	5·95	80·4
					3	$\frac{15}{16}$	—	—	5·37	72·5
8×4 ×$\frac{1}{2}$	·496	19·5	·86	5·74	0	—	5·45	73·5	—	—
					1	$\frac{15}{16}$	4·95	66·9	5·28	71·2
					2	$\frac{15}{16}$	4·45	60·1	4·81	64·9
					3	$\frac{15}{16}$	—	—	4·35	58·7
7×3$\frac{1}{2}$×$\frac{5}{8}$	·623	21·0	·74	6·18	0	—	5·88	79·4	—	—
					1	$\frac{15}{16}$	5·26	71·0	5·60	75·5
					2	$\frac{15}{16}$	4·63	62·5	5·01	67·7
7×3$\frac{1}{2}$×$\frac{1}{2}$	·497	17·0	·75	5·00	0	—	4·75	64·1	—	—
					1	$\frac{15}{16}$	4·25	57·4	4·53	61·2
					2	$\frac{15}{16}$	3·75	50·6	4·07	54·9
7×3$\frac{1}{2}$×$\frac{3}{8}$	·372	12·9	·76	3·79	0	—	3·60	48·5	—	—
					1	$\frac{15}{16}$	3·22	43·5	3·45	46·5
					2	$\frac{15}{16}$	2·84	38·4	3·10	41·8
6×4 ×$\frac{3}{4}$	·748	23·6	·86	6·94	0	—	6·44	87·0	—	—
					1	$\frac{15}{16}$	5·66	76·5	6·24	84·3
					2	$\frac{15}{16}$	4·86	65·6	5·54	74·8
6×4 ×$\frac{5}{8}$	·622	19·9	·86	5·86	0	—	5·43	73·2	—	—
					1	$\frac{15}{16}$	4·78	64·5	5·27	71·2
					2	$\frac{15}{16}$	4·11	55·5	4·69	63·3
6×4 ×$\frac{1}{2}$	·496	16·1	·87	4·74	0	—	4·38	59·2	—	—
					1	$\frac{15}{16}$	3·87	52·2	4·27	57·7
					2	$\frac{15}{16}$	3·33	45·0	3·81	51·4

Each weight per foot is for angle only. Weights of end connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

TIES

Unequal Angles

LONG LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

BASED ON
B.S. 449
1959
AS AMENDED
1962

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$6\times3\frac{1}{2}\times\frac{5}{8}$	·620	18·8	·75	5·53	0	—	5·19	70·1	—	—
					1	$\frac{15}{16}$	4·56	61·6	4·95	66·8
					2	$\frac{15}{16}$	3·91	52·8	4·36	58·9
$6\times3\frac{1}{2}\times\frac{1}{2}$	·497	15·3	·76	4·50	0	—	4·22	56·9	—	—
					1	$\frac{15}{16}$	3·71	50·1	4·03	54·4
					2	$\frac{15}{16}$	3·19	43·1	3·56	48·1
$6\times3\frac{1}{2}\times\frac{3}{8}$	·371	11·6	·76	3·41	0	—	3·19	43·1	—	—
					1	$\frac{15}{16}$	2·81	38·0	3·06	41·3
					2	$\frac{15}{16}$	2·42	32·7	2·71	36·6
$6\times3\ \times\frac{5}{8}$	·623	17·8	·63	5·24	0	—	4·99	67·4	—	—
					1	$\frac{13}{16}$	—	—	4·73	63·9
					2	$\frac{13}{16}$	3·90	52·7	4·22	57·0
					1	$\frac{15}{16}$	4·37	59·0	—	—
$6\times3\ \times\frac{1}{2}$	·496	14·4	·64	4·24	0	—	4·03	54·4	—	—
					1	$\frac{13}{16}$	—	—	3·83	51·7
					2	$\frac{13}{16}$	3·16	42·7	3·43	46·3
					1	$\frac{15}{16}$	3·53	47·7	—	—
$6\times3\ \times\frac{3}{8}$	·373	11·0	·64	3·24	0	—	3·07	41·5	—	—
					1	$\frac{13}{16}$	—	—	2·93	39·6
					2	$\frac{13}{16}$	2·42	32·7	2·63	35·5
					1	$\frac{15}{16}$	2·70	36·4	—	—
$5\times3\frac{1}{2}\times\frac{5}{8}$	·621	16·7	·75	4·91	0	—	4·53	61·1	—	—
					1	$\frac{15}{16}$	3·87	52·3	4·33	58·4
					2	$\frac{15}{16}$	—	—	3·74	50·5
$5\times3\frac{1}{2}\times\frac{1}{2}$	·498	13·6	·75	4·00	0	—	3·68	49·7	—	—
					1	$\frac{15}{16}$	3·16	42·7	3·53	47·7
					2	$\frac{15}{16}$	—	—	3·07	41·4
$5\times3\frac{1}{2}\times\frac{3}{8}$	·371	10·3	·76	3·03	0	—	2·79	37·6	—	—
					1	$\frac{15}{16}$	2·40	32·3	2·68	36·2
					2	$\frac{15}{16}$	—	—	2·34	31·5

The above safe loads are calculated for an axial stress of 13·5 tons/inch² on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Unequal Angles

LONG LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$5\times3\ \times\frac{1}{2}$	·496	12·7	·64	3·73	0	—	3·50	47·3	—	—
					1	$\frac{13}{16}$	—	—	3·33	45·0
					2	$\frac{13}{16}$	2·61	35·2	2·93	39·5
					1	$\frac{15}{16}$	2·99	40·4	—	—
$5\times3\ \times\frac{3}{8}$	·372	9·7	·65	2·85	0	—	2·67	36·0	—	—
					1	$\frac{13}{16}$	—	—	2·55	34·4
					2	$\frac{13}{16}$	2·00	26·9	2·25	30·3
					1	$\frac{15}{16}$	2·28	30·8	—	—
$5\times3\ \times\frac{5}{16}$	·308	8·1	·65	2·38	0	—	2·23	30·0	—	—
					1	$\frac{13}{16}$	—	—	2·13	28·8
					2	$\frac{13}{16}$	1·67	22·5	1·88	25·4
					1	$\frac{15}{16}$	1·91	25·8	—	—
$4\times3\frac{1}{2}\times\frac{5}{8}$	·623	14·6	·72	4·30	0	—	3·84	51·8	—	—
					1	$\frac{15}{16}$	3·15	42·5	3·71	50·1
$4\times3\frac{1}{2}\times\frac{1}{2}$	·493	11·9	·72	3·50	0	—	3·12	42·2	—	—
					1	$\frac{15}{16}$	2·57	34·7	3·03	40·9
$4\times3\frac{1}{2}\times\frac{3}{8}$	·374	9·1	·72	2·68	0	—	2·39	32·2	—	—
					1	$\frac{15}{16}$	1·97	26·6	2·33	31·4
$4\times3\frac{1}{2}\times\frac{5}{16}$	·309	7·6	·73	2·23	0	—	1·99	26·9	—	—
					1	$\frac{15}{16}$	1·65	22·2	1·94	26·2
$4\times3\ \times\frac{1}{2}$	·496	11·0	·63	3·23	0	—	2·96	39·9	—	—
					1	$\frac{13}{16}$	—	—	2·83	38·2
					1	$\frac{15}{16}$	2·43	32·7	—	—
$4\times3\ \times\frac{3}{8}$	·371	8·4	·64	2·47	0	—	2·25	30·4	—	—
					1	$\frac{13}{16}$	—	—	2·17	29·2
					1	$\frac{15}{16}$	1·85	25·0	—	—
$4\times3\ \times\frac{5}{16}$	·311	7·1	·64	2·09	0	—	1·91	25·7	—	—
					1	$\frac{13}{16}$	1·62	21·8	1·84	24·8

Each weight per foot is for angle only. Weights of end connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

TIES

Unequal Angles

LONG LEG ATTACHED

BASED ON
B.S. 449
1959
AS AMENDED
1962

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$4\times2\frac{1}{2}\times\frac{3}{8}$	·373	7·8	·54	2·29	0	—	2·14	28·9	—	—
					1	$\frac{13}{16}$	—	—	1·99	26·9
					1	$\frac{15}{16}$	1·75	23·7	—	—
$4\times2\frac{1}{2}\times\frac{5}{16}$	·308	6·5	·54	1·91	0	—	1·79	24·1	—	—
					1	$\frac{13}{16}$	1·51	20·4	1·66	22·5
$4\times2\frac{1}{2}\times\frac{1}{4}$	·248	5·3	·54	1·56	0	—	1·45	19·6	—	—
					1	$\frac{13}{16}$	1·23	16·6	1·36	18·3
$3\frac{1}{2}\times3\times\frac{1}{2}$	·499	10·2	·62	3·00	0	—	2·69	36·3	—	—
					1	$\frac{13}{16}$	—	—	2·60	35·0
					1	$\frac{15}{16}$	2·14	28·9	—	—
$3\frac{1}{2}\times3\times\frac{3}{8}$	·373	7·8	·62	2·29	0	—	2·05	27·7	—	—
					1	$\frac{13}{16}$	—	—	1·99	26·9
					1	$\frac{15}{16}$	1·64	22·1	—	—
$3\frac{1}{2}\times3\times\frac{5}{16}$	·308	6·5	·62	1·91	0	—	1·71	23·1	—	—
					1	$\frac{13}{16}$	1·42	19·1	1·66	22·5
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·370	7·1	·53	2·09	0	—	1·92	25·9	—	—
					1	$\frac{13}{16}$	1·58	21·3	1·79	24·1
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·309	6·0	·53	1·76	0	—	1·62	21·9	—	—
					1	$\frac{13}{16}$	1·34	18·0	1·51	20·4
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	4·8	·54	1·41	0	—	1·30	17·5	—	—
					1	$\frac{13}{16}$	1·07	14·5	1·22	16·4
$3\times2\frac{1}{2}\times\frac{3}{8}$	·372	6·5	·52	1·91	0	—	1·72	23·3	—	—
					1	$\frac{13}{16}$	1·37	18·4	1·61	21·7
$3\times2\frac{1}{2}\times\frac{5}{16}$	·311	5·5	·52	1·62	0	—	1·46	19·7	—	—
					1	$\frac{13}{16}$	1·16	15·6	1·36	18·4
$3\times2\frac{1}{2}\times\frac{1}{4}$	·246	4·4	·52	1·30	0	—	1·17	15·7	—	—
					1	$\frac{13}{16}$	·93	12·6	1·10	14·8

The above safe loads are calculated for an axial stress of 13·5 tons/inch² on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Unequal Angles

LONG LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$3\times2\times\frac{3}{8}$	·372	5·9	·43	1·73	0	—	1·60	21·6	—	—
					1	$\frac{13}{16}$	1·26	17·0	1·43	19·3
$3\times2\times\frac{5}{16}$	·311	5·0	·43	1·47	0	—	1·36	18·3	—	—
					1	$\frac{13}{16}$	1·07	14·5	1·22	16·4
$3\times2\times\frac{1}{4}$	·245	4·0	·43	1·18	0	—	1·08	14·6	—	—
					1	$\frac{13}{16}$	·86	11·6	·98	13·2
$2\frac{1}{2}\times2\times\frac{3}{8}$	·367	5·2	·42	1·53	0	—	1·38	18·6	—	—
					1	$\frac{13}{16}$	1·03	13·9	1·23	16·6
$2\frac{1}{2}\times2\times\frac{5}{16}$	·306	4·4	·42	1·29	0	—	1·17	15·7	—	—
					1	$\frac{13}{16}$	·87	11·8	1·05	14·1
$2\frac{1}{2}\times2\times\frac{1}{4}$	·246	3·6	·42	1·06	0	—	·95	12·8	—	—
					1	$\frac{11}{16}$	·75	10·2	·89	12·0
$2\frac{1}{2}\times2\times\frac{3}{16}$	·181	2·7	·43	·79	0	—	·71	9·5	—	—
					1	$\frac{11}{16}$	·56	7·6	·67	9·0
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{1}{4}$	·249	3·2	·32	·94	0	—	·88	11·9	—	—
					1	$\frac{11}{16}$	·69	9·3	·77	10·4
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{3}{16}$	·183	2·4	·32	·71	0	—	·66	8·8	—	—
					1	$\frac{11}{16}$	·52	6·9	·58	7·8
$2\times1\frac{1}{2}\times\frac{1}{4}$	·241	2·7	·32	·79	0	—	·72	9·7	—	—
					1	$\frac{11}{16}$	·53	7·1	·63	8·4
$2\times1\frac{1}{2}\times\frac{3}{16}$	·184	2·1	·32	·62	0	—	·56	7·5	—	—
					1	$\frac{11}{16}$	·41	5·5	·49	6·6

Each weight per foot is for angle only. Weights of end connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

TIES

Unequal Angles

SHORT LEG ATTACHED

BASED ON
B.S. 449
1959
AS AMENDED
1962

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
9×4×⅞	·872	36·1	·83	10·62	0	—	7·25	97·9	—	—
					1	15/16	5·87	79·2	9·80	132
					2	15/16	—	—	8·98	121
9×4×¾	·745	31·2	·84	9·17	0	—	6·29	84·9	—	—
					1	15/16	5·11	69·0	8·47	114
					2	15/16	—	—	7·77	105
9×4×⅝	·622	26·3	·84	7·74	0	—	5·32	71·8	—	—
					1	15/16	4·34	58·6	7·16	96·6
					2	15/16	—	—	6·57	88·7
9×4×½	·495	21·2	·85	6·23	0	—	4·29	58·0	—	—
					1	15/16	3·52	47·5	5·77	77·8
					2	15/16	—	—	5·30	71·6
8×6×⅞	·870	39·0	1·28	11·47	0	—	9·37	127	—	—
					1	15/16	8·29	112	10·65	144
					2	15/16	—	—	9·84	133
8×6×¾	·746	33·8	1·29	9·93	0	—	8·12	110	—	—
					1	15/16	7·19	97·0	9·24	125
					2	15/16	—	—	8·54	115
8×6×⅝	·621	28·4	1·29	8·36	0	—	6·83	92·1	—	—
					1	15/16	6·05	81·7	7·77	105
					2	15/16	—	—	7·19	97·1
8×6×½	·495	22·9	1·30	6·73	0	—	5·50	74·2	—	—
					1	15/16	4·88	65·9	6·27	84·6
					2	15/16	—	—	5·80	78·4

The above safe loads are calculated for an axial stress of 13·5 tons/inch^2 on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Unequal Angles

SHORT LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
8×4×¾	·747	28·7	·85	8·44	0	—	6·06	81·8	—	—
					1	15/16	4·94	66·7	7·74	104
					2	15/16	—	—	7·04	95·0
8×4×⅝	·623	24·2	·85	7·12	0	—	5·12	69·2	—	—
					1	15/16	4·19	56·6	6·54	88·3
					2	15/16	—	—	5·95	80·4
8×4×½	·496	19·5	·86	5·74	0	—	4·14	55·9	—	—
					1	15/16	3·40	45·9	5·28	71·2
					2	15/16	—	—	4·81	64·9
7×3½×⅝	·623	21·0	·74	6·18	0	—	4·44	59·9	—	—
					1	15/16	3·50	47·2	5·60	75·5
					2	15/16	—	—	5·01	67·7
7×3½×½	·497	17·0	·75	5·00	0	—	3·60	48·6	—	—
					1	15/16	2·85	38·5	4·53	61·2
					2	15/16	—	—	4·07	54·9
7×3½×⅜	·372	12·9	·76	3·79	0	—	2·74	36·9	—	—
					1	15/16	2·18	29·4	3·45	46·5
					2	15/16	—	—	3·10	41·8
6×4×¾	·748	23·6	·86	6·94	0	—	5·49	74·1	—	—
					1	15/16	4·49	60·6	6·24	84·3
					2	15/16	—	—	5·54	74·8
6×4×⅝	·622	19·9	·86	5·86	0	—	4·63	62·5	—	—
					1	15/16	3·81	51·4	5·27	71·2
					2	15/16	—	—	4·69	63·3
6×4×½	·496	16·1	·87	4·74	0	—	3·75	50·6	—	—
					1	15/16	3·09	41·8	4·27	57·7
					2	15/16	—	—	3·81	51·4

Each weight per foot is for angle only. Weights of end connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

TIES

Unequal Angles

SHORT LEG ATTACHED

BASED ON
B.S. 449
1959
AS AMENDED
1962

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$6\times3\frac{1}{2}\times\frac{5}{8}$	·620	18·8	·75	5·53	0	—	4·19	56·6	—	—
					1	$\frac{15}{16}$	3·31	44·7	4·95	66·8
					2	$\frac{15}{16}$	—	—	4·36	58·9
$6\times3\frac{1}{2}\times\frac{1}{2}$	·497	15·3	·76	4·50	0	—	3·41	46·1	—	—
					1	$\frac{15}{16}$	2·71	36·6	4·03	54·4
					2	$\frac{15}{16}$	—	—	3·56	48·1
$6\times3\frac{1}{2}\times\frac{3}{8}$	·371	11·6	·76	3·41	0	—	2·59	35·0	—	—
					1	$\frac{15}{16}$	2·07	27·9	3·06	41·3
					2	$\frac{15}{16}$	—	—	2·71	36·6
$6\times3\ \times\frac{5}{8}$	·623	17·8	·63	5·24	0	—	3·75	50·7	—	—
					1	$\frac{13}{16}$	2·93	39·6	4·73	63·9
					2	$\frac{13}{16}$	—	—	4·22	57·0
$6\times3\ \times\frac{1}{2}$	·496	14·4	·64	4·24	0	—	3·05	41·1	—	—
					1	$\frac{13}{16}$	2·40	32·4	3·83	51·7
					2	$\frac{13}{16}$	—	—	3·43	46·3
$6\times3\ \times\frac{3}{8}$	·373	11·0	·64	3·24	0	—	2·33	31·5	—	—
					1	$\frac{13}{16}$	1·85	24·9	2·93	39·6
					2	$\frac{13}{16}$	—	—	2·63	35·5
$5\times3\frac{1}{2}\times\frac{5}{8}$	·621	16·7	·75	4·91	0	—	3·94	53·1	—	—
					1	$\frac{15}{16}$	3·12	42·1	4·33	58·4
					2	$\frac{15}{16}$	—	—	3·74	50·5
$5\times3\frac{1}{2}\times\frac{1}{2}$	·498	13·6	·75	4·00	0	—	3·21	43·3	—	—
					1	$\frac{15}{16}$	2·56	34·5	3·53	47·7
					2	$\frac{15}{16}$	—	—	3·07	41·4
$5\times3\frac{1}{2}\times\frac{3}{8}$	·371	10·3	·76	3·03	0	—	2·43	32·8	—	—
					1	$\frac{15}{16}$	1·95	26·3	2·68	36·2
					2	$\frac{15}{16}$	—	—	2·34	31·5

The above safe loads are calculated for an axial stress of 13·5 tons/inch² on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Unequal Angles

SHORT LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$5\times3\ \times\frac{1}{2}$	·496	12·7	·64	3·73	0	—	2·86	38·6	—	—
					1	$\frac{13}{16}$	2·26	30·5	3·33	45·0
					2	$\frac{13}{16}$	—	—	2·93	39·5
$5\times3\ \times\frac{3}{8}$	·372	9·7	·65	2·85	0	—	2·19	29·5	—	—
					1	$\frac{13}{16}$	1·74	23·5	2·55	34·4
					2	$\frac{13}{16}$	—	—	2·25	30·3
$5\times3\ \times\frac{5}{16}$	·308	8·1	·65	2·38	0	—	1·83	24·7	—	—
					1	$\frac{13}{16}$	1·46	19·7	2·13	28·8
					2	$\frac{13}{16}$	—	—	1·88	25·4
$4\times3\frac{1}{2}\times\frac{5}{8}$	·623	14·6	·72	4·30	0	—	3·64	49·2	—	—
					1	$\frac{15}{16}$	2·89	39·0	3·71	50·1
					2	$\frac{15}{16}$	—	—	3·13	42·2
$4\times3\frac{1}{2}\times\frac{1}{2}$	·498	11·9	·72	3·50	0	—	2·97	40·1	—	—
					1	$\frac{15}{16}$	2·36	31·9	3·03	40·9
					2	$\frac{15}{16}$	—	—	2·56	34·6
$4\times3\frac{1}{2}\times\frac{3}{8}$	·374	9·1	·72	2·68	0	—	2·27	30·6	—	—
					1	$\frac{13}{16}$	1·88	25·4	2·37	32·0
					2	$\frac{13}{16}$	—	—	2·07	27·9
$4\times3\frac{1}{2}\times\frac{5}{16}$	·309	7·6	·73	2·23	0	—	1·89	25·6	—	—
					1	$\frac{13}{16}$	1·57	21·2	1·98	26·8
					2	$\frac{13}{16}$	—	—	1·73	23·4
$4\times3\ \times\frac{1}{2}$	·496	11·0	·63	3·23	0	—	2·64	35·7	—	—
					1	$\frac{13}{16}$	2·09	28·3	2·83	38·2
					2	$\frac{13}{16}$	—	—	2·43	32·8
$4\times3\ \times\frac{3}{8}$	·371	8·4	·64	2·47	0	—	2·02	27·3	—	—
					1	$\frac{13}{16}$	1·61	21·7	2·17	29·2
					2	$\frac{13}{16}$	—	—	1·86	25·2
$4\times3\ \times\frac{5}{16}$	·311	7·1	·64	2·09	0	—	1·71	23·1	—	—
					1	$\frac{13}{16}$	1·37	18·4	1·84	24·8
					2	$\frac{13}{16}$	—	—	1·58	21·4

Each weight per foot is for angle only. Weights of end connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

TIES

Unequal Angles

SHORT LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

BASED ON
B.S. 449
1959
AS AMENDED
1962

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$4\times2\frac{1}{2}\times\frac{3}{8}$	·373	7·8	·54	2·29	0	—	1·78	24·0	—	—
					1	$\frac{13}{16}$	1·33	18·0	1·99	26·9
$4\times2\frac{1}{2}\times\frac{5}{16}$	·308	6·5	·54	1·91	0	—	1·49	20·1	—	—
					1	$\frac{13}{16}$	1·12	15·1	1·66	22·5
$4\times2\frac{1}{2}\times\frac{1}{4}$	·248	5·3	·54	1·56	0	—	1·21	16·4	—	—
					1	$\frac{13}{16}$	·91	12·3	1·36	18·3
$3\frac{1}{2}\times3\times\frac{1}{2}$	·499	10·2	·62	3·00	0	—	2·54	34·2	—	—
					1	$\frac{13}{16}$	2·01	27·1	2·60	35·0
$3\frac{1}{2}\times3\times\frac{3}{8}$	·373	7·8	·62	2·29	0	—	1·94	26·1	—	—
					1	$\frac{13}{16}$	1·54	20·8	1·99	26·9
$3\frac{1}{2}\times3\times\frac{5}{16}$	·308	6·5	·62	1·91	0	—	1·62	21·8	—	—
					1	$\frac{13}{16}$	1·29	17·4	1·66	22·5
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·370	7·1	·53	2·09	0	—	1·69	22·8	—	—
					1	$\frac{13}{16}$	1·26	17·0	1·79	24·1
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·309	6·0	·53	1·76	0	—	1·43	19·2	—	—
					1	$\frac{13}{16}$	1·07	14·5	1·51	20·4
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	4·8	·54	1·41	0	—	1·14	15·4	—	—
					1	$\frac{11}{16}$	·91	12·3	1·25	16·8
					1	$\frac{13}{16}$	·86	11·7	1·22	16·4
$3\times2\frac{1}{2}\times\frac{3}{8}$	·372	6·5	·52	1·91	0	—	1·61	21·7	—	—
					1	$\frac{13}{16}$	1·20	16·2	1·61	21·7
$3\times2\frac{1}{2}\times\frac{5}{16}$	·311	5·5	·52	1·62	0	—	1·36	18·3	—	—
					1	$\frac{13}{16}$	1·02	13·8	1·36	18·4
$3\times2\frac{1}{2}\times\frac{1}{4}$	·246	4·4	·52	1·30	0	—	1·09	14·7	—	—
					1	$\frac{11}{16}$	·87	11·7	1·13	15·2
					1	$\frac{13}{16}$	·82	11·1	1·10	14·8

The above safe loads are calculated for an axial stress of 13·5 tons/inch² on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Unequal Angles

SHORT LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$3\times2\times\frac{3}{8}$	·372	5·9	·43	1·73	0	—	1·36	18·4	—	—
					1	$\frac{11}{16}$	·99	13·4	1·48	19·9
$3\times2\times\frac{5}{16}$	·311	5·0	·43	1·47	0	—	1·16	15·6	—	—
					1	$\frac{11}{16}$	·85	11·4	1·26	17·0
$3\times2\times\frac{1}{4}$	·245	4·0	·43	1·18	0	—	·93	12·5	—	—
					1	$\frac{11}{16}$	·68	9·2	1·01	13·6
$2\frac{1}{2}\times2\times\frac{3}{8}$	·367	5·2	·42	1·53	0	—	1·26	17·1	—	—
					1	$\frac{11}{16}$	·92	12·4	1·28	17·2
$2\frac{1}{2}\times2\times\frac{5}{16}$	·306	4·4	·42	1·29	0	—	1·07	14·4	—	—
					1	$\frac{11}{16}$	·78	10·6	1·08	14·6
$2\frac{1}{2}\times2\times\frac{1}{4}$	·246	3·6	·42	1·06	0	—	·87	11·8	—	—
					1	$\frac{11}{16}$	·64	8·6	·89	12·0
$2\frac{1}{2}\times2\times\frac{3}{16}$	·181	2·7	·43	·79	0	—	·65	8·8	—	—
					1	$\frac{11}{16}$	·48	6·5	·67	9·0
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{1}{4}$	·249	3·2	·32	·94	0	—	·72	9·6	—	—
					1	$\frac{9}{16}$	·50	6·7	·80	10·8
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{3}{16}$	·183	2·4	·32	·71	0	—	·54	7·2	—	—
					1	$\frac{9}{16}$	·38	5·1	·60	8·1
$2\times1\frac{1}{2}\times\frac{1}{4}$	·241	2·7	·32	·79	0	—	·64	8·6	—	—
					1	$\frac{9}{16}$	·45	6·1	·66	8·8
$2\times1\frac{1}{2}\times\frac{3}{16}$	·184	2·1	·32	·62	0	—	·50	6·7	—	—
					1	$\frac{9}{16}$	·36	4·8	·51	6·9

Each weight per foot is for angle only. Weights of end connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

TIES

Two Angles
Gusset between Angles

BASED ON
B.S. 449
1959
AS AMENDED
1962

SAFE LOADS IN TONS FOR HIGH YIELD STEEL

Nominal Thickness of each Angle in inches	Holes Deducted from each Angle		SUM OF LEG-LENGTHS OF EACH ANGLE IN INCHES								
	Number	dia.	16	14	13	12	10½	10	9½	9	8½
1	0	—	405								
	1	15/16	380								
	2	15/16	355								
	3	15/16	330								
7/8	0	—	357	310	287	263					
	1	15/16	335	288	265	241					
	2	15/16	313	266	242	219					
	3	15/16	291	244	220	197					
3/4	0	—	309	268	248	228		187			
	1	15/16	290	249	229	209		169			
	2	15/16	271	230	210	190		150			
	3	15/16	252	212	191	171		—			
5/8	0	—	260	226	209	192	167	158	149	141	133
	1	15/16	244	210	193	177	151	142	134	126	117
	2	15/16	228	194	177	161	135	127	118	110	—
	3	15/16	212	178	162	145	—	—	—	—	—
	1	13/16	246	212	195	179	153	144	136	128	119
	2	13/16	232	198	182	165	140	131	122	114	105
1/2	0	—		182	168	155	135	128	121	114	108
	1	15/16		169	156	142	122	115	109	102	95·4
	2	15/16		157	143	130	110	103	96·2	89·2	—
	3	15/16		144	131	117	—	—	—	—	—
	1	13/16		171	157	144	124	117	110	103	97·1
	2	13/16		160	147	133	113	106	99·6	92·6	86·2
3/8	0	—				117	102	97·6	92·0	87·4	81·9
	1	15/16				108	93·0	88·1	82·6	77·9	72·5
	2	15/16				98·6	83·6	78·7	—	—	—
	1	13/16				109	94·3	89·4	83·9	79·2	73·7
	2	13/16				101	86·1	81·2	75·7	71·0	65·6

The above safe loads are calculated for an axial stress of 13·5 tons/inch^2 on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959 as amended 1962.
The radii of gyration of the ties tabulated above may be obtained by reference to tables on pages 332 to 345 inclusive.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Two Angles
Gusset between Angles

SAFE LOADS IN TONS FOR HIGH YIELD STEEL

Nominal Thickness of each Angle in inches	Holes Deducted from each Angle		SUM OF LEG-LENGTHS OF EACH ANGLE IN INCHES									
	Number	dia.	8	7½	7	6½	6	5½	5	4½	4	3½
3/4	0	—	147									
	1	15/16	128									
	1	13/16	131									
	2	13/16	114									
5/8	0	—	125	116	107							
	1	13/16	111	102	93·6							
	2	13/16	97·2	88·6	79·9							
1/2	0	—	101	94·5	87·3	81·0	73·8					
	1	13/16	90·0	83·5	76·4	70·1	62·9					
	2	13/16	79·1	72·6	65·6	59·1	52·1					
3/8	0	—	77·0	72·3	66·6	61·9	56·4	51·6	46·8	41·2		
	1	13/16	68·8	64·1	58·5	53·7	48·2	43·4	38·6	33·2		
	2	13/16	60·6	55·9	50·3	45·5	40·1	35·3	30·5	—		
	1	11/16				55·0	49·5	44·7	39·9	34·4		
	2	11/16				48·0	42·6	37·8	33·0	27·6		
5/16	0	—	64·3	60·3	56·4	51·7	47·6	43·7	39·7	34·9	30·9	
	1	13/16	57·6	53·5	49·6	44·9	40·8	36·8	32·9	28·2	—	
	1	11/16				46·0	41·9	37·9	33·9	29·3	25·2	
	2	11/16				40·2	36·1	32·1	28·1	23·6	19·5	
1/4	0	—			45·3	42·0	38·2	35·0	31·8	28·5	25·4	21·4
	1	13/16			39·8	36·6	32·8	29·6	26·4	23·1	—	—
	1	11/16			40·7	37·4	33·6	30·4	27·2	24·0	20·8	16·9
	2	11/16			36·1	32·8	29·1	25·8	22·7	19·4	16·2	12·5
	1	9/16								24·8	21·7	17·8
3/16	0	—								21·4	19·1	16·7
	1	11/16								18·0	15·7	13·3
	1	9/16								18·6	16·3	13·9

For explanation of tables, see notes commencing pages 162 and 184.

TIES

Two Equal Angles back to back
Gusset on back of Angles

BASED ON
B.S. 449
1959
AS AMENDED
1962

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of Two Equal Angles		Weight per foot in lbs	Space between Angles s inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis y-y	Axis x-x		No.	Dia.		
8×8×1	·996	102·0	5/8	3·61	2·43	30·01	0	—	27·40	370
							1	15/16	25·24	341
							2	15/16	23·01	311
8×8×7/8	·871	90·0	5/8	3·59	2·45	26·48	0	—	24·16	326
							1	15/16	22·27	301
							2	15/16	20·32	274
8×8×3/4	·746	77·8	5/8	3·56	2·46	22·88	0	—	20·86	282
							1	15/16	19·25	260
							2	15/16	17·58	237
8×8×5/8	·621	65·4	5/8	3·54	2·48	19·23	0	—	17·51	236
							1	15/16	16·16	218
							2	15/16	14·77	199

The above safe loads are calculated for an axial stress of 13.5 tons/inch² on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Two Equal Angles back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of Two Equal Angles		Weight per foot in lbs	Space between Angles s inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis y-y	Axis x-x		No.	Dia.		
6×6×7/8	·872	66·2	1/2	2·74	1·81	19·48	0	—	17·79	240
							1	15/16	15·89	215
							2	13/16	14·44	195
6×6×3/4	·747	57·4	1/2	2·72	1·82	16·88	0	—	15·41	208
							1	15/16	13·78	186
							2	13/16	12·54	169
6×6×5/8	·623	48·4	1/2	2·69	1·84	14·24	0	—	12·99	175
							1	15/16	11·64	157
							2	13/16	10·60	143
6×6×1/2	·496	39·0	1/2	2·67	1·85	11·48	0	—	10·46	141
							1	15/16	9·38	127
							2	13/16	8·56	116
6×6×3/8	·371	29·6	1/2	2·64	1·87	8·70	0	—	7·91	107
							1	15/16	7·10	95·9
							2	13/16	6·49	87·6

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

TIES

Two Equal Angles back to back
Gusset on back of Angles

BASED ON
B.S. 449
1959
AS AMENDED
1962

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of Two Equal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
$5\times5\times\frac{3}{4}$	·748	47·2	$\frac{1}{2}$	2·32	1·50	13·89	0 1	— $\frac{15}{16}$	12·69 11·05	171 149
$5\times5\times\frac{5}{8}$	·622	39·8	$\frac{1}{2}$	2·29	1·52	11·71	0 1	— $\frac{15}{16}$	10·69 9·33	144 126
$5\times5\times\frac{1}{2}$	·496	32·2	$\frac{1}{2}$	2·27	1·53	9·47	0 1	— $\frac{15}{16}$	8·64 7·56	117 102
$5\times5\times\frac{3}{8}$	·373	24·6	$\frac{1}{2}$.	2·24	1·55	7·23	0 1	— $\frac{15}{16}$	6·58 5·77	88·9 77·9
$4\times4\times\frac{3}{4}$	·749	37·0	$\frac{3}{8}$	1·87	1·18	10·89	0 1	— $\frac{15}{16}$	9·96 8·30	134 112
$4\times4\times\frac{5}{8}$	·624	31·4	$\frac{3}{8}$	1·85	1·20	9·23	0 1	— $\frac{15}{16}$	8·44 7·06	114 95·3
$4\times4\times\frac{1}{2}$	·496	25·4	$\frac{3}{8}$	1·82	1·21	7·47	0 1	— $\frac{15}{16}$	6·82 5·73	92·1 77·4
$4\times4\times\frac{3}{8}$	·372	19·4	$\frac{3}{8}$	1·80	1·22	5·70	0 1	— $\frac{15}{16}$	5·20 4·38	70·2 59·2
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{5}{8}$	·621	27·0	$\frac{3}{8}$	1·65	1·04	7·94	0 1	— $\frac{15}{16}$	7·26 5·88	98·0 79·4
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{1}{2}$	·496	22·0	$\frac{3}{8}$	1·62	1·05	6·47	0 1	— $\frac{15}{16}$	5·91 4·81	79·8 65·0
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{3}{8}$	·371	16·8	$\frac{3}{8}$	1·60	1·06	4·94	0 1	— $\frac{13}{16}$	4·51 3·80	60·9 51·3
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{5}{16}$	·311	14·2	$\frac{3}{8}$	1·58	1·07	4·18	0 1	— $\frac{13}{16}$	3·81 3·22	51·5 43·5

The above safe loads are calculated for an axial stress of 13·5 tons/inch² on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Two Equal Angles back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of Two Equal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
$3\times3\times\frac{1}{2}$	·496	18·6	$\frac{5}{16}$	1·40	·89	5·47	0 1	— $\frac{13}{16}$	5·00 4·05	67·6 54·7
$3\times3\times\frac{3}{8}$	·370	14·2	$\frac{5}{16}$	1·37	·90	4·17	0 1	— $\frac{13}{16}$	3·82 3·11	51·6 42·0
$3\times3\times\frac{5}{16}$	·309	12·0	$\frac{5}{16}$	1·36	·91	3·53	0 1	— $\frac{13}{16}$	3·22 2·63	43·5 35·5
$3\times3\times\frac{1}{4}$	·245	9·6	$\frac{5}{16}$	1·34	·92	2·83	0 1	— $\frac{13}{16}$	2·58 2·11	34·9 28·5
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·372	11·8	$\frac{5}{16}$	1·18	·75	3·47	0 1	— $\frac{13}{16}$	3·16 2·43	42·6 32·8
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·17	·76	2·94	0 1	— $\frac{13}{16}$	2·67 2·07	36·1 27·9
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	8·0	$\frac{5}{16}$	1·15	·76	2·35	0 1 1	— $\frac{11}{16}$ $\frac{13}{16}$	2·14 1·74 1·66	28·8 23·5 22·4
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{3}{8}$	·367	10·4	$\frac{5}{16}$	1·08	·67	3·06	0 1	— $\frac{11}{16}$	2·78 2·18	37·5 29·4
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·07	·68	2·59	0 1	— $\frac{11}{16}$	2·35 1·85	31·8 25·0
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{1}{4}$	·246	7·2	$\frac{5}{16}$	1·05	·68	2·11	0 1	— $\frac{11}{16}$	1·92 1·52	25·9 20·5
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·04	·69	1·58	0 1	— $\frac{11}{16}$	1·43 1·14	19·3 15·4
$2\times2\times\frac{5}{16}$	·308	7·8	$\frac{5}{16}$	·97	·60	2·29	0 1	— $\frac{11}{16}$	2·08 1·58	28·1 21·3
$2\times2\times\frac{1}{4}$	·249	6·4	$\frac{5}{16}$	·96	·60	1·89	0 1	— $\frac{11}{16}$	1·71 1·30	23·1 17·6
$2\times2\times\frac{3}{16}$	·183	4·8	$\frac{5}{16}$	·94	·61	1·41	0 1	— $\frac{11}{16}$	1·28 ·98	17·3 13·2

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

TIES

Two Unequal Angles long legs back to back
Gusset on back of Angles

BASED ON
B.S. 449
1959
AS AMENDED
1962

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
9×4 ×$\frac{7}{8}$	·872	72·2	$\frac{5}{8}$	1·61	2·86	21·23	0	—	16·30	220
							1	$\frac{15}{16}$	13·62	184
9×4 ×$\frac{3}{4}$	·745	62·4	$\frac{5}{8}$	1·58	2·88	18·34	0	—	14·12	191
							1	$\frac{15}{16}$	11·84	160
9×4 ×$\frac{5}{8}$	·622	52·6	$\frac{5}{8}$	1·56	2·89	15·48	0	—	11·94	161
							1	$\frac{15}{16}$	10·05	136
9×4 ×$\frac{1}{2}$	·495	42·4	$\frac{5}{8}$	1·53	2·91	12·46	0	—	9·62	130
							1	$\frac{15}{16}$	8·13	110
8×6 ×$\frac{7}{8}$	·870	78·0	$\frac{5}{8}$	2·58	2·50	22·94	0	—	20·03	270
							1	$\frac{15}{16}$	17·97	243
							2	$\frac{13}{16}$	16·37	221
8×6 ×$\frac{3}{4}$	·746	67·6	$\frac{5}{8}$	2·56	2·52	19·87	0	—	17·35	234
							1	$\frac{15}{16}$	15·58	210
							2	$\frac{13}{16}$	14·21	192
8×6 ×$\frac{5}{8}$	·621	56·8	$\frac{5}{8}$	2·54	2·54	16·71	0	—	14·58	197
							1	$\frac{15}{16}$	13·12	177
							2	$\frac{13}{16}$	11·98	162
8×6 ×$\frac{1}{2}$	·495	45·8	$\frac{5}{8}$	2·51	2·55	13·46	0	—	11·74	158
							1	$\frac{15}{16}$	10·57	143
							2	$\frac{13}{16}$	9·67	130
8×4 ×$\frac{3}{4}$	·747	57·4	$\frac{5}{8}$	1·64	2·55	16·88	0	—	13·44	181
							1	$\frac{15}{16}$	11·29	152
8×4 ×$\frac{5}{8}$	·623	48·4	$\frac{5}{8}$	1·61	2·56	14·24	0	—	11·36	153
							1	$\frac{15}{16}$	9·57	129
8×4 ×$\frac{1}{2}$	·496	39·0	$\frac{5}{8}$	1·58	2·58	11·48	0	—	9·16	124
							1	$\frac{15}{16}$	7·75	105
7×3½×$\frac{5}{8}$	·623	42·0	$\frac{5}{8}$	1·46	2·23	12·36	0	—	9·84	133
							1	$\frac{15}{16}$	8·03	108
7×3½×$\frac{1}{2}$	·497	34·0	$\frac{5}{8}$	1·43	2·25	10·00	0	—	7·97	108
							1	$\frac{15}{16}$	6·54	88·3
7×3½×$\frac{3}{8}$	·372	25·8	$\frac{5}{8}$	1·40	2·27	7·59	0	—	6·06	81·8
							1	$\frac{15}{16}$	4·99	67·4

The above safe loads are calculated for an axial stress of 13·5 tons/inch^2 on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Two Unequal Angles long legs back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
6×4 ×$\frac{3}{4}$	·748	47·2	$\frac{1}{2}$	1·73	1·87	13·89	0	—	11·85	160
							1	$\frac{15}{16}$	9·96	134
6×4 ×$\frac{5}{8}$	·622	39·8	$\frac{1}{2}$	1·70	1·89	11·71	0	—	10·00	135
							1	$\frac{15}{16}$	8·43	114
6×4 ×$\frac{1}{2}$	·496	32·2	$\frac{1}{2}$	1·68	1·91	9·47	0	—	8·09	109
							1	$\frac{15}{16}$	6·84	92·4
6×3½× $\frac{5}{8}$	·620	37·6	$\frac{1}{2}$	1·47	1·90	11·05	0	—	9·16	124
							1	$\frac{15}{16}$	7·48	101
6×3½× $\frac{1}{2}$	·497	30·6	$\frac{1}{2}$	1·45	1·91	8·99	0	—	7·45	101
							1	$\frac{15}{16}$	6·12	82·6
6×3½× $\frac{3}{8}$	·371	23·2	$\frac{1}{2}$	1·42	1·93	6·82	0	—	5·65	76·3
							1	$\frac{15}{16}$	4·66	62·9
6×3 × $\frac{5}{8}$	·623	35·6	$\frac{1}{2}$	1·25	1·90	10·47	0	—	8·33	112
							1	$\frac{13}{16}$	6·75	91·1
6×3 × $\frac{1}{2}$	·496	28·8	$\frac{1}{2}$	1·22	1·92	8·47	0	—	6·75	91·2
							1	$\frac{13}{16}$	5·51	74·3
6×3 × $\frac{3}{8}$	·373	22·0	$\frac{1}{2}$	1·20	1·93	6·47	0	—	5·17	69·8
							1	$\frac{13}{16}$	4·24	57·2
5×3½× $\frac{5}{8}$	·621	33·4	$\frac{1}{2}$	1·55	1·56	9·82	0	—	8·46	114
							1	$\frac{15}{16}$	6·91	93·3
5×3½× $\frac{1}{2}$	·498	27·2	$\frac{1}{2}$	1·52	1·57	8·00	0	—	6·90	93·1
							1	$\frac{15}{16}$	5·66	76·4
5×3½× $\frac{3}{8}$	·371	20·6	$\frac{1}{2}$	1·49	1·59	6·06	0	—	5·23	70·6
							1	$\frac{15}{16}$	4·31	58·1
5×3 × $\frac{1}{2}$	·496	25·4	$\frac{1}{2}$	1·29	1·58	7·47	0	—	6·23	84·2
							1	$\frac{13}{16}$	5·09	68·7
5×3 × $\frac{3}{8}$	·372	19·4	$\frac{1}{2}$	1·26	1·60	5·70	0	—	4·76	64·3
							1	$\frac{13}{16}$	3·91	52·8
5×3 ×$\frac{5}{16}$	·308	16·2	$\frac{1}{2}$	1·25	1·60	4·76	0	—	3·98	53·7
							1	$\frac{13}{16}$	3·27	44·2

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

TIES

Two Unequal Angles long legs back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

BASED ON
B.S. 449
1959
AS AMENDED
1962

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
$4 \times 3\frac{1}{2} \times \frac{5}{8}$	·623	29·2	$\frac{3}{8}$	1·59	1·21	8·59	0 1	— $\frac{15}{16}$	7·71 6·27	104 84·6
$4 \times 3\frac{1}{2} \times \frac{1}{2}$	·498	23·8	$\frac{3}{8}$	1·57	1·23	7·00	0 1	— $\frac{15}{16}$	6·27 5·13	84·7 69·2
$4 \times 3\frac{1}{2} \times \frac{3}{8}$	·374	18·2	$\frac{3}{8}$	1·54	1·24	5·35	0 1	— $\frac{13}{16}$	4·80 4·06	64·8 54·8
$4 \times 3\frac{1}{2} \times \frac{5}{16}$	·309	15·2	$\frac{3}{8}$	1·53	1·25	4·47	0 1	— $\frac{13}{16}$	4·00 3·39	54·0 45·7
$4 \times 3 \times \frac{1}{2}$	·496	22·0	$\frac{3}{8}$	1·32	1·24	6·47	0 1	— $\frac{13}{16}$	5·65 4·61	76·3 62·2
$4 \times 3 \times \frac{3}{8}$	·371	16·8	$\frac{3}{8}$	1·30	1·25	4·94	0 1	— $\frac{13}{16}$	4·32 3·53	58·3 47·7
$4 \times 3 \times \frac{5}{16}$	·311	14·2	$\frac{3}{8}$	1·28	1·26	4·18	0 1	— $\frac{13}{16}$	3·65 3·00	49·3 40·5
$4 \times 2\frac{1}{2} \times \frac{3}{8}$	·373	15·6	$\frac{3}{8}$	1·06	1·26	4·58	0 1	— $\frac{13}{16}$	3·87 3·01	52·2 40·6
$4 \times 2\frac{1}{2} \times \frac{5}{16}$	·308	13·0	$\frac{3}{8}$	1·04	1·27	3·83	0 1	— $\frac{13}{16}$	3·23 2·52	43·6 34·1
$4 \times 2\frac{1}{2} \times \frac{1}{4}$	·248	10·6	$\frac{3}{8}$	1·03	1·28	3·11	0 1	— $\frac{13}{16}$	2·63 2·06	35·5 27·8
$3\frac{1}{2} \times 3 \times \frac{1}{2}$	·499	20·4	$\frac{3}{8}$	1·37	1·07	6·00	0 1	— $\frac{13}{16}$	5·37 4·36	72·5 58·9
$3\frac{1}{2} \times 3 \times \frac{3}{8}$	·373	15·6	$\frac{3}{8}$	1·34	1·08	4·58	0 1	— $\frac{13}{16}$	4·10 3·35	55·3 45·2
$3\frac{1}{2} \times 3 \times \frac{5}{16}$	·308	13·0	$\frac{3}{8}$	1·33	1·09	3·83	0 1	— $\frac{13}{16}$	3·42 2·80	46·2 37·8
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	·370	14·2	$\frac{3}{8}$	1·10	1·09	4·17	0 1	— $\frac{13}{16}$	3·62 2·81	48·9 38·0
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	·309	12·0	$\frac{3}{8}$	1·08	1·10	3·53	0 1	— $\frac{13}{16}$	3·06 2·39	41·3 32·2
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	·245	9·6	$\frac{3}{8}$	1·07	1·11	2·83	0 1 1	— $\frac{11}{16}$ $\frac{13}{16}$	2·45 2·01 1·92	33·1 27·1 26·0

The above safe loads are calculated for an axial stress of 13·5 tons/inch² on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Two Unequal Angles long legs back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
$3 \times 2\frac{1}{2} \times \frac{3}{8}$	·372	13·0	$\frac{5}{16}$	1·12	·92	3·82	0 1	— $\frac{13}{16}$	3·41 2·64	46·0 35·6
$3 \times 2\frac{1}{2} \times \frac{5}{16}$	·311	11·0	$\frac{5}{16}$	1·11	·93	3·23	0 1	— $\frac{13}{16}$	2·88 2·24	38·9 30·3
$3 \times 2\frac{1}{2} \times \frac{1}{4}$	·246	8·8	$\frac{5}{16}$	1·09	·93	2·59	0 1 1	— $\frac{11}{16}$ $\frac{13}{16}$	2·31 1·89 1·80	31·2 25·5 24·4
$3 \times 2 \times \frac{3}{8}$	·372	11·8	$\frac{5}{16}$	·89	·94	3·47	0 1	— $\frac{11}{16}$	2·95 2·23	39·8 30·2
$3 \times 2 \times \frac{5}{16}$	·311	10·0	$\frac{5}{16}$	·87	·94	2·94	0 1	— $\frac{11}{16}$	2·50 1·91	33·7 25·7
$3 \times 2 \times \frac{1}{4}$	·245	8·0	$\frac{5}{16}$	·86	·95	2·35	0 1	— $\frac{11}{16}$	2·00 1·53	27·0 20·7
$2\frac{1}{2} \times 2 \times \frac{3}{8}$	·367	10·4	$\frac{5}{16}$	·93	·76	3·06	0 1	— $\frac{11}{16}$	2·69 2·03	36·3 27·5
$2\frac{1}{2} \times 2 \times \frac{5}{16}$	·306	8·8	$\frac{5}{16}$	·92	·77	2·59	0 1	— $\frac{11}{16}$	2·28 1·73	30·7 23·4
$2\frac{1}{2} \times 2 \times \frac{1}{4}$	·246	7·2	$\frac{5}{16}$	·90	·78	2·11	0 1	— $\frac{11}{16}$	1·86 1·42	25·1 19·2
$2\frac{1}{2} \times 2 \times \frac{3}{16}$	·181	5·4	$\frac{5}{16}$	·89	·79	1·58	0 1	— $\frac{11}{16}$	1·39 1·07	18·7 14·4
$2\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{4}$	·249	6·4	$\frac{5}{16}$	·67	·79	1·89	0 1	— $\frac{9}{16}$	1·56 1·15	21·1 15·5
$2\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$	·183	4·8	$\frac{5}{16}$	·65	·80	1·41	0 1	— $\frac{9}{16}$	1·17 ·87	15·8 11·8
$2 \times 1\frac{1}{2} \times \frac{1}{4}$	·241	5·4	$\frac{5}{16}$	·71	·62	1·59	0 1	— $\frac{9}{16}$	1·38 1·01	18·6 13·7
$2 \times 1\frac{1}{2} \times \frac{3}{16}$	·184	4·2	$\frac{5}{16}$	·69	·63	1·24	0 1	— $\frac{9}{16}$	1·07 ·79	14·5 10·7

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

TIES

Two Unequal Angles short legs back to back
Gusset on back of Angles

BASED ON
B.S. 449
1959
AS AMENDED
1962

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
9×4×7/8	·872	72·2	5/8	4·71	1·01	21·23	0	—	20·67	279
							1	15/16	18·98	256
							2	15/16	17·28	233
							3	13/16	16·25	219
9×4×3/4	·745	62·4	5/8	4·68	1·02	18·34	0	—	17·84	241
							1	15/16	16·40	221
							2	15/16	14·94	202
							3	13/16	14·06	190
9×4×5/8	·622	52·6	5/8	4·66	1·03	15·48	0	—	15·04	203
							1	15/16	13·83	187
							2	15/16	12·62	170
							3	13/16	11·88	160
9×4×1/2	·495	42·4	5/8	4·62	1·04	12·46	0	—	12·09	163
							1	15/16	11·13	150
							2	15/16	10·16	137
							3	13/16	9·57	129
8×6×7/8	·870	78·0	5/8	3·84	1·74	22·94	0	—	21·60	292
							1	15/16	19·82	268
							2	15/16	18·00	243
8×6×3/4	·746	67·6	5/8	3·81	1·75	19·87	0	—	18·70	252
							1	15/16	17·17	232
							2	15/16	15·60	211
8×6×5/8	·621	56·8	5/8	3·79	1·77	16·71	0	—	15·71	212
							1	15/16	14·43	195
							2	15/16	13·13	177
8×6×1/2	·495	45·8	5/8	3·76	1·78	13·46	0	—	12·63	171
							1	15/16	11·62	157
							2	15/16	10·58	143

The above safe loads are calculated for an axial stress of 13·5 tons/inch² on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

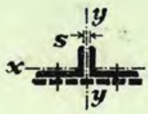
TIES

Two Unequal Angles short legs back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
8×4 ×3/4	·747	57·4	5/8	4·13	1·05	16·88	0	—	16·34	221
							1	15/16	14·88	201
							2	15/16	13·40	181
8×4 ×5/8	·623	48·4	5/8	4·10	1·06	14·24	0	—	13·77	186
							1	15/16	12·55	169
							2	15/16	11·32	153
8×4 ×1/2	·496	39·0	5/8	4·07	1·07	11·48	0	—	11·08	150
							1	15/16	10·11	137
							2	15/16	9·13	123
7×3½×5/8	·623	42·0	5/8	3·63	·92	12·36	0	—	11·96	161
							1	15/16	10·74	145
							2	15/16	9·51	128
7×3½×1/2	·497	34·0	5/8	3·60	·93	10·00	0	—	9·66	130
							1	15/16	8·69	117
							2	15/16	7·70	104
7×3½×3/8	·372	25·8	5/8	3·57	·94	7·59	0	—	7·32	98·8
							1	15/16	6·59	88·9
							2	15/16	5·85	79·0
6×4 ×3/4	·748	47·2	1/2	2·98	1·11	13·89	0	—	13·22	178
							1	15/16	11·71	158
							2	13/16	10·58	143
6×4 ×5/8	·622	39·8	1/2	2·95	1·13	11·71	0	—	11·14	150
							1	15/16	9·88	133
							2	13/16	8·94	121
6×4 ×1/2	·496	32·2	1/2	2·93	1·14	9·47	0	—	9·00	121
							1	15/16	8·00	108
							2	13/16	7·24	97·8

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.



TIES

Two Unequal Angles short legs back to back
Gusset on back of Angles

BASED ON
B.S. 449
1959
AS AMENDED
1962

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
$6\times3\frac{1}{2}\times\frac{5}{8}$	·620	37·6	$\frac{1}{2}$	3·03	·95	11·05	0	—	10·61	143
							1	$\frac{15}{16}$	9·38	127
							2	$\frac{13}{16}$	8·46	114
$6\times3\frac{1}{2}\times\frac{1}{2}$	·497	30·6	$\frac{1}{2}$	3·00	·96	8·99	0	—	8·62	116
							1	$\frac{15}{16}$	7·63	103
							2	$\frac{13}{16}$	6·89	93·1
$6\times3\frac{1}{2}\times\frac{3}{8}$	·371	23·2	$\frac{1}{2}$	2·97	·98	6·82	0	—	6·52	88·0
							1	$\frac{15}{16}$	5·78	78·1
							2	$\frac{13}{16}$	5·23	70·6
$6\times3\ \times\frac{5}{8}$	·623	35·6	$\frac{1}{2}$	3·12	·78	10·47	0	—	10·15	137
							1	$\frac{15}{16}$	8·93	121
							2	$\frac{13}{16}$	8·02	108
$6\times3\ \times\frac{1}{2}$	·496	28·8	$\frac{1}{2}$	3·09	·79	8·47	0	—	8·20	111
							1	$\frac{15}{16}$	7·23	97·5
							2	$\frac{13}{16}$	6·50	87·8
$6\times3\ \times\frac{3}{8}$	·373	22·0	$\frac{1}{2}$	3·06	·80	6·47	0	—	6·25	84·4
							1	$\frac{15}{16}$	5·52	74·5
							2	$\frac{13}{16}$	4·97	67·2
$5\times3\frac{1}{2}\times\frac{5}{8}$	·621	33·4	$\frac{1}{2}$	2·49	·99	9·82	0	—	9·31	126
							1	$\frac{15}{16}$	8·05	109
$5\times3\frac{1}{2}\times\frac{1}{2}$	·498	27·2	$\frac{1}{2}$	2·46	1·00	8·00	0	—	7·58	102
							1	$\frac{15}{16}$	6·56	88·6
$5\times3\frac{1}{2}\times\frac{3}{8}$	·371	20·6	$\frac{1}{2}$	2·43	1·01	6·06	0	—	5·73	77·4
							1	$\frac{15}{16}$	4·98	67·2

The above safe loads are calculated for an axial stress of 13·5 tons/inch² on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Two Unequal Angles short legs back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
$5\times3\ \times\frac{1}{2}$	·496	25·4	$\frac{1}{2}$	2·54	·82	7·47	0	—	7·16	96·7
							1	$\frac{15}{16}$	6·17	83·3
$5\times3\ \times\frac{3}{8}$	·372	19·4	$\frac{1}{2}$	2·51	·84	5·70	0	—	5·46	73·7
							1	$\frac{15}{16}$	4·71	63·6
$5\times3\ \times\frac{5}{16}$	·308	16·2	$\frac{1}{2}$	2·49	·84	4·76	0	—	4·55	61·5
							1	$\frac{15}{16}$	3·94	53·2
$4\times3\frac{1}{2}\times\frac{5}{8}$	·623	29·2	$\frac{3}{8}$	1·91	1·02	8·59	0	—	7·98	108
							1	$\frac{15}{16}$	6·65	89·8
$4\times3\frac{1}{2}\times\frac{1}{2}$	·498	23·8	$\frac{3}{8}$	1·88	1·03	7·00	0	—	6·50	87·7
							1	$\frac{15}{16}$	5·43	73·3
$4\times3\frac{1}{2}\times\frac{3}{8}$	·374	18·2	$\frac{3}{8}$	1·86	1·05	5·35	0	—	4·96	67·0
							1	$\frac{15}{16}$	4·16	56·2
$4\times3\frac{1}{2}\times\frac{5}{16}$	·309	15·2	$\frac{3}{8}$	1·84	1·05	4·47	0	—	4·14	55·9
							1	$\frac{13}{16}$	3·57	48·2
$4\times3\ \times\frac{1}{2}$	·496	22·0	$\frac{3}{8}$	1·95	·86	6·47	0	—	6·10	82·4
							1	$\frac{15}{16}$	5·08	68·5
$4\times3\ \times\frac{3}{8}$	·371	16·8	$\frac{3}{8}$	1·92	·87	4·94	0	—	4·65	62·8
							1	$\frac{15}{16}$	3·88	52·4
$4\times3\ \times\frac{5}{16}$	·311	14·2	$\frac{3}{8}$	1·91	·88	4·18	0	—	3·93	53·1
							1	$\frac{13}{16}$	3·38	45·6
$4\times2\frac{1}{2}\times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	2·00	·69	4·58	0	—	4·38	59·2
							1	$\frac{15}{16}$	3·63	49·0
$4\times2\frac{1}{2}\times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	1·98	·70	3·83	0	—	3·66	49·4
							1	$\frac{13}{16}$	3·12	42·1
$4\times2\frac{1}{2}\times\frac{1}{4}$	·248	10·6	$\frac{3}{8}$	1·96	·70	3·11	0	—	2·97	40·1
							1	$\frac{13}{16}$	2·54	34·3

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

TIES

Two Unequal Angles short legs back to back
Gusset on back of Angles

BASED ON
B.S. 449
1959
AS AMENDED
1962

PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

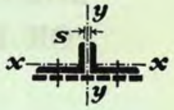
Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
3½×3 ×½	·499	20·4	⅜	1·68	·87	6·00	0	—	5·59	75·5
							1	15/16	4·53	61·1
3½×3 ×⅜	·373	15·6	⅜	1·66	·89	4·58	0	—	4·27	57·6
							1	15/16	3·47	46·8
3½×3 ×5/16	·308	13·0	⅜	1·64	·89	3·83	0	—	3·56	48·1
							1	13/16	2·99	40·4
3½×2½×⅜	·370	14·2	⅜	1·72	·71	4·17	0	—	3·96	53·4
							1	13/16	3·30	44·5
3½×2½×5/16	·309	12·0	⅜	1·71	·72	3·53	0	—	3·34	45·1
							1	13/16	2·79	37·6
3½×2½×¼	·245	9·6	⅜	1·69	·72	2·83	0	—	2·68	36·1
							1	13/16	2·24	30·2
3 ×2½×⅜	·372	13·0	5/16	1·43	·73	3·82	0	—	3·57	48·2
							1	13/16	2·89	39·0
3 ×2½×5/16	·311	11·0	5/16	1·42	·73	3·23	0	—	3·02	40·8
							1	13/16	2·45	33·1
3 ×2½×¼	·246	8·8	5/16	1·40	·74	2·59	0	—	2·42	32·7
							1	13/16	1·97	26·5

The above safe loads are calculated for an axial stress of 13·5 tons/inch² on the effective areas as specified in clauses 41 and 42 of B.S. 449 : 1959, as amended 1962.

BASED ON
B.S. 449
1959
AS AMENDED
1962

TIES

Two Unequal Angles short legs back to back
Gusset on back of Angles



PROPERTIES AND SAFE LOADS FOR HIGH YIELD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
3 ×2 ×⅜	·372	11·8	5/16	1·51	·56	3·47	0	—	3·29	44·4
							1	13/16	2·63	35·5
3 ×2 ×5/16	·311	10·0	5/16	1·50	·56	2·94	0	—	2·78	37·6
							1	13/16	2·23	30·2
3 ×2 ×¼	·245	8·0	5/16	1·48	·57	2·35	0	—	2·22	30·0
							1	13/16	1·79	24·2
2½×2 ×⅜	·367	10·4	5/16	1·24	·57	3·06	0	—	2·85	38·5
							1	13/16	2·18	29·4
2½×2 ×5/16	·306	8·8	5/16	1·23	·58	2·59	0	—	2·41	32·6
							1	13/16	1·85	25·0
2½×2 ×¼	246	7·2	5/16	1·22	·59	2·11	0	—	1·97	26·6
							1	11/16	1·59	21·4
2½×2 ×3/16	·181	5·4	5/16	1·20	·59	1·58	0	—	1·47	19·8
							1	11/16	1·19	16·1
2½×1½×¼	·249	6·4	5/16	1·29	·41	1·89	0	—	1·80	24·3
							1	11/16	1·43	19·3
2½×1½×3/16	·183	4·8	5/16	1·27	·42	1·41	0	—	1·34	18·1
							1	11/16	1·07	14·5
2 ×1½×¼	·241	5·4	5/16	1·02	·43	1·59	0	—	1·49	20·1
							1	11/16	1·11	15·0
2 ×1½×3/16	·184	4·2	5/16	1·00	·43	1·24	0	—	1·15	15·6
							1	11/16	·87	11·7

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 184.

SHEARING AND BEARING VALUES FOR H.Y.S. STEEL POWER-DRIVEN SHOP RIVETS

BASED ON
B.S. 449
1959
AS AMENDED
1962

Gross Dia. of Rivet after driving in inches	Area in square inches	Shearing Value @ 9·0 tons/inch²		SIMPLE BEARING VALUE @ 80% OF 27 TONS/INCH² *and* ENCLOSED BEARING VALUE @ 27 TONS/INCH² (SEE FOOTNOTE)										
				Thickness in inches of plate passed through or of enclosed plate										
		Single Shear	Double Shear	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{7}{8}$
$\frac{3}{8}$	·1104	·99	1·99	**1·52** **1·90**	2·02 2·53	2·53 3·16								
$\frac{7}{16}$	·1503	1·35	2·71	**1·77** **2·21**	**2·36** 2·95	2·95 3·69	3·54							
$\frac{1}{2}$	·1963	1·77	3·53	**2·02** **2·53**	**2·70** **3·37**	**3·37** 4·22	4·05 5·06	4·72						
$\frac{9}{16}$	·2485	2·24	4·47	**2·28** **2·85**	**3·04** **3·80**	**3·80** 4·75	4·56 5·70	5·32						
$\frac{5}{8}$	·3068	2·76	5·52	2·53 **3·16**	**3·37** **4·22**	**4·22** **5·27**	**5·06** 6·33	5·91 7·38	6·75					
$\frac{11}{16}$	·3712	3·34	6·68	2·78 **3·48**	**3·71** 4·64	**4·64** **5·80**	**5·57** 6·96	**6·50** 8·12	7·42	8·35				
$\frac{3}{4}$	·4418	3·98	7·95	3·04 3·80	**4·05** **5·06**	**5·06** **6·33**	**6·07** **7·59**	**7·09** 8·86	8·10 10·12	9·11				
$\frac{13}{16}$	·5185	4·67	9·33	3·29 4·11	4·39 **5·48**	**5·48** **6·86**	**6·58** **8·23**	**7·68** 9·60	**8·77** 10·97	9·87	10·97			
$\frac{7}{8}$	·6013	5·41	10·82	3·54 4·43	4·72 **5·91**	**5·91** **7·38**	**7·09** **8·86**	**8·27** **10·34**	**9·45** 11·81	**10·63** 13·29	11·81	12·99		
$\frac{15}{16}$	·6903	6·21	12·43	3·80 4·75	5·06 **6·33**	**6·33** **7·91**	**7·59** **9·49**	**8·86** **11·07**	**10·12** 12·66	**11·39** 14·24	12·66	13·92		
1	·7854	7·07	14·14	4·05 5·06	5·40 6·75	6·75 **8·44**	**8·10** **10·12**	**9·45** **11·81**	**10·80** **13·50**	**12·15** 15·19	**13·50** 16·87	14·85	16·20	
$1\frac{1}{16}$	·8866	7·98	15·96	4·30 5·38	5·74 7·17	7·17 **8·96**	**8·61** **10·76**	**10·04** **12·55**	**11·47** **14·34**	**12·91** 16·14	**14·34** 17·93	**15·78**	17·21	20·08

Upper line of Bearing Values for each diameter of rivet are Simple Bearing Values.
Lower line of Bearing Values for each diameter of rivet are Enclosed Bearing Values.
For areas to be deducted from a bar for one hole, see table on page 154.
For weights of rivets, see page 708.
For explanation of table, see Notes on page 187.

BASED ON
B.S. 449
1959
AS AMENDED
1962

SHEARING AND BEARING VALUES FOR H.Y.S. STEEL POWER-DRIVEN FIELD RIVETS

Gross Dia. of Rivet after driving in inches	Area in square inches	Shearing Value @ 8·5 tons/inch²		SIMPLE BEARING VALUE @ 80% OF 25 TONS/INCH² *and* ENCLOSED BEARING VALUE @ 25 TONS/INCH² (SEE FOOTNOTE)										
				Thickness in inches of plate passed through or of enclosed plate										
		Single Shear	Double Shear	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{7}{8}$
$\frac{3}{8}$	·1104	·94	1·88	**1·41** **1·76**	**1·87** 2·34	2·34 2·93	2·81							
$\frac{7}{16}$	·1503	1·28	2·56	**1·64** **2·05**	**2·19** 2·73	2·73 3·42	3·28							
$\frac{1}{2}$	·1963	1·67	3·34	**1·87** **2·34**	**2·50** **3·12**	**3·12** 3·91	3·75 4·69	4·37						
$\frac{9}{16}$	·2845	2·11	4·22	**2·11** **2·64**	**2·81** **3·52**	**3·52** 4·39	4·22 5·27	4·92	5·62					
$\frac{5}{8}$	·3068	2·61	5·22	2·34 **2·93**	**3·12** **3·91**	**3·91** **4·88**	**4·69** 5·86	5·47 6·84	6·25					
$\frac{11}{16}$	·3712	3·16	6·31	2·58 **3·22**	**3·44** **4·30**	**4·30** **5·37**	**5·16** 6·45	**6·02** 7·52	6·87	7·73				
$\frac{3}{4}$	·4418	3·76	7·51	2·81 3·52	3·75 **4·69**	**4·69** **5·86**	**5·62** **7·03**	**6·56** 8·20	**7·50** 9·37	8·44	9·37			
$\frac{13}{16}$	·5185	4·41	8·81	3·05 3·81	4·06 **5·08**	**5·08** **6·35**	**6·09** **7·62**	**7·11** 8·89	**8·12** 10·16	9·14	10·16			
$\frac{7}{8}$	·6013	5·11	10·22	3·28 4·10	4·37 **5·47**	**5·47** **6·84**	**6·56** **8·20**	**7·66** **9·57**	**8·75** 10·94	**9·84** 12·30	10·94	12·03		
$\frac{15}{16}$	·6903	5·87	11·74	3·52 4·39	4·69 5·86	5·86 **7·32**	**7·03** **8·79**	**8·20** **10·25**	**9·37** **11·72**	**10·55** 13·18	**11·72** 14·65	12·89	14·06	
1	·7854	6·68	13·35	3·75 4·69	5·00 6·25	6·25 **7·81**	**7·50** **9·37**	**8·75** **10·94**	**10·00** **12·50**	**11·25** 14·06	**12·50** 15·62	13·75	15·00	
$1\frac{1}{16}$	·8866	7·54	15·07	3·98 4·98	5·31 6·64	6·64 **8·30**	**7·97** **9·96**	**9·30** **11·62**	**10·62** **13·28**	**11·95** **14·94**	**13·28** 16·60	**14·61** 18·26	15·94	18·59

Upper line of Bearing Values for each diameter of rivet are Simple Bearing Values.
Lower line of Bearing Values for each diameter of rivet are Enclosed Bearing Values.
For areas to be deducted from a bar for one hole, see table on page 154.
For weights of rivets, see page 708.
For explanation of table, see Notes on page 187.

SHEARING AND BEARING VALUES FOR H.Y.S. STEEL HAND-DRIVEN RIVETS

BASED ON
B.S. 449
1959
AS AMENDED
1962

Gross Dia. of Rivet after driving in inches	Area in square inches	Shearing Value @ 7·5 tons/inch^2		SIMPLE BEARING VALUE @ 80% OF 23 TONS/INCH^2 *and* ENCLOSED BEARING VALUE @ 23 TONS/INCH^2 (SEE FOOTNOTE)									
				Thickness in inches of plate passed through or of enclosed plate									
		Single Shear	Double Shear	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4
3/8	·1104	·83	1·66	1·29	1·72	2·16							
				1·62	2·16	2·70							
7/16	·1503	1·13	2·25	1·51	2·01	2·52	3·02						
				1·89	2·52	3·14							
1/2	·1963	1·47	2·94	1·72	2·30	2·87	3·45	4·02					
				2·16	2·87	3·59	4·31						
9/16	·2485	1·86	3·73	1·94	2·59	3·23	3·88	4·53					
				2·43	3·23	4·04	4·85						
5/8	·3068	2·30	4·60	2·16	2·87	3·59	4·31	5·03	5·75				
				2·70	3·59	4·49	5·39	6·29					
11/16	·3712	2·78	5·57	2·37	3·16	3·95	4·74	5·53	6·32	7·12			
				2·96	3·95	4·94	5·93	6·92					
3/4	·4418	3·31	6·63	2·59	3·45	4·31	5·17	6·04	6·90	7·76			
				3·23	4·31	5·39	6·47	7·55	8·62				
13/16	·5185	3·89	7·78	2·80	3·74	4·67	5·61	6·54	7·47	8·41	9·34		
				3·50	4·67	5·84	7·01	8·18	9·34				
7/8	·6013	4·51	9·02	3·02	4·02	5·03	6·04	7·04	8·05	9·06	10·06		
				3·77	5·03	6·29	7·55	8·80	10·06	11·32			
15/16	·6903	5·18	10·35	3·23	4·31	5·39	6·47	7·55	8·62	9·70	10·78	11·86	
				4·04	5·39	6·74	8·09	9·43	10·78	12·13			
1	·7854	5·89	11·78	3·45	4·60	5·75	6·90	8·05	9·20	10·35	11·50	12·65	13·80
				4·31	5·75	7·19	8·62	10·06	11·50	12·94	14·37		
1 1/16	·8866	6·65	13·30	3·67	4·89	6·11	7·33	8·55	9·77	11·00	12·22	13·44	14·66
				4·58	6·11	7·64	9·16	10·69	12·22	13·75	15·27		

Upper line of Bearing Values for each diameter of rivet are Simple Bearing Values.
Lower line of Bearing Values for each diameter of rivet are Enclosed Bearing Values.
For areas to be deducted from a bar for one hole, see table on page 154.
For weights of rivets, see page 708.
For explanation of table, see Notes on page 187.

BASED ON
B.S. 449
1959
AS AMENDED
1962

SHEARING AND BEARING VALUES FOR H.Y.S. STEEL CLOSE TOLERANCE AND TURNED BOLTS

Dia. of Bolt Shank in inches	Area in square inches	Shearing Value @ 9·0 tons/inch^2		SIMPLE BEARING VALUE @ 80% OF 27 TONS/INCH^2 *and* ENCLOSED BEARING VALUE @ 27 TONS/INCH^2 (SEE FOOTNOTE)										
				Thickness in inches of plate passed through or of enclosed plate										
		Single Shear	Double Shear	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8
3/8	·1104	·99	1·99	1·52	2·02	2·53								
				1·90	2·53	3·16								
7/16	·1503	1·35	2·71	1·77	2·36	2·95	3·54							
				2·21	2·95	3·69								
1/2	·1963	1·77	3·53	2·02	2·70	3·37	4·05	4·72						
				2·53	3·37	4·22	5·06							
9/16	·2485	2·24	4·47	2·28	3·04	3·80	4·56	5·32						
				2·85	3·80	4·75	5·70							
5/8	·3068	2·76	5·52	2·53	3·37	4·22	5·06	5·91	6·75					
				3·16	4·22	5·27	6·33	7·38						
11/16	·3712	3·34	6·68	2·78	3·71	4·64	5·57	6·50	7·42	8·35				
				3·48	4·64	5·80	6·96	8·12						
3/4	·4418	3·98	7·95	3·04	4·05	5·06	6·07	7·09	8·10	9·11				
				3·80	5·06	6·33	7·59	8·86	10·12					
13/16	·5185	4·67	9·33	3·29	4·39	5·48	6·58	7·68	8·77	9·87	10·97			
				4·11	5·48	6·86	8·23	9·60	10·97					
7/8	·6013	5·41	10·82	3·54	4·72	5·91	7·09	8·27	9·45	10·63	11·81	12·99		
				4·43	5·91	7·38	8·86	10·34	11·81	13·29				
15/16	·6903	6·21	12·43	3·80	5·06	6·33	7·59	8·86	10·12	11·39	12·66	13·92		
				4·75	6·33	7·91	9·49	11·07	12·66	14·24				
1	·7854	7·07	14·14	4·05	5·40	6·75	8·10	9·45	10·80	12·15	13·50	14·85	16·20	
				5·06	6·75	8·44	10·12	11·81	13·50	15·19	16·87			
1 1/16	·8866	7·98	15·96	4·30	5·74	7·17	8·61	10·04	11·47	12·91	14·34	15·78	17·21	20·08
				5·38	7·17	8·96	10·76	12·55	14·34	16·14	17·93			

Upper line of Bearing Values for each diameter of bolt are Simple Bearing Values.
Lower line of Bearing Values for each diameter of bolt are Enclosed Bearing Values.
For areas to be deducted from a bar for one hole, see table on page 154,
For dimensions and weights of bolts, see pages 710 and 712.
For explanation of table, see Notes on page 187.

SHEARING AND BEARING VALUES FOR H.Y.S. STEEL BLACK BOLTS

BASED ON
B.S. 449
1959
AS AMENDED
1962

Dia. of Bolt Shank in inches	Area in square inches	Shearing Value @ 7·0 tons/inch²		SIMPLE BEARING VALUE @ 80% OF 12·5 TONS/INCH² *and* ENCLOSED BEARING VALUE @ 12·5 TONS/INCH² (SEE FOOTNOTE)												
				Thickness in inches of plate passed through or of enclosed plate												
		Single Shear	Double Shear	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8	1	1 1/8
3/8	·1104	0·77	1·55	0·70	**0·94**	**1·17**	**1·41**	1·64	1·87							
				0·88	**1·17**	**1·46**	1·76	2·05								
7/16	·1503	1·05	2·10	0·82	**1·09**	**1·37**	**1·64**	**1·91**	2·19	2·46						
				1·03	**1·37**	**1·71**	**2·05**	2·39	2·73							
1/2	·1963	1·37	2·75	0·94	1·25	**1·56**	**1·87**	**2·19**	**2·50**	2·81	3·12					
				1·17	**1·56**	**1·95**	**2·34**	**2·73**	3·12	3·52						
9/16	·2485	1·74	3·48	1·05	1·41	**1·76**	**2·11**	**2·46**	**2·81**	**3·16**	3·52	3·87				
				1·32	**1·76**	**2·20**	**2·64**	**3·08**	3·52	3·96						
5/8	·3068	2·15	4·30	1·17	1·56	1·95	**2·34**	**2·73**	**3·12**	**3·52**	**3·91**	4·30	4·69			
				1·46	1·95	**2·44**	**2·93**	**3·42**	**3·91**	4·39	4·88					
11/16	·3712	2·60	5·20	1·29	1·72	2·15	2·58	**3·01**	**3·44**	**3·87**	**4·30**	**4·73**	**5·16**	6·02	6·87	
				1·61	2·15	**2·69**	**3·22**	**3·76**	**4·30**	**4·83**	5·37	5·91				
3/4	·4418	3·09	6·19	1·41	1·87	2·34	2·81	**3·28**	**3·75**	**4·22**	**4·69**	**5·16**	**5·62**	6·56	7·50	
				1·76	2·34	2·93	**3·52**	**4·10**	**4·69**	**5·27**	**5·86**	6·45	7·03			
13/16	·5185	3·63	7·26	1·52	2·03	2·54	3·05	3·55	**4·06**	**4·57**	**5·08**	**5·59**	**6·09**	**7·11**	8·12	9·14
				1·90	2·54	3·17	**3·81**	**4·44**	**5·08**	**5·71**	**6·35**	**6·98**	7·62	8·89		
7/8	·6013	4·21	8·42	1·64	2·19	2·73	3·28	3·83	**4·37**	**4·92**	**5·47**	**6·02**	**6·56**	**7·66**	8·75	9·84
				2·05	2·73	3·42	4·10	**4·79**	**5·47**	**6·15**	**6·84**	**7·52**	**8·20**	9·57	10·94	
15/16	·6903	4·83	9·66	1·76	2·34	2·93	3·52	4·10	4·69	**5·27**	**5·86**	**6·45**	**7·03**	**8·20**	**9·37**	10·55
				2·20	2·93	3·66	4·39	**5·13**	**5·86**	**6·59**	**7·32**	**8·06**	**8·79**	10·25	11·72	13·18
1	·7854	5·50	11·00	1·87	2·50	3·12	3·75	4·37	5·00	**5·62**	**6·25**	**6·87**	**7·50**	**8·75**	**10·00**	11·25
				2·34	3·12	3·91	4·69	5·47	**6·25**	**7·03**	**7·81**	**8·59**	**9·37**	**10·94**	12·50	14·06
1 1/16	·8866	6·21	12·41	1·99	2·66	3·32	3·98	4·65	5·31	5·98	**6·64**	**7·30**	**7·97**	**9·30**	**10·62**	**11·95**
				2·49	3·32	4·15	4·98	5·81	**6·64**	**7·47**	**8·30**	**9·13**	**9·96**	**11·62**	13·28	14·94

Upper line of Bearing Values for each diameter of bolt are Simple Bearing Values.
Lower line of Bearing Values for each diameter of bolt are Enclosed Bearing Values.
For areas to be deducted from a bar for one hole, see table on page 154.
For dimensions and weights of bolts, see pages 709, 710 and 711.
For explanation of table, see Notes on page 187.

HIGH STRENGTH FRICTION GRIP BOLTS

TO B.S. 3139: 1959 PART 1

GENERAL GRADE BOLTS

SHEAR VALUES OF BOLTS PER INTERFACE

Diameter of Bolt Shank in inches	Shear Value without wind tons	Shear Value including wind tons
1/2	1·73	2·01
5/8	2·75	3·21
3/4	4·07	4·75
7/8	5·17	6·03
1	6·78	7·91
1 1/8	8·10	9·45
1 1/4	10·29	12·00
1 1/2	14·80	17·26

For dimensions and weights of bolts, see pages 712 and 713.
For explanation of table, see page 188.

STRENGTH OF FILLET WELDS

HIGH YIELD STRESS (WELDING QUALITY) STRUCTURAL STEEL

PERMISSIBLE LOADS IN TONS PER LINEAR INCH

Size of Fillet in inches	H.Y.S. Steel with Electrodes to B.S. 2549 : 1954 at 8·5 tons/inch^2 tons	H.Y.S. Steel with Electrodes to B.S. 639 : 1952 at 7·0 tons/inch^2 tons	Size of Fillet in inches	H.Y.S. Steel with Electrodes to B.S. 2549 : 1954 at 8·5 tons/inch^2 tons	H.Y.S. Steel with Electrodes to B.S. 639 : 1952 at 7·0 tons/inch^2 tons
$\frac{1}{4}$	1·50	1·23	$\frac{11}{16}$	4·13	3·40
$\frac{5}{16}$	1·87	1·54	$\frac{3}{4}$	4·50	3·71
$\frac{3}{8}$	2·25	1·85	$\frac{13}{16}$	4·88	4·02
$\frac{7}{16}$	2·62	2·16	$\frac{7}{8}$	5·25	4·33
$\frac{1}{2}$	3·00	2·47	$\frac{15}{16}$	5·63	4·64
$\frac{9}{16}$	3·38	2·78	1	6·01	4·94
$\frac{5}{8}$	3·75	3·09			

STRENGTH OF FULL PENETRATION BUTT WELDS

HIGH YIELD STRESS (WELDING QUALITY) STRUCTURAL STEEL

PERMISSIBLE LOADS IN TONS PER LINEAR INCH

Plate Thickness in inches	H.Y.S. Steel with Electrodes to B.S. 2549 : 1954		H.Y.S. Steel with Electrodes to B.S. 639 : 1952		Plate Thickness in inches	H.Y.S. Steel with Electrodes to B.S. 2549 : 1954		H.Y.S. Steel with Electrodes to B.S. 639 : 1952	
	Shear at 8·5 tons/inch^2 tons	Tension or Compression at 13·5 tons/inch^2 tons	Shear at 7·0 tons/inch^2 tons	Tension or Compression at 9·5 tons/inch^2 tons		Shear at 8·5 tons/inch^2 tons	Tension or Compression at 13·5 tons/inch^2 tons	Shear at 7·0 tons/inch^2 tons	Tension or Compression at 9·5 tons/inch^2 tons
$\frac{1}{4}$	2·12	3·37	1·75	2·37	$\frac{7}{8}$	7·43	11·81	6·12	8·31
$\frac{5}{16}$	2·65	4·21	2·18	2·96	1	8·50	13·50	7·00	9·50
$\frac{3}{8}$	3·18	5·06	2·62	3·56	$1\frac{1}{4}$	10·62	16·87	8·75	11·87
$\frac{7}{16}$	3·71	5·90	3·06	4·15	$1\frac{1}{2}$	12·75	20·25	10·50	14·25
$\frac{1}{2}$	4·25	6·75	3·50	4·75	$1\frac{3}{4}$	14·87	23·62	12·25	16·62
$\frac{5}{8}$	5·31	8·43	4·37	5·93	2	17·00	27·00	14·00	19·00
$\frac{3}{4}$	6·37	10·12	5·25	7·12					

For incomplete penetration welds the above loads must be multiplied by 0·625.
For explanation of tables, see Notes on page 191.

AUTOFAB BEAMS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

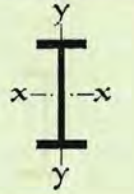
Size D×B inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS															
		25 ·0308	30 ·0214	35 ·0157	40 ·0120	45 ·0095	50 ·0077	55 ·0064	60 ·0053	65 ·0046	70 ·0039	75 ·0034	80 ·0030	85 ·0027	90 ·0024	95 ·0021	100 ·0019
78×22	456·5					**740†**	**684**	*622*	*570*	*526*	*489*	*456*	*428*	402	380	360	342
	388·5						**596†**	**542**	**497**	**459**	*426*	*397*	*373*	351	331	314	298
	351·9				**600†**	**585**	**527**	**479**	**439**	*405*	*376*	*351*	*329*	310	293	277	263
	315·4			**604†**	**571**	**507**	**457**	*415*	*381*	*351*	*326*	*304*	*285*	269	254	240	228
	278·8		**608†**	**551**	**482**	*428*	*385*	*350*	*321*	*296*	*275*	*257*	*241*	227	214	203	193
78×18	370·6					**592†**	**558**	**507**	**465**	*429*	*398*	*372*	*349*	328	310	294	279
	340·9				**596†**	**558**	**502**	**457**	*419*	*386*	*359*	*335*	*314*	295	279	264	251
	311·1			**600†**	**557**	**495**	**446**	*405*	*372*	*343*	*318*	*297*	*279*	262	248	235	223
	281·4		**604†**	**555**	**486**	*432*	*389*	*353*	*324*	*299*	*278*	*259*	*243*	229	216	205	194
	251·6	**608†**	**551**	**472**	*413*	*367*	*331*	*301*	*276*	*254*	*236*	*220*	*207*	195	184	174	165
	221·9	**544**	**453**	*389*	*340*	*302*	*272*	*247*	*227*	*209*	*194*	*181*	*170*	160	151	143	136
78×14	293·3		**596†**	**583**	**510**	**454**	*408*	*371*	*340*	*314*	*292*	*272*	*255*	240	227	215	204
	270·3		**600†**	**521**	**456**	*405*	*365*	*332*	*304*	*281*	*261*	*243*	*228*	215	203	192	182
	247·4	**604†**	**534**	**458**	*401*	*356*	*321*	*292*	*267*	*247*	*229*	*214*	*200*	189	178	169	160
	224·4	**552**	**460**	*394*	*345*	*307*	*276*	*251*	*230*	*212*	*197*	*184*	*172*	162	153	145	138
	185·2	**440**	**367**	*314*	*275*	*244*	*220*	*200*	*183*	*169*	*157*	*147*	*137*	129	122	116	110
	162·1	**348**	*290*	*248*	*217*	*193*	*174*	*158*	*145*	*134*	*124*	*116*	*109*	102	96·6	91·5	86·9
72×22	443·7					**680†**	**621**	*565*	*518*	*478*	*444*	*414*	388	365	345	327	311
	378·3					**548†**	**542**	**493**	**452**	*417*	*387*	*361*	339	319	301	285	271
	341·7				**552†**	**532**	**479**	**435**	*399*	*368*	*342*	*319*	299	281	266	252	239
	305·2			**556†**	**518**	**460**	*414*	*376*	*345*	*319*	*296*	*276*	259	244	230	218	207
	268·6		**560†**	**498**	**436**	*387*	*349*	*317*	*291*	*268*	*249*	*232*	218	205	194	184	174
72×18	360·4					**544†**	**507**	**461**	*422*	*390*	*362*	*338*	317	298	281	267	253
	330·7				**548†**	**506**	**456**	*414*	*380*	*351*	*325*	*304*	285	268	253	240	228
	300·9			**552†**	**505**	**449**	*404*	*367*	*337*	*311*	*289*	*269*	252	238	224	213	202
	271·2		**556†**	**502**	**439**	*391*	*352*	*320*	*293*	*270*	*251*	*234*	220	207	195	185	176
	241·4	**560†**	**497**	*426*	*373*	*331*	*298*	*271*	*249*	*229*	*213*	*199*	186	175	166	157	149
	211·7	**489**	*407*	*349*	*305*	*271*	*244*	*222*	*204*	*188*	*175*	*163*	153	144	136	129	122
72×14	283·1		**548†**	**528**	**462**	*410*	*369*	*336*	*308*	*284*	*264*	*246*	231	217	205	194	185
	260·1	**552†**	**549**	**471**	*412*	*366*	*329*	*299*	*275*	*253*	*235*	*220*	206	194	183	173	165
	237·2	**556†**	**482**	*413*	*361*	*321*	*289*	*263*	*241*	*222*	*206*	*193*	181	170	161	152	144
	214·2	**496**	*413*	*354*	*310*	*275*	*248*	*225*	*207*	*191*	*177*	*165*	155	146	138	130	124
	176·3	**394**	*329*	*282*	*246*	*219*	*197*	*179*	*164*	*152*	*141*	*131*	123	116	110	104	98·6
	153·2	*309*	*258*	*221*	*193*	*172*	*155*	*141*	*129*	*119*	*111*	*103*	96·7	91·0	85·9	81·4	77·4

Generally, tabular loads are based on a flexural stress of 13·5 tons/inch^2 assuming adequate lateral support.
Tabular loads printed in prominent type require a spacing of stiffeners less than 1½ times the depth of the web plate.
Tabular loads marked † are the maximum shear loads for the web and are less than the permissible flexural load.
Tabular loads printed in italics and in ordinary type require a spacing of stiffeners 1½ times the depth of the web plate.

BASED ON
B.S. 449
1959
AS AMENDED

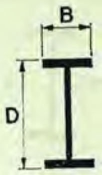
AUTOFAB BEAMS

DIMENSIONS AND PROPERTIES



Composed of		Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Area of Web Plate in square inches	Ratio D/T	Size D×B inches
Web Plate	Flange Plates		Axis *x-x*	Axis *y-y*	Axis *y-y*	Axis *x-x*	Axis *y-y*			
$74\times\frac{5}{8}$	22×2	134·25	148207	3551	5·14	3800	322·8	46·25	39·0	**78×22**
$74\frac{1}{2}\times\frac{1}{2}$	$22\times1\frac{3}{4}$	114·25	129169	3106	5·21	3312	282·4	37·25	44·6	
$75\times\frac{1}{2}$	$22\times1\frac{1}{2}$	103·50	114153	2663	5·07	2927	242·1	37·50	52·0	
$75\frac{1}{2}\times\frac{1}{2}$	$22\times1\frac{1}{4}$	92·75	98934	2219	4·89	2537	201·7	37·75	62·4	
$76\times\frac{1}{2}$	22×1	82·00	83513	1775	4·65	2141	161·4	38·00	78·0	
$74\times\frac{1}{2}$	18×2	109·00	120876	1945	4·22	3099	216·1	37·00	39·0	**78×18**
$74\frac{1}{2}\times\frac{1}{2}$	$18\times1\frac{3}{4}$	100·25	108816	1702	4·12	2790	189·1	37·25	44·6	
$75\times\frac{1}{2}$	$18\times1\frac{1}{2}$	91·50	96594	1459	3·99	2477	162·1	37·50	52·0	
$75\frac{1}{2}\times\frac{1}{2}$	$18\times1\frac{1}{4}$	82·75	84207	1216	3·83	2159	135·1	37·75	62·4	
$76\times\frac{1}{2}$	18×1	74·00	71655	972·8	3·63	1837	108·1	38·00	78·0	
$76\frac{1}{2}\times\frac{1}{2}$	$18\times\frac{3}{4}$	65·25	58936	729·8	3·34	1511	81·1	38·25	104·0	
$74\frac{1}{2}\times\frac{1}{2}$	$14\times1\frac{3}{4}$	86·25	88464	801·1	3·05	2268	114·4	37·25	44·6	**78×14**
$75\times\frac{1}{2}$	$14\times1\frac{1}{2}$	79·50	79035	686·8	2·94	2027	98·1	37·50	52·0	
$75\frac{1}{2}\times\frac{1}{2}$	$14\times1\frac{1}{4}$	72·75	69479	572·5	2·81	1782	81·8	37·75	62·4	
$76\times\frac{1}{2}$	14×1	66·00	59796	458·1	2·63	1533	65·4	38·00	78·0	
$76\frac{1}{2}\times\frac{7}{16}$	$14\times\frac{3}{4}$	54·47	47653	343·5	2·51	1222	49·1	33·47	104·0	
$77\times\frac{7}{16}$	$14\times\frac{1}{2}$	47·69	37667	229·2	2·19	965·8	32·7	33·69	156·0	
$68\times\frac{5}{8}$	22×2	130·50	124206	3551	5·22	3450	322·8	42·50	36·0	**72×22**
$68\frac{1}{2}\times\frac{1}{2}$	$22\times1\frac{3}{4}$	111·25	108412	3106	5·28	3011	282·4	34·25	41·1	
$69\times\frac{1}{2}$	$22\times1\frac{1}{2}$	100·50	95709	2663	5·15	2659	242·1	34·50	48·0	
$69\frac{1}{2}\times\frac{1}{2}$	$22\times1\frac{1}{4}$	89·75	82821	2219	4·97	2301	201·7	34·75	57·6	
$70\times\frac{1}{2}$	22×1	79·00	69746	1775	4·74	1937	161·4	35·00	72·0	
$68\times\frac{1}{2}$	18×2	106·00	101325	1945	4·28	2815	216·1	34·00	36·0	**72×18**
$68\frac{1}{2}\times\frac{1}{2}$	$18\times1\frac{3}{4}$	97·25	91136	1702	4·18	2532	189·1	34·25	41·1	
$69\times\frac{1}{2}$	$18\times1\frac{1}{2}$	88·50	80796	1459	4·06	2244	162·1	34·50	48·0	
$69\frac{1}{2}\times\frac{1}{2}$	$18\times1\frac{1}{4}$	79·75	70306	1216	3·90	1953	135·1	34·75	57·6	
$70\times\frac{1}{2}$	18×1	71·00	59664	972·7	3·70	1657	108·1	35·00	72·0	
$70\frac{1}{2}\times\frac{1}{2}$	$18\times\frac{3}{4}$	62·25	48868	729·7	3·42	1357	81·1	35·25	96·0	
$68\frac{1}{2}\times\frac{1}{2}$	$14\times1\frac{3}{4}$	83·25	73859	801·0	3·10	2052	114·4	34·25	41·1	**72×14**
$69\times\frac{1}{2}$	$14\times1\frac{1}{2}$	76·50	65883	686·7	3·00	1830	98·1	34·50	48·0	
$69\frac{1}{2}\times\frac{1}{2}$	$14\times1\frac{1}{4}$	69·75	57791	572·4	2·86	1605	81·8	34·75	57·6	
$70\times\frac{1}{2}$	14×1	63·00	49581	458·1	2·70	1377	65·4	35·00	72·0	
$70\frac{1}{2}\times\frac{7}{16}$	$14\times\frac{3}{4}$	51·84	39428	343·5	2·57	1095	49·1	30·84	96·0	
$71\times\frac{7}{16}$	$14\times\frac{1}{2}$	45·06	30942	229·2	2·26	859·5	32·7	31·06	144·0	

Tabular loads printed in ordinary type produce a deflection exceeding 1/360th of the span.
Loads producing deflection of 1/360th span may be obtained from $W = CI_x$, where C is the coefficient given below the appropriate span and I_x is the inertia of the beam.
Weights per foot are for the girder sections only and do not include any allowance for stiffeners, connections or weld.
Flanges are welded to the web by automatic fillet welding.
Autofab beams can be supplied in lengths up to 80 feet (see page 27). Girders exceeding 80 ft. can be fabricated by conventional methods.
For explanation of tables see notes commencing page 172.



AUTOFAB BEAMS

SAFE LOADS FOR HIGH YIELD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

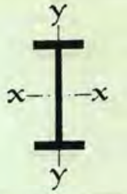
Size D×B inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS															
		25 ·0308	30 ·0214	35 ·0157	40 ·0120	45 ·0095	50 ·0077	55 ·0064	60 ·0053	65 ·0046	70 ·0039	75 ·0034	80 ·0030	85 ·0027	90 ·0024	95 ·0021	100 ·0019
66×22	431·0					**620†**	*559*	*509*	*466*	*430*	*400*	373	350	329	311	294	280
	368·1					**500†**	**489**	**445**	*408*	*376*	*349*	326	306	288	272	257	245
	331·5				**504†**	**479**	**431**	*392*	*359*	*332*	*308*	288	270	254	240	227	216
	295·0			**508†**	**466**	*414*	*373*	*339*	*310*	*287*	*266*	248	233	219	207	196	186
	258·4		**512†**	**447**	*391*	*348*	*313*	*285*	*261*	*241*	*224*	209	196	184	174	165	157
66×18	350·2					**496†**	**456**	*415*	*380*	*351*	*326*	304	285	269	254	240	228
	320·5				**500†**	**456**	*410*	*373*	*342*	*316*	*293*	273	256	241	228	216	205
	263·9					**378†**	**349**	**317**	**291**	**268**	**249**	233	218	205	194	184	175
	234·0			**381†**	**376**	**334**	**301**	**274**	**251**	*232*	*215*	201	188	177	167	158	150
	204·0		**384†**	**360**	**315**	**280**	**252**	*229*	*210*	*194*	*180*	168	158	148	140	133	126
	174·0	**387†**	**337**	**289**	**253**	*225*	*202*	*184*	*169*	*156*	*145*	135	127	119	112	107	101
66×14	272·9		**500†**	**473**	*414*	*368*	*331*	*301*	*276*	*255*	*237*	221	207	195	184	174	166
	249·9	**504†**	**492**	**422**	*369*	*328*	*295*	*268*	*246*	*227*	*211*	197	184	174	164	155	148
	200·0		**381†**	**348**	**305**	**271**	*244*	*222*	*203*	*187*	*174*	162	152	143	135	128	122
	176·8	**384†**	**343**	**294**	**258**	*229*	*206*	*187*	*172*	*159*	*147*	137	129	121	114	108	103
	153·7	**335**	**279**	*240*	*210*	*186*	*168*	*152*	*140*	*129*	*120*	112	105	98·6	93·1	88·2	83·8
	130·5	**257**	*215*	*184*	*161*	*143*	*129*	*117*	*107*	*99·0*	*91·9*	85·8	80·4	75·7	71·5	67·7	64·4
60×22	418·2				**560†**	**555**	*499*	*454*	*416*	384	357	333	312	294	277	263	250
	357·9					**452†**	**437**	*397*	*364*	336	312	291	273	257	243	230	219
	321·3				**456†**	**428**	*385*	*350*	*321*	296	275	257	241	227	214	203	193
	284·8			**460†**	**415**	*369*	*332*	*302*	*277*	256	237	222	208	195	185	175	166
	248·2	**464†**	**464**	*398*	*348*	*309*	*278*	*253*	*232*	214	199	186	174	164	155	147	139
60×18	340·0					**448†**	**407**	*370*	*339*	313	291	272	255	240	226	214	204
	310·3				**452†**	**406**	*366*	*333*	*305*	281	261	244	229	215	203	193	183
	256·3					**342†**	**312**	**284**	**260**	240	223	208	195	183	173	164	156
	226·3			**345†**	**336**	**299**	**269**	*244*	*224*	207	192	179	168	158	149	141	134
	196·4		**348†**	**321**	**281**	**250**	*225*	*204*	*187*	173	160	150	140	132	125	118	112
	166·4	**351†**	**300**	**257**	*225*	*200*	*180*	*163*	*150*	138	128	120	112	106	99·8	94·6	89·9
60×14	262·7		**452†**	**421**	*368*	*327*	*294*	*268*	*245*	227	210	196	184	173	164	155	147
	239·7	**456†**	**436**	*374*	*327*	*291*	*262*	*238*	*218*	201	187	175	164	154	145	138	131
	192·3		**345†**	**310**	**271**	*241*	*217*	*197*	*181*	167	155	145	136	128	120	114	108
	169·2	**348†**	**305**	**261**	*229*	*203*	*183*	*166*	*152*	141	131	122	114	108	102	96·3	91·4
	146·0	**296**	**247**	*212*	*185*	*165*	*148*	*135*	*123*	114	106	98·7	92·6	87·1	82·3	78·0	74·1
	122·8	*226*	*188*	*161*	*141*	*125*	*113*	*103*	*94·0*	86·8	80·6	75·2	70·5	66·4	62·7	59·4	56·4

Generally, tabular loads are based on a flexural stress of 13·5 tons/inch² assuming adequate lateral support.
Tabular loads printed in prominent type require a spacing of stiffeners less than 1½ times the depth of the web plate.
Tabular loads marked † are the maximum shear loads for the web and are less than the permissible flexural load.
Tabular loads printed in italics and in ordinary type require a spacing of stiffeners 1½ times the depth of the web plate.

BASED ON
B.S. 449
1959
AS AMENDED

AUTOFAB BEAMS

DIMENSIONS AND PROPERTIES



Composed of		Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Area of Web Plate in square inches	Ratio D/T	Size D×B inches
Web Plate	Flange Plates		Axis x-x	Axis y-y	Axis y-y	Axis x-x	Axis y-y			
62 × ⅝	**22 × 2**	126·75	102554	3551	5·29	3108	322·8	38·75	33·0	**66×22**
62½ × ½	**22 × 1¾**	108·25	89657	3106	5·36	2717	282·4	31·25	37·7	
63 × ½	**22 × 1½**	97·50	79075	2663	5·23	2396	242·1	31·50	44·0	
63½ × ½	**22 × 1¼**	86·75	68324	2219	5·06	2070	201·7	31·75	52·8	
64 × ½	**22 × 1**	76·00	57401	1775	4·83	1739	161·4	32·00	66·0	
62 × ½	**18 × 2**	103·00	83682	1945	4·35	2536	216·1	31·00	33·0	**66×18**
62½ × ½	**18 × 1¾**	94·25	75206	1702	4·25	2279	189·1	31·25	37·7	
63 × ⅜	**18 × 1½**	77·63	63987	1458	4·33	1939	162·0	23·63	44·0	
63½ × ⅜	**18 × 1¼**	68·81	55174	1215	4·20	1672	135·0	23·81	52·8	
64 × ⅜	**18 × 1**	60·00	46220	972·3	4·03	1401	108·0	24·00	66·0	
64½ × ⅜	**18 × ¾**	51·19	37125	729·3	3·77	1125	81·0	24·19	88·0	
62½ × ½	**14 × 1¾**	80·25	60754	801·0	3·16	1841	114·4	31·25	37·7	**66×14**
63 × ½	**14 × 1½**	73·50	54109	686·7	3·06	1640	98·1	31·50	44·0	
63½ × ⅜	**14 × 1¼**	58·81	44691	571·9	3·12	1354	81·7	23·81	52·8	
64 × ⅜	**14 × 1**	52·00	37769	457·6	2·97	1145	65·4	24·00	66·0	
64½ × ⅜	**14 × ¾**	45·19	30739	343·3	2·76	931·5	49·0	24·19	88·0	
65 × ⅜	**14 × ½**	38·38	23598	228·9	2·44	715·1	32·7	24·38	132·0	
56 × ⅝	**22 × 2**	123·00	83184	3550	5·37	2773	322·8	35·00	30·0	**60×22**
56½ × ½	**22 × 1¾**	105·25	72851	3106	5·43	2428	282·4	28·25	34·3	
57 × ½	**22 × 1½**	94·50	64196	2663	5·31	2140	242·0	28·50	40·0	
57½ × ½	**22 × 1¼**	83·75	55387	2219	5·15	1846	201·7	28·75	48·0	
58 × ½	**22 × 1**	73·00	46424	1775	4·93	1547	161·4	29·00	60·0	
56 × ½	**18 × 2**	100·00	67893	1945	4·41	2263	216·1	28·00	30·0	**60×18**
56½ × ½	**18 × 1¾**	91·25	60972	1702	4·32	2032	189·1	28·25	34·3	
57 × ⅜	**18 × 1½**	75·38	51998	1458	4·40	1733	162·0	21·38	40·0	
57½ × ⅜	**18 × 1¼**	66·56	44777	1215	4·27	1493	135·0	21·56	48·0	
58 × ⅜	**18 × 1**	57·75	37429	972·3	4·10	1248	108·0	21·75	60·0	
58½ × ⅜	**18 × ¾**	48·94	29954	729·3	3·86	998·5	81·0	21·94	80·0	
56½ × ½	**14 × 1¾**	77·25	49093	800·9	3·22	1636	114·4	28·25	34·3	**60×14**
57 × ½	**14 × 1½**	70·50	43658	686·6	3·12	1455	98·1	28·50	40·0	
57½ × ⅜	**14 × 1¼**	56·56	36147	571·9	3·18	1205	81·7	21·56	48·0	
58 × ⅜	**14 × 1**	49·75	30467	457·6	3·03	1016	65·4	21·75	60·0	
58½ × ⅜	**14 × ¾**	42·94	24688	343·3	2·83	822·9	49·0	21·94	80·0	
59 × ⅜	**14 × ½**	36·13	18809	228·9	2·52	627·0	32·7	22·13	120·0	

Tabular loads printed in ordinary type produce a deflection exceeding 1/360th of the span.
Loads producing deflection of 1/360th span may be obtained from $W = CI_x$, where C is the coefficient given below the appropriate span and I_x is the inertia of the beam.
Weights per foot are for the girder sections only and do not include any allowance for stiffeners, conneetions or weld.
Flanges are welded to the web by automatic fillet welding.
Autofab beams can be supplied in lengths up to 80 feet (see page 27). Girders exceeding 80 ft. can be fabricated by conventional methods.
For explanation of tables see notes commencing page 172.

AUTOFAB BEAMS

SAFE LOADS FOR HIGH YIELD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

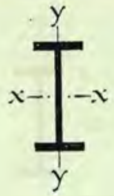
Size D × B inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS															
		20 ·0481	25 ·0308	30 ·0214	35 ·0157	40 ·0120	45 ·0095	50 ·0077	55 ·0064	60 ·0053	65 ·0046	70 ·0039	75 ·0034	80 ·0030	85 ·0027	90 ·0024	100 ·0019
54 × 22	405·5					*500†*	*489*	*440*	*400*	367	339	314	293	275	259	244	220
	347·7						**404†**	**386**	*351*	322	297	276	258	241	227	215	193
	311·1					**408†**	*378*	*340*	*309*	283	262	243	227	213	200	189	170
	274·6				**412†**	*366*	*326*	*293*	*266*	244	225	209	195	183	172	163	147
	238·0		**416†**	**409**	*350*	*306*	*272*	*245*	*223*	204	189	175	163	153	144	136	123
54 × 18	329·8					**400†**	**399**	*359*	*327*	299	276	257	240	225	211	200	180
	300·1				**404†**	**403**	*358*	*323*	*293*	269	248	230	215	202	190	179	161
	248·6						**306†**	**276**	**251**	230	212	197	184	172	162	153	138
	218·7				**309†**	**297**	**264**	*237*	*216*	198	182	169	158	148	140	132	119
	188·7			**312†**	**283**	**247**	*220*	*198*	*180*	165	152	141	132	124	116	110	98·9
	158·7		**315†**	**263**	*225*	*197*	*175*	*158*	*143*	131	121	113	105	98·6	92·8	87·6	78·9
54 × 14	252·5			**404†**	*370*	*324*	*288*	*259*	*235*	216	199	185	173	162	152	144	129
	229·5		**408†**	*383*	*328*	*287*	*255*	*230*	*209*	192	177	164	153	144	135	128	115
	184·7			**309†**	**273**	*238*	*212*	*191*	*173*	159	147	136	127	119	112	106	95·4
	161·5		**312†**	**267**	*229*	*200*	*178*	*160*	*146*	134	123	115	107	100	94·4	89·1	80·2
	127·2	**262†**	**249**	**207**	**178**	*155*	*138*	*124*	*113*	104	95·7	88·8	82·9	77·7	73·2	69·1	62·2
	103·9	**232**	**185**	*154*	*132*	*116*	*103*	*92·6*	*84·2*	77·2	71·3	66·2	61·8	57·9	54·5	51·5	46·3
48 × 22	392·7	→				*440†*	*425*	*383*	348	319	294	273	255	239	225	213	191
	337·5						**356†**	*337*	306	280	259	240	224	210	198	187	168
	300·9					**360†**	*329*	*296*	269	247	228	211	197	185	174	164	148
	264·4				**364†**	*319*	*283*	*255*	232	212	196	182	170	159	150	142	127
	227·8		**368†**	*355*	*304*	*266*	*236*	*213*	193	177	164	152	142	133	125	118	106
48 × 18	319·6					**352†**	*347*	*312*	284	260	240	223	208	195	184	174	156
	289·9				**356†**	*350*	*311*	*280*	255	234	216	200	187	175	165	156	140
	241·0					**270†**	**267**	**240**	218	200	185	172	160	150	141	133	120
	211·0				**273†**	**258**	*229*	*206*	188	172	159	147	138	129	121	115	103
	181·1			**276†**	**246**	*215*	*191*	*172*	156	143	132	123	115	107	101	95·5	86·0
	151·1	**279†**	**273**	*228*	*195*	*171*	*152*	*137*	124	114	105	97·6	91·1	85·4	80·4	75·9	68·3
48 × 14	242·3			**356†**	*320*	*280*	*249*	*224*	204	187	172	160	149	140	132	124	112
	219·3		**360†**	*331*	*284*	*249*	*221*	*199*	181	166	153	142	133	124	117	110	99·4
	177·0			**273†**	**236**	*207*	*184*	*166*	150	138	127	118	110	103	97·4	92·0	82·8
	153·9		**276†**	*231*	*198*	*173*	*154*	*139*	126	116	107	99·1	92·5	86·7	81·6	77·1	69·4
	120·8	**232†**	**215**	**179**	*154*	*134*	*119*	*108*	97·8	89·6	82·7	76·8	71·7	67·2	63·3	59·7	53·8
	97·5	**199**	*159*	*133*	*114*	*99·4*	*88·3*	*79·5*	72·3	66·3	61·2	56·8	53·0	49·7	46·8	44·2	39·8

Generally, tabular loads are based on a flexural stress of 13·5 tons/inch^2 assuming adequate lateral support.
Tabular loads printed in prominent type require a spacing of stiffeners less than $1\frac{1}{2}$ times the depth of the web plate.
Tabular loads marked † are the maximum shear loads for the web and are less than the permissible flexural load.
Tabular loads printed in italics and in ordinary type require a spacing of stiffeners $1\frac{1}{2}$ times the depth of the web plate, except the line marked → where the intermediate stiffeners are not required.

BASED ON
B.S. 449
1959
AS AMENDED

AUTOFAB BEAMS

DIMENSIONS AND PROPERTIES



Composed of		Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Area of Web Plate in square inches	Ratio $\frac{D}{T}$	Size D × B inches
Web Plate	Flange Plates		Axis *x-x*	Axis *y-y*	Axis *y-y*	Axis *x-x*	Axis *y-y*			
$50 \times \frac{5}{8}$	22×2	119·25	66028	3550	5·46	2445	322·8	31·25	27·0	**54 × 22**
$50\frac{1}{2} \times \frac{1}{2}$	$22 \times 1\frac{3}{4}$	102·25	57940	3106	5·51	2146	282·4	25·25	30·9	
$51 \times \frac{1}{2}$	$22 \times 1\frac{1}{2}$	91·50	51018	2663	5·39	1890	242·0	25·50	36·0	
$51\frac{1}{2} \times \frac{1}{2}$	$22 \times 1\frac{1}{4}$	80·75	43959	2219	5·24	1628	201·7	25·75	43·2	
$52 \times \frac{1}{2}$	22×1	70·00	36761	1775	5·04	1362	161·4	26·00	54·0	
$50 \times \frac{1}{2}$	18×2	97·00	53904	1945	4·48	1996	216·1	25·00	27·0	**54 × 18**
$50\frac{1}{2} \times \frac{1}{2}$	$18 \times 1\frac{3}{4}$	88·25	48381	1702	4·39	1792	189·1	25·25	30·9	
$51 \times \frac{3}{8}$	$18 \times 1\frac{1}{2}$	73·13	41365	1458	4·47	1532	162·0	19·12	36·0	
$51\frac{1}{2} \times \frac{3}{8}$	$18 \times 1\frac{1}{4}$	64·31	35578	1215	4·35	1318	135·0	19·31	43·2	
$52 \times \frac{3}{8}$	18×1	55·50	29678	972·2	4·19	1099	108·0	19·50	54·0	
$52\frac{1}{2} \times \frac{3}{8}$	$18 \times \frac{3}{4}$	46·69	23663	729·2	3·95	876·4	81·0	19·69	72·0	
$50\frac{1}{2} \times \frac{1}{2}$	$14 \times 1\frac{3}{4}$	74·25	38822	800·9	3·28	1438	114·4	25·25	30·9	**54 × 14**
$51 \times \frac{1}{2}$	$14 \times 1\frac{1}{2}$	67·50	34476	686·5	3·19	1277	98·1	25·50	36·0	
$51\frac{1}{2} \times \frac{3}{8}$	$14 \times 1\frac{1}{4}$	54·31	28620	571·9	3·25	1060	81·7	19·31	43·2	
$52 \times \frac{3}{8}$	14×1	47·50	24059	457·6	3·10	891·1	65·4	19·50	54·0	
$52\frac{1}{2} \times \frac{5}{16}$	$14 \times \frac{3}{4}$	37·41	18656	343·1	3·03	691·0	49·0	16·41	72·0	
$53 \times \frac{5}{16}$	$14 \times \frac{1}{2}$	30·56	13895	228·8	2·74	514·6	32·7	16·56	108·0	
$44 \times \frac{5}{8}$	22×2	115·50	51018	3550	5·54	2126	322·8	27·50	24·0	**48 × 22**
$44\frac{1}{2} \times \frac{1}{2}$	$22 \times 1\frac{3}{4}$	99·25	44868	3106	5·59	1870	282·4	22·25	27·4	
$45 \times \frac{1}{2}$	$22 \times 1\frac{1}{2}$	88·50	39486	2662	5·49	1645	242·0	22·50	32·0	
$45\frac{1}{2} \times \frac{1}{2}$	$22 \times 1\frac{1}{4}$	77·75	33983	2219	5·34	1416	201·7	22·75	38·4	
$46 \times \frac{1}{2}$	22×1	67·00	28358	1775	5·15	1182	161·4	23·00	48·0	
$44 \times \frac{1}{2}$	18×2	94·00	41661	1944	4·55	1736	216·1	22·00	24·0	**48 × 18**
$44\frac{1}{2} \times \frac{1}{2}$	$18 \times 1\frac{3}{4}$	85·25	37378	1701	4·47	1557	189·1	22·25	27·4	
$45 \times \frac{3}{8}$	$18 \times 1\frac{1}{2}$	70·88	32048	1458	4·54	1335	162·0	16·88	32·0	
$45\frac{1}{2} \times \frac{3}{8}$	$18 \times 1\frac{1}{4}$	62·06	27537	1215	4·43	1147	135·0	17·06	38·4	
$46 \times \frac{3}{8}$	18×1	53·25	22926	972·2	4·27	955·2	108·0	17·25	48·0	
$46\frac{1}{2} \times \frac{3}{8}$	$18 \times \frac{3}{4}$	44·44	18213	729·2	4·05	758·9	81·0	17·44	64·0	
$44\frac{1}{2} \times \frac{1}{2}$	$14 \times 1\frac{3}{4}$	71·25	29888	800·8	3·35	1245	114·4	22·25	27·4	**48 × 14**
$45 \times \frac{1}{2}$	$14 \times 1\frac{1}{2}$	64·50	26508	686·5	3·26	1105	98·1	22·50	32·0	
$45\frac{1}{2} \times \frac{3}{8}$	$14 \times 1\frac{1}{4}$	52·06	22072	571·9	3·31	919·7	81·7	17·06	38·4	
$46 \times \frac{3}{8}$	14×1	45·25	18507	457·5	3·18	771·1	65·4	17·25	48·0	
$46\frac{1}{2} \times \frac{5}{16}$	$14 \times \frac{3}{4}$	35·53	14340	343·1	3·11	597·5	49·0	14·53	64·0	
$47 \times \frac{5}{16}$	$14 \times \frac{1}{2}$	28·69	10601	228·8	2·82	441·7	32·7	14·69	96·0	

Tabular loads printed in ordinary type produce a deflection exceeding 1/360th of the span.
Loads producing deflection of 1/360th span may be obtained from $W = CI_x$, where C is the coefficient given below the appropriate span and I_x is the inertia of the beam.
Weights per foot are for the girder sections only and do not include any allowance for stiffeners, connections or weld.
Flanges are welded to the web by automatic fillet welding.
Autofab beams can be supplied in lengths up to 80 feet (see page 27). Girders exceeding 80 ft. can be fabricated by conventional methods.
For explanation of tables see notes commencing page 172.

AUTOFAB BEAMS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Size D×B inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS															
		20 ·0481	25 ·0308	30 ·0214	35 ·0157	40 ·0120	45 ·0095	50 ·0077	55 ·0064	60 ·0053	65 ·0046	70 ·0039	75 ·0034	80 ·0030	85 ·0027	90 ·0024	100 ·0019
42×22	380·0	→				*380†*	363	327	297	272	251	233	218	204	192	181	163
	327·3						*308†*	283	262	240	221	206	192	180	169	160	144
	290·7					*312†*	281	253	230	211	195	181	169	158	149	141	127
	254·2			*316†*	*311*	*272*	242	218	198	181	168	156	145	136	128	121	109
	217·6		*320†*	*302*	*259*	*227*	202	181	165	151	140	130	121	113	107	101	90·7
42×18	309·4					*304†*	296	267	242	222	205	190	178	167	157	148	133
	279·7				*308†*	*299*	266	239	217	199	184	171	159	150	141	133	120
	233·3					**234†**	**229***	206	187	171	158	147	137	129	121	114	103
	203·4				**237†**	**221**	196	177	161	147	136	126	118	110	104	98·2	88·3
	173·4			**240†**	*210*	*184*	163	147	133	122	113	105	97·9	91·8	86·4	81·6	73·4
	143·4	**243†**	**233**	*194*	*166*	*145*	129	116	106	96·9	89·4	83·0	77·5	72·7	68·4	64·6	58·1
42×14	232·1			*308†*	*272*	*238*	212	191	173	159	147	136	127	119	112	106	95·3
	209·1		*312†*	*281*	*241*	*211*	188	169	154	141	130	121	113	106	99·3	93·8	84·4
	169·4		**237†**	**235**	*202*	*176*	157	141	128	118	109	101	94·1	88·2	83·0	78·4	70·5
	146·2	**240†**	**236**	*197*	*169*	*148*	131	118	107	98·4	90·8	84·3	78·7	73·8	69·4	65·6	59·0
	114·4	**202†**	**183**	*152*	*131*	*114*	102	91·4	83·1	76·2	70·3	65·3	60·9	57·1	53·8	50·8	45·7
	91·2	**168**	*134*	*112*	*95·8*	*83·8*	74·5	67·0	61·0	55·9	51·6	47·9	44·7	41·9	39·4	37·2	33·5

Generally, tabular loads are based on a flexural stress of 13·5 tons/inch² assuming adequate lateral support.
Tabular loads printed in prominent type require a spacing of stiffeners less than 1½ times the depth of the web plate.
Tabular loads marked † are the maximum shear loads for the web and are less than the permissible flexural load.
Tabular loads printed in italics and in ordinary type require a spacing of stiffeners 1½ times the depth of the web plate, except the line marked → where the intermediate stiffeners are not required.

BASED ON
B.S. 449
1959
AS AMENDED

AUTOFAB BEAMS

DIMENSIONS AND PROPERTIES

Composed of		Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Area of Web Plate in square inches	Ratio D/T	Size D×B inches
Web Plate	Flange Plates		Axis *x-x*	Axis *y-y*	Axis *y-y*	Axis *x-x*	Axis *y-y*			
38 ×⅝	**22×2**	111·75	38087	3550	5·64	1814	322·7	23·75	21·0	**42×22**
38½×½	**22×1¾**	96·25	33584	3106	5·68	1599	282·4	19·25	24·0	
39 ×½	**22×1½**	85·50	29548	2662	5·58	1407	242·0	19·50	28·0	
39½×½	**22×1¼**	74·75	25408	2219	5·45	1210	201·7	19·75	33·6	
40 ×½	**22×1**	64·00	21161	1775	5·27	1008	161·4	20·00	42·0	
38 ×½	**18×2**	91·00	31110	1944	4·62	1481	216·0	19·00	21·0	**42×18**
38½×½	**18×1¾**	82·25	27910	1701	4·55	1329	189·0	19·25	24·0	
39 ×⅜	**18×1½**	68·63	24007	1458	4·61	1143	162·0	14·63	28·0	
39½×⅜	**18×1¼**	59·81	20613	1215	4·51	981·6	135·0	14·81	33·6	
40 ×⅜	**18×1**	51·00	17132	972·2	4·37	815·8	108·0	15·00	42·0	
40½×⅜	**18×¾**	42·19	13563	729·2	4·16	645·9	81·0	15·19	56·0	
38½×½	**14×1¾**	68·25	22236	800·7	3·43	1059	114·4	19·25	24·0	**42×14**
39 ×½	**14×1½**	61·50	19702	686·4	3·34	938·2	98·1	19·50	28·0	
39½×⅜	**14×1¼**	49·81	16460	571·8	3·39	783·8	81·7	14·81	33·6	
40 ×⅜	**14×1**	43·00	13769	457·5	3·26	655·7	65·4	15·00	42·0	
40½×⁵⁄₁₆	**14×¾**	33·66	10664	343·1	3·19	507·8	49·0	12·66	56·0	
41 ×⁵⁄₁₆	**14×½**	26·81	7823	228·8	2·92	372·5	32·7	12·81	84·0	

Tabular loads with asterisk or printed in ordinary type produce a deflection exceeding 1/360th of the span.
Loads producing deflection of 1/360th span may be obtained from $W = CI_X$, where C is the coefficient given below the appropriate span and I_X is the inertia of the beam.
Weights per foot are for the girder sections only and do not include any allowance for stiffeners, connections or weld.
Flanges are welded to the web by automatic fillet welding.
Autofab beams can be supplied in lengths up to 80 feet (see page 27). Girders exceeding 80 ft. can be fabricated by conventional methods.
For explanation of tables see notes commencing page 172.

UNIVERSAL BEAMS AS TIES

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Serial Size and Weight/foot	Gross		With holes in flanges				With extra holes in web			
	Area ins^2	Safe Load tons	No.	Dia. ins	Nett Area ins^2	Safe Load tons	No.	Dia. ins	Nett Area ins^2	Safe Load tons
36×16½×260	76·56	1034	4	$1\frac{1}{16}$	70·44	951	2	$1\frac{1}{16}$	68·64	927
230	67·73	914	4	$1\frac{1}{16}$	62·37	842	2	$1\frac{1}{16}$	60·74	820
36×12 ×194	57·11	771	4	$\frac{15}{16}$	52·38	707	2	$\frac{15}{16}$	50·94	688
170	49·98	675	4	$\frac{15}{16}$	45·85	619	2	$\frac{15}{16}$	44·57	602
150	44·16	596	4	$\frac{15}{16}$	40·63	549	2	$\frac{15}{16}$	39·46	533
135	39·69	536	4	$\frac{15}{16}$	36·71	496	2	$\frac{15}{16}$	35·59	480
33×11½×152	44·71	604	4	$\frac{15}{16}$	40·75	550	2	$\frac{15}{16}$	39·56	534
130	38·26	517	4	$\frac{15}{16}$	35·05	473	2	$\frac{15}{16}$	33·96	458
118	34·69	468	4	$\frac{15}{16}$	31·91	431	2	$\frac{15}{16}$	30·87	417
30×10½×132	38·83	524	4	$\frac{15}{16}$	35·08	474	2	$\frac{15}{16}$	33·93	458
116	34·13	461	4	$\frac{15}{16}$	30·94	418	2	$\frac{15}{16}$	29·88	403
99	29·11	393	4	$\frac{15}{16}$	26·52	358	2	$\frac{15}{16}$	25·57	345
27×10 ×114	33·53	453	4	$\frac{15}{16}$	30·03	405	2	$\frac{15}{16}$	28·96	391
102	30·01	405	4	$\frac{15}{16}$	26·91	363	2	$\frac{15}{16}$	25·94	350
94	27·65	373	4	$\frac{15}{16}$	24·85	335	2	$\frac{15}{16}$	23·93	323
84	27·41	334	4	$\frac{15}{16}$	22·32	301	2	$\frac{15}{16}$	21·45	290
24×12 ×160	47·05	635	4	$\frac{15}{16}$	42·42	573	2	$\frac{15}{16}$	41·05	554
120	35·29	476	4	$\frac{15}{16}$	31·80	429	2	$\frac{15}{16}$	30·76	415
100	29·43	397	4	$\frac{15}{16}$	26·52	358	2	$\frac{15}{16}$	25·64	346
24× 9 × 94	27·63	373	4	$\frac{15}{16}$	24·36	329	2	$\frac{15}{16}$	23·39	316
84	24·71	334	4	$\frac{15}{16}$	21·81	294	2	$\frac{15}{16}$	20·93	283
76	22·37	302	4	$\frac{15}{16}$	19·81	267	2	$\frac{15}{16}$	18·98	256
68	20·00	270	4	$\frac{15}{16}$	17·82	241	2	$\frac{15}{16}$	17·04	230
21×13 ×142	41·78	564	4	$1\frac{1}{16}$	37·13	501	2	$1\frac{1}{16}$	35·73	482
127	37·38	505	4	$1\frac{1}{16}$	33·19	448	2	$1\frac{1}{16}$	31·94	431
112	32·97	445	4	$1\frac{1}{16}$	29·29	395	2	$1\frac{1}{16}$	28·17	380
21× 8¼× 82	24·12	326	4	$\frac{15}{16}$	20·97	283	2	$\frac{15}{16}$	20·03	270
73	21·46	290	4	$\frac{15}{16}$	18·68	252	2	$\frac{15}{16}$	17·83	241
68	20·02	270	4	$\frac{15}{16}$	17·45	236	2	$\frac{15}{16}$	16·64	225
62	18·23	246	4	$\frac{15}{16}$	15·92	215	2	$\frac{15}{16}$	15·17	205
55	16·17	218	4	$\frac{15}{16}$	14·22	192	2	$\frac{15}{16}$	13·51	182
18× 7½× 66	19·40	262	4	$\frac{15}{16}$	16·51	223	2	$\frac{15}{16}$	15·67	212
60	17·64	238	4	$\frac{15}{16}$	15·03	203	2	$\frac{15}{16}$	14·25	192
55	16·19	219	4	$\frac{15}{16}$	13·83	187	2	$\frac{15}{16}$	13·10	177
50	14·71	199	4	$\frac{15}{16}$	12·57	170	2	$\frac{15}{16}$	11·90	161
45	13·23	179	4	$\frac{15}{16}$	11·35	153	2	$\frac{15}{16}$	10·72	145
18× 6 × 55	16·18	218	4	$\frac{15}{16}$	13·39	181	2	$\frac{15}{16}$	12·60	170
50	14·71	199	4	$\frac{15}{16}$	12·20	165	2	$\frac{15}{16}$	11·47	155
45	13·22	178	4	$\frac{15}{16}$	11·01	149	2	$\frac{15}{16}$	10·33	139

The above safe loads are based on an axial stress of 13·5 tons/inch^2.

BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL BEAMS AS TIES

SAFE LOADS FOR HIGH YIELD STEEL

Serial Size and Weight/foot	Gross		With holes in flanges				With extra holes in web			
	Area ins^2	Safe Load tons	No.	Dia. ins	Nett Area ins^2	Safe Load tons	No.	Dia. ins	Nett Area ins^2	Safe Load tons
16×7 ×50	14·70	198	4	$\frac{15}{16}$	12·34	167	2	$\frac{15}{16}$	11·63	157
45	13·24	179	4	$\frac{15}{16}$	11·13	150	2	$\frac{15}{16}$	10·48	141
40	11·77	159	4	$\frac{15}{16}$	9·88	133	2	$\frac{15}{16}$	9·30	126
36	10·59	143	4	$\frac{15}{16}$	8·98	121	2	$\frac{15}{16}$	8·42	114
16×5½×31	9·12	123	4	$\frac{15}{16}$	7·47	101	2	$\frac{15}{16}$	6·96	94·0
26	7·64	103	4	$\frac{15}{16}$	6·36	85·9	2	$\frac{15}{16}$	5·89	79·5
16×6 ×50	14·70	198	4	$\frac{15}{16}$	12·03	162	2	$\frac{15}{16}$	11·28	152
45	13·23	179	4	$\frac{15}{16}$	10·86	147	2	$\frac{15}{16}$	10·17	137
40	11·76	159	4	$\frac{15}{16}$	9·71	131	2	$\frac{15}{16}$	9·07	122
15×6 ×45	13·24	179	4	$\frac{15}{16}$	10·84	146	2	$\frac{15}{16}$	10·13	137
40	11·77	159	4	$\frac{15}{16}$	9·65	130	2	$\frac{15}{16}$	9·00	122
35	10·29	139	4	$\frac{15}{16}$	8·45	114	2	$\frac{15}{16}$	7·88	106
14×6¾×45	13·23	179	4	$\frac{15}{16}$	10·91	147	2	$\frac{15}{16}$	10·24	138
38	11·17	151	4	$\frac{15}{16}$	9·25	125	2	$\frac{15}{16}$	8·66	117
34	10·00	135	4	$\frac{15}{16}$	8·30	112	2	$\frac{15}{16}$	7·76	105
30	8·81	119	4	$\frac{15}{16}$	7·37	99·5	2	$\frac{15}{16}$	6·86	92·6
14×5 ×26	7·64	103	4	$\frac{13}{16}$	6·27	84·6	2	$\frac{13}{16}$	5·85	79·0
22	6·47	87·3	4	$\frac{13}{16}$	5·38	72·6	2	$\frac{13}{16}$	5·00	67·5
12×6½×36	10·59	143	4	$\frac{15}{16}$	8·56	116	2	$\frac{15}{16}$	7·99	108
31	9·12	123	4	$\frac{15}{16}$	7·38	99·6	2	$\frac{15}{16}$	6·88	92·9
27	7·97	108	4	$\frac{15}{16}$	6·47	87·3	2	$\frac{15}{16}$	6·02	81·3
12×5 ×32	9·42	127	4	$\frac{13}{16}$	7·63	103	2	$\frac{13}{16}$	7·06	95·3
28	8·23	111	4	$\frac{13}{16}$	6·68	90·2	2	$\frac{13}{16}$	6·17	83·3
25	7·35	99·2	4	$\frac{13}{16}$	5·98	80·7	2	$\frac{13}{16}$	5·52	74·5
12×4 ×22	6·47	87·3	4	$\frac{13}{16}$	5·09	68·7	2	$\frac{13}{16}$	4·67	63·0
19	5·62	75·9	4	$\frac{13}{16}$	4·49	60·6	2	$\frac{13}{16}$	4·10	55·4
16·5	4·86	65·6	4	$\frac{13}{16}$	3·99	53·9	2	$\frac{13}{16}$	3·62	48·9
10×5¾×29	8·53	115	4	$\frac{15}{16}$	6·65	89·8	2	$\frac{15}{16}$	6·11	82·5
25	7·35	99·2	4	$\frac{15}{16}$	5·74	77·5	2	$\frac{15}{16}$	5·27	71·1
21	6·19	83·6	4	$\frac{15}{16}$	4·91	66·3	2	$\frac{15}{16}$	4·46	60·2
10×4 ×19	5·61	75·7	4	$\frac{13}{16}$	4·33	58·5	2	$\frac{13}{16}$	3·92	52·9
17	4·98	67·2	4	$\frac{13}{16}$	3·91	52·8	2	$\frac{13}{16}$	3·52	47·5
15	4·40	59·4	4	$\frac{13}{16}$	3·53	47·7	2	$\frac{13}{16}$	3·16	42·7
8×5¼×20	5·88	79·4	4	$\frac{15}{16}$	4·46	60·2	2	$\frac{15}{16}$	3·99	53·9
17	5·00	67·5	4	$\frac{15}{16}$	3·84	51·8	2	$\frac{15}{16}$	3·41	46·0

The above safe loads are based on an axial stress of 13·5 tons/inch^2.

UNIVERSAL COLUMNS AS TIES

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Serial Size and Weight/foot	Gross		With holes in flanges				With extra holes in web			
	Area ins²	Safe Load tons	No.	Dia. ins	Nett Area ins²	Safe Load tons	No.	Dia. ins	Nett Area ins²	Safe Load tons
14×16 ×426*	125·25	1691	4	$1\frac{1}{16}$	112·36	1517	2	$1\frac{1}{16}$	108·38	1463
370*	108·78	1469	4	$1\frac{1}{16}$	97·48	1316	2	$1\frac{1}{16}$	93·96	1268
314*	92·30	1246	4	$1\frac{1}{16}$	82·60	1115	2	$1\frac{1}{16}$	79·59	1074
264	77·63	1048	4	$1\frac{1}{16}$	69·39	937	2	$1\frac{1}{16}$	66·83	902
228	67·06	905	4	$1\frac{1}{16}$	59·89	809	2	$1\frac{1}{16}$	57·67	779
193	56·73	766	4	$1\frac{1}{16}$	50·62	683	2	$1\frac{1}{16}$	48·73	658
158	46·47	627	4	$1\frac{1}{16}$	41·42	559	2	$1\frac{1}{16}$	39·87	538
Column Core 320*	94·12	1271	4	$1\frac{1}{16}$	85·22	1150	2	$1\frac{1}{16}$	81·20	1096
14×14½×136	39·98	540	4	$1\frac{1}{16}$	35·46	479	2	$1\frac{1}{16}$	34·06	460
119	34·99	472	4	$1\frac{1}{16}$	31·00	419	2	$1\frac{1}{16}$	29·79	402
103	30·26	409	4	$1\frac{1}{16}$	26·80	362	2	$1\frac{1}{16}$	25·75	348
87	25·56	345	4	$1\frac{1}{16}$	22·64	306	2	$1\frac{1}{16}$	21·75	294
12×12 ×190	55·86	754	4	$\frac{15}{16}$	49·35	666	2	$\frac{15}{16}$	47·36	639
161	47·38	640	4	$\frac{15}{16}$	41·81	564	2	$\frac{15}{16}$	40·11	541
133	39·11	528	4	$\frac{15}{16}$	34·47	465	2	$\frac{15}{16}$	33·05	446
106	31·19	421	4	$\frac{15}{16}$	27·49	371	2	$\frac{15}{16}$	26·33	355
92	27·06	365	4	$\frac{15}{16}$	23·85	322	2	$\frac{15}{16}$	22·83	308
79	23·22	313	4	$\frac{15}{16}$	20·46	276	2	$\frac{15}{16}$	19·58	264
65	19·11	258	4	$\frac{15}{16}$	16·84	227	2	$\frac{15}{16}$	16·11	217
10×10 ×112	32·92	444	4	$\frac{15}{16}$	28·24	381	2	$\frac{15}{16}$	26·82	362
89	26·19	354	4	$\frac{15}{16}$	22·45	303	2	$\frac{15}{16}$	21·30	288
72	21·18	286	4	$\frac{15}{16}$	18·15	245	2	$\frac{15}{16}$	17·19	232
60	17·66	238	4	$\frac{15}{16}$	15·10	204	2	$\frac{15}{16}$	14·32	193
49	14·40	194	4	$\frac{15}{16}$	12·31	166	2	$\frac{15}{16}$	11·67	158
8× 8 × 58	17·06	230	4	$\frac{15}{16}$	14·03	189	2	$\frac{15}{16}$	13·07	176
48	14·11	190	4	$\frac{15}{16}$	11·55	156	2	$\frac{15}{16}$	10·79	146
40	11·76	159	4	$\frac{15}{16}$	9·67	131	2	$\frac{15}{16}$	8·99	121
35	10·30	139	4	$\frac{15}{16}$	8·45	114	2	$\frac{15}{16}$	7·86	106
31	9·12	123	4	$\frac{15}{16}$	7·50	101	2	$\frac{15}{16}$	6·96	94·0
6× 6 × 25	7·35	99·2	4	$\frac{15}{16}$	5·65	76·3	2	$\frac{15}{16}$	5·05	68·2
20	5·93	80·1	4	$\frac{15}{16}$	4·55	61·4	2	$\frac{15}{16}$	4·07	54·9
15·7	4·62	62·4	4	$\frac{15}{16}$	3·61	48·7	2	$\frac{15}{16}$	3·16	42·7

The above safe loads are based on an axial stress of 13·5 tons/inch².
NOTE: Sections marked thus* have flange thicknesses exceeding 2″ and are based on an axial stress of $Y_s/1{\cdot}63$ where Y_s = yield stress agreed with manufacturer, with a maximum value of 22 tons/inch². For the purpose of these tables Y_s has been taken as 22 tons/inch².

R.S. JOISTS AND CHANNELS AS TIES

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR HIGH YIELD STEEL

Serial Size and Weight/foot	Gross		With holes in flanges				With extra holes in web			
	Area ins²	Safe Load tons	No.	Dia. ins	Nett Area ins²	Safe Load tons	No.	Dia. ins	Nett Area ins²	Safe Load tons
Joists										
8×4 ×17	5·00	67·5	4	$\frac{11}{16}$	3·88	52·4	2	$\frac{11}{16}$	3·56	48·1
7×4 ×14·5	4·26	57·5	4	$\frac{11}{16}$	3·28	44·3	2	$\frac{11}{16}$	2·99	40·4
6×3½×11·5	3·38	45·6	4	$\frac{9}{16}$	2·65	35·8	2	$\frac{9}{16}$	2·43	32·8
5×3 × 9	2·64	35·6	4	$\frac{9}{16}$	1·96	26·5	2	$\frac{9}{16}$	1·76	23·8
4×2½× 6·5	1·91	25·8	4	$\frac{7}{16}$	1·45	19·6	1	$\frac{7}{16}$	1·38	18·6
3×2 × 4·5	1·32	17·8	4	$\frac{7}{16}$	·93	12·6	1	$\frac{7}{16}$	·86	11·6
Channels										
17×4 ×44	12·94	175	2	$\frac{13}{16}$	11·86	160	2	$\frac{13}{16}$	11·08	150
15×4 ×37	10·88	147	2	$\frac{13}{16}$	9·84	133	2	$\frac{13}{16}$	9·17	124
12×4 ×31	9·12	123	2	$\frac{13}{16}$	8·17	110	2	$\frac{13}{16}$	7·52	102
12×3½×28	8·23	111	2	$\frac{13}{16}$	7·36	99·4	2	$\frac{13}{16}$	6·71	90·6
10×3½×24	7·06	95·3	2	$\frac{13}{16}$	6·19	83·6	2	$\frac{13}{16}$	5·60	75·6
10×3 ×19	5·59	75·5	2	$\frac{13}{16}$	4·89	66·0	2	$\frac{13}{16}$	4·37	59·0
9×3½×22	6·47	87·3	2	$\frac{13}{16}$	5·62	75·9	2	$\frac{13}{16}$	5·07	68·4
9×3 ×17·5	5·15	69·5	2	$\frac{13}{16}$	4·44	59·9	2	$\frac{13}{16}$	3·95	53·3
8×3½×20	5·88	79·4	2	$\frac{13}{16}$	5·06	68·3	2	$\frac{13}{16}$	4·54	61·3
8×3 ×16	4·70	63·5	2	$\frac{13}{16}$	3·99	53·9	2	$\frac{13}{16}$	3·53	47·7
7×3½×18	5·29	71·4	2	$\frac{13}{16}$	4·50	60·8	2	$\frac{13}{16}$	4·01	54·1
7×3 ×14	4·11	55·5	2	$\frac{13}{16}$	3·45	46·6	2	$\frac{13}{16}$	3·03	40·9
6×3½×16	4·71	63·6	2	$\frac{13}{16}$	3·97	53·6	2	$\frac{13}{16}$	3·51	47·4
6×3 ×12	3·53	47·7	2	$\frac{13}{16}$	2·95	39·8	2	$\frac{13}{16}$	2·54	34·3
5×2½×10	2·94	39·7	2	$\frac{13}{16}$	2·35	31·7	2	$\frac{13}{16}$	1·94	26·2
4×2 × 7	2·06	27·8	2	$\frac{11}{16}$	1·65	22·3	1	$\frac{11}{16}$	1·48	20·0
3×1½× 4·5	1·32	17·8	2	$\frac{9}{16}$	1·02	13·8	1	$\frac{9}{16}$	·91	12·3

The above safe loads are based on an axial stress of 13·5 tons/inch².

PART V

Safe Loads for and Properties of British Standard Sections

to B.S.4: Part 1: 1962 amended

also

Autofab Beams and Pressed Trough Sections

for MILD STEEL to B.S.15: 1961

UNIVERSAL BEAMS

BASED ON
B.S. 449
1959
AS AMENDED

WEB CAPACITIES IN TONS FOR MILD STEEL

				BUCKLING VALUE IN TONS FOR UNSTIFFENED WEB				
				Simply supported on End Bearing		Continuous over Intermediate Bearing		
Serial Size inches	Weight per foot lbs	Web Thickness *t* inches	Depth between fillets *d* inches	Beam Component	Stiff Bearing or Flange Pl. Component per inch	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness
36 × 16½	260	·845	31·16	118·95	6·56	237·91	6·56	13·13
	230	·765	31·16	100·27	5·59	200·54	5·59	11·18
36 × 12	194	·770	32·25	100·50	5·51	201·01	5·51	11·02
	170	·680	32·25	78·54	4·34	157·07	4·34	8·69
	150	·625	32·25	64·96	3·62	129·92	3·62	7·25
	135	·597	32·25	58·10	3·27	116·20	3·27	6·54
33 × 11½	152	·635	29·79	68·80	4·11	137·59	4·11	8·21
	130	·580	29·79	56·01	3·38	112·02	3·38	6·77
	118	·552	29·79	49·74	3·03	99·48	3·03	6·05
30 × 10½	132	·615	26·81	64·57	4·26	129·14	4·26	8·52
	116	·564	26·81	53·92	3·59	107·83	3·59	7·19
	99	·508	26·81	42·56	2·87	85·13	2·87	5·74
27 × 10	114	·570	24·04	55·33	4·06	110·65	4·06	8·11
	102	·518	24·04	45·85	3·39	91·69	3·39	6·77
	94	·490	24·04	40·63	3·02	81·25	3·02	6·04
	84	·462	24·04	35·40	2·65	70·79	2·65	5·30
24 × 12	160	·732	20·93	77·88	6·25	155·76	6·25	12·50
	120	·556	20·93	51·94	4·27	103·89	4·27	8·55
	100	·468	20·93	38·04	3·17	76·08	3·17	6·34
24 × 9	94	·516	21·38	45·22	3·72	90·44	3·72	7·45
	84	·470	21·38	37·74	3·13	75·49	3·13	6·27
	76	·440	21·38	32·76	2·74	65·51	2·74	5·48
	68	·416	21·38	28·75	2·42	57·49	2·42	4·85
21 × 13	142	·659	17·72	61·21	5·70	122·43	5·70	11·41
	127	·588	17·72	52·58	4·95	105·16	4·95	9·90
	112	·527	17·72	44·91	4·28	89·82	4·28	8·55
21 × 8¼	82	·502	18·61	41·69	3·89	83·38	3·89	7·78
	73	·455	18·61	35·19	3·31	70·39	3·31	6·63
	68	·430	18·61	31·68	3·00	63·36	3·00	6·00
	62	·400	18·61	27·38	2·61	54·77	2·61	5·22
	55	·376	18·61	23·86	2·29	47·72	2·29	4·59
18 × 7½	66	·450	15·92	32·84	3·57	65·69	3·57	7·14
	60	·416	15·92	28·89	3·17	57·78	3·17	6·33
	55	·390	15·92	25·77	2·84	51·55	2·84	5·69
	50	·358	15·92	21·94	2·44	43·87	2·44	4·87
	45	·334	15·92	18·95	2·12	37·91	2·12	4·25

For explanation of tables, see notes commencing page 168.
The web buckling and direct bearing values are applicable to end bearings, intermediate bearings and intermediate concentrated loads.

BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL BEAMS

WEB CAPACITIES IN TONS FOR MILD STEEL

		DIRECT BEARING VALUE IN TONS						
		Simply supported on End Bearing			Continuous over Intermediate Bearing			
Serial Size inches	Weight per foot lbs	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	Shear Value in Tons
36 × 16½	260	44·61	10·14	17·56	89·22	10·14	35·12	183·74
	230	37·52	9·18	15·90	75·05	9·18	31·80	164·69
36 × 12	194	33·85	9·24	16·00	67·70	9·24	32·01	168·54
	170	27·63	8·16	14·13	55·26	8·16	28·27	147·53
	150	23·32	7·50	12·99	46·63	7·50	25·98	134·40
	135	20·47	7·16	12·41	40·95	7·16	24·82	127·34
33 × 11½	152	24·55	7·62	13·20	49·10	7·62	26·40	127·64
	130	20·01	6·96	12·05	40·02	6·96	24·11	115·19
	118	17·73	6·62	11·47	35·45	6·62	22·95	108·87
30 × 10½	132	22·24	7·38	12·78	44·48	7·38	25·56	111·81
	116	18·64	6·77	11·72	37·28	6·77	23·44	101·52
	99	15·10	6·10	10·56	30·20	6·10	21·12	90·46
27 × 10	114	19·19	6·84	11·85	38·38	6·84	23·69	93·30
	102	16·31	6·22	10·77	32·62	6·22	21·53	84·13
	94	14·61	5·88	10·18	29·23	5·88	20·37	79·12
	84	12·72	5·54	9·60	25·45	5·54	19·20	73·98
24 × 12	160	30·35	8·78	15·21	60·70	8·78	30·43	109·45
	120	19·53	6·67	11·56	39·06	6·67	23·11	81·10
	100	14·93	5·62	9·73	29·86	5·62	19·45	67·39
24 × 9	94	15·60	6·19	10·72	31·21	6·19	21·45	75·20
	84	13·24	5·64	9·77	26·47	5·64	19·54	67·93
	76	11·57	5·28	9·14	23·14	5·28	18·29	63·12
	68	10·07	4·99	8·65	20·15	4·99	17·29	59·18
21 × 13	142	25·61	7·91	13·70	51·23	7·91	27·39	84·85
	127	21·51	7·06	12·22	43·02	7·06	24·44	74·93
	112	17·96	6·32	10·95	35·93	6·32	21·91	66·40
21 × 8¼	82	14·76	6·02	10·43	29·53	6·02	20·87	64·58
	73	12·44	5·46	9·46	24·87	5·46	18·91	57·99
	68	11·26	5·16	8·94	22·52	5·16	17·87	54·52
	62	9·89	4·80	8·31	19·79	4·80	16·63	50·38
	55	8·56	4·51	7·81	17·11	4·51	15·63	46·92
18 × 7½	66	11·60	5·40	9·35	23·19	5·40	18·71	49·68
	60	10·07	4·99	8·65	20·15	4·99	17·29	45·55
	55	8·92	4·68	8·11	17·83	4·68	16·21	42·40
	50	7·74	4·30	7·44	15·48	4·30	14·88	38·66
	45	6·73	4·01	6·94	13·47	4·01	13·88	35·79

Let W = web value in tons, Cj = beam component, Cp = flange plate component, Cb = stiff bearing component, tp = thickness, in inches, of flange plates between beam and bearing and lb = length, in inches, of stiff bearing; then, for web buckling or direct bearing, either at end or intermediate bearings, $W = Cj + tp.Cp + lb.Cb$.

UNIVERSAL BEAMS

BASED ON
B.S. 449
1959
AS AMENDED

WEB CAPACITIES IN TONS FOR MILD STEEL

Serial Size	Weight per foot	Web thickness *t*	Depth between fillets *d*	BUCKLING VALUE IN TONS FOR UNSTIFFENED WEB				
				Simply supported on End Bearing		Continuous over Intermediate Bearing		
				Beam Component	Stiff Bearing or Flange Pl. Component per inch	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness
inches	lbs	inches	inches					
18× 6	55	·420	15·92	29·43	3·21	58·86	3·21	6·43
	50	·389	15·92	25·71	2·83	51·42	2·83	5·66
	45	·360	15·92	22·17	2·46	44·34	2·46	4·93
16×7	50	·380	14·07	23·93	2·95	47·87	2·95	5·89
	45	·346	14·07	20·40	2·53	40·80	2·53	5·06
	40	·307	14·07	16·26	2·03	32·52	2·03	4·06
	36	·299	14·07	15·27	1·93	30·54	1·93	3·85
16×6	50	·399	14·07	25·98	3·17	51·96	3·17	6·34
	45	·368	14·07	22·74	2·80	45·48	2·80	5·60.
	40	·340	14·07	19·72	2·46	39·44	2·46	4·91
16×5½	31	·272	14·07	12·46	1·57	24·91	1·57	3·15
	26	·249	14·07	10·03	1·28	20·05	1·28	2·56
15×6	45	·381	13·12	23·41	3·06	46·82	3·06	6·12
	40	·344	13·12	19·87	2·62	39·74	2·62	5·25
	35	·306	13·12	16·12	2·15	32·23	2·15	4·30
14×6¾	45	·357	12·17	20·63	2·88	41·27	2·88	5·76
	38	·313	12·17	16·65	2·36	33·31	2·36	4·72
	34	·287	12·17	14·23	2·03	28·46	2·03	4·07
	30	·270	12·17	12·58	1·82	25·16	1·82	3·63
14×5	26	·257	12·17	11·42	1·64	22·84	1·64	3·29
	22	·233	12·17	9·14	1·33	18·28	1·33	2·66
12×6½	36	·305	10·34	15·10	2·47	30·19	2·47	4·93
	31	·265	10·34	12·04	1·99	24·09	1·99	3·99
	27	·240	10·34	10·04	1·68	20·08	1·68	3·36
12×5	32	·350	10·34	18·12	2·96	36·23	2·96	5·93
	28	·313	10·34	15·43	2·56	30·86	2·56	5·11
	25	·284	10·34	13·29	2·22	26·58	2·22	4·45
12×4	22	·260	10·84	11·49	1·87	22·99	1·87	3·74
	19	·240	10·84	9·79	1·61	19·59	1·61	3·22
	16·5	·230	10·84	8·88	1·48	17·76	1·48	2·96
10×5¾	29	·289	8·51	12·52	2·45	25·05	2·45	4·90
	25	·252	8·51	10·29	2·04	20·58	2·04	4·08
	21	·240	8·51	9·41	1·90	18·83	1·90	3·80
10×4	19	·250	8·84	10·17	1·98	20·33	1·98	3·97
	17	·240	8·84	9·44	1·87	18·88	1·87	3·73
	15	·230	8·84	8·73	1·75	17·46	1·75	3·49
8×5¼	20	·248	6·69	8·73	2·15	17·46	2·15	4·29
	17	·230	6·69	7·82	1·96	15·65	1·96	3·91

For explanation of tables, see notes commencing page 168.
The web buckling and direct bearing values are applicable to end bearings, intermediate bearings and intermediate concentrated loads.

BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL BEAMS

WEB CAPACITIES IN TONS FOR MILD STEEL

Serial Size	Weight per foot	DIRECT BEARING VALUE IN TONS						Shear Value in Tons
		Simply supported on End Bearing			Continuous over Intermediate Bearing			
		Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	
inches	lbs							
18×6	55	10·43	5·04	8·73	20·86	5·04	17·46	46·14
	50	9·06	4·67	8·09	18·11	4·67	16·17	42·39
	45	7·78	4·32	7·48	15·56	4·32	14·96	38·88
16×7	50	8·61	4·56	7·90	17·22	4·56	15·80	37·05
	45	7·37	4·15	7·19	14·74	4·15	14·38	33·47
	40	6·16	3·68	6·38	12·31	3·68	12·76	29·47
	36	5·53	3·59	6·21	11·06	3·59	12·43	28·43
16×6	50	9·62	4·79	8·29	19·24	4·79	16·59	39·24
	45	8·26	4·42	7·65	16·52	4·42	15·30	35·84
	40	7·03	4·08	7·07	14·06	4·08	14·13	32·76
16×5½	31	5·00	3·26	5·65	10·01	3·26	11·31	25·85
	26	4·06	2·99	5·18	8·13	2·99	10·35	23·37
15×6	45	8·63	4·57	7·92	17·26	4·57	15·84	34·98
	40	7·26	4·13	7·15	14·51	4·13	14·30	31·27
	35	5·98	3·67	6·36	11·96	3·67	12·72	27·54
14×6¾	45	8·01	4·28	7·42	16·03	4·28	14·84	30·69
	38	6·34	3·76	6·51	12·69	3·76	13·01	26·52
	34	5·46	3·44	5·97	10·92	3·44	11·93	24·11
	30	4·74	3·24	5·61	9·48	3·24	11·22	22·45
14×5	26	4·59	3·08	5·34	9·19	3·08	10·68	21·42
	22	3·75	2·80	4·84	7·51	2·80	9·69	19·18
12×6½	36	6·02	3·66	6·34	12·04	3·66	12·68	22·40
	31	4·82	3·18	5·51	9·64	3·18	11·02	19·22
	27	4·04	2·88	4·99	8·08	2·88	9·98	17·22
12×5	32	6·84	4·20	7·27	13·68	4·20	14·55	25·66
	28	5·63	3·76	6·51	11·25	3·76	13·01	22·67
	25	4·78	3·41	5·90	9·56	3·41	11·81	20·38
12×4	22	3·97	3·12	5·40	7·94	3·12	10·81	19·20
	19	3·29	2·88	4·99	6·58	2·88	9·98	17·51
	16·5	2·77	2·76	4·78	5·55	2·76	9·56	16·56
10×5¾	29	5·14	3·47	6·01	10·27	3·47	12·01	17·72
	25	4·11	3·02	5·24	8·22	3·02	10·48	15·24
	21	3·47	2·88	4·99	6·93	2·88	9·98	14·26
10×4	19	3·66	3·00	5·20	7·33	3·00	10·39	15·37
	17	3·19	2·88	4·99	6·39	2·88	9·98	14·57
	15	2·77	2·76	4·78	5·55	2·76	9·56	13·80
8×5¼	20	3·74	2·98	5·15	7·47	2·98	10·31	12·11
	17	3·13	2·76	4·78	6·26	2·76	9·56	11·04

Let W=web value in tons, Cj=beam component, Cp=flange plate component, Cb=stiff bearing component, tp=thickness, in inches, of flange plates between beam and bearing and lb=length, in inches, of stiff bearing; then, for web buckling or direct bearing, either at end or intermediate bearings, $W = Cj + tp.Cp + lb.Cb$.

UNIVERSAL COLUMNS
AS BEAMS

BASED ON
B.S. 449
1959
AS AMENDED

WEB CAPACITIES IN TONS FOR MILD STEEL

Serial Size	Weight per foot	Web Thickness t	Depth between fillets d	BUCKLING VALUE IN TONS FOR UNSTIFFENED WEB				
				Simply supported on End Bearing		Continuous over Intermediate Bearing		
				Beam Component	Stiff Bearing or Flange Pl. Component per inch	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness
inches	*lbs*	*inches*	*inches*					
14×16	264	1·205	11·42	92·81	11·25	185·62	11·25	22·50
	228	1·045	11·42	77·84	9·73	155·68	9·73	19·46
	193	·890	11·42	63·91	8·25	127·81	8·25	16·49
	158	·730	11·42	50·30	6·71	100·61	6·71	13·41
14×14½	136	·660	11·42	44·45	6·03	88·89	6·03	12·05
	119	·570	11·42	37·31	5·15	74·62	5·15	10·29
	103	·495	11·42	31·36	4·40	62·71	4·40	8·80
	87	·420	11·42	25·39	3·63	50·78	3·63	7·25
12×12	190	1·060	9·71	71·19	9·90	142·38	9·90	19·80
	161	·905	9·71	58·50	8·43	117·00	8·43	16·86
	133	·755	9·71	46·79	6·99	93·58	6·99	13·99
	106	·620	9·71	36·68	5·70	73·36	5·70	11·39
	92	·545	9·71	31·34	4·97	62·68	4·97	9·93
	79	·470	9·71	26·20	4·23	52·39	4·23	8·46
	65	·390	9·71	20·76	3·43	41·53	3·43	6·85
10×10	112	·755	7·88	40·03	7·04	80·07	7·04	14·07
	89	·615	7·88	31·00	5·70	62·00	5·70	11·40
	72	·510	7·88	24·62	4·69	49·24	4·69	9·38
	60	·415	7·88	19·30	3·76	38·59	3·76	7·53
	49	·340	7·88	15·11	3·02	30·21	3·02	6·04
8× 8	58	·510	6·33	20·69	4·73	41·39	4·73	9·46
	48	·405	6·33	15·82	3·72	31·63	3·72	7·44
	40	·365	6·33	13·74	3·33	27·49	3·33	6·66
	35	·315	6·33	11·54	2·84	23·09	2·84	5·69
	31	·288	6·33	10·30	2·57	20·60	2·57	5·15
6× 6	25	·320	4·86	9·38	2·95	18·76	2·95	5·89
	20	·258	4·86	7·26	2·34	14·52	2·34	4·68
	15·7	·240	4·86	6·49	2·16	12·99	2·16	4·33

For explanation of tables, see notes commencing page 167.
The web buckling and direct bearing values are applicable to end bearings, intermediate bearings and intermediate concentrated loads.

BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL COLUMNS
AS BEAMS

WEB CAPACITIES IN TONS FOR MILD STEEL

Serial Size	Weight per foot	DIRECT BEARING VALUE IN TONS						Shear Value in Tons
		Simply supported on End Bearing			Continuous over Intermediate Bearing			
		Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	Beam Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	
inches	*lbs*							
14×16	264	63·57	14·46	25·05	127·13	14·46	50·09	119·29
	228	49·70	12·54	21·72	99·39	12·54	43·44	100·32
	193	37·70	10·68	18·50	75·40	10·68	37·00	82·77
	158	27·13	8·76	15·17	54·26	8·76	30·35	65·70
14×14½	136	22·81	7·92	13·72	45·63	7·92	27·44	58·41
	119	18·22	6·84	11·85	36·44	6·84	23·69	49·59
	103	14·54	5·94	10·29	29·07	5·94	20·58	42·32
	87	11·24	5·04	8·73	22·49	5·04	17·46	35·28
12×12	190	51·47	12·72	22·03	102·93	12·72	44·06	91·46
	161	39·24	10·86	18·81	78·48	10·86	37·62	75·37
	133	28·81	9·06	15·69	57·62	9·06	31·38	60·61
	106	20·44	7·44	12·89	40·88	7·44	25·77	47·91
	92	16·49	6·54	11·33	32·99	6·54	22·66	41·27
	79	13·05	5·64	9·77	26·10	5·64	19·54	34·91
	65	9·78	4·68	8·11	19·55	4·68	16·21	28·36
10×10	112	27·43	9·06	15·69	54·86	9·06	31·38	51·55
	89	19·15	7·38	12·78	38·30	7·38	25·56	40·15
	72	13·86	6·12	10·60	27·73	6·12	21·20	32·13
	60	10·20	4·98	8·63	20·41	4·98	17·25	25·52
	49	7·48	4·08	7·07	14·95	4·08	14·13	20·40
8× 8	58	12·80	6·12	10·60	25·61	6·12	21·20	26·77
	48	9·12	4·86	8·42	18·23	4·86	16·84	20·65
	40	7·27	4·38	7·59	14·54	4·38	15·17	18·07
	35	5·85	3·78	6·55	11·69	3·78	13·09	15·35
	31	4·99	3·46	5·99	9·97	3·46	11·97	13·82
6× 6	25	5·01	3·84	6·65	10·03	3·84	13·30	12·23
	20	3·59	3·10	5·36	7·17	3·10	10·72	9·60
	15·7	2·84	2·88	4·99	5·68	2·88	9·98	8·64

Let W=web value in tons, Cj=beam component, Cp=flange plate component, Cb=stiff bearing component, tp=thickness, in inches, of flange plates between beam and bearing and lb=length, in inches, of stiff bearing; then, for web buckling or direct bearing, either at end or intermediate bearings, $W=Cj+tp.Cp+lb.Cb$.

JOISTS

WEB CAPACITIES IN TONS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Size D×B inches	Weight per foot lbs	Web thickness *t* inches	Depth between fillets *d* inches	BUCKLING VALUE IN TONS FOR UNSTIFFENED WEB				
				Simply supported on End Bearing		Continuous over Intermediate Bearing		
				Joist Component	Stiff Bearing or Flange Pl. Component per inch	Joist Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness
8×4	17	·230	6·34	7·93	1·98	15·86	1·98	3·96
7×4	14·5	·210	5·44	6·41	1·83	12·83	1·83	3·66
6×3½	11·5	·194	4·64	5·15	1·72	10·29	1·72	3·43
5×3	9	·178	3·71	4·00	1·60	8·01	1·60	3·20
4×2½	6·5	·161	2·88	2·93	1·47	5·87	1·47	2·93
3×2	4·5	·150	1·98	2·08	1·39	4·16	1·39	2·78

CHANNELS

WEB CAPACITIES IN TONS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Size D×B inches	Weight per foot lbs	Web thickness *t* inches	Depth between fillets *d* inches	BUCKLING VALUE IN TONS FOR UNSTIFFENED WEB				
				Simply supported on End Bearing		Continuous over Intermediate Bearing		
				Channel Component	Stiff Bearing or Flange Pl. Component per inch	Channel Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness
17×4	44	·48	14·27	34·50	4·06	68·99	4·06	8·12
15×4	37	·41	12·30	25·93	3·46	51·86	3·46	6·91
12×4	31	·40	9·42	21·28	3·55	42·56	3·55	7·09
12×3½	28	·40	9·66	21·18	3·53	42·37	3·53	7·06
10×3½	24	·36	7·67	16·15	3·23	32·30	3·23	6·46
10×3	19	·32	8·02	14·04	2·81	28·09	2·81	5·62
9×3½	22	·34	6·69	13·84	3·08	27·69	3·08	6·15
9×3	17·5	·30	7·01	11·98	2·66	23·97	2·66	5·33
8×3½	20	·32	5·72	11·66	2·92	23·32	2·92	5·83
8×3	16	·28	6·00	10·04	2·51	20·09	2·51	5·02
7×3½	18	·30	4·76	9·64	2·75	19·28	2·75	5·51
7×3	14	·26	5·07	8·24	2·35	16·48	2·35	4·71
6×3½	16	·28	3·82	7·76	2·59	15·53	2·59	5·18
6×3	12	·25	4·17	6·86	2·29	13·73	2·29	4·58
5×2½	10	·25	3·31	5·78	2·31	11·56	2·31	4·63
4×2	7	·24	2·59	4·47	2·24	8·94	2·24	4·47
3×1½	4·5	·20	1·80	2·80	1·87	5·61	1·87	3·74

For explanation of tables, see notes commencing page 168.
The web buckling and direct bearing values are applicable to end bearings, intermediate bearings and intermediate concentrated loads.

BASED ON
B.S. 449
1959

JOISTS

WEB CAPACITIES IN TONS FOR MILD STEEL

Size D×B inches	Weight per foot lbs	DIRECT BEARING VALUE IN TONS						Shear Value in Tons
		Simply supported on End Bearing			Continuous over Intermediate Bearing			
		Joist Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	Joist Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	
8×4	17	3·97	2·76	4·78	7·94	2·76	9·56	11·04
7×4	14·5	3·40	2·52	4·36	6·81	2·52	8·73	8·82
6×3½	11·5	2·74	2·33	4·03	5·48	2·33	8·06	6·98
5×3	9	2·39	2·14	3·70	4·77	2·14	7·40	5·34
4×2½	6·5	1·87	1·93	3·35	3·75	1·93	6·69	3·86
3×2	4·5	1·59	1·80	3·12	3·18	1·80	6·24	2·70

BASED ON
B.S. 449
1959

CHANNELS

WEB CAPACITIES IN TONS FOR MILD STEEL

Size D×B inches	Weight per foot lbs	DIRECT BEARING VALUE IN TONS						Shear Value in Tons
		Simply supported on End Bearing			Continuous over Intermediate Bearing			
		Channel Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	Channel Component	Stiff Bearing Component per linear inch	Flange Pl. Component per inch of thickness	
17×4	44	13·62	5·76	9·93	27·24	5·76	19·95	48·96
15×4	37	11·50	4·92	8·52	23·01	4·92	17·04	36·90
12×4	31	10·72	4·80	8·31	21·45	4·80	16·63	28·80
12×3½	28	9·73	4·80	8·31	19·45	4·80	16·63	28·80
10×3½	24	8·72	4·32	7·48	17·43	4·32	14·96	21·60
10×3	19	6·58	3·84	6·65	13·17	3·84	13·30	19·20
9×3½	22	8·16	4·08	7·07	16·32	4·08	14·13	18·36
9×3	17·5	6·20	3·60	6·24	12·41	3·60	12·47	16·20
8×3½	20	7·58	3·84	6·65	15·16	3·84	13·30	15·36
8×3	16	5·82	3·36	5·82	11·64	3·36	11·64	13·44
7×3½	18	6·98	3·60	6·24	13·97	3·60	12·47	12·60
7×3	14	5·21	3·12	5·40	10·43	3·12	10·81	10·92
6×3½	16	6·34	3·36	5·82	12·69	3·36	11·64	10·08
6×3	12	4·75	3·00	5·20	9·51	3·00	10·39	9·00
5×2½	10	4·39	3·00	5·20	8·78	3·00	10·39	7·50
4×2	7	3·52	2·88	4·99	7·03	2·88	9·98	5·76
3×1½	4·5	2·49	2·40	4·16	4·99	2·40	8·31	3·60

Let W = web value in tons, C = joist or channel component, Cp = flange plate component, Cb = stiff bearing component, tp = thickness, in inches, of flange plates between beam and bearing and lb = length, in inches, of stiff bearing; then, for web buckling or direct bearing either at end or at intermediate bearing, $W = C + tp.Cp + lb.Cb$.

UNIVERSAL BEAMS

BASED ON
B.S. 449 : 1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Serial Size inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS															
		14 ·0983	16 ·0752	18 ·0594	20 ·0481	22 ·0398	24 ·0334	26 ·0285	28 ·0246	32 ·0188	36 ·0149	40 ·0120	44 ·0099	48 ·0084	56 ·0061	64 ·0047	72 ·0037
36 × 16½	260					**303**	**277**	**256**	*238*	*208*	*185*	*166*	*151*	*139*	119	104	92·5
	230					**266**	**244**	**225**	**209**	*183*	*162*	*146*	*133*	*122*	104	91·4	81·2
36 × 12	194			**258**	**232**	**211**	*194*	*179*	*166*	*145*	*129*	*116*	*106*	*96·8*	82·9	72·6	64·5
	170			**225**	**203**	**184**	**169**	*156*	*145*	*127*	*113*	*101*	*92·1*	*84·5*	72·4	63·3	56·3
	150			**196**	**176**	**160**	**147**	**135**	*126*	*110*	*97·8*	*88·0*	*80·0*	*73·3*	62·9	55·0	48·9
	135			**171**	**154**	**140**	**128**	**118**	*110*	*96·0*	*85·3*	*76·8*	*69·8*	*64·0*	54·9	48·0	42·7
33 × 11½	152			**189**	**170**	**155**	**142**	*131*	*122*	*106*	*94·6*	*85·1*	*77·4*	70·9	60·8	53·2	47·3
	130			**157**	**142**	**129**	**118**	*109*	*101*	*88·6*	*78·7*	*70·8*	*64·4*	59·0	50·6	44·3	39·4
	118			**139**	**126**	**114**	**105**	*96·6*	*89·7*	*78·5*	*69·7*	*62·8*	*57·1*	52·3	44·8	39·2	34·9
30 × 10½	132			**148**	**133**	*121*	*111*	*102*	*94·9*	*83·1*	*73·8*	*66·4*	60·4	55·4	47·5	41·5	
	116			**128**	**115**	*104*	*95·6*	*88·3*	*82·0*	*71·7*	*63·8*	*57·4*	52·2	47·8	41·0	35·9	
	99			**106**	**95·5**	**86·8**	*79·6*	*73·4*	*68·2*	*59·7*	*53·0*	*47·7*	43·4	39·8	34·1	29·8	
27 × 10	114		**131**	**116**	*105*	*95·2*	*87·3*	*80·6*	*74·8*	*65·5*	*58·2*	52·4	47·6	43·6	37·4	32·7	
	102		**117**	**104**	**93·2**	*84·7*	*77·7*	*71·7*	*66·6*	*58·3*	*51·8*	46·6	42·4	38·8	33·3	29·1	
	94		**106**	**94·4**	**85·0**	*77·3*	*70·8*	*65·4*	*60·7*	*53·1*	*47·2*	42·5	38·6	35·4	30·3	26·6	
	84		**92·7**	**82·4**	**74·2**	*67·4*	*61·8*	*57·1*	*53·0*	*46·4*	*41·2*	37·1	33·7	30·9	26·5	23·2	
24 × 12	160	**200**	**175**	*155*	*140*	*127*	*117*	*108*	*99·9*	*87·4*	77·7	69·9	63·6	58·3	49·9		
	120	**150**	**131**	**116**	**105**	*95·2*	*87·2*	*80·5*	*74·8*	*65·4*	58·2	52·3	47·6	43·6	37·4		
	100	**124**	**109**	**96·8**	**87·1**	**79·2**	*72·6*	*67·0*	*62·2*	*54·4*	48·4	43·6	39·6	36·3	31·1		
24 × 9	94	**110**	**96·6**	*85·9*	*77·3*	*70·3*	*64·4*	*59·5*	*55·2*	*48·3*	43·0	38·7	35·1	32·2	27·6		
	84	**98·1**	**85·9**	**76·3**	*68·7*	*62·5*	*57·3*	*52·8*	*49·1*	*42·9*	38·2	34·4	31·2	28·6	24·5		
	76	**87·7**	**76·7**	**68·2**	*61·4*	*55·8*	*51·2*	*47·2*	*43·8*	*38·4*	34·1	30·7	27·9	25·6	21·9		
	68	**76·5**	**67·0**	**59·5**	*53·6*	*48·7*	*44·7*	*41·2*	*38·3*	*33·5*	29·8	26·8	24·4	22·3	19·1		
21 × 13	142	**159**	**139**	**123**	*111*	*101*	*92·5*	*85·4*	*79·3*	69·4	61·7	55·5	50·5	46·3			
	127	**142**	**124**	**111**	*99·5*	*90·4*	*82·9*	*76·5*	*71·0*	62·2	55·3	49·7	45·2	41·4			
	112	**125**	**109**	**97·1**	*87·4*	*79·4*	*72·8*	*67·2*	*62·4*	54·6	48·6	43·7	39·7	36·4			
21 × 8¼	82	**85·3**	*74·6*	*66·3*	*59·7*	*54·2*	*49·7*	*45·9*	*42·6*	37·3	33·2	29·8	27·1	24·9			
	73	**75·3**	*65·9*	*58·6*	*52·7*	*47·9*	*44·0*	*40·6*	*37·7*	33·0	29·3	26·4	24·0	22·0			
	68	**70·0**	*61·2*	*54·4*	*49·0*	*44·5*	*40·8*	*37·7*	*35·0*	30·6	27·2	24·5	22·3	20·4			
	62	**63·2**	**55·3**	*49·2*	*44·2*	*40·2*	*36·9*	*34·0*	*31·6*	27·6	24·6	22·1	20·1	18·4			
	55	**54·7**	**47·9**	*42·5*	*38·3*	*34·8*	*31·9*	*29·5*	*27·4*	23·9	21·3	19·1	17·4	16·0			
18 × 7½	66	*59·6*	*52·2*	*46·4*	*41·7*	*37·9*	*34·8*	32·1	29·8	26·1	23·2	20·9					
	60	*53·9*	*47·2*	*41·9*	*37·7*	*34·3*	*31·4*	29·0	26·9	23·6	21·0	18·9					
	55	*49·1*	*43·0*	*38·2*	*34·4*	*31·2*	*28·6*	26·4	24·5	21·5	19·1	17·2					
	50	**44·5**	*38·9*	*34·6*	*31·2*	*28·3*	*26·0*	24·0	22·2	19·5	17·3	15·6					
	45	**39·5**	*34·5*	*30·7*	*27·6*	*25·1*	*23·0*	21·2	19·7	17·3	15·3	13·8					

Generally, tabular loads are based on a flexural stress of 10·5 tons/inch², assuming adequate lateral support. Beams without adequate lateral support must not exceed the critical span *Lc*, unless the allowable compressive stress is reduced in accordance with clause 19.*a*.(ii) of B.S. 449 : 1959.
Tabular loads printed in bold face type exceed the load buckling capacity of the unstiffened web without allowance for actual length of bearing; the load bearing capacity should be checked, see page 168.

BASED ON
B.S. 449 : 1959
AS AMENDED

UNIVERSAL BEAMS

DIMENSIONS AND PROPERTIES

Critical Span *Lc* feet	Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Ratio $\frac{D}{T}$	Serial Size inches
		Axis *x-x*	Axis *y-y*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
25·85	76·56	17234	1021	3·65	951·1	123·3	25·2	**36 × 16½**
25·43	67·73	14988	870·9	3·59	835·5	105·7	28·5	
17·64	57·11	12103	355·4	2·49	663·6	58·7	29·0	**36 × 12**
17·35	49·98	10470	300·6	2·45	579·1	50·0	32·9	
16·86	44·16	9012·1	250·4	2·38	502·9	41·8	38·1	
16·22	39·69	7801·3	207·4	2·29	438·9	34·7	44·7	
16·93	44·71	8147·6	256·1	2·39	486·4	44·3	31·8	**33 × 11½**
16·22	38·26	6699·0	201·4	2·29	404·8	35·0	38·7	
15·72	34·69	5896·0	170·8	2·22	358·7	29·8	44·4	
15·44	38·83	5753·1	185·0	2·18	379·7	35·1	30·3	**30 × 10½**
15·02	34·13	4919·1	153·2	2·12	327·9	29·2	35·3	
14·38	29·11	4049·1	120·2	2·03	272·8	23·0	43·0	
14·95	33·53	4080·5	149·6	2·11	299·2	29·7	29·3	**27 × 10**
14·73	30·01	3604·1	129·5	2·08	266·3	25·9	32·7	
14·45	27·65	3266·8	115·1	2·04	242·8	23·0	36·0	
13·95	24·71	2827·7	95·9	1·97	211·9	19·3	41·9	
22·94	47·05	4979·2	359·7	2·77	399·6	58·7	20·2	**24 × 12**
18·98	35·29	3635·3	254·0	2·68	299·1	42·0	26·1	
18·63	29·43	2987·3	203·6	2·63	248·9	33·9	31·0	
13·60	27·63	2683·0	102·2	1·92	220·9	22·6	27·9	**24 × 9**
13·39	24·71	2364·3	88·3	1·89	196·3	19·6	31·2	
13·10	22·37	2096·4	76·5	1·85	175·4	17·0	35·1	
12·68	20·00	1815·1	63·9	1·79	153·1	14·3	40·7	
25·64	41·78	3403·9	386·0	3·04	317·2	58·8	19·6	**21 × 13**
23·88	37·38	3018·0	338·6	3·01	284·2	51·8	21·6	
21·48	32·97	2621·4	289·7	2·96	249·7	44·6	24·3	
12·68	24·12	1827·8	77·1	1·79	170·5	18·5	25·5	**21 × 8¼**
12·47	21·46	1600·3	66·2	1·76	150·7	16·0	28·7	
12·32	20·02	1478·3	60·4	1·74	139·9	14·6	30·8	
12·11	18·23	1326·8	53·1	1·71	126·4	12·9	34·1	
11·69	16·17	1137·9	43·9	1·65	109·4	10·7	40·0	
12·21	19·40	1096·8	53·2	1·66	119·2	14·0	23·9	**18 × 7½**
11·55	17·64	984·0	47·1	1·63	107·8	12·5	26·3	
11·40	16·19	889·9	42·0	1·61	98·2	11·1	28·8	
11·26	14·71	800·6	37·2	1·59	89·0	9·91	31·6	
10·98	13·23	704·8	31·9	1·55	78·9	8·54	35·7	

Tabular loads printed in italic type are within the web buckling capacity of the unstiffened web and produce a total deflection not exceeding 1/360th of the span.
Tabular loads printed in ordinary type should be checked for deflection, see page 169.
For explanation of tables, see notes commencing pages 162 and 167.

UNIVERSAL BEAMS

BASED ON
B.S. 449 : 1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Serial Size inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS															
		7 ·3930	**8** ·3009	**9** ·2378	**10** ·1926	**12** ·1337	**14** ·0983	**16** ·0752	**18** ·0594	**20** ·0481	**22** ·0398	**24** ·0334	**26** ·0285	**28** ·0246	**30** ·0214	**32** ·0188	**36** ·0149
18×6	55		**83·0**	**73·8**	**66·4**	*55·4*	*47·4*	*41·5*	*36·9*	*33·2*	*30·2*	*27·7*	25·6	23·7	22·1	20·8	18·5
	50		**75·0**	**66·6**	**60·0**	*50·0*	*42·8*	*37·5*	*33·3*	*30·0*	*27·3*	*25·0*	23·1	21·4	20·0	18·7	16·7
	45		**66·6**	**59·2**	**53·3**	**44·4**	*38·1*	*33·3*	*29·6*	*26·6*	*24·2*	*22·2*	20·5	19·0	17·8	16·6	14·8
16×7	50	**74·1†**	**70·6**	**62·8**	**56·5**	*47·1*	*40·3*	*35·3*	*31·4*	*28·2*	*25·7*	23·5	21·7	20·2	18·8	17·7	15·7
	45	**66·9†**	**63·3**	**56·3**	**50·7**	**42·2**	*36·2*	*31·7*	*28·2*	*25·3*	*23·0*	21·1	19·5	18·1	16·9	15·8	14·1
	40	**58·9†**	**56·3**	**50·1**	**45·1**	**37·6**	*32·2*	*28·2*	*25·0*	*22·5*	*20·5*	18·8	17·3	16·1	15·0	14·1	12·5
	36	**56·3**	**49·3**	**43·8**	**39·4**	**32·8**	*28·1*	*24·6*	*21·9*	*19·7*	17·9	16·4	15·2	14·1	13·1	12·3	10·9
16×6	50	**78·5†**	**69·1**	**61·4**	**55·3**	*46·1*	*39·5*	*34·6*	*30·7*	*27·6*	*25·1*	23·0	21·3	19·7	18·4	17·3	15·4
	45	**70·5**	**61·7**	**54·8**	**49·3**	*41·1*	*35·2*	*30·8*	*27·4*	*24·7*	*22·4*	20·6	19·0	17·6	16·4	15·4	13·7
	40	**61·7**	**54·0**	**48·0**	**43·2**	*36·0*	*30·9*	*27·0*	*24·0*	*21·6*	*19·6*	18·0	16·6	15·4	14·4	13·5	12·0
16×5½	31	**47·3**	**41·4**	**36·8**	**33·1**	**27·6**	*23·7*	*20·7*	*18·4*	*16·6*	15·0	13·8	12·7	11·8	11·0	10·3	9·1
	26	**38·1**	**33·3**	**29·6**	**26·7**	**22·2**	*19·0*	*16·7*	*14·8*	*13·3*	12·1	11·1	10·3	9·5	8·8	8·3	7·4
15×6	45	**66·8**	**58·4**	**52·0**	*46·8*	*39·0*	*33·4*	*29·2*	*26·0*	*23·4*	21·3	19·5	18·0	16·7	15·6	14·6	
	40	**59·1**	**51·7**	**46·0**	**41·4**	*34·5*	*29·5*	*25·9*	*23·0*	*20·7*	18·8	17·2	15·9	14·8	13·8	12·9	
	35	**51·4**	**45·0**	**40·0**	**36·0**	*30·0*	*25·7*	*22·5*	*20·0*	*18·0*	16·4	15·0	13·8	12·8	12·0	11·2	
14×6¾	45	**61·4†**	**57·1**	**50·8**	**45·7**	*38·1*	*32·6*	*28·6*	*25·4*	22·9	20·8	19·0	17·6	16·3	15·2	14·3	
	38	**53·0†**	**47·8**	**42·5**	**38·2**	*31·8*	*27·3*	*23·9*	*21·2*	19·1	17·4	15·9	14·7	13·6	12·7	11·9	
	34	**48·2†**	**42·4**	**37·7**	**33·9**	*28·3*	*24·2*	*21·2*	*18·9*	17·0	15·4	14·1	13·1	12·1	11·3	10·6	
	30	**41·8**	**36·6**	**32·5**	**29·3**	*24·4*	*20·9*	*18·3*	*16·3*	14·6	13·3	12·2	11·3	10·4	9·7	9·1	
14×5	26	**34·8**	**30·4**	**27·1**	**24·4**	*20·3*	*17·4*	*15·2*	*13·5*	12·2	11·1	10·1	9·3	8·7	8·1	7·6	
	22	**28·6**	**25·0**	**22·2**	**20·0**	*16·7*	*14·3*	*12·5*	*11·1*	10·0	9·1	8·3	7·7	7·1	6·6	6·2	
12×6½	36	**44·8†**	**40·2**	**35·7**	**32·1**	*26·8*	*22·9*	*20·1*	17·9	16·1	14·6	13·4	12·4	11·5			
	31	**38·4†**	**34·5**	**30·6**	**27·6**	*23·0*	*19·7*	*17·2*	15·3	13·8	12·5	11·5	10·6	9·8			
	27	**34·1**	**29·8**	**26·5**	**23·9**	*19·9*	*17·0*	*14·9*	13·3	11·9	10·8	9·9	9·1	8·5			
12×5	32	**37·3**	*32·6*	*29·0*	*26·1*	*21·8*	*18·6*	*16·3*	14·5	13·1	11·9	10·9	10·0	9·3			
	28	**32·3**	*28·3*	*25·2*	*22·6*	*18·9*	*16·2*	*14·1*	12·6	11·3	10·3	9·4	8·6	8·0			
	25	**28·7**	*25·1*	*22·3*	*20·1*	*16·7*	*14·3*	*12·6*	11·2	10·0	9·1	8·3	7·7	7·1			
12×4	22	**25·3**	*22·1*	*19·7*	*17·7*	*14·8*	*12·6*	*11·1*	9·8	8·8	8·0	7·3	6·8	6·3			
	19	**21·4**	*18·7*	*16·6*	*15·0*	*12·5*	*10·7*	*9·3*	8·3	7·4	6·8	6·2	5·7	5·3			
	16·5	*17·5*	*15·3*	*13·6*	*12·2*	*10·2*	*8·7*	*7·6*	6·8	6·1	5·5	5·1	4·7	4·3			
10×5¾	29	**30·8**	**27·0**	*24·0*	*21·6*	*18·0*	*15·4*	13·5	12·0	10·8	9·8	8·9					
	25	**26·4**	**23·1**	*20·5*	*18·5*	*15·4*	13·2	11·5	10·3	9·2	8·4	7·7					
	21	**21·5**	*18·8*	*16·7*	*15·1*	*12·5*	10·7	9·4	8·3	7·5	6·8	6·2					
10×4	19	*18·8*	*16·4*	*14·6*	*13·2*	*11·0*	*9·4*	8·2	7·3	6·5	5·9	5·4					
	17	*16·2*	*14·2*	*12·6*	*11·3*	*9·4*	8·1	7·0	6·3	5·6	5·1	4·7					
	15	*13·8*	*12·1*	*10·7*	*9·6*	*8·0*	6·9	6·0	5·3	4·8	4·3	4·0					
8×5¼	20	*17·0*	*14·9*	*13·2*	*11·9*	9·9	8·5	7·4	6·6	5·9							
	17	*14·1*	*12·3*	*11·0*	*9·8*	8·2	7·0	6·1	5·4	4·9							

Generally, tabular loads are based on a flexural stress of 10·5 tons/inch², assuming adequate lateral support. Beams without adequate lateral support must not exceed the critical span *Lc*, unless the allowable compressive stress is reduced in accordance with clause 19.*a*.(ii) of B.S. 449 : 1959.

Tabular loads printed in bold face type exceed the load buckling capacity of the unstiffened web without allowance for actual length of bearing; the load bearing capacity should be checked, see page 168.

BASED ON
B.S. 449 : 1959
AS AMENDED

UNIVERSAL BEAMS

DIMENSIONS AND PROPERTIES

Critical Span *Lc* feet	Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Ratio	Serial Size inches
		Axis *x-x*	Axis *y-y*	Axis *y-y*	Axis *x-x*	Axis *y-y*	**D**/**T**	
9·12	16·18	868·7	26·3	1·27	94·9	8·70	24·6	**18×6**
8·85	14·71	777·9	23·1	1·25	85·7	7·69	27·1	
8·71	13·22	685·2	19·9	1·23	76·1	6·66	30·6	
10·91	14·70	655·4	34·8	1·54	80·7	9·84	25·9	**16×7**
10·77	13·24	583·3	30·5	1·52	72·4	8·66	28·6	
10·62	11·77	515·5	26·5	1·50	64·4	7·58	31·8	
10·27	10·59	446·3	22·1	1·45	56·3	6·34	37·0	
9·90	14·70	647·2	25·1	1·31	79·0	8·31	23·1	**16×6**
9·07	13·23	571·8	21·8	1·28	70·5	7·25	25·7	
8·85	11·76	495·4	18·5	1·25	61·7	6·16	29·4	
8·15	9·12	374·9	12·0	1·15	47·3	4·29	36·0	**16×5½**
7·65	7·64	298·1	8·96	1·08	38·1	3·21	46·0	
9·64	13·24	511·2	22·7	1·31	66·8	7·49	23·9	**15×6**
9·14	11·77	447·6	19·6	1·29	59·1	6·48	26·8	
8·92	10·29	385·5	16·5	1·26	51·4	5·49	30·6	
11·45	13·23	468·1	30·7	1·52	65·3	9·01	23·2	**14×6¾**
10·55	11·17	385·3	24·6	1·49	54·6	7·28	27·5	
10·34	10·00	339·2	21·3	1·46	48·5	6·30	30·9	
9·99	8·81	289·6	17·5	1·41	41·8	5·21	36·2	
7·22	7·64	241·6	8·00	1·02	34·8	3·23	33·1	**14×5**
6·94	6·47	196·2	6·17	·98	28·6	2·50	41·0	
11·49	10·59	280·8	23·7	1·50	45·9	7·23	22·7	**12×6½**
10·41	9·12	238·4	19·8	1·47	39·4	6·07	26·0	
10·20	7·97	204·2	16·6	1·44	34·1	5·11	29·9	
8·25	9·42	227·9	10·5	1·06	37·3	4·27	22·2	**12×5**
7·30	8·23	195·2	8·81	1·03	32·3	3·60	25·4	
7·22	7·35	171·6	7·59	1·02	28·7	3·12	28·4	
5·95	6·47	155·7	4·55	·84	25·3	2·26	29·0	**12×4**
5·74	5·62	130·1	3·67	·81	21·4	1·83	34·8	
5·38	4·86	105·3	2·79	·76	17·5	1·39	44·6	
11·03	8·53	157·3	15·2	1·34	30·8	5·25	20·4	**10×5¾**
9·80	7·35	133·2	12·7	1·31	26·4	4·40	23·4	
8·85	6·19	106·3	9·74	1·25	21·5	3·39	29·1	
6·09	5·61	96·2	4·19	·86	18·8	2·08	26·0	**10×4**
5·88	4·98	81·8	3·45	·83	16·2	1·72	30·8	
5·67	4·40	68·8	2·79	·80	13·8	1·39	37·2	
9·55	5·88	69·2	8·50	1·20	17·0	3·23	21·5	**8×5¼**
8·22	5·00	56·4	6·72	1·16	14·1	2·56	26·0	

Tabular loads printed in italic type are within the web buckling capacity of the unstiffened web and produce a total deflection not exceeding 1/360th of the span.

Tabular loads printed in ordinary type should be checked for deflection, see page 169.

For explanation of tables, see notes commencing pages 162 and 167.

Tabular loads marked thus † are based on the maximum shear value of the web and are less than the permissible flexural load.

UNIVERSAL COLUMNS AS BEAMS

BASED ON
B.S. 449
1959
AS AMENDED

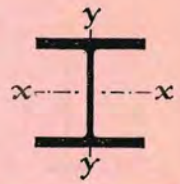
SAFE LOADS FOR MILD STEEL

Serial Size inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS														
		7 ·3930	**8** ·3009	**10** ·1926	**12** ·1337	**14** ·0983	**16** ·0752	**18** ·0594	**20** ·0481	**22** ·0398	**24** ·0334	**26** ·0285	**28** ·0246	**30** ·0214	**32** ·0188	**36** ·0149	**40** ·0120
14×16	264				**239†**	**214**	**187**	*166*	*150*	*136*	125	115	107	99·7	93·5	84·1	74·8
	228				**201†**	**184**	**161**	*143*	*129*	*117*	107	99·0	91·9	85·8	80·4	71·5	64·4
	193				**165†**	**155**	**136**	*121*	*108*	98·6	90·4	83·5	77·5	72·3	67·8	60·3	54·2
	158				**131†**	**127**	**111**	*98·5*	*88·7*	80·6	73·9	68·2	63·3	59·1	55·4	49·3	44·3
14×14½	136				**117†**	**108**	**94·5**	*84·0*	*75·6*	68·7	63·0	58·1	54·0	50·4	47·2	42·0	
	119				**99·2†**	**94·7**	**82·9**	*73·7*	66·3	60·3	55·2	51·0	47·3	44·2	41·4	36·8	
	103				**84·6†**	**81·8**	**71·6**	**63·6**	57·3	52·0	47·7	44·0	40·9	38·2	35·8	31·8	
	87				**70·6†**	**69·0**	**60·4**	**53·7**	48·3	43·9	40·3	37·2	34·5	32·2	30·2	26·8	
12×12	190			**183†**	**153**	*132*	*115*	*102*	92·1	83·7	76·8	70·9	65·8	61·4	57·6		
	161			**151†**	**130**	*111*	*97·2*	*86·4*	77·8	70·7	64·8	59·8	55·5	51·8	48·6		
	133			**121†**	**106**	*91·2*	*79·8*	*71·0*	63·9	58·1	53·2	49·1	45·6	42·6	39·9		
	106			**95·8†**	**84·3**	*72·2*	*63·2*	56·2	50·6	46·0	42·1	38·9	36·1	33·7	31·6		
	92			**82·5†**	**72·9**	*62·5*	*54·7*	48·6	43·7	39·8	36·5	33·6	31·2	29·2	27·3		
	79			**69·8†**	**62·5**	**53·5**	*46·9*	41·6	37·5	34·1	31·2	28·8	26·8	25·0	23·4		
	65			**56·7†**	**51·3**	**44·0**	*38·5*	34·2	30·8	28·0	25·7	23·7	22·0	20·5	19·2		
10×10	112		**103†**	**88·4**	*73·7*	*63·1*	55·3	49·1	44·2	40·2	36·8	34·0	31·6				
	89		**80·3†**	**69·8**	*58·2*	*49·8*	43·6	38·8	34·9	31·7	29·1	26·8	24·9				
	72		**64·3†**	**56·1**	*46·7*	*40·0*	35·0	31·1	28·0	25·5	23·4	21·6	20·0				
	60		**51·0†**	**47·0**	**39·1**	*33·5*	29·4	26·1	23·5	21·3	19·6	18·1	16·8				
	49		**40·8†**	**38·2**	**31·8**	27·3	23·9	21·2	19·1	17·4	15·9	14·7	13·6				
8×8	58	**52·0**	**45·5**	*36·4*	*30·3*	26·0	22·7	20·2	18·2	16·5							
	48	**41·3†**	**37·8**	*30·2*	25·2	21·6	18·9	16·8	15·1	13·7							
	40	**35·5**	**31·1**	*24·8*	20·7	17·7	15·5	13·8	12·4	11·3							
	35	**30·7†**	**27·2**	*21·8*	18·1	15·5	13·6	12·1	10·9	9·8							
	31	**27·4**	**24·0**	*19·2*	16·0	13·7	12·0	10·7	9·5	8·7							
6×6	25	*16·7*	*14·6*	11·7	9·7	8·3	7·3										
	20	*13·5*	*11·8*	9·4	7·8	6·7	5·9										
	15·7	*10·1*	*8·8*	7·0	5·8	5·0	4·4										

Generally, tabular loads are based on a flexural stress of 10·5 tons/inch^2, assuming adequate lateral support. Beams without adequate lateral support must not exceed the critical span *Lc*, unless the allowable compressive stress is reduced in accordance with clause 19.*a*.(ii) of B.S. 449 : 1959, amended.
Tabular loads printed in prominent type exceed the load buckling capacity of the unstiffened web without allowance for actual length of bearing; the load bearing capacity should be checked, see page 168.
Tabular loads marked † are based on the maximum shear value of the web and are less than the permissible flexural load.

BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL COLUMNS AS BEAMS



DIMENSIONS AND PROPERTIES

Critical Span *Lc* feet	Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Ratio $\frac{D}{T}$	Serial Size inches
		Axis *x-x*	Axis *y-y*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
46·40	77·63	3526·0	1331·2	4·14	427·4	166·1	8·5	**14×16**
44·93	67·06	2942·4	1124·8	4·10	367·8	141·8	9·5	
43·06	56·73	2402·4	930·1	4·05	310·0	118·4	10·8	
40·73	46·47	1900·6	745·0	4·00	253·4	95·8	12·6	
37·17	39·98	1593·0	567·8	3·77	216·0	77·0	13·9	**14×14½**
35·47	34·99	1373·1	491·8	3·75	189·4	67·1	15·5	
33·32	30·26	1165·8	419·7	3·72	163·6	57·6	17·5	
30·56	25·56	966·9	349·7	3·70	138·1	48·2	20·3	
36·59	55·86	1892·6	589·7	3·25	263·2	93·1	8·3	**12×12**
35·23	47·38	1541·9	486·3	3·20	222·2	77·7	9·3	
33·60	39·11	1221·3	389·9	3·16	182·5	63·1	10·8	
31·28	31·19	930·7	300·9	3·11	144·5	49·2	13·1	
29·75	27·06	788·9	256·4	3·08	125·0	42·2	14·7	
27·86	23·22	663·1	216·4	3·05	107·1	35·8	16·8	
25·17	19·11	533·4	174·6	3·02	88·0	29·1	20·0	
29·53	32·92	718·7	235·4	2·67	126·3	45·2	9·1	**10×10**
27·90	26·19	542·4	180·6	2·63	99·7	35·2	10·9	
26·12	21·18	420·7	141·8	2·59	80·1	27·9	13·0	
24·63	17·66	343·7	116·5	2·57	67·1	23·1	15·0	
22·50	14·40	272·9	93·0	2·54	54·6	18·6	17·9	
22·33	17·06	227·3	74·9	2·10	52·0	18·2	10·8	**8×8**
21·29	14·11	183·7	60·9	2·08	43·2	15·0	12·4	
19·65	11·76	146·3	49·0	2·04	35·5	12·1	14·8	
18·69	10·30	126·5	42·5	2·03	31·1	10·6	16·5	
17·50	9·12	109·7	37·0	2·01	27·4	9·24	18·5	
14·95	7·35	53·3	17·0	1·52	16·7	5·60	14·0	**6×6**
13·70	5·93	41·9	13·4	1·50	13·5	4·46	16·8	
11·25	4·62	30·3	9·69	1·45	10·1	3·23	22·3	

Tabular loads printed in italic type are within the buckling capacity of the unstiffened web and produce a total deflection not exceeding 1/360th of the span.
Tabular loads printed in ordinary type produce a deflection exceeding 1/360th of the span.
Loads producing a deflection of 1/360th span may be obtained from $W = CI_x$, where C is the coefficient given below the appropriate span and I_x is the inertia of the beam.
For explanation of tables, see notes commencing pages 163 and 167.

JOISTS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Size D×B inches	Weight per foot lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS													
		3 2·140	**4** 1·204	**5** ·7704	**6** ·5350	**7** ·3930	**8** ·3009	**9** ·2378	**10** ·1926	**11** ·1592	**12** ·1337	**14** ·0983	**16** ·0752	**18** ·0594	**20** ·0481
8×4	17		**†22·1**	**19·3**	**16·1**	*13·8*	*12·1*	*10·7*	*9·6*	*8·7*	8·0	6·8	6·0	5·3	4·8
7×4	14·5		**†17·6**	**14·6**	*12·2*	*10·5*	*9·1*	*8·1*	7·3	6·6	6·0	5·2	4·5		
6×3½	11·5	**†14·0**	**12·4**	*9·9*	*8·2*	*7·0*	*6·1*	5·5	4·9	4·5	4·1	3·5			
5×3	9	**†10·7**	*8·0*	*6·4*	*5·3*	4·5	4·0	3·5	3·2	2·9					
4×2½	6·5	**6·1**	*4·5*	*3·6*	3·0	2·6	2·2	2·0	1·8						
3×2	4·5	*3·1*	*2·3*	1·8	1·5	1·3	1·1								

CHANNELS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

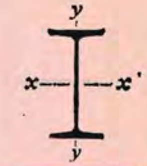
Size D×B inches	Weight per foot lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS														
		4 1·204	**6** ·5350	**8** ·3009	**10** ·1926	**12** ·1337	**14** ·0983	**16** ·0752	**18** ·0594	**20** ·0481	**22** ·0398	**24** ·0334	**26** ·0285	**28** ·0246	**32** ·0188	**36** ·0149
17×4	44		**70·6**	*52·9*	*42·3*	*35·3*	*30·2*	*26·5*	*23·5*	*21·2*	*19·2*	17·6	16·3	15·1	13·2	11·8
15×4	37		**55·7**	*41·7*	*33·4*	*27·8*	*23·9*	*20·9*	*18·6*	*16·7*	15·2	13·9	12·8	11·9	10·4	
12×4	31	**57·6**	*38·4*	*28·8*	*23·0*	*19·2*	*16·4*	*14·4*	12·8	11·5	10·5	9·5	8·8	8·2		
12×3½	28	**49·5**	*33·0*	*24·7*	*19·8*	*16·5*	*14·1*	*12·4*	11·0	9·8	8·9	8·2	7·6	7·0		
10×3½	24	**37·4**	*24·9*	*18·7*	*15·0*	*12·5*	10·7	9·3	8·3	7·4	6·8	6·2				
10×3	19	**28·3**	*18·9*	*14·2*	*11·3*	*9·4*	8·0	7·0	6·2	5·6	5·1	4·7				
9×3½	22	**31·6**	*21·1*	*15·8*	*12·7*	*10·5*	9·0	7·9	7·0	6·3						
9×3	17·5	**24·4**	*16·3*	*12·2*	*9·7*	*8·1*	6·9	6·0	5·4	4·8						
8×3½	20	**26·2**	*17·5*	*13·1*	*10·5*	8·7	7·4	6·5	5·8	5·2						
8×3	16	**20·5**	*13·7*	*10·2*	*8·1*	6·8	5·8	5·1	4·5	4·0						
7×3½	18	**21·1**	*14·0*	*10·5*	8·4	7·0	6·0	5·2	4·6							
7×3	14	*16·1*	*10·7*	*8·0*	6·4	5·3	4·5	4·0	3·5							
6×3½	16	**16·3**	*10·9*	*8·1*	6·5	5·4	4·6	4·0								
6×3	12	*11·9*	*7·9*	*5·9*	4·7	3·9	3·4	2·9								
5×2½	10	*8·1*	*5·4*	4·0	3·2	2·7	2·3									
4×2	7	*4·3*	2·9	2·1	1·7	1·4	1·2									
3×1½	4·5	*2·0*	1·3	1·0	0·8	0·6										

Generally, tabular loads are based on a flexural stress of 10·5 tons/inch², assuming adequate lateral support. Beams without adequate lateral support must not exceed the critical span *Lc*, unless the allowable compressive stress is reduced in accordance with clause 19.*a*.(ii) of B.S. 449 : 1959, as amended.
Tabular loads printed in bold face type exceed the load buckling capacity of the unstiffened web without allowance for actual length of bearing; the load bearing capacity should be checked, see page 168.

BASED ON
B.S. 449
1959
AS AMENDED

JOISTS

DIMENSIONS AND PROPERTIES



Size D×B inches	Weight per foot in lbs	Critical Span *Lc* feet	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T	Area in square inches
			Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
8×4	17	7·42	55·11	3·91	3·32	·88	13·78	1·95	19·6	5·00
7×4	14·5	7·51	36·57	3·36	2·93	·89	10·45	1·68	19·6	4·26
6×3½	11·5	6·81	21·22	2·07	2·51	·78	7·07	1·18	18·4	3·38
5×3	9	6·23	11·46	1·21	2·08	·68	4·58	·81	16·7	2·64
4×2½	6·5	5·42	5·24	·61	1·66	·57	2·62	·49	15·3	1·91
3×2	4·5	4·49	2·00	·27	1·23	·45	1·33	·27	13·4	1·32

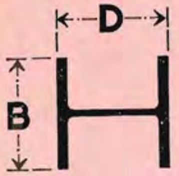
BASED ON
B.S. 449
1959
AS AMENDED

CHANNELS

DIMENSIONS AND PROPERTIES

Size D×B inches	Weight per foot in lbs	Dimension *p*	Critical Span *Lc* feet	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T	Area in square inches
				Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*		
17×4	44	·91	7·65	514·11	15·10	6·30	1·08	60·48	4·89	25·6	12·94
15×4	37	·99	8·48	357·82	13·93	5·73	1·13	47·71	4·63	23·3	10·88
12×4	31	1·05	9·44	197·34	12·00	4·65	1·15	32·89	4·06	20·5	9·12
12×3½	28	·86	7·53	169·64	7·82	4·54	·97	28·27	2·96	22·3	8·23
10×3½	24	·95	8·74	106·86	7·27	3·89	1·01	21·37	2·85	18·7	7·06
10×3	19	·73	6·33	80·88	3·91	3·81	·84	16·18	1·72	23·2	5·59
9×3½	22	1·00	9·30	81·38	6·85	3·55	1·03	18·08	2·74	17·2	6·47
9×3	17·5	·79	7·06	62·70	3·81	3·49	·86	13·93	1·72	20·5	5·15
8×3½	20	1·04	9·76	59·85	6·35	3·19	1·04	14·96	2·58	15·8	5·88
8×3	16	·84	7·73	46·86	3·64	3·16	·88	11·71	1·68	18·2	4·70
7×3½	18	1·09	10·19	42·12	5·79	2·82	1·05	12·03	2·40	14·5	5·29
7×3	14	·87	7·93	32·13	3·22	2·79	·88	9·18	1·51	17·3	4·11
6×3½	16	1·13	10·54	28·01	5·17	2·44	1·05	9·34	2·18	13·2	4·71
6×3	12	·87	8·02	20·46	2·73	2·41	·88	6·82	1·28	16·9	3·53
5×2½	10	·76	7·31	11·59	1·62	1·99	·74	4·64	·93	13·8	2·94
4×2	7	·60	5·80	4·99	·70	1·56	·58	2·50	·50	13·3	2·06
3×1½	4·5	·47	4·63	1·78	·26	1·16	·44	1·19	·25	11·2	1·32

Tabular loads marked thus † are based on the maximum shear value of the web and are less than the permissible flexural load.
Tabular loads printed in italic type are within the web buckling capacity of the unstiffened web and produce a total deflection not exceeding 1/360th of the span.
Tabular loads printed in ordinary type should be checked for deflection, see page 169.
For explanation of tables, see notes commencing pages 162 and 167.



UNIVERSAL COLUMNS

SAFE LOADS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Serial Size in inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		10	**12**	**14**	**16**	**20**	**24**	**28**	**32**	**36**	**40**	**44**	**48**	**52**	**56**	**60**
14×16	426	1127	1127	1118	1096	1036	953	849	736	629	537	458	395	342	299	262
	370	979	979	969	949	894	819	726	626	534	454	387	332	288	251	221
	314	845	835	821	802	754	688	606	521	442	375	319	274	237	207	182
	264	710	701	689	673	631	573	503	430	364	308	262	225	194	169	148
	228	613	605	594	580	543	492	429	367	310	262	223	191	165	144	126
	193	518	511	502	489	457	412	359	305	257	217	184	158	137	119	104
	158	424	418	410	400	372	335	290	246	206	174	148	126	109	95·3	83·6
Column Core	320	847	847	836	817	767	698	614	526	446	378	322	276	239	208	183
14×14½	136	364	357	349	339	311	274	233	194	162	135	114	97·4	84·1	73·0	
	119	318	313	305	296	272	239	202	169	140	117	99·2	84·6	72·8	63·3	
	103	275	270	264	256	234	205	173	144	120	100	84·5	72·2	62·2		
	87	232	228	222	216	197	172	146	121	100	83·7	70·6	60·3	51·9		
12×12	190	501	489	472	451	394	328	266	215	176	145	122	103			
	161	424	413	398	380	330	272	220	177	145	119	100	85·3			
	133	350	340	327	311	270	222	178	143	117	96·3	80·9				
	106	278	270	260	247	212	173	138	111	90·6	74·8	62·5				
	92	241	234	225	213	182	148	118	94·9	77·2	63·7	53·3				
	79	207	200	192	182	155	126	100	80·2	65·1	53·6	45·0				
	65	170	165	158	149	126	102	81·1	64·8	52·5	43·4	36·2				

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 180. Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959

UNIVERSAL COLUMNS

DIMENSIONS AND PROPERTIES

Serial Size in inches	Depth of Section **D**	Width of Section **B**	Area of Section in square inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio **D/T**
				Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	
14×16	18·69	16·695	125·25	2359·5	6610·3	**4·34**	7·26	282·7	707·4	6·2
	17·94	16·475	108·78	1986·0	5454·2	**4·27**	7·08	241·1	608·1	6·7
	17·19	16·235	92·30	1631·4	4399·4	**4·20**	6·90	201·0	511·9	7·5
	16·50	16·025	77·63	1331·2	3526·0	**4·14**	6·74	166·1	427·4	8·5
	16·00	15·865	67·06	1124·8	2942·4	**4·10**	6·62	141·8	367·8	9·5
	15·50	15·710	56·73	930·1	2402·4	**4·05**	6·51	118·4	310·0	10·8
	15·00	15·550	46·47	745·0	1900·6	**4·00**	6·40	95·8	253·4	12·6
Column Core	16·81	16·710	94·12	1635·1	4141·7	**4·17**	6·63	195·7	492·8	8·0
14×14½	14·75	14·740	39·98	567·8	1593·0	**3·77**	6·31	77·0	216·0	13·9
	14·50	14·650	34·99	491·8	1373·1	**3·75**	6·26	67·1	189·4	15·5
	14·25	14·575	30·26	419·7	1165·8	**3·72**	6·21	57·6	163·6	17·5
	14·00	14·500	25·56	349·7	966·9	**3·70**	6·15	48·2	138·1	20·3
12×12	14·38	12·670	55·86	589·7	1892·6	**3·25**	5·82	93·1	263·2	8·3
	13·88	12·515	47·38	486·3	1541·9	**3·20**	5·70	77·7	222·2	9·3
	13·38	12·365	39·11	389·9	1221·3	**3·16**	5·59	63·1	182·5	10·8
	12·88	12·230	31·19	300·9	930·7	**3·11**	5·46	49·2	144·5	13·1
	12·62	12·155	27·06	256·4	788·9	**3·08**	5·40	42·2	125·0	14·7
	12·38	12·080	23·22	216·4	663·1	**3·05**	5·34	35·8	107·1	16·8
	12·12	12·000	19·11	174·6	533·4	**3·02**	5·28	29·1	88·0	20·0

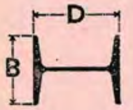
Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

UNIVERSAL COLUMNS

SAFE LOADS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Serial Size in inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		4	6	8	10	12	14	16	18	20	22	24	26	28	32	36
10×10	112	307	303	296	287	275	258	237	214	190	167	146	129	114	89·7	72·2
	89	244	240	235	228	217	203	186	167	148	130	114	100	88·1	69·4	55·9
	72	197	194	190	184	175	163	149	133	117	103	90·0	78·7	69·3	54·7	43·9
	60	164	162	158	153	145	136	123	110	96·9	84·8	74·1	64·8	57·0	44·9	36·2
	49	134	132	129	124	118	110	99·7	88·7	77·8	67·9	59·3	51·8	45·6	35·8	28·8
8×8	58	158	154	148	139	127	112	96·3	81·7	69·3	59·1	50·6	43·9	38·2		
	48	131	127	122	115	104	91·8	78·7	66·6	56·4	48·0	41·2	35·6	31·0		
	40	109	106	102	95·0	85·9	74·9	63·9	53·9	45·5	38·7	33·2	28·6	25·0		
	35	95·2	92·8	88·9	83·1	74·9	65·3	55·6	46·9	39·5	33·6	28·8	24·9	21·7		
	31	84·3	82·1	78·6	73·2	65·9	57·2	48·5	40·8	34·4	29·2	25·0	21·6	18·8		
6×6	25	66·9	63·4	57·5	48·9	39·6	31·5	25·2	20·5	16·9	14·1					
	20	53·9	51·1	46·0	39·0	31·4	24·9	19·9	16·1	13·3	11·1					
	15·7	41·9	39·4	35·2	29·3	23·3	18·3	14·6	11·8	9·7						



JOIST STANCHIONS

SAFE LOADS FOR MILD STEEL

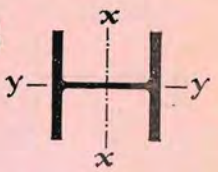
BASED ON
B.S. 449
1959
AS AMENDED

Size D×B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		3	4	5	6	7	8	9	10	11	12	13				
8×4	17	44·3	41·6	37·4	32·1	26·6	21·9	18·0	15·0	12·6	10·7	9·2				
7×4	14·5	37·8	35·5	32·1	27·7	23·0	19·0	15·6	13·0	11·0	9·3	8·0				
6×3½	11·5	29·3	26·8	23·0	18·8	15·1	12·1	9·8	8·1	6·3						
5×3	9	22·1	19·3	15·6	12·1	9·4	7·4	6·0	4·9							
4×2½	6·5	14·9	11·9	8·8	6·5	4·9	3·8									
3×2	4·5	8·6	5·9	4·1	2·9											

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 180. Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959

UNIVERSAL COLUMNS



DIMENSIONS AND PROPERTIES

Serial Size in inches	Depth of Section **D**	Width of Section **B**	Area of Section square ins	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio **D/T**
				Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	
10×10	11·38	10·415	32·92	235·4	718·7	**2·67**	4·67	45·2	126·3	9·1
	10·88	10·275	26·19	180·6	542·4	**2·63**	4·55	35·2	99·7	10·9
	10·50	10·170	21·18	141·8	420·7	**2·59**	4·46	27·9	80·1	13·0
	10·25	10·075	17·66	116·5	343·7	**2·57**	4·41	23·1	67·1	15·0
	10·00	10·000	14·40	93·0	272·9	**2·54**	4·35	18·6	54·6	17·9
8×8	8·75	8·222	17·06	74·9	227·3	**2·10**	3·65	18·2	52·0	10·8
	8·50	8·117	14·11	60·9	183·7	**2·08**	3·61	15·0	43·2	12·4
	8·25	8·077	11·76	49·0	146·3	**2·04**	3·53	12·1	35·5	14·8
	8·12	8·027	10·30	42·5	126·5	**2·03**	3·50	10·6	31·1	16·5
	8·00	8·000	9·12	37·0	109·7	**2·01**	3·47	9·24	27·4	18·5
6×6	6·37	6·080	7·35	17·0	53·3	**1·52**	2·69	5·60	16·7	14·0
	6·20	6·018	5·93	13·4	41·9	**1·50**	2·66	4·46	13·5	16·8
	6·00	6·000	4·62	9·69	30·3	**1·45**	2·56	3·23	10·1	22·3

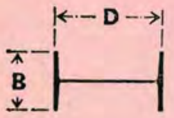
BASED ON
B.S. 449
1959

JOIST STANCHIONS

DIMENSIONS AND PROPERTIES

Size **D×B** inches	Weight per foot in lbs	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio **D/T**	Area in square ins.
		Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*		
8×4	17	3·91	55·1	**·88**	3·32	1·95	13·8	19·6	5·00
7×4	14·5	3·36	36·6	**·89**	2·93	1·68	10·4	19·6	4·26
6×3½	11·5	2·07	21·2	**·78**	2·51	1·18	7·07	18·4	3·38
5×3	9	1·21	11·5	**·68**	2·08	·81	4·58	16·7	2·64
4×2½	6·5	·61	5·24	**·57**	1·66	·49	2·62	15·3	1·91
3×2	4·5	·27	2·00	**·45**	1·23	·27	1·33	13·4	1·32

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



UNIVERSAL BEAMS AS STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Serial Size in inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		10	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**28**	**32**	**36**	**40**	**44**	**48**	**54**
36×16½	260				643	617	585	549	510	428	354	293	245	207	176	141
	230				566	542	513	479	444	371	306	252	210	177	151	
36×12	194		465	430	388	344	300	261	227	174	137	110				
	170		404	372	335	295	257	223	194	148	116	93·1				
	150	376	352	322	288	252	218	188	163	125	97·3					
	135	334	311	281	248	215	185	159	137	104	81·6					
33×11½	152	381	357	328	293	256	222	192	166	127	99·3					
	130	322	300	271	239	207	178	153	132	101	78·7					
	118	289	267	240	210	180	154	132	114	86·0	67·3					
30×10½	132	322	296	264	230	196	168	143	123	93·4	72·5					
	116	280	256	226	195	166	141	120	103	77·8						
	99	235	212	185	157	133	112	94·8	81·4	61·3						
27×10	114	274	251	221	190	162	137	117	100	75·9						
	102	244	222	195	167	142	120	102	87·7	66·0						
	94	223	202	176	150	127	107	91·0	78·1	58·8						
	84	197	176	152	128	107	90·2	76·3	65·3	49·1						
24×12	160		397	375	348	317	284	251	222	173	137	111	90·9			
	120		295	277	255	230	204	180	158	123	96·7	77·9	63·8			
	100		244	229	210	188	167	146	128	98·9	78·0	62·8				
24×9	94	217	193	165	138	115	96·4	81·6	69·6	52·2						
	84	193	170	144	121	100	84·0	71·0	60·5	45·3						
	76	172	151	127	106	87·7	73·2	61·8	52·8							
	68	151	131	109	89·8	74·1	61·7	52·1	44·3							
21×13	142			346	327	304	278	251	225	179	143	116	95·8	80·2		
	127			308	291	270	246	222	199	158	126	102	84·3	70·3		
	112			270	254	235	214	192	171	135	108	87·4	72·0	60·1		
21×8¼	82	182	158	131	108	89·4	74·5	62·8	53·4							
	73	160	138	114	93·9	77·3	64·3	54·1	46·1							
	68	149	127	105	86·1	70·7	58·9	49·4	42·1							
	62	134	113	93·3	76·3	62·6	51·9	43·7	37·1							
	55	115	96·7	78·6	63·7	52·1	43·2	36·2	30·7							
18×7½	66	139	117	95·2	77·2	63·2	52·4	44·0	37·3							
	60	125	104	84·2	68·1	55·7	46·1	38·6	32·7							
	55	113	93·8	75·9	61·3	49·9	41·4	34·7	29·3							
	50	102	84·0	67·7	54·5	44·4	36·7	30·7								
	45	89·7	73·1	58·4	46·9	38·2	31·6	26·4								

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 180. Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

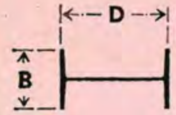
BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL BEAMS AS STANCHIONS

DIMENSIONS AND PROPERTIES

Serial Size in inches	Depth of Section **D**	Width of Section **B**	Area in square inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio $\frac{D}{T}$
				Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	
36×16½	36·24	16·555	76·56	1021	17234	**3·65**	15·00	123·3	951·1	25·2
	35·88	16·475	67·73	870·9	14988	**3·59**	14·88	105·7	835·5	28·5
36×12	36·48	12·117	57·11	355·4	12103	**2·49**	14·56	58·7	663·6	29·0
	36·16	12·027	49·98	300·6	10470	**2·45**	14·47	50·0	579·1	32·9
	35·84	11·972	44·16	250·4	9012·1	**2·38**	14·29	41·8	502·9	38·1
	35·55	11·944	39·69	207·4	7801·3	**2·29**	14·02	34·7	438·9	44·7
33×11½	33·50	11·565	44·71	256·1	8147·6	**2·39**	13·50	44·3	486·4	31·8
	33·10	11·510	38·26	201·4	6699·0	**2·29**	13·23	35·0	404·8	38·7
	32·87	11·482	34·69	170·8	5896·0	**2·22**	13·04	29·8	358·7	44·4
30×10½	30·30	10·551	38·83	185·0	5753·1	**2·18**	12·17	35·1	379·7	30·3
	30·00	10·500	34·13	153·2	4919·1	**2·12**	12·00	29·2	327·9	35·3
	29·68	10·444	29·11	120·2	4049·1	**2·03**	11·79	23·0	272·8	43·0
27×10	27·28	10·070	33·53	149·6	4080·5	**2·11**	11·03	29·7	299·2	29·3
	27·07	10·018	30·01	129·5	3604·1	**2·08**	10·96	25·9	266·3	32·7
	26·91	9·990	27·65	115·1	3266·8	**2·04**	10·87	23·0	242·8	36·0
	26·69	9·962	24·71	95·9	2827·7	**1·97**	10·70	19·3	211·9	41·9
24×12	24·92	12·264	47·05	359·7	4979·2	**2·77**	10·29	58·7	399·6	20·2
	24·31	12·088	35·29	254·0	3635·3	**2·68**	10·15	42·0	299·1	26·1
	24·00	12·000	29·43	203·6	2987·3	**2·63**	10·08	33·9	248·9	31·0
24×9	24·29	9·061	27·63	102·2	2683·0	**1·92**	9·85	22·6	220·9	27·9
	24·09	9·015	24·71	88·3	2364·3	**1·89**	9·78	19·6	196·3	31·2
	23·91	8·985	22·37	76·5	2096·4	**1·85**	9·68	17·0	175·4	35·1
	23·71	8·961	20·00	63·9	1815·1	**1·79**	9·53	14·3	153·1	40·7
21×13	21·46	13·132	41·78	386·0	3403·9	**3·04**	9·03	58·8	317·2	19·6
	21·24	13·061	37·38	338·6	3018·0	**3·01**	8·99	51·8	284·2	21·6
	21·00	13·000	32·97	289·7	2621·4	**2·96**	8·92	44·6	249·7	24·3
21×8¼	21·44	8·342	24·12	77·1	1827·8	**1·79**	8·70	18·5	170·5	25·5
	21·24	8·295	21·46	66·2	1600·3	**1·76**	8·64	16·0	150·7	28·7
	21·13	8·270	20·02	60·4	1478·3	**1·74**	8·59	14·6	139·9	30·8
	20·99	8·240	18·23	53·1	1326·8	**1·71**	8·53	12·9	126·4	34·1
	20·80	8·216	16·17	43·9	1137·9	**1·65**	8·39	10·7	109·4	40·0
18×7½	18·40	7·592	19·40	53·2	1096·8	**1·66**	7·52	14·0	119·2	23·9
	18·25	7·558	17·64	47·1	984·0	**1·63**	7·47	12·5	107·8	26·3
	18·12	7·532	16·19	42·0	889·9	**1·61**	7·41	11·1	98·2	28·8
	18·00	7·500	14·71	37·2	800·6	**1·59**	7·38	9·91	89·0	31·6
	17·86	7·476	13·23	31·9	704·8	**1·55**	7·30	8·54	78·9	35·7

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



UNIVERSAL BEAMS AS STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

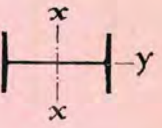
SAFE LOADS FOR MILD STEEL

Serial Size in inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		5	6	7	8	9	10	11	12	13	14	15	16	18	20	22
18×6	55		133	123	112	99·6	87·4	76·3	66·6	58·2	51·3	45·3	40·2	32·3		
	50		120	111	100	89·0	77·8	67·7	59·0	51·5	45·2	40·0	35·6	28·6		
	45		107	98·7	88·9	78·5	68·4	59·3	51·6	45·1	39·5	34·9	31·0	24·8		
16×7	50			122	116	108	99·0	89·7	80·5	72·0	64·3	57·6	51·5	41·9	34·6	29·0
	45			110	104	96·2	88·1	79·6	71·2	63·6	56·8	50·7	45·5	36·9	30·4	25·4
	40			96·9	91·3	84·7	77·3	69·7	62·3	55·4	49·4	44·0	39·4	32·0	26·4	22·0
	36			86·1	80·6	74·2	67·1	60·1	53·4	47·3	42·0	37·4	33·5	27·1	22·3	
16×6	50		122	114	104	93·6	82·8	72·6	63·6	55·8	49·1	43·5	38·7	31·2		
	45		109	101	92·2	82·2	72·2	63·1	55·2	48·2	42·5	37·6	33·3	26·8		
	40		95·8	88·7	80·3	71·1	62·2	54·1	47·1	41·2	36·2	32·0	28·4	22·9		
16×5½	31	76·8	71·6	64·9	57·3	49·7	42·7	36·8	31·7	27·6	24·1	21·3	18·9			
	26	63·1	57·9	51·6	44·6	38·1	32·5	27·7	23·9	20·7	18·1	15·9	14·0			
15×6	45		110	103	94·0	84·3	74·6	65·4	57·3	50·2	44·2	39·2	34·9	28·1		
	40		97·0	90·5	82·5	73·7	64·9	56·8	49·7	43·5	38·3	33·9	30·2	24·3		
	35		84·1	78·0	70·7	62·8	55·0	47·9	41·8	36·5	32·1	28·4	25·2	20·3		
14×6¾	45			109	103	96·1	88·0	79·5	71·2	63·6	56·7	50·7	45·4	36·9	30·3	25·4
	38			91·7	86·4	80·0	72·9	65·5	58·5	52·1	46·4	41·3	37·0	30·1	24·7	20·6
	34			81·5	76·5	70·4	63·8	57·2	50·9	45·2	40·2	35·8	32·0	25·9	21·3	
	30		74·7	70·8	65·9	60·3	54·2	48·2	42·6	37·7	33·4	29·7	26·5	21·4	17·6	
14×5	26	61·7	55·8	48·7	41·5	35·0	29·6	25·1	21·6	18·6	16·2	14·2				
	22	51·3	45·8	39·5	33·3	27·9	23·4	19·8	17·0	14·7	12·8					
12×6½	36			87·2	82·2	76·2	69·6	62·7	56·0	49·9	44·5	39·6	35·5	28·8	23·7	19·8
	31			74·5	70·0	64·6	58·7	52·6	46·9	41·7	37·1	33·0	29·5	23·9	19·7	16·5
	27		67·9	64·6	60·4	55·6	50·2	44·8	39·8	35·2	31·3	27·8	24·9	20·1	16·6	
12×5	32	77·2	70·6	62·5	53·8	45·8	38·9	33·1	28·4	24·6	21·5	18·9				
	28	66·8	60·5	53·0	45·3	38·3	32·4	27·5	23·6	20·4	17·8	15·6				
	25	59·4	53·7	46·8	39·9	33·7	28·5	24·2	20·7	17·9	15·6	13·7				
12×4	22	46·8	39·5	32·3	26·3	21·5	17·8	15·0	12·8							
	19	39·5	32·8	26·6	21·5	17·6	14·5	12·1	10·3							
	16·5	32·3	26·2	20·8	16·7	13·5	11·1	9·3								
10×5¾	29		71·2	67·0	61·6	55·6	49·4	43·5	38·2	33·6	29·6	26·2	23·4	18·8	15·4	
	25		60·9	57·0	52·2	46·8	41·4	36·3	31·8	27·9	24·6	21·7	19·4	15·6		
	21		50·4	46·7	42·3	37·4	32·7	28·5	24·8	21·7	19·0	16·8	15·0	12·0		
10×4	19	41·3	35·1	29·0	23·7	19·4	16·1	13·6	11·6							
	17	35·7	30·0	24·4	19·8	16·2	13·5	11·3	9·5							
	15	30·7	25·3	20·4	16·5	13·4	11·1	9·3	7·9							
8×5¼	20	50·1	47·1	43·2	38·6	33·8	29·3	25·4	22·0	19·2	16·8	14·8	13·2	10·6		
	17	42·2	39·4	35·8	31·7	27·6	23·7	20·5	17·7	15·4	13·5	11·9	10·5			

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 180. Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959
AS AMENDED

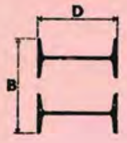
UNIVERSAL BEAMS AS STANCHIONS



DIMENSIONS AND PROPERTIES

Serial Size in inches	Depth of Section D	Width of Section B	Area in square inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T
				Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	
18×6	18·31	6·042	16·18	26·3	868·7	1·27	7·33	8·70	94·9	24·6
	18·16	6·011	14·71	23·1	777·9	1·25	7·27	7·69	85·7	27·1
	18·00	5·982	13·22	19·9	685·2	1·23	7·20	6·66	76·1	30·6
16×7	16·25	7·073	14·70	34·8	655·4	1·54	6·68	9·84	80·7	25·9
	16·12	7·039	13·24	30·5	583·3	1·52	6·64	8·66	72·4	28·6
	16·00	7·000	11·77	26·5	515·5	1·50	6·62	7·58	64·4	31·8
	15·85	6·992	10·59	22·1	446·3	1·45	6·49	6·34	56·3	37·0
16×6	16·39	6·052	14·70	25·1	647·2	1·31	6·64	8·31	79·0	23·1
	16·23	6·021	13·23	21·8	571·8	1·28	6·57	7·25	70·5	25·7
	16·06	5·993	11·76	18·5	495·4	1·25	6·49	6·16	61·7	29·4
16×5½	15·84	5·605	9·12	12·0	374·9	1·15	6·41	4·29	47·3	36·0
	15·64	5·582	7·64	8·96	298·1	1·08	6·25	3·21	38·1	46·0
15×6	15·30	6·075	13·24	22·7	511·2	1·31	6·21	7·49	66·8	23·9
	15·15	6·038	11·77	19·6	447·6	1·29	6·17	6·48	59·1	26·8
	15·00	6·000	10·29	16·5	385·5	1·26	6·12	5·49	51·4	30·6
14×6¾	14·33	6·820	13·23	30·7	468·1	1·52	5·95	9·01	65·3	23·2
	14·12	6·776	11·17	24·6	385·3	1·49	5·87	7·28	54·6	27·5
	14·00	6·750	10·00	21·3	339·2	1·46	5·83	6·30	48·5	30·9
	13·86	6·733	8·81	17·5	289·6	1·41	5·73	5·21	41·8	36·2
14×5	13·89	4·960	7·64	8·00	241·6	1·02	5·62	3·23	34·8	33·1
	13·72	4·936	6·47	6·17	196·2	·98	5·51	2·50	28·6	41·0
12×6½	12·24	6·565	10·59	23·7	280·8	1·50	5·15	7·23	45·9	22·7
	12·09	6·525	9·12	19·8	238·4	1·47	5·11	6·07	39·4	26·0
	11·96	6·500	7·97	16·6	204·2	1·44	5·06	5·11	34·1	29·9
12×5	12·22	4·930	9·42	10·5	227·9	1·06	4·92	4·27	37·3	22·2
	12·07	4·893	8·23	8·81	195·2	1·03	4·87	3·60	32·3	25·4
	11·96	4·864	7·35	7·59	171·6	1·02	4·83	3·12	28·7	28·4
12×4	12·31	4·030	6·47	4·55	155·7	·84	4·91	2·26	25·3	29·0
	12·16	4·010	5·62	3·67	130·1	·81	4·81	1·83	21·4	34·8
	12·00	4·000	4·86	2·79	105·3	·76	4·65	1·39	17·5	44·6
10×5¾	10·22	5·799	8·53	15·2	157·3	1·34	4·29	5·25	30·8	20·4
	10·08	5·762	7·35	12·7	133·2	1·31	4·26	4·40	26·4	23·4
	9·90	5·750	6·19	9·74	106·3	1·25	4·14	3·39	21·5	29·1
10×4	10·25	4·020	5·61	4·19	96·2	·86	4·14	2·08	18·8	26·0
	10·12	4·010	4·98	3·45	81·8	·83	4·05	1·72	16·2	30·8
	10·00	4·000	4·40	2·79	68·8	·80	3·95	1·39	13·8	37·2
8×5¼	8·14	5·268	5·88	8·50	69·2	1·20	3·43	3·23	17·0	21·5
	8·00	5·250	5·00	6·72	56·4	1·16	3·36	2·56	14·1	26·0

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Size D×B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET													
		16	18	20	22	24	26	28	32	36	40	45	50	55	60
$21\frac{7}{16} \times 25\frac{5}{16}$	164										399	380	358	333	305
$21\frac{1}{4} \times 25\frac{5}{16}$	146										354	337	317	294	270
$21\frac{1}{8} \times 25\frac{1}{4}$	136									341	330	314	295	273	250
$21 \times 25\frac{1}{4}$	124									310	300	285	267	247	226
$18\frac{3}{8} \times 22\frac{1}{16}$	132								328	315	300	278	253	227	203
$18\frac{1}{4} \times 22\frac{1}{16}$	120								298	287	272	252	230	206	184
$18\frac{1}{8} \times 22\frac{1}{16}$	110								273	263	250	231	210	189	168
18×22	100								248	238	226	209	190	171	152
$18\frac{5}{16} \times 20\frac{9}{16}$	110								272	261	248	229	208	186	166
$18\frac{3}{16} \times 20\frac{1}{2}$	100								247	237	224	207	187	168	149
$18 \times 20\frac{1}{2}$	90								221	212	201	184	166	149	132
$16\frac{1}{4} \times 20\frac{1}{16}$	100							250	240	227	212	191	169	149	131
$16\frac{1}{8} \times 20\frac{1}{16}$	90							225	216	204	190	171	152	133	117
16×20	80							200	191	181	169	152	134	118	103
$15\frac{7}{8} \times 20$	72							179	171	161	149	134	118	103	90·3
$16\frac{3}{8} \times 19\frac{1}{16}$	100							250	239	226	211	190	168	148	129
$16\frac{1}{4} \times 19$	90							224	214	202	188	169	150	131	115
$16\frac{1}{16} \times 19$	80							199	190	179	166	148	131	115	100
$15\frac{5}{16} \times 18\frac{1}{16}$	90						225	220	208	194	178	157	137	119	103
$15\frac{1}{8} \times 18\frac{1}{16}$	80						200	195	185	172	158	139	121	105	91·7
15×18	70						175	171	161	150	138	121	106	91·6	79·7
$14\frac{5}{16} \times 18\frac{5}{16}$	90						222	217	204	189	172	151	130	113	97·6
$14\frac{1}{8} \times 18\frac{1}{4}$	76						187	182	171	158	143	125	108	93·2	80·6
$14 \times 18\frac{1}{4}$	68						167	163	153	141	127	111	95·7	82·6	71·3
$13\frac{7}{8} \times 18\frac{1}{4}$	60					150	147	143	133	122	110	95·5	82·1	70·6	61·0
$12\frac{1}{4} \times 16\frac{9}{16}$	72				179	174	169	163	148	132	117	98·5	83·3	70·8	60·7
$12\frac{1}{16} \times 16\frac{1}{2}$	62				154	150	145	139	127	113	99·3	83·9	70·9	60·2	51·7
$11\frac{15}{16} \times 16\frac{1}{2}$	54				134	130	126	121	110	97·7	85·6	72·2	60·9	51·7	44·3
$12\frac{1}{4} \times 14\frac{7}{16}$	64				157	152	146	140	126	110	96·0	80·4	67·4	57·1	48·9
$12\frac{1}{16} \times 14\frac{3}{8}$	56				137	133	128	122	109	96·1	83·6	70·0	58·7	49·7	42·6
$11\frac{15}{16} \times 14\frac{3}{8}$	50				122	118	114	108	97·2	85·2	74·0	61·9	51·9	43·9	37·6
$10\frac{1}{4} \times 13\frac{13}{16}$	58		145	140	134	127	120	113	96·9	82·3	69·9	57·2	47·5	39·9	33·9
$10\frac{1}{16} \times 13\frac{3}{4}$	50		124	120	115	110	103	96·8	83·2	70·7	60·0	49·1	40·7	34·2	29·1
$9\frac{7}{8} \times 13\frac{3}{4}$	42		104	101	96·3	91·4	85·9	80·2	68·6	58·0	49·1	40·1	33·3	27·9	23·7
$8\frac{1}{8} \times 11\frac{3}{4}$	40	96·8	92·1	86·5	80·1	73·4	66·8	60·5	49·4	40·6	33·7	27·1	22·2		
$8 \times 11\frac{3}{4}$	34	81·7	77·4	72·4	66·8	61·0	55·3	49·9	40·6	33·3	27·6	22·2	18·2		

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 180. Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959

COMPOUND STANCHIONS

COMPOSITION AND PROPERTIES

Composed of Two Universal Beams Latticed	Area in square inches	Centres of Beam Webs *c* inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T
			Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	
$21 \times 8\frac{1}{4}$ @ 82	48·24	17·0	3655·6	3639·5	8·70	**8·69**	341·0	287·2	25·5
73	42·92	17·0	3200·6	3233·4	**8·64**	8·68	301·4	255·7	28·7
68	40·04	17·0	2956·6	3013·7	**8·59**	8·68	279·8	238·5	30·8
62	36·46	17·0	2653·6	2740·4	**8·53**	8·67	252·8	217·2	34·1
$18 \times 7\frac{1}{2}$ @ 66	38·80	14·5	2193·6	2145·8	7·52	**7·44**	238·4	194·3	23·9
60	35·28	14·5	1968·0	1948·6	7·47	**7·43**	215·6	176·7	26·3
55	32·38	14·5	1779·8	1786·0	**7·41**	7·43	196·4	162·1	28·8
50	29·42	14·5	1601·2	1620·8	**7·38**	7·42	178·0	147·3	31·6
18×6 @ 55	32·36	14·5	1737·4	1753·5	**7·33**	7·36	189·8	170·7	24·6
50	29·42	14·5	1555·8	1592·6	**7·27**	7·36	171·4	155·3	27·1
45	26·44	14·5	1370·4	1429·6	**7·20**	7·35	152·3	139·6	30·6
16×7 @ 50	29·40	13·0	1310·8	1311·8	**6·68**	6·68	161·4	130·7	25·9
45	26·48	13·0	1166·6	1179·8	**6·64**	6·67	144·8	117·7	23·6
40	23·54	13·0	1031·0	1047·6	**6·62**	6·67	128·8	104·8	31·8
36	21·18	13·0	892·6	939·1	**6·49**	6·66	112·6	93·9	37·0
16×6 @ 50	29·40	13·0	1294·4	1292·4	6·64	**6·63**	157·9	135·7	23·1
45	26·46	13·0	1143·6	1161·5	**6·57**	6·63	140·9	122·1	25·7
40	23·52	13·0	990·8	1030·7	**6·49**	6·62	123·4	108·5	29·4
15×6 @ 45	26·48	12·0	1022·4	998·7	6·21	**6·14**	133·6	110·5	23·9
40	23·54	12·0	895·2	886·6	6·17	**6·14**	118·2	98·3	26·8
35	20·58	12·0	771·0	773·9	**6·12**	6·13	102·8	86·0	30·6
$14 \times 6\frac{3}{4}$ @ 45	26·46	11·5	936·2	936·2	5·95	**5·95**	130·6	102·2	23·2
38	22·34	11·5	770·6	787·8	**5·87**	5·94	109·2	86·2	27·5
34	20·00	11·5	678·4	703·9	**5·83**	5·93	97·0	77·1	30·9
30	17·62	11·5	579·2	617·6	**5·73**	5·92	83·6	67·7	36·2
$12 \times 6\frac{1}{2}$ @ 36	21·18	10·0	561·6	576·9	**5·15**	5·22	91·8	69·7	22·7
31	18·24	10·0	476·8	495·6	**5·11**	5·21	78·8	60·0	26·0
27	15·94	10·0	408·4	431·7	**5·06**	5·20	68·2	52·3	29·9
12×5 @ 32	18·84	9·5	455·8	446·1	4·92	**4·87**	74·6	61·8	22·2
28	16·46	9·5	390·4	389·0	4·87	**4·86**	64·7	54·1	25·4
25	14·70	9·5	343·2	346·8	**4·83**	4·86	57·4	48·3	28·4
$10 \times 5\frac{3}{4}$ @ 29	17·06	8·0	314·6	303·4	4·29	**4·22**	61·6	44·0	20·4
25	14·70	8·0	266·4	260·6	4·26	**4·21**	52·8	37·9	23·4
21	12·38	8·0	212·6	217·6	**4·14**	4·19	43·0	31·6	29·1
$8 \times 5\frac{1}{4}$ @ 20	11·76	6·5	138·4	141·2	**3·43**	**3·47**	34·0	24·0	21·5
17	10·00	6·5	112·8	119·1	**3·36**	3·45	28·2	20·7	26·0

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

UNIVERSAL COLUMNS

CASED

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

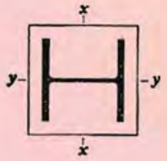
Minimum Size $D_c \times B_c$ inches	Core Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET													
		8	12	16	20	24	28	32	36	40	44	48	52	56	64
22¾×20¾	426	1269	1269	1234	1166	1072	955	829	708	604	516	444	384	336	261
22 ×20½	370	1114	1114	1080	1018	932	826	713	608	517	440	378	328	286	223
21¼×20¼	314	987	964	927	872	794	701	602	511	433	369	316	274	239	
20½×20¼	264	846	826	793	744	675	592	507	429	363	309	265	229	199	
20 ×20	228	743	725	695	651	589	515	440	371	314	267	229	197	172	
19½×19¾	193	643	627	600	560	505	440	374	315	266	226	193	168	146	
19 ×19¾	158	545	531	508	472	425	368	312	262	221	188	160	139	121	
21 ×20¾	320	978	978	943	886	806	709	608	515	436	371	319	275	240	
18¾×18¾	136	476	462	439	402	355	301	251	209	175	148	126	109	94·4	
18½×18¾	119	429	416	394	361	318	269	224	187	156	132	113	96·9	84·2	
18¼×18¾	103	384	372	352	322	282	239	199	165	138	116	99·4	85·6		
18 ×18½	87	338	327	309	283	247	209	173	144	120	101	86·5	74·4		
18½×16¾	190	606	581	539	476	400	326	265	217	180	151	128			
18 ×16¾	161	525	504	466	410	343	279	226	185	153	129	109			
17½×16½	133	446	427	394	345	288	234	189	155	128	107	91·0			
17 ×16¼	106	369	353	326	285	237	192	155	127	105	87·9	74·6			
16¾×16¼	92	330	316	291	254	210	170	138	112	92·9	77·7	65·9			
16½×16¼	79	294	281	258	225	186	151	122	99·2	82·2	68·8	58·3			
16¼×16	65	254	242	222	194	160	129	104	84·7	70·0	58·9	50·0			
15½×14½	112	366	344	306	254	202	159	126	102	83·9					
15 ×14½	89	303	284	252	209	165	130	103	83·2	68·7					
14½×14¼	72	254	238	211	173	137	107	84·8	68·5	56·4					
14¼×14¼	60	221	207	183	150	118	92·6	73·4	59·3	48·8					
14 ×14	49	189	177	156	128	100	78·3	62·1	50·3	41·3					
12¾×12¼	58	198	180	149	114	85·7	65·7	51·4	41·2						
12½×12¼	48	171	154	127	97·0	73·0	55·8	43·7	35·0						
12¼×12¼	40	149	135	111	84·6	63·7	48·7	38·2	30·5						
12¼×12¼	35	136	123	101	76·8	*57·6*	*43·4*	*33·7*	*26·8*						
12 ×12	31	124	111	91·5	*68·9*	*50·0*	*37·7*	*29·2*	*23·4*						
10½×10¼	25	94·3	*79·1*	*50·5*	*33·7*	*24·0*	*17·8*								
10¼×10¼	20	81·2	*62·7*	*39·7*	*26·6*	*18·9*	*14·0*								
10 ×10	15·7	68·5	*46·6*	*29·2*	*19·4*	*13·7*	*10·2*								

The above safe loads are calculated for effective slenderness ratios not exceeding 180 for the cased section, and the term "effective length" at the head of the table is applicable only to the cased section.
The maximum permissible length of the uncased section should be checked in accordance with clause 30.*b*, B.S. 449 : 1959, as amended.
Tabular loads printed in italics are based on loads restricted to 100% in excess of those permitted on the uncased section.

BASED ON
B.S. 449
1959

UNIVERSAL COLUMNS

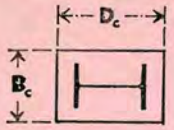
CASED



DIMENSIONS AND PROPERTIES

Core Composed of One Universal Column	Core Area in square inches	Cased Section Area in square inches	Radius of Gyration			Elastic Modulus	
			Axis *y-y*		Axis *x-x* Core only	Axis *y-y*	Axis *x-x*
			Cased Section	Core Only			
14×16 @426	125·25	472·06	4·34	4·34	7·26	282·7	707·4
370	108·78	451·00	4·27	4·27	7·08	241·1	608·1
314	92·30	430·31	4·20	4·20	6·90	201·0	511·9
264	77·63	415·13	4·14	4·14	6·74	166·1	427·4
228	67·06	400·00	4·10	4·10	6·62	141·8	367·8
193	56·73	385·13	4·05	4·05	6·51	118·4	310·0
158	46·47	375·25	4·00	4·00	6·40	95·8	253·4
Column Core @320	94·12	435·75	4·17	4·17	6·63	195·7	492·8
14×14½ @136	39·98	351·56	3·77	3·77	6·31	77·0	216·0
119	34·99	346·88	3·75	3·75	6·26	67·1	189·4
103	30·26	342·19	3·72	3·72	6·21	57·6	163·6
87	25·56	333·00	3·70	3·70	6·15	48·2	138·1
12×12 @190	55·86	309·88	3·33	3·25	5·82	93·1	263·2
161	47·38	301·50	3·30	3·20	5·70	77·7	222·2
133	39·11	288·75	3·27	3·16	5·59	63·1	182·5
106	31·19	276·25	3·25	3·11	5·46	49·2	144·5
92	27·06	272·19	3·23	3·08	5·40	42·2	125·0
79	23·22	268·13	3·22	3·05	5·34	35·8	107·1
65	19·11	260·00	3·20	3·02	5·28	29·1	88·0
10×10 @112	32·92	224·75	2·88	2·67	4·67	45·2	126·3
89	26·19	217·50	2·86	2·63	4·55	35·2	99·7
72	21·18	206·63	2·83	2·59	4·46	27·9	80·1
60	17·66	203·06	2·82	2·57	4·41	23·1	67·1
49	14·40	196·00	2·80	2·54	4·35	18·6	54·6
8× 8 @ 58	17·06	156·19	2·44	2·10	3·65	18·2	52·0
48	14·11	153·13	2·42	2·08	3·61	15·0	43·2
40	11·76	150·06	2·42	2·04	3·53	12·1	35·5
35	10·30	150·06	2·41	2·03	3·50	10·6	31·1
31	9·12	144·00	2·40	2·01	3·47	9·24	27·4
6× 6 @ 25	7·35	107·63	2·02	1·52	2·69	5·60	16·7
20	5·93	105·06	2·00	1·50	2·66	4·46	13·5
15·7	4·62	100·00	2·00	1·45	2·56	3·23	10·1

The weights per foot are for the main steel shaft only. Weights of bases and connections are to be added and suitable allowances made where necessary for binding wire and casing.
The stanchions must be constructed to comply with the requirements of Clause 30.*b* of B.S.449: 1959.
For explanation of tables, see notes commencing pages 162 and 181.



UNIVERSAL BEAMS AS CASED STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Minimum Size $D_c \times B_c$ inches	Core Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET													
		8	10	12	14	16	18	20	24	28	32	36	40	44	48
34½ × 14¾	132	506	494	477	454	426	392	*335*	*247*	*187*	*145*	*116*	*94·6*		
34 × 14½	116	459	447	431	411	385	*332*	*282*	*206*	*156*	*121*	*96·6*	*78·9*		
33¾ × 14½	99	412	401	387	369	*314*	*265*	*223*	*163*	*123*	*95·3*	*75·8*	*62·0*		
31½ × 14¼	114	439	427	411	389	362	*324*	*275*	*201*	*152*	*118*	*94·1*	*76·8*		
31¼ × 14¼	102	406	394	379	359	334	*283*	*240*	*175*	*132*	*102*	*81·8*	*66·8*		
31 × 14	94	381	370	356	337	*300*	*254*	*214*	*156*	*118*	*91·1*	*72·6*	*59·2*		
30¾ × 14	84	353	343	330	*303*	*256*	*215*	*180*	*131*	*98·3*	*76·2*	*60·6*	*49·6*		
29 × 16½	160	576	565	551	532	508	479	444	369	299	242	198	164	137	116
28½ × 16¼	120	463	455	443	427	407	383	355	294	238	192	*156*	*128*	*107*	*90·4*
28 × 16	100	405	397	387	373	355	334	309	255	*198*	*156*	*126*	*103*	*85·6*	*72·4*
28½ × 13¼	94	361	349	333	311	*276*	*230*	*193*	*139*	*104*	*81·2*	*64·7*			
28¼ × 13¼	84	334	323	307	287	*241*	*201*	*168*	*121*	*90·7*	*70·5*	*56·1*			
28 × 13	76	310	299	285	*255*	*211*	*175*	*146*	*106*	*79·1*	*61·0*	*48·5*			
27¾ × 13	68	287	278	*261*	*218*	*180*	*148*	*123*	*88·5*	*66·2*	*51·4*	*40·8*			
25½ × 17¼	142	518	509	498	483	465	442	415	352	290	237	195	162	136	116
25¼ × 17¼	127	476	468	457	444	426	405	380	322	265	216	177	147	124	105
25 × 17	112	432	425	415	403	387	367	344	291	239	195	160	133	112	94·8
25½ × 12½	82	310	298	282	260	*217*	*179*	*149*	*107*	*79·9*	*62·0*	*49·2*			
25¼ × 12½	73	285	274	259	*229*	*188*	*155*	*129*	*92·2*	*68·8*	*53·1*	*42·3*			
25¼ × 12½	68	272	261	247	*210*	*172*	*141*	*118*	*84·3*	*62·8*	*48·6*	*38·7*			
25 × 12¼	62	254	243	*227*	*187*	*153*	*125*	*104*	*74·3*	*55·4*	*42·8*				
25 × 12¼	55	235	226	*193*	*157*	*127*	*104*	*86·4*	*61·4*	*45·8*	*35·3*				
22½ × 11¾	66	250	238	222	*190*	*154*	*126*	*105*	*74·7*	*55·7*	*42·9*				
22¼ × 11¾	60	233	222	207	*168*	*136*	*111*	*92·2*	*65·5*	*48·9*	*37·7*				
22¼ × 11¾	55	220	210	*188*	*152*	*123*	*99·8*	*82·8*	*58·7*	*43·8*	*33·8*				
22 × 11½	50	204	195	*168*	*135*	*109*	*88·7*	*73·3*	*52·3*	*38·7*	*30·9*				
22 × 11½	45	191	*179*	*146*	*117*	*93·8*	*76·4*	*63·1*	*44·8*	*33·2*	*25·7*				
22½ × 10¼	55	206	*175*	*133*	*103*	*80·4*	*64·7*	*53·1*	*37·3*						
22¼ × 10¼	50	192	*156*	*118*	*90·4*	*71·1*	*57·2*	*46·8*	*32·8*						
22 × 10	45	177	*137*	*103*	*79·0*	*62·1*	*49·6*	*40·7*	*28·5*						
20¼ × 11¼	50	196	186	*161*	*129*	*103*	*83·9*	*69·2*	*49·1*	*36·4*	*28·1*				
20¼ × 11¼	45	183	173	*142*	*114*	*90·9*	*73·8*	*60·7*	*43·2*	*32·0*					
20 × 11	40	168	*155*	*125*	*98·9*	*78·9*	*64·0*	*52·7*	*37·4*	*27·8*					
20 × 11	36	157	*134*	*107*	*84·9*	*67·0*	*54·2*	*44·6*	*31·5*	*23·4*					
20½ × 10¼	50	187	*166*	*127*	*98·2*	*77·4*	*62·4*	*51·0*	*35·9*						
20¼ × 10¼	45	173	*144*	*110*	*84·9*	*66·7*	*53·6*	*43·9*	*31·0*						
20¼ × 10	40	159	*124*	*94·3*	*72·3*	*56·9*	*45·7*	*37·4*	*26·2*						
20 × 9¾	31	*115*	*85·5*	*63·5*	*48·3*	*37·8*	*30·2*	*24·7*							
19¾ × 9¾	26	*89·2*	*65·0*	*47·7*	*36·1*	*28·0*	*22·5*	*18·3*							
19½ × 10¼	45	172	*149*	*115*	*88·4*	*69·7*	*56·2*	*46·0*	*32·3*						
19¼ × 10¼	40	158	*130*	*99·4*	*76·5*	*60·4*	*48·5*	*39·8*	*28·0*						
19 × 10	35	*141*	*110*	*83·6*	*64·3*	*50·4*	*40·6*	*33·1*	*23·3*						

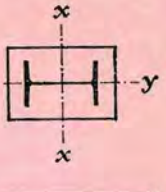
The above safe loads are calculated for effective slenderness ratios not exceeding 180 for the cased section, and the term "effective length" at the head of the table is applicable only to the cased section.

The maximum permissible length of the uncased section should be checked in accordance with clause 30.*b*, B.S. 449 : 1959, as amended.

Tabular loads printed in italics are based on loads restricted to 100% in excess of those permitted on the uncased section.

BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL BEAMS AS CASED STANCHIONS



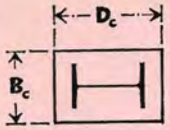
DIMENSIONS AND PROPERTIES

Core Composed of One Universal Beam	Core Area in square inches	Cased Section Area in square inches	Radius of Gyration			Elastic Modulus	
			Axis *y-y*		Axis *x-x* Core only	Axis *y-y*	Axis *x-x*
			Cased Section	Core Only			
30 × 10½ @ **132**	38·83	508·88	2·91	2·18	12·17	35·1	379·7
116	34·13	493·00	2·90	2·12	12·00	29·2	327·9
99	29·11	489·38	2·89	2·03	11·79	23·0	272·8
27 × 10 @ **114**	33·53	448·88	2·81	2·11	11·03	29·7	299·2
102	30·01	445·31	2·80	2·08	10·96	25·9	266·3
94	27·65	434·00	2·80	2·04	10·87	23·0	242·8
84	24·71	430·50	2·79	1·97	10·70	19·3	211·9
24 × 12 @ **160**	47·05	478·50	3·25	2·77	10·29	58·7	399·6
120	35·29	463·13	3·22	2·68	10·15	42·0	299·1
100	29·43	448·00	3·20	2·63	10·08	33·9	248·9
24 × 9 @ **94**	27·63	377·63	2·61	1·92	9·85	22·6	220·9
84	24·71	374·31	2·60	1·89	9·78	19·6	196·3
76	22·37	364·00	2·60	1·85	9·68	17·0	175·4
68	20·00	360·75	2·59	1·79	9·53	14·3	153·1
21 × 13 @ **142**	41·78	439·88	3·43	3·04	9·03	58·8	317·2
127	37·38	435·56	3·41	3·01	8·99	51·8	284·2
112	32·97	425·00	3·40	2·96	8·92	44·6	249·7
21 × 8¼ @ **82**	24·12	318·75	2·47	1·79	8·70	18·5	170·5
73	21·46	315·63	2·46	1·76	8·64	16·0	150·7
68	20·02	315·63	2·45	1·74	8·59	14·6	139·9
62	18·23	306·25	2·45	1·71	8·53	12·9	126·4
55	16·17	306·25	2·44	1·65	8·39	10·7	109·4
18 × 7½ @ **66**	19·40	264·38	2·32	1·66	7·52	14·0	119·2
60	17·64	261·44	2·31	1·63	7·47	12·5	107·8
55	16·19	261·44	2·31	1·61	7·41	11·1	98·2
50	14·71	253·00	2·30	1·59	7·38	9·91	89·0
45	13·23	253·00	2·30	1·55	7·30	8·54	78·9
18 × 6 @ **55**	16·18	230·63	2·01	1·27	7·33	8·70	94·9
50	14·71	228·06	2·00	1·25	7·27	7·69	85·7
45	13·22	220·00	2·00	1·23	7·20	6·66	76·1
16 × 7 @ **50**	14·70	227·81	2·21	1·54	6·68	9·84	80·7
45	13·24	227·81	2·21	1·52	6·64	8·66	72·4
40	11·77	220·00	2·20	1·50	6·62	7·58	64·4
36	10·59	220·00	2·20	1·45	6·49	6·34	56·3
16 × 6 @ **50**	14·70	210·13	2·01	1·31	6·64	8·31	79·0
45	13·23	207·56	2·00	1·28	6·57	7·25	70·5
40	11·76	202·50	2·00	1·25	6·49	6·16	61·7
16 × 5½ @ **31**	9·12	195·00	1·92	1·15	6·41	4·29	47·3
26	7·64	192·56	1·92	1·08	6·25	3·21	38·1
15 × 6 @ **45**	13·24	199·88	2·02	1·31	6·21	7·49	66·8
40	11·77	197·31	2·01	1·29	6·17	6·48	59·1
35	10·29	190·00	2·00	1·26	6·12	5·49	51·4

The weights per foot are for the main steel shaft only. Weights of bases and connections are to be added and suitable allowances made where necessary for binding wire and casing.

The stanchions must be constructed to comply with the requirements of Clause 30.*b* of B.S. 449 : 1959, as amended.

For explanation of tables, see notes commencing pages 162 and 181.



UNIVERSAL BEAMS AND JOISTS AS CASED STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

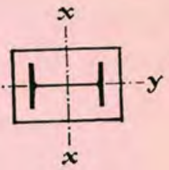
SAFE LOADS FOR MILD STEEL

Minimum Size $D_c \times B_c$ inches	Core Weight per foot in lbs.	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET													
		4	6	8	10	12	14	16	18	20	22	24	26	28	30
UNIVERSAL BEAMS															
18½×11	45	185	181	175	165	*142*	*113*	*90·9*	*73·7*	*60·7*	*50·8*	*43·1*	*37·0*	*32·0*	*28·1*
18¼×11	38	165	162	156	*146*	*117*	*92·8*	*74·1*	*60·1*	*49·3*	*41·2*	*35·0*	*30·1*	*26·0*	*22·8*
18 ×10¾	34	152	149	144	*128*	*102*	*80·3*	*64·0*	*51·8*	*42·6*	*35·7*	*30·1*	*25·9*	*22·4*	*19·6*
18 ×10¾	30	141	138	*132*	*108*	*85·3*	*66·8*	*52·9*	*42·7*	*35·2*	*29·3*	*24·8*	*21·3*	*18·4*	
18 × 9	26	120	*112*	*83·0*	*59·2*	*43·1*	*32·5*	*25·2*	*20·1*	*16·3*					
17¾× 9	22	108	*91·6*	*66·5*	*46·8*	*33·9*	*25·5*	*19·8*	*15·7*	*12·8*					
16¼×10¾	36	152	148	143	134	*112*	*89·0*	*71·0*	*57·6*	*47·4*	*39·6*	*33·7*	*28·8*	*25·0*	*21·8*
16¼×10¾	31	138	135	130	*117*	*93·8*	*74·1*	*59·0*	*47·8*	*39·3*	*32·9*	*27·9*	*23·8*	*20·7*	*18·1*
16 ×10½	27	126	123	118	*100*	*79·5*	*62·6*	*49·8*	*40·2*	*33·1*	*27·6*	*23·4*	*20·0*	*17·3*	*15·1*
16¼× 9	32	131	127	*108*	*77·8*	*56·8*	*43·0*	*33·5*	*26·6*	*21·8*	*18·1*				
16¼× 9	28	120	116	*90·6*	*64·8*	*47·2*	*35·5*	*27·7*	*22·1*	*17·9*					
16 × 9	25	112	*107*	*79·8*	*56·9*	*41·5*	*31·3*	*24·2*	*19·3*	*15·7*					
16½× 8¼	22	101	*79·0*	*52·6*	*35·7*	*25·5*	*19·0*	*14·7*							
16¼× 8¼	19	*90·5*	*65·6*	*43·0*	*29·1*	*20·6*	*15·4*	*11·9*							
16 × 8	16·5	*76·0*	*52·3*	*33·4*	*22·3*	*15·8*	*11·8*								
14¼×10	29	123	119	114	*98·7*	*76·4*	*59·3*	*46·8*	*37·6*	*30·9*	*25·8*	*21·8*	*18·6*		
14¼×10	25	112	109	103	*82·8*	*63·6*	*49·1*	*38·7*	*31·2*	*25·5*	*21·2*	*18·0*	*15·4*		
14 × 9¾	21	99·1	96·4	*84·5*	*65·5*	*49·6*	*38·1*	*29·9*	*24·1*	*19·7*	*16·3*	*13·8*	*11·8*		
14¼× 8¼	19	87·0	*70·3*	*47·4*	*32·3*	*23·1*	*17·2*	*13·3*							
14¼× 8¼	17	*81·1*	*60·0*	*39·6*	*26·9*	*19·2*	*14·3*	*11·0*							
14 × 8	15	*70·5*	*50·6*	*32·9*	*22·2*	*15·8*	*11·8*	*9·0*							
12¼× 9½	20	89·9	87·1	*77·3*	*58·7*	*44·0*	*33·6*	*26·3*	*21·2*	*17·3*	*14·3*	*12·1*			
12 × 9¼	17	80·1	77·6	*63·4*	*47·5*	*35·3*	*27·0*	*21·0*	*16·9*	*13·7*	*11·4*	*9·6*			
JOISTS															
12×8	17	74·9	*64·2*	*43·7*	*30·0*	*21·5*	*16·0*	*12·4*	*9·8*						
11×8	14·5	65·7	*55·4*	*37·9*	*26·0*	*18·7*	*14·0*	*10·8*	*8·6*						
10×7½	11·5	53·4	*37·7*	*24·2*	*16·3*	*11·5*	*8·6*	*6·6*							
9×7	9	*38·6*	*24·2*	*14·9*	*9·8*	*6·9*	*5·1*								
8×6½	6·5	*23·8*	*13·1*	*7·7*	*5·0*										
7×6	4·5	*12·0*	*5·9*	*3·4*											

The above safe loads are calculated for effective slenderness ratios not exceeding 180 for the cased section, and the term "effective length" at the head of the table is applicable only to the cased section.
The maximum permissible length of the uncased section should be checked in accordance with clause 30.*b*, B.S. 449 : 1959, as amended.
Tabular loads printed in italics are based on loads restricted to 100% in excess of those permitted on the uncased section.

BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL BEAMS AND JOISTS AS CASED STANCHIONS



DIMENSIONS AND PROPERTIES

Core Composed of One Universal Beam or Joist	Core Area in square inches	Cased Section Area in square inches	Radius of Gyration			Elastic Modulus	
			Axis *y-y*		Axis *x-x* Core only	Axis *y-y*	Axis *x-x*
			Cased Section	Core Only			
UNIVERSAL BEAMS							
14×6¾ @ 45	13·23	203·50	2·16	1·52	5·95	9·01	65·3
38	11·17	200·75	2·16	1·49	5·87	7·28	54·6
34	10·00	193·50	2·15	1·46	5·83	6·30	48·5
30	8·81	193·50	2·15	1·41	5·73	5·21	41·8
14×5 @ 26	7·64	162·00	1·79	1·02	5·62	3·23	34·8
22	6·47	159·75	1·79	·98	5·51	2·50	28·6
12×6½ @ 36	10·59	174·69	2·11	1·50	5·15	7·23	45·9
31	9·12	174·69	2·10	1·47	5·11	6·07	39·4
27	7·97	168·00	2·10	1·44	5·06	5·11	34·1
12×5 @ 32	9·42	146·25	1·79	1·06	4·92	4·27	37·3
28	8·23	146·25	1·78	1·03	4·87	3·60	32·3
25	7·35	144·00	1·77	1·02	4·83	3·12	28·7
12×4 @ 22	6·47	136·13	1·61	·84	4·91	2·26	25·3
19	5·62	134·06	1·60	·81	4·81	1·83	21·4
16·5	4·86	128·00	1·60	·76	4·65	1·39	17·5
10×5¾ @ 29	8·53	142·50	1·96	1·34	4·29	5·25	30·8
25	7·35	142·50	1·95	1·31	4·26	4·40	26·4
21	6·19	136·50	1·95	1·25	4·14	3·39	21·5
10×4 @ 19	5·61	117·56	1·60	·86	4·14	2·08	18·8
17	4·98	117·56	1·60	·83	4·05	1·72	16·2
15	4·40	112·00	1·60	·80	3·95	1·39	13·8
8×5¼ @ 20	5·88	116·38	1·85	1·20	3·43	3·23	17·0
17	5·00	111·00	1·85	1·16	3·36	2·56	14·1
JOISTS							
8×4 @ 17	5·00	96·00	1·60	·88	3·32	1·95	13·78
7×4 @ 14·5	4·26	88·00	1·60	·89	2·93	1·68	10·45
6×3½ @ 11·5	3·38	75·00	1·50	·78	2·51	1·18	7·07
5×3 @ 9	2·64	63·00	1·40	·68	2·08	·81	4·58
4×2½ @ 6·5	1·91	52·00	1·30	·57	1·66	·49	2·62
3×2 @ 4·5	1·32	42·00	1·20	·45	1·23	·27	1·33

The weights per foot are for the main steel shaft only. Weights of bases and connections are to be added and suitable allowances made where necessary for binding wire and casing.
The stanchions must be constructed to comply with the requirements of clause 30.*b* of B.S. 449 : 1959, as amended.
For explanation of tables, see notes commencing pages 162 and 181.

CHANNEL STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Size D×B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
17×4	44			107	98·1	87·3	75·6	64·6	55·0	47·0	40·4	35·0	30·6	26·9	23·7	
15×4	37			91·1	84·6	76·3	67·1	57·9	49·7	42·6	36·8	32·0	28·0	24·6	21·8	
12×4	31			76·8	71·6	64·9	57·3	49·7	42·7	36·8	31·7	27·6	24·1	21·3	18·9	16·8
12×3½	28			65·0	57·8	49·6	41·7	34·9	29·3	24·7	21·2	18·2	15·9			
10×3½	24			56·8	51·2	44·5	37·8	31·9	26·9	22·8	19·5	16·9	14·7	12·9		
10×3	19		45·7	40·5	34·1	27·9	22·7	18·6	15·4	12·9	11·0					
9×3½	22			52·5	47·6	41·7	35·6	30·1	25·5	21·6	18·6	16·0	14·0	12·3		
9×3	17·5		42·4	37·9	32·3	26·6	21·7	17·9	14·8	12·5	10·6					
8×3½	20			47·9	43·5	38·3	32·8	27·8	23·5	20·0	17·2	14·8	12·9	11·4		
8×3	16		39·1	35·1	30·2	25·0	20·6	16·9	14·1	11·8	10·1	8·6				
7×3½	18			43·2	39·4	34·8	29·9	25·3	21·5	18·3	15·7	13·6	11·8	10·4		
7×3	14		34·2	30·7	26·4	21·9	18·0	14·8	12·3	10·4	8·8	7·5				
6×3½	16			38·5	35·1	30·9	26·6	22·6	19·1	16·3	14·0	12·1	10·6	9·2		
6×3	12		29·3	26·4	22·6	18·8	15·4	12·7	10·6	8·8	7·5	6·5				
5×2½	10		22·7	19·1	15·3	12·1	9·6	7·7	6·4	5·3						
4×2	7	16·2	13·1	9·7	7·2	5·5	4·3									
3×1½	4·5	8·4	5·7	3·9	2·8											

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 180. Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

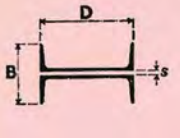
BASED ON
B.S. 449
1959

CHANNEL STANCHIONS

DIMENSIONS AND PROPERTIES

Size D×B inches	Area of Section in square inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio D/T
		Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	
17×4	12·94	15·10	514·11	**1·08**	6·30	4·89	60·48	25·6
15×4	10·88	13·93	357·82	**1·13**	5·73	4·63	47·71	23·3
12×4	9·12	12·00	197·34	**1·15**	4·65	4·06	32·89	20·5
12×3½	8·23	7·82	169·64	**·97**	4·54	2·96	28·27	22·3
10×3½	7·06	7·27	106·86	**1·01**	3·89	2·85	21·37	18·7
10×3	5·59	3·91	80·88	**·84**	3·81	1·72	16·18	23·2
9×3½	6·47	6·85	81·38	**1·03**	3·55	2·74	18·08	17·2
9×3	5·15	3·81	62·70	**·86**	3·49	1·72	13·93	20·5
8×3½	5·88	6·35	59·85	**1·04**	3·19	2·58	14·96	15·8
8×3	4·70	3·64	46·86	**·88**	3·16	1·68	11·71	18·2
7×3½	5·29	5·79	42·12	**1·05**	2·82	2·40	12·03	14·5
7×3	4·11	3·22	32·13	**·88**	2·79	1·51	9·18	17·3
6×3½	4·71	5·17	28·01	**1·05**	2·44	2·18	9·34	13·2
6×3	3·53	2·73	20·46	**·88**	2·41	1·28	6·82	16·9
5×2½	2·94	1·62	11·59	**·74**	1·99	·93	4·64	13·8
4×2	2·06	·70	4·99	**·58**	1·56	·50	2·50	13·3
3×1½	1·32	·26	1·78	**·44**	1·16	·25	1·19	11·2

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STRUTS

Two channels back to back

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Size D×B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		4	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**32**	**36**
17×8⅝	88			209	183	152	124	100	81·8	67·6	56·7	48·0	*51·6*	*44·9*	*34·6*	
15×8⅝	74			180	161	137	113	92·7	76·1	63·3	53·1	45·3	*48·8*	*42·3*	*32·6*	*25·9*
12×8⅝	62			152	137	119	98·7	81·2	67·0	55·8	47·1	40·0	34·4	*37·4*	*29·0*	*23·1*
12×7⅝	56			129	110	88·6	70·6	56·5	45·9	37·7	31·6	*33·5*	*28·7*	*24·9*		
10×7⅝	48			114	99·3	82·4	66·8	54·0	44·1	36·5	30·5	25·9	*27·8*	*24·1*	*18·7*	
10×6½	38		92·1	78·3	61·6	47·2	36·3	28·6	23·0	*23·6*	*19·6*	*16·6*	*14·2*			
9×7½	44			104	91·0	75·6	61·2	49·5	40·4	33·5	28·0	23·7	*25·5*	*22·1*	*17·1*	
9×6½	35		86·1	74·7	60·1	46·6	36·2	28·6	23·0	18·9	*19·7*	*16·7*	*14·3*	*12·4*		
8×7½	40			95·7	84·4	70·8	57·7	46·8	38·3	31·8	26·7	22·6	*24·3*	*21·1*	*16·3*	
8×6½	32		79·6	70·1	57·4	45·1	35·2	27·9	22·6	18·6	*19·3*	*16·4*	*14·0*	*12·1*		
7×7½	36			86·9	77·3	65·5	53·7	43·9	36·0	29·9	25·1	21·3	*22·9*	*19·9*	*15·4*	
7×6⅜	28		69·3	60·7	49·4	38·6	30·1	23·8	19·2	15·7	*16·4*	*13·9*	*11·9*	*10·3*		
6×7⅜	32			76·9	68·1	57·4	47·0	38·2	31·3	25·9	21·8	18·6	*19·9*	*17·3*	*13·3*	
6×6⅜	24		59·5	52·1	42·4	33·1	25·8	20·4	16·5	13·5	*14·1*	*11·9*	*10·2*	*8·8*		
5×5⅜	20		47·3	38·9	29·7	22·3	17·1	13·4	10·7	*11·0*	*9·0*	*7·7*				
4×4⅜	14		29·2	21·2	14·9	10·8	8·1	*7·8*	*6·2*	*5·1*						
3×3⅜	9	21·1	15·0	9·7	6·5	*5·8*	*4·3*	*3·3*								

The above safe loads are tabulated for ratios of slenderness up to but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the "effective lengths" of struts in accordance with Table 17 and clause 33 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959

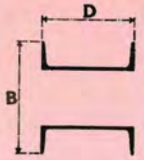
COMPOUND STRUTS

Two channels back to back

COMPOSITION AND PROPERTIES

Composed of Two Channels	Area in square inches	Space between Webs *s* inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio **D/T**
			Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	
17×4 @44	25·88	·625	69·0	1028·2	**1·63**	6·30	16·01	121·0	25·6
15×4 @37	21·76	·625	64·8	715·6	**1·73**	5·73	15·04	95·4	23·3
12×4 @31	18·24	·625	57·7	394·7	**1·78**	4·65	13·38	65·8	20·5
12×3½@28	16·46	·625	38·2	339·3	**1·52**	4·54	10·02	56·5	22·3
10×3½@24	14·11	·625	37·1	213·7	**1·62**	3·89	9·72	42·7	18·7
10×3 @19	11·17	·500	18·6	161·8	**1·29**	3·81	5·71	32·4	23·2
9×3½@22	12·94	·500	33·8	162·8	**1·62**	3·55	9·01	36·2	17·2
9×3 @17·5	10·29	·500	18·7	125·4	**1·35**	3·49	5·75	27·9	20·5
8×3½@20	11·76	·500	32·3	119·7	**1·66**	3·19	8·62	29·9	15·8
8×3 @16	9·41	·500	18·4	93·7	**1·40**	3·16	5·68	23·4	18·2
7×3½@18	10·59	·500	30·5	84·2	**1·70**	2·82	8·12	24·1	14·5
7×3 @14	8·23	·375	15·6	64·3	**1·38**	2·79	4·89	18·4	17·3
6×3½@16	9·41	·375	26·6	56·0	**1·68**	2·44	7·22	18·7	13·2
6×3 @12	7·06	·375	13·4	40·9	**1·38**	2·41	4·20	13·6	16·9
5×2½@10	5·88	·375	8·56	23·2	**1·21**	1·99	3·19	9·27	13·8
4×2 @ 7	4·12	·375	3·92	9·98	**·98**	1·56	1·79	4·99	13·3
3×1½@ 4·5	2·65	·375	1·66	3·56	**·79**	1·16	·98	2·38	11·2

Each weight per foot is for the shaft only, weight of connections, etc., to be added.
D/T ratios are tabulated to facilitate the design of struts subject to bending.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Size D×B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		12	14	16	18	20	22	24	26	28	30	32	36	40	44	48
17×18½	88								221	216	211	205	192	177	161	145
15×17½	74							185	181	176	171	164	151	136	122	108
12×15	62					154	149	144	138	131	124	116	101	86·9	74·9	64·7
12×14	56					137	133	127	121	115	107	100	86·2	73·8	63·3	54·6
10×12½	48			120	116	111	105	98·3	91·3	84·1	77·0	70·4	58·8	49·2	41·7	35·6
10×12	38			95·0	91·5	87·5	82·7	77·3	71·6	65·9	60·3	55·1	46·0	38·5	32·6	27·8
9×12	44			108	103	97·3	90·8	83·8	76·7	69·7	63·3	57·3	47·3	39·4	33·2	23·2
9×11½	35			85·3	81·3	76·5	71·2	65·4	59·7	54·2	49·1	44·4	36·5	30·4	25·5	21·8
8×11	40		98·7	94·1	88·3	81·7	74·6	67·4	60·6	54·3	48·8	43·8	35·7	29·5	24·7	
8×10½	32		78·8	74·9	70·2	64·9	59·1	53·3	47·8	42·9	38·4	34·5	28·1	23·2	19·5	
7×10	36	89·5	84·7	78·7	71·8	64·4	57·1	50·5	44·6	39·4	35·0	31·3	25·3	20·7		
7×9½	28	69·3	65·5	60·7	55·2	49·4	43·7	38·6	34·1	30·1	26·7	23·8	19·2	15·7		

The above safe loads are tabulated for ratios of slenderness not exceeding 180.
Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

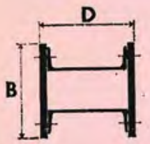
BASED ON
B.S. 449
1959

COMPOUND STANCHIONS

COMPOSITION AND PROPERTIES

Composed of Two Steel Channels Latticed	Area in square inches	Space between Webs *s* inches	Moment of Inertia		Radius of Gyration		Elastic Modulus		Ratio **D/T**
			Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	
17×4 @44	25·88	10·5	1013·0	1023·2	**6·26**	6·30	109·5	121·0	25·6
15×4 @37	21·76	9·5	745·1	715·6	5·85	**5·73**	85·2	95·4	23·3
12×4 @31	18·24	7·0	401·1	394·7	4·69	4·65	53·5	65·8	20·5
12×3½@28	16·46	7·0	328·3	339·3	**4·47**	4·54	46·9	56·5	22·3
10×3½@24	14·11	5·5	207·8	213·7	**3·84**	3·89	33·3	42·7	18·7
10×3 @19	11·17	6·0	163·3	161·8	3·82	**3·81**	27·2	32·4	23·2
9×3½@22	12·94	5·0	171·8	162·8	3·64	**3·55**	28·6	36·2	17·2
9×3 @17.5	10·29	5·5	136·3	125·4	3·64	**3·49**	23·7	27·9	20·5
8×3½@20	11·76	4·0	121·5	119·7	3·21	**3·19**	22·1	29·9	15·8
8×3 @16	9·41	4·5	97·1	93·7	3·21	**3·16**	18·5	23·4	18·2
7×3½@18	10·59	3·0	82·3	84·2	**2·79**	2·82	16·5	24·1	14·5
7×3 @14	8·23	3·5	62·8	64·3	**2·76**	2·79	13·2	18·4	17·3

Each weight per foot is for the shaft only, weight of base, etc., to be added.
D/T ratios are tabulated to facilitate the design of stanchions subject to bending.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

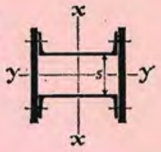
SAFE LOADS FOR MILD STEEL

Size **D×B** inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		14	**15**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**	**32**	**36**	**40**	**44**	**48**
20 ×18	274·6						676	657	636	613	587	558	498	438	383	335
19½×18	244·0						600	583	565	544	521	495	442	389	340	297
19 ×18	213·4						523	509	493	474	454	432	385	339	296	259
18¾×18	198·1						485	472	456	439	420	400	356	313	274	239
18½×18	182·8						447	435	421	405	387	369	328	289	252	221
							Rivets ⅞-in. diameter									
18 ×16	240·2					583	563	540	514	486	456	426	367	314	269	232
17½×16	213·0					516	498	477	454	429	402	375	322	276	237	204
17 ×16	185·8					448	432	414	393	371	348	324	278	238	204	175
16¾×16	172·2					414	399	383	363	343	321	299	257	219	188	162
16½×16	158·6					380	367	351	333	314	294	274	235	200	171	148
							Rivets ⅞-in. diameter									
15 ×14	207·8			513	494	472	447	418	387	357	327	298	249	209	177	150
14½×14	184·0			452	436	416	393	367	339	312	285	261	217	182	154	131
14 ×14	160·2			392	377	359	338	316	291	267	245	223	185	155	131	112
13¾×14	148·3			361	348	331	311	290	268	246	224	204	170	142	120	102
13½×14	136·4			331	318	302	284	265	244	223	204	185	154	128	108	92·6
							Rivets ⅞-in. diameter									
15 ×14	201·8				483	463	439	412	384	355	326	298	250	210	177	152
14½×14	178·0				425	406	385	361	336	310	285	261	218	183	155	133
14 ×14	154·2				366	350	331	310	288	266	244	223	186	156	132	113
13¾×14	142·3			349	336	322	304	285	264	243	223	204	170	142	121	103
13½×14	130·4			319	307	293	277	259	240	221	202	185	154	129	109	93·1
							Rivets ⅞-in. diameter									
13 ×12	173·4		419	410	389	364	336	307	278	251	227	205	167	139	117	99·3
12½×12	153·0	376	369	361	342	319	295	269	244	220	198	179	147	122	102	87·0
12 ×12	132·6	324	318	311	294	275	253	231	209	189	170	153	125	104	87·2	74·3
11¾×12	122·4	299	293	286	271	253	233	212	192	173	156	140	115	95·3	80·0	68·1
11½×12	112·2	273	267	261	247	230	212	193	175	158	142	128	105	86·8	72·9	61·8
							Rivets ⅞-in. diameter									

The above safe loads are tabulated for ratios of slenderness not exceeding 180.
Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.
Approximate safe loads for stanchions with plates of intermediate thicknesses can be obtained by interpolation.

BASED ON
B.S. 449
1959

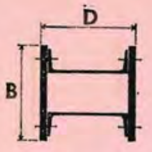
COMPOUND STANCHIONS



COMPOSITION AND PROPERTIES

Composed of		Area in square inches	Space between Webs *s* inches	Moment of Inertia		Radius of Gyration		Elastic Modulus	
Two Steel Channels	Plates each Flange to form			Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
17×4 @ 44	18×1½	79·88	8·0	2112·7	5658·7	**5·14**	8·42	234·7	565·9
	18×1¼	70·88	8·0	1869·7	4781·0	**5·14**	8·21	207·7	490·4
	18×1	61·88	8·0	1626·7	3947·3	**5·13**	7·99	180·7	415·5
	18×⅞	57·38	8·0	1505·2	3546·4	**5·12**	7·86	167·2	378·3
	18×¾	52·88	8·0	1383·7	3156·2	**5·12**	7·73	153·7	341·2
15×4 @ 37	16×1½	69·76	6·0	1398·5	3991·6	**4·48**	7·56	174·8	443·5
	16×1¼	61·76	6·0	1227·8	3361·5	**4·46**	7·38	153·5	384·2
	16×1	53·76	6·0	1057·2	2766·4	**4·43**	7·17	132·1	325·5
	16×⅞	49·76	6·0	971·8	2481·6	**4·42**	7·06	121·5	296·3
	16×¾	45·76	6·0	886·5	2205·1	**4·40**	6·94	110·8	267·3
12×4 @ 31	14×1½	60·24	4·0	879·3	2316·2	**3·82**	6·20	125·6	308·8
	14×1¼	53·24	4·0	765·0	1935·4	**3·79**	6·03	109·3	266·9
	14×1	46·24	4·0	650·7	1580·1	**3·75**	5·85	93·0	225·7
	14×⅞	42·74	4·0	593·5	1411·5	**3·73**	5·75	84·8	205·3
	14×¾	39·24	4·0	536·3	1249·1	**3·70**	5·64	76·6	185·1
12×3½ @ 28	14×1½	58·46	5·0	887·3	2260·8	**3·90**	6·22	126·8	301·4
	14×1¼	51·46	5·0	773·0	1880·0	**3·88**	6·04	110·4	259·3
	14×1	44·46	5·0	658·6	1524·7	**3·85**	5·86	94·1	217·8
	14×⅞	40·96	5·0	601·5	1356·1	**3·83**	5·75	85·9	197·3
	14×¾	37·46	5·0	544·3	1193·7	**3·81**	5·64	77·8	176·8
10×3½ @ 24	12×1½	50·11	4·0	569·4	1410·7	**3·37**	5·31	94·9	217·0
	12×1¼	44·11	4·0	497·4	1166·8	**3·36**	5·14	82·9	186·7
	12×1	38·11	4·0	425·4	941·7	**3·34**	4·97	70·9	157·0
	12×⅞	35·11	4·0	389·4	835·9	**3·33**	4·88	64·9	142·3
	12×¾	32·11	4·0	353·4	734·6	**3·32**	4·78	58·9	127·8

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STANCHIONS

BASED ON
B.S. 449
1959
AS AMENDED

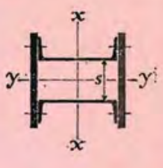
SAFE LOADS FOR MILD STEEL

Size D×B inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		12	14	16	18	20	22	24	26	28	30	32	36	40	44	48
13 ×12	162·4			388	369	347	321	294	268	243	219	198	163	135	114	96·8
12½×12	142·0			339	322	303	280	257	234	212	191	173	142	118	99·3	84·5
12 ×12	121·6			289	275	258	239	219	199	180	163	147	121	100	84·4	71·7
11¾×12	111·4			265	252	236	219	200	182	165	149	135	110	91·7	77·2	65·5
11½×12	101·2			240	228	214	198	182	165	149	135	122	100	83·1	70·0	59·4
Rivets ¾-in. diameter																
12 ×12	169·4			401	381	357	330	302	274	247	223	202	165	137	115	98·0
11½×12	149·0			352	333	312	289	264	239	216	195	176	144	120	101	85·5
11 ×12	128·6		315	302	286	267	247	225	204	184	166	150	123	102	85·5	72·8
10¾×12	118·4		289	277	262	245	226	206	187	169	152	137	112	93·0	78·1	66·6
10½×12	108·2		263	252	239	223	206	188	170	153	138	124	102	84·4	70·8	60·4
Rivets ⅞-in. diameter																
12 ×12	159·4			382	364	342	317	291	265	240	217	196	161	134	112	95·9
11½×12	139·0			332	316	297	276	253	230	209	189	171	140	117	97·9	83·4
11 ×12	118·6			283	269	253	234	215	195	177	160	145	119	98·7	83·0	70·7
10¾×12	108·4			258	245	230	214	196	178	162	146	132	108	90·1	75·7	64·5
10½×12	93·2			233	222	208	193	177	161	146	132	119	98·1	81·4	68·5	58·3
Rivets ¾-in. diameter																
10 ×10	111·0	265	249	229	207	184	162	142	125	110	97·7	87·1	70·1	57·5		
9¾×10	102·5	244	229	210	189	168	148	129	114	100	88·8	79·3	63·7			
9½×10	94·0	222	208	191	172	152	134	117	103	90·6	80·2	71·5	57·5			
9¼×10	85·5	201	188	172	154	136	119	104	91·4	80·6	71·4	63·5	51·1			
9 ×10	77·0	179	167	153	136	120	105	91·9	80·4	70·7	62·6	55·8	44·9			
Rivets ⅞-in. diameter																
10 ×10	102·0	248	234	218	198	177	157	139	122	108	95·9	85·7	69·2	56·8		
9¾×10	93·5	227	214	199	181	162	143	126	111	98·3	87·3	77·9	62·8	51·5		
9½×10	85·0	205	194	179	163	145	128	113	99·8	88·1	78·2	69·7	56·1	46·0		
9¼×10	76·5	184	173	160	145	130	115	101	89·0	78·6	69·8	62·2	50·1	41·0		
9 ×10	68·0	163	153	141	128	114	101	88·5	77·9	68·7	61·1	54·4	43·8	35·9		
Rivets ¾-in. diameter																

The above safe loads are tabulated for ratios of slenderness not exceeding 180.
Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.
Approximate safe loads for stanchions with plates of intermediate thicknesses can be obtained by interpolation.

BASED ON
B.S. 449
1959

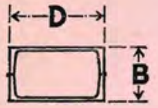
COMPOUND STANCHIONS



COMPOSITION AND PROPERTIES

Composed of		Area in square inches	Space between Webs *s* inches	Moment of Inertia		Radius of Gyration		Elastic Modulus	
Two Steel Channels	Plates each Flange to form			Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
10×3 @ 19	12×1½	47·17	5·0	556·4	1358·8	**3·43**	5·37	92·7	209·0
	12×1¼	41·17	5·0	484·4	1114·9	**3·43**	5·20	80·7	178·4
	12×1	35·17	5·0	412·4	889·8	**3·42**	5·03	68·7	148·3
	12×⅞	32·17	5·0	376·4	784·0	**3·42**	4·94	62·7	133·4
	12×¾	29·17	5·0	340·4	682·6	**3·42**	4·84	56·7	118·7
9×3½ @ 22	12×1½	48·94	4·0	561·8	1161·8	**3·39**	4·87	93·6	193·6
	12×1¼	42·94	4·0	489·8	954·6	**3·38**	4·72	81·6	166·0
	12×1	36·94	4·0	417·8	764·8	**3·36**	4·55	69·6	139·0
	12×⅞	33·94	4·0	381·8	676·1	**3·35**	4·46	63·6	125·8
	12×¾	30·94	4·0	345·8	591·4	**3·34**	4·37	57·6	112·6
9×3 @ 17·5	12×1½	46·29	5·0	550·8	1124·4	**3·45**	4·93	91·8	187·4
	12×1¼	40·29	5·0	478·8	917·3	**3·45**	4·77	79·8	159·5
	12×1	34·29	5·0	406·8	727·4	**3·44**	4·61	67·8	132·3
	12×⅞	31·29	5·0	370·8	638·7	**3·44**	4·52	61·8	118·8
	12×¾	28·29	5·0	334·8	554·0	**3·44**	4·43	55·8	105·5
8×3½ @ 20	10×1	31·76	2·0	228·4	526·4	**2·68**	4·07	45·7	105·3
	10×⅞	29·26	2·0	207·6	465·4	**2·66**	3·99	41·5	95·5
	10×¾	26·76	2·0	186·7	407·5	**2·64**	3·90	37·3	85·8
	10×⅝	24·26	2·0	165·9	352·6	**2·61**	3·81	33·2	76·2
	10×½	21·76	2·0	145·1	300·5	**2·58**	3·72	29·0	66·8
8×3 @ 16	10×1	29·41	3·0	225·4	500·4	**2·77**	4·13	45·1	100·1
	10×⅞	26·91	3·0	204·6	439·4	**2·76**	4·04	40·9	90·1
	10×¾	24·41	3·0	183·8	381·5	**2·74**	3·95	36·8	80·3
	10×⅝	21·91	3·0	162·9	326·6	**2·73**	3·86	32·6	70·6
	10×½	19·41	3·0	142·1	274·5	**2·71**	3·76	28·4	61·0

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STANCHIONS

Two channels welded toe to toe

SAFE LOADS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Size **D × B** inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		8	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**28**	**32**	**36**	**40**	**44**	**48**
17×8	88				219	209	197	183	169	153	124	101	82·2	68·0	57·0	48·3
15×8	74				183	175	164	152	139	126	101	81·9	66·7	55·2	46·4	39·3
12×8	62				153	145	136	126	115	104	83·5	67·2	54·7	45·2	37·9	
12×7	56			140	132	123	113	101	90·0	79·7	62·4	49·4	39·9	32·8		
10×7	48			119	112	104	94·0	84·0	74·2	65·4	50·9	40·3	32·5	26·6		
10×6	38			89·8	82·6	74·0	64·9	56·4	48·9	42·4	32·5	25·4	20·3			
9×7	44			108	102	94·2	85·3	76·0	67·0	59·0	45·8	36·3	29·2	23·9		
9×6	35		87·5	82·1	75·1	67·1	58·6	50·7	43·9	38·0	29·0	22·7				
8×7	40			98·1	92·1	84·7	76·4	67·7	59·6	52·3	40·6	32·1	25·8	21·2		
8×6	32		79·6	74·4	67·7	59·9	52·2	45·0	38·8	33·5	25·5	20·0				
7×7	36			87·9	82·3	75·4	67·7	59·9	52·6	46·1	35·6	28·1	22·6			
7×6	28		69·4	64·8	58·8	51·9	45·1	38·8	33·4	28·9	22·0	17·2				
6×7	32			75·9	69·9	62·8	55·3	48·1	41·7	36·2	27·7	21·7	17·4			
6×6	24		59·5	55·4	50·2	44·3	38·5	33·1	28·5	24·6	18·7	14·6				
5×5	20	49·9	45·8	40·4	34·3	28·7	23·9	20·0	16·9	14·4	10·8					
4×4	14	32·2	27·4	22·2	17·7	14·1	11·5	9·4	7·9							
3×3	9	16·2	11·9	8·8	6·6	5·2										

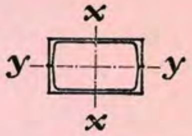
The above safe loads are tabulated for ratios of slenderness not exceeding 180.
Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959

COMPOUND STANCHIONS

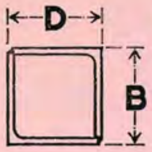
Two channels welded toe to toe

COMPOSITION AND PROPERTIES



Composed of Two Steel Channels	Area in square inches	Moment of Inertia		Radius of Gyration		Elastic Modulus	
		Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
17×4 @ 44	25·88	277·0	1028·2	**3·27**	6·30	69·2	121·0
15×4 @ 37	21·76	224·9	715·6	**3·21**	5·73	56·2	95·4
12×4 @ 31	18·24	183·0	394·7	**3·17**	4·65	45·8	65·8
12×3½ @ 28	16·46	130·6	339·3	**2·82**	4·54	37·3	56·5
10×3½ @ 24	14·11	106·2	213·7	**2·74**	3·89	30·4	42·7
10×3 @ 19	11·17	65·3	161·8	**2·42**	3·81	21·8	32·4
9×3½ @ 22	12·94	94·8	162·8	**2·71**	3·55	27·1	36·2
9×3 @ 17·5	10·29	58·1	125·4	**2·38**	3·49	19·4	27·9
8×3½ @ 20	11·76	83·8	119·7	**2·67**	3·19	23·9	29·9
8×3 @ 16	9·41	51·2	93·7	**2·33**	3·16	17·1	23·4
7×3½ @ 18	10·59	73·3	84·2	**2·63**	2·82	20·9	24·1
7×3 @ 14	8·23	43·9	64·3	**2·31**	2·79	14·6	18·4
6×3½ @ 16	9·41	63·3	56·0	2·59	**2·44**	18·1	18·7
6×3 @ 12	7·06	37·5	40·9	**2·30**	2·41	12·5	13·6
5×2½ @ 10	5·88	21·0	23·2	**1·89**	1·99	8·38	9·27
4×2 @ 7	4·12	9·51	9·98	**1·52**	1·56	4·76	4·99
3×1½ @ 4·5	2·65	3·32	3·56	**1·12**	1·16	2·21	2·38

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



TWO ANGLES AS STANCHIONS

Welded toe to toe

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Size $D\times B$ inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
		8	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**	**32**	**36**	**40**
$8\frac{7}{8}\times8\frac{7}{8}$	102				249	235	219	201	182	163	146	130	116	104	84·7	69·7
$8\frac{3}{4}\times8\frac{3}{4}$	90·0				220	208	194	178	162	145	130	116	104	92·8	75·5	62·4
$8\frac{5}{8}\times8\frac{5}{8}$	77·8				191	181	169	155	141	126	113	101	90·5	81·1	66·0	54·6
$8\frac{1}{2}\times8\frac{1}{2}$	65·4				160	152	142	131	119	107	96·0	85·8	76·9	69·0	56·2	46·4
$6\frac{3}{4}\times6\frac{3}{4}$	66·2		163	152	137	121	104	89·5	76·8	66·4	57·6	50·4	44·4	39·3		
$6\frac{5}{8}\times6\frac{5}{8}$	57·4		142	132	120	106	91·4	78·6	67·6	58·4	50·6	44·4	39·1	34·7		
$6\frac{1}{2}\times6\frac{1}{2}$	48·4		120	112	102	89·9	78·0	67·2	57·9	49·9	43·4	38·0	33·5	29·7		
$6\frac{3}{8}\times6\frac{3}{8}$	39·0		97·1	90·7	82·6	73·1	63·6	54·9	47·3	40·9	35·5	31·2	27·5	24·4		
$6\frac{1}{4}\times6\frac{1}{4}$	29·6		73·7	69·0	63·0	55·9	48·8	42·1	36·4	31·4	27·4	23·9	21·1	18·7		
$5\frac{5}{8}\times5\frac{5}{8}$	47·2	118	108	95·5	81·1	67·8	56·4	47·2	39·9	34·0	29·4	25·5				
$5\frac{1}{2}\times5\frac{1}{2}$	39·8	99·6	91·8	81·3	69·4	58·0	48·4	40·6	34·3	29·2	25·2	21·9				
$5\frac{3}{8}\times5\frac{3}{8}$	32·2		74·6	66·3	56·8	47·6	39·8	33·4	28·2	24·2	20·8	18·1				
$5\frac{1}{4}\times5\frac{1}{4}$	24·6		57·2	51·0	43·9	36·9	30·9	25·9	21·9	18·8	16·2	14·1				
$4\frac{5}{8}\times4\frac{5}{8}$	37·0	83·9	70·6	56·5	44·7	35·6	28·9	23·8	19·8							
$4\frac{1}{2}\times4\frac{1}{2}$	31·4	71·6	60·6	48·8	38·8	30·9	25·1	20·7	17·3							
$4\frac{3}{8}\times4\frac{3}{8}$	25·4	58·4	49·7	40·2	32·0	25·7	20·8	17·1	14·3							
$4\frac{1}{4}\times4\frac{1}{4}$	19·4	44·9	38·4	31·2	24·9	20·0	16·3	13·4	11·2							
4×4	27·0	56·0	44·3	33·9	26·2	20·6	16·6									
$3\frac{7}{8}\times3\frac{7}{8}$	22·0	46·2	36·8	28·3	21·9	17·3	13·9									
$3\frac{3}{4}\times3\frac{3}{4}$	16·8	35·7	28·6	22·1	17·2	13·5	10·9	8·9								
$3\frac{11}{16}\times3\frac{11}{16}$	14·2	30·4	24·4	18·9	14·7	11·6	9·3	7·6								
$3\frac{3}{8}\times3\frac{3}{8}$	18·6	33·4	24·6	18·2	13·8	10·8										
$3\frac{1}{4}\times3\frac{1}{4}$	14·2	26·0	19·3	14·3	10·9	8·4										
$3\frac{3}{16}\times3\frac{3}{16}$	12·0	22·2	16·5	12·3	9·3	7·3										
$3\frac{1}{8}\times3\frac{1}{8}$	9·6	17·9	13·4	9·9	7·6	5·9										
$2\frac{15}{16}\times2\frac{15}{16}$	15·2	20·9	14·5	10·4												
$2\frac{13}{16}\times2\frac{13}{16}$	11·8	16·8	11·7	8·4	6·2											
$2\frac{3}{4}\times2\frac{3}{4}$	10·0	14·5	10·1	7·2	5·4											
$2\frac{11}{16}\times2\frac{11}{16}$	8·0	11·7	8·2	5·9	4·4											

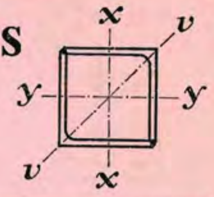
The above safe loads are tabulated for ratios of slenderness not exceeding 180.
Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959

TWO ANGLES AS STANCHIONS

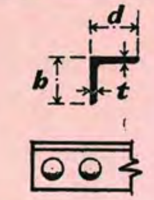
Welded toe to toe

COMPOSITION AND PROPERTIES



Composed of Two Equal Angles	Actual Thickness	Area in square inches	Moment of Inertia		Radius of Gyration		Elastic Modulus	
			Axis *v-v*	Axis *x-x* or *y-y*	Axis *v-v*	Axis *x-x* or *y-y*	Axis *v-v*	Axis *x-x* or *y-y*
$8\times8\times1$	·996	30·01	280·8	307·7	**3·06**	3·20	49·65	69·26
$8\times8\times\frac{7}{8}$	·871	26·48	251·4	271·8	**3·08**	3·20	44·44	62·04
$8\times8\times\frac{3}{4}$	·746	22·88	220·4	235·2	**3·10**	3·21	38·95	54·48
$8\times8\times\frac{5}{8}$	·621	19·23	187·7	198·1	**3·12**	3·21	33·18	46·54
$6\times6\times\frac{7}{8}$	·872	19·48	100·4	111·4	**2·27**	2·39	23·65	32·95
$6\times6\times\frac{3}{4}$	·747	16·88	88·7	96·6	**2·29**	2·39	20·90	29·12
$6\times6\times\frac{5}{8}$	·623	14·24	76·2	81·7	**2·31**	2·39	17·97	25·08
$6\times6\times\frac{1}{2}$	·496	11·48	62·6	66·0	**2·33**	2·40	14·75	20·66
$6\times6\times\frac{3}{8}$	·371	8·70	48·2	50·2	**2·35**	2·40	11·36	16·02
$5\times5\times\frac{3}{4}$	·748	13·89	49·4	54·8	**1·89**	1·99	13·93	19·45
$5\times5\times\frac{5}{8}$	·622	11·71	42·6	46·3	**1·91**	1·99	12·06	16·79
$5\times5\times\frac{1}{2}$	·496	9·47	35·3	37·5	**1·93**	1·99	9·98	13·93
$5\times5\times\frac{3}{8}$	·373	7·23	27·5	28·7	**1·95**	1·99	7·76	10·91
$4\times4\times\frac{3}{4}$	·749	10·89	23·9	27·3	**1·48**	1·58	8·45	11·77
$4\times4\times\frac{5}{8}$	·624	9·23	20·8	23·1	**1·50**	1·58	7·37	10·24
$4\times4\times\frac{1}{2}$	·496	7·47	17·4	18·7	**1·52**	1·58	6·14	8·53
$4\times4\times\frac{3}{8}$	·372	5·70	13·6	14·3	**1·54**	1·58	4·81	6·72
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{5}{8}$	·621	7·94	13·4	15·1	**1·30**	1·38	5·43	7·54
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{1}{2}$	·496	6·47	11·3	12·3	**1·32**	1·38	4·57	6·34
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{3}{8}$	·371	4·94	8·89	9·42	**1·34**	1·38	3·59	5·01
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{5}{16}$	·311	4·18	7·62	7·93	**1·35**	1·38	3·08	4·31
$3\times3\times\frac{1}{2}$	·496	5·47	6·85	7·58	**1·12**	1·18	3·23	4·48
$3\times3\times\frac{3}{8}$	·370	4·17	5·42	5·79	**1·14**	1·18	2·56	3·55
$3\times3\times\frac{5}{16}$	·309	3·53	4·65	4·90	**1·15**	1·18	2·19	3·06
$3\times3\times\frac{1}{4}$	·245	2·83	3·78	3·94	**1·16**	1·18	1·78	2·51
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{2}$	·493	4·47	3·79	4·42	**0·92**	0·99	2·14	3·01
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·372	3·47	3·08	3·42	**0·94**	0·99	1·74	2·43
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·311	2·94	2·67	2·90	**0·95**	0·99	1·51	2·11
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	2·35	2·18	2·33	**0·96**	1·00	1·23	1·73

Each weight per foot is for the shaft only, weight of base, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



STRUTS

Equal Angles

Two or more rivets or bolts in line, or welded, at ends

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Size d×b×t inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	3	4	5	6	8	10	12	14	16	18	20	24	28	32	36
8 × 8 × 1					126	115	100	84·6	70·1	58·1	48·5	34·9	*32·6*	*25·3*	*20·1*
8 × 8 × ⅞					112	102	89·1	75·2	62·4	51·8	43·2	31·1	*29·2*	*22·5*	*17·9*
8 × 8 × ¾					96·6	88·4	77·5	65·5	54·5	45·2	37·8	27·2	*25·5*	*19·7*	*15·7*
8 × 8 × ⅝					81·2	74·3	65·1	55·0	45·7	38·0	31·8	22·9	*21·4*	*16·6*	*13·2*
6 × 6 × ⅞				82·0	71·8	58·3	45·5	35·4	28·1	22·6	18·5	*16·4*	*12·2*		
6 × 6 × ¾				71·0	62·2	50·5	39·4	30·7	24·3	19·6	16·1	*14·2*	*10·5*		
6 × 6 × ⅝				60·1	52·8	43·0	33·7	26·3	20·8	16·8	13·8	*12·1*	*9·0*		
6 × 6 × ½				48·4	42·5	34·7	27·1	21·2	16·8	13·6	11·1	*9·7*	*7·3*		
6 × 6 × ⅜				36·8	32·4	26·5	20·8	16·3	12·9	10·4	8·5	*7·5*	*5·6*		
5 × 5 × ¾			58·3	54·3	43·2	32·1	23·9	18·1	14·2	*14·2*	*11·6*				
5 × 5 × ⅝			49·4	46·1	36·9	27·6	20·5	15·6	12·2	*12·2*	*9·9*	*6·9*			
5 × 5 × ½			39·9	37·3	29·9	22·3	16·6	12·6	9·8	*9·8*	*8·0*	*5·6*			
5 × 5 × ⅜			30·5	28·5	23·0	17·2	12·8	9·7	7·6	*7·6*	*6·2*	*4·4*			
4 × 4 × ¾		45·6	41·4	36·0	24·9	17·2	12·4	*11·5*	*8·9*	*7·1*					
4 × 4 × ⅝		38·9	35·4	30·9	21·6	14·9	10·7	*10·0*	*7·7*	*6·1*					
4 × 4 × ½		31·4	28·6	25·0	17·4	12·0	8·6	*8·1*	*6·2*	*4·9*					
4 × 4 × ⅜		24·0	21·9	19·1	13·3	9·2	6·6	*6·1*	*4·8*	*3·8*					
3½ × 3½ × ⅝		31·8	27·7	22·8	14·8	10·0	7·1	*6·6*	*5·1*						
3½ × 3½ × ½		25·9	22·5	18·6	12·1	8·1	5·8	*5·4*	*4·1*						
3½ × 3½ × ⅜		19·8	17·2	14·2	9·2	6·2	4·4	*4·1*	*3·1*						
3½ × 3½ × 5⁄16		16·8	14·7	12·2	8·0	5·4	3·8	*3·5*	*2·7*						
3 × 3 × ½	22·9	20·0	16·2	12·6	7·7	5·1	*4·5*	*3·3*							
3 × 3 × ⅜	17·5	15·3	12·4	9·6	5·9	3·9	*3·4*	*2·5*							
3 × 3 × 5⁄16	14·8	12·9	10·4	8·1	4·9	3·2	*2·9*	*2·1*							
3 × 3 × ¼	11·9	10·4	8·5	6·6	4·1	2·7	*2·4*	*1·7*							
2½ × 2½ × ⅜	13·6	10·9	8·1	6·0	3·5	*2·9*	*2·0*								
2½ × 2½ × 5⁄16	11·6	9·2	6·9	5·1	3·0	*2·4*	*1·7*								
2½ × 2½ × ¼	9·2	7·4	5·5	4·1	2·4	*2·0*	*1·4*								
2¼ × 2¼ × ⅜	11·3	8·4	6·0	4·4	*3·2*	*2·1*									
2¼ × 2¼ × 5⁄16	9·5	7·1	5·1	3·7	*2·7*	*1·7*									
2¼ × 2¼ × ¼	7·8	5·8	4·2	3·0	*2·2*	*1·4*									
2¼ × 2¼ × 3⁄16	5·8	4·3	3·1	2·2	*1·6*	*1·0*									
2 × 2 × 5⁄16	7·6	5·3	3·7	2·6	*1·9*										
2 × 2 × ¼	6·2	4·3	3·0	2·1	*1·5*										
2 × 2 × 3⁄16	4·7	3·3	2·2	1·6	*1·1*										

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.

Safe loads are calculated for the length of strut centre to centre of intersections in accordance with clause 30.*c*.(i) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or 2 rivets in line or their equivalent in welding.

These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

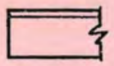
STRUTS

Equal Angles

DIMENSIONS AND PROPERTIES

Size d×b×t inches	Actual Thickness inches	Weight per foot in lbs	Distance in inches			Radius of Gyration		Elastic Modulus	Area in square inches
			nx or ny	nv	nu	Axis v-v	Axis u-u	x-x or y-y	
8 × 8 × 1	·996	51·0	5·64	3·33	5·66	**1·56**	3·06	15·69	15·01
8 × 8 × ⅞	·871	45·0	5·69	3·27	5·66	**1·57**	3·08	13·91	13·24
8 × 8 × ¾	·746	38·9	5·74	3·20	5·66	**1·58**	3·10	12·08	11·44
8 × 8 × ⅝	·621	32·7	5·79	3·13	5·66	**1·58**	3·12	10·20	9·61
6 × 6 × ⅞	·872	33·1	4·19	2·56	4·24	**1·17**	2·27	7·58	9·74
6 × 6 × ¾	·747	28·7	4·23	2·50	4·24	**1·17**	2·29	6·60	8·44
6 × 6 × ⅝	·623	24·2	4·28	2·43	4·24	**1·18**	2·31	5·61	7·12
6 × 6 × ½	·496	19·5	4·33	2·36	4·24	**1·18**	2·33	4·54	5·74
6 × 6 × ⅜	·371	14·8	4·38	2·29	4·24	**1·19**	2·35	3·46	4·35
5 × 5 × ¾	·748	23·6	3·48	2·14	3·54	**·97**	1·89	4·49	6·94
5 × 5 × ⅝	·622	19·9	3·53	2·08	3·54	**·98**	1·91	3·81	5·86
5 × 5 × ½	·496	16·1	3·58	2·01	3·54	**·98**	1·93	3·10	4·74
5 × 5 × ⅜	·373	12·3	3·63	1·94	3·54	**·99**	1·95	2·38	3·61
4 × 4 × ¾	·749	18·5	2·73	1·79	2·83	**·77**	1·48	2·78	5·44
4 × 4 × ⅝	·624	15·7	2·78	1·73	2·83	**·78**	1·50	2·37	4·62
4 × 4 × ½	·496	12·7	2·83	1·66	2·83	**·78**	1·52	1·94	3·73
4 × 4 × ⅜	·372	9·7	2·87	1·59	2·83	**·78**	1·54	1·49	2·85
3½ × 3½ × ⅝	·621	13·5	2·41	1·55	2·47	**·68**	1·30	1·77	3·97
3½ × 3½ × ½	·496	11·0	2·45	1·48	2·47	**·68**	1·32	1·46	3·23
3½ × 3½ × ⅜	·371	8·4	2·50	1·42	2·47	**·68**	1·34	1·12	2·47
3½ × 3½ × 5⁄16	·311	7·1	2·52	1·38	2·47	**·69**	1·35	·95	2·09
3 × 3 × ½	·496	9·3	2·08	1·31	2·12	**·58**	1·12	1·05	2·73
3 × 3 × ⅜	·370	7·1	2·12	1·24	2·12	**·58**	1·14	·80	2·09
3 × 3 × 5⁄16	·309	6·0	2·15	1·20	2·12	**·58**	1·15	·68	1·76
3 × 3 × ¼	·245	4·8	2·17	1·17	2·12	**·59**	1·16	·55	1·41
2½ × 2½ × ⅜	·372	5·9	1·74	1·07	1·77	**·49**	·94	·56	1·73
2½ × 2½ × 5⁄16	·311	5·0	1·77	1·04	1·77	**·49**	·95	·48	1·47
2½ × 2½ × ¼	·245	4·0	1·79	1·00	1·77	**·49**	·96	·38	1·18
2¼ × 2¼ × ⅜	·367	5·2	1·56	·98	1·59	**·44**	·84	·44	1·53
2¼ × 2¼ × 5⁄16	·306	4·4	1·58	·95	1·59	**·44**	·85	·38	1·29
2¼ × 2¼ × ¼	·246	3·6	1·60	·91	1·59	**·44**	·86	·31	1·06
2¼ × 2¼ × 3⁄16	·181	2·7	1·63	·88	1·59	**·44**	·87	·23	·79
2 × 2 × 5⁄16	·308	3·9	1·39	·86	1·41	**·39**	·75	·29	1·15
2 × 2 × ¼	·249	3·2	1·41	·83	1·41	**·39**	·76	·24	·94
2 × 2 × 3⁄16	·183	2·4	1·44	·79	1·41	**·39**	·77	·18	·71

Each weight per foot is for the shaft only. Weight of connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



STRUTS

Equal angles

Single-bolted or single-riveted at ends

SAFE LOADS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Size $d \times b \times t$ inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS													
	2	3	4	5	6	7	8	9	10					
$3 \times 3 \times \frac{1}{2}$							*4·5*							
$3 \times 3 \times \frac{3}{8}$							*3·5*							
$3 \times 3 \times \frac{5}{16}$						*3·7*	*2·9*							
$3 \times 3 \times \frac{1}{4}$						*3·1*	*2·4*							
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$					*3·6*	*2·7*								
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$				*4·2*	*3·0*	*2·3*								
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$				*3·4*	*2·4*	1·8								
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{8}$					*2·6*									
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{5}{16}$				*3·0*	*2·2*									
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{1}{4}$				*2·5*	*1·8*									
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{16}$			*2·7*	*1·8*	*1·3*									
$2 \times 2 \times \frac{5}{16}$			*3·2*	*2·2*										
$2 \times 2 \times \frac{1}{4}$			*2·6*	*1·8*										
$2 \times 2 \times \frac{3}{16}$			*2·0*	*1·3*										

The above safe loads are calculated in accordance with Clause 30.*c*.(i) B.S. 449 : 1959, as amended.
In all cases the values represent the capacity of the angle; loads printed in italics exceed the mild steel black bolt value.
Safe loads are tabulated for L/r values not exceeding 180, where L is the length centre to centre of intersections.

BASED ON
B.S. 449
1959

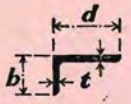
STRUTS

Equal angles

DIMENSIONS AND PROPERTIES

Size $d \times b \times t$ inches	Actual Thick-ness inches	Weight per foot in lbs	Distance in inches			Radius of Gyration		Elastic Modulus	Area in square inches
			nx or ny	nv	nu	Axis v-v	Axis u-u	x-x or y-y	
$3 \times 3 \times \frac{1}{2}$	·496	9·3	2·08	1·31	2·12	**·58**	1·12	1·05	2·73
$3 \times 3 \times \frac{3}{8}$	·370	7·1	2·12	1·24	2·12	**·58**	1·14	·80	2·09
$3 \times 3 \times \frac{5}{16}$	·309	6·0	2·15	1·20	2·12	**·58**	1·15	·68	1·76
$3 \times 3 \times \frac{1}{4}$	·245	4·8	2·17	1·17	2·12	**·59**	1·16	·55	1·41
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	·372	5·9	1·74	1·07	1·77	**·49**	·94	·56	1·73
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	·311	5·0	1·77	1·04	1·77	**·49**	·95	·48	1·47
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	·245	4·0	1·79	1·00	1·77	**·49**	·96	·38	1·18
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{8}$	·367	5·2	1·56	·98	1·59	**·44**	·84	·44	1·53
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{5}{16}$	·306	4·4	1·58	·95	1·59	**·44**	·85	·38	1·29
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{1}{4}$	·246	3·6	1·60	·91	1·59	**·44**	·86	·31	1·06
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{16}$	·181	2·7	1·63	·88	1·59	**·44**	·87	·23	·79
$2 \times 2 \times \frac{5}{16}$	·308	3·9	1·39	·86	1·41	**·39**	·75	·29	1·15
$2 \times 2 \times \frac{1}{4}$	·249	3·2	1·41	·83	1·41	**·39**	·76	·24	·94
$2 \times 2 \times \frac{3}{16}$	·183	2·4	1·44	·79	1·41	**·39**	·77	·18	·71

Each weight per foot is for the shaft only. Weight of connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



STRUTS

Unequal Angles

Two or more rivets or bolts in line, or welded, at ends

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

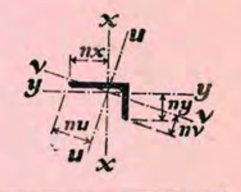
Size *d*×*b*×*t* inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	4	**5**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**
9×4 ×⅞		84·1	75·0	54·3	38·2	27·7	20·8	*20·1*	*16·0*	*13·0*					
9×4 ×¾		73·1	65·4	47·7	33·6	24·4	18·3	*17·8*	*14·1*	*11·6*					
9×4 ×⅝		61·7	55·2	40·2	28·4	20·6	15·5	*15·0*	*11·9*	*9·7*					
9×4 ×½		49·9	44·9	33·0	23·3	16·9	12·8	*12·4*	*9·8*	*8·0*					
8×6 ×⅞				89·2	75·6	61·0	48·5	38·7	31·4	25·9	21·6	*22·9*	*19·6*	*17·0*	*14·9*
8×6 ×¾				77·6	66·0	53·3	42·5	34·0	27·6	22·7	19·0	*20·2*	*17·3*	*15·0*	*13·1*
8×6 ×⅝				65·3	55·5	44·9	35·8	28·6	23·2	19·1	16·0	*17·0*	*14·6*	*12·6*	*11·1*
8×6 ×½				52·8	45·0	36·5	29·1	23·3	19·0	15·6	13·1	*13·9*	*11·9*	*10·3*	*9·0*
8×4 ×¾		67·6	60·8	44·6	31·6	23·0	17·3	*16·8*	*13·4*	*10·9*					
8×4 ×⅝		57·0	51·3	37·7	26·6	19·4	14·6	*14·2*	*11·3*	*9·1*					
8×4 ×½		46·2	41·7	30·8	21·9	15·9	12·0	*11·7*	*9·2*	*7·5*					
7×3½×⅝	51·2	45·9	39·2	26·6	18·2	13·0	*12·1*	*9·3*	*7·4*						
7×3½×½	41·6	37·4	32·2	22·0	15·0	10·8	*10·1*	*7·7*	*6·2*						
7×3½×⅜	31·7	28·6	24·7	17·0	11·7	8·3	*7·8*	*6·0*	*4·8*						
6×4 ×¾		55·9	50·4	37·3	26·5	19·3	14·5	*14·1*	*11·2*	*9·1*					
6×4 ×⅝		47·2	42·5	31·5	22·4	16·3	12·2	*11·9*	*9·4*	*7·7*					
6×4 ×½		38·4	34·7	25·9	18·5	13·5	10·1	*9·8*	*7·8*	*6·3*					
6×3½×⅝	46·0	41·4	35·6	24·3	16·6	11·9	*11·1*	*8·5*	*6·8*						
6×3½×½	37·6	34·0	29·4	20·2	13·9	9·9	*9·2*	*7·2*	*5·7*						
6×3½×⅜	28·5	25·8	22·3	15·3	10·5	7·5	*7·0*	*5·4*	*4·3*						
6×3 ×⅝	40·4	34·0	27·2	17·2	11·5	*10·2*	*7·5*								
6×3 ×½	33·0	28·0	22·5	14·3	9·5	*8·4*	*6·3*								
6×3 ×⅜	25·2	21·4	17·2	10·9	7·3	*6·4*	*4·8*								
5×3½×⅝	40·9	36·8	31·6	21·6	14·8	10·6	*9·8*	*7·6*	*6·0*						
5×3½×½	33·3	30·0	25·7	17·6	12·0	8·6	*8·0*	*6·2*	*4·9*						
5×3½×⅜	25·3	22·9	19·8	13·6	9·3	6·6	*6·2*	*4·8*	*3·8*						
5×3 ×½	29·0	24·6	19·8	12·6	8·4	*7·4*	*5·5*								
5×3 ×⅜	22·4	19·1	15·5	9·8	6·6	*5·8*	*4·3*								
5×3 ×5/16	18·7	15·9	12·9	8·2	5·5	*4·8*	*3·6*								

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut centre to centre of intersections in accordance with clause 30.*c.*(i) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

STRUTS

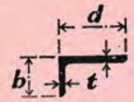
Unequal Angles



DIMENSIONS AND PROPERTIES

Size *d*×*b*×*t* inches	Actual Thickness inches	Weight per foot in lbs	Distance in inches				Radius of Gyration		Elastic Modulus		Area in square inches
			nx	*ny*	*nv*	*nu*	Axis *v-v*	Axis *u-u*	Axis *x-x*	Axis *y-y*	
9 ×4 ×⅞	·872	36·1	5·56	3·05	2·43	5·64	**·83**	2·91	15·57	3·52	10·62
9 ×4 ×¾	·745	31·2	5·61	3·10	2·45	5·68	**·84**	2·93	13·50	3·07	9·17
9 ×4 ×⅝	·622	26·3	5·66	3·15	2·47	5·72	**·84**	2·95	11·43	2·61	7·74
9 ×4 ×½	·495	21·2	5·72	3·20	2·50	5·76	**·85**	2·97	9·23	2·12	6·23
8 ×6 ×⅞	·870	39·0	5·40	4·40	2·97	5·51	**1·28**	2·76	13·30	7·86	11·47
8 ×6 ×¾	·746	33·8	5·45	4·44	2·96	5·53	**1·29**	2·79	11·57	6·85	9·93
8 ×6 ×⅝	·621	28·4	5·50	4·49	2·96	5·54	**1·29**	2·81	9·77	5·80	8·36
8 ×6 ×½	·495	22·9	5·55	4·54	2·96	5·56	**1·30**	2·83	7·90	4·71	6·73
8 ×4 ×¾	·747	28·7	5·06	3·05	2·37	5·14	**·85**	2·62	10·80	3·04	8·44
8 ×4 ×⅝	·623	24·2	5·11	3·10	2·39	5·17	**·85**	2·64	9·15	2·58	7·12
8 ×4 ×½	·496	19·5	5·17	3·15	2·41	5·21	**·86**	2·66	7·40	2·10	5·74
7 ×3½×⅝	·623	21·0	4·44	2·68	2·08	4·51	**·74**	2·30	6·92	1·94	6·18
7 ×3½×½	·497	17·0	4·50	2·73	2·09	4·54	**·75**	2·32	5·62	1·59	5·00
7 ×3½×⅜	·372	12·9	4·55	2·78	2·11	4·58	**·76**	2·33	4·28	1·22	3·79
6 ×4 ×¾	·748	23·6	3·93	2·93	2·12	4·04	**·86**	2·00	6·20	2·94	6·94
6 ×4 ×⅝	·622	19·9	3·98	2·97	2·12	4·06	**·86**	2·03	5·26	2·50	5·86
6 ×4 ×½	·496	16·1	4·03	3·02	2·12	4·08	**·87**	2·05	4·27	2·04	4·74
6 ×3½×⅝	·620	18·8	3·88	2·63	1·96	3·96	**·75**	1·99	5·12	1·90	5·53
6 ×3½×½	·497	15·3	3·93	2·67	1·97	3·99	**·76**	2·00	4·18	1·56	4·50
6 ×3½×⅜	·371	11·6	3·99	2·72	1·99	4·02	**·76**	2·02	3·18	1·20	3·41
6 ×3 ×⅝	·623	17·8	3·78	2·27	1·76	3·84	**·63**	1·95	5·00	1·40	5·24
6 ×3 ×½	·496	14·4	3·83	2·31	1·78	3·88	**·64**	1·97	4·06	1·14	4·24
6 ×3 ×⅜	·373	11·0	3·88	2·36	1·80	3·91	**·64**	1·99	3·11	·88	3·24
5 ×3½×⅝	·621	16·7	3·31	2·55	1·80	3·40	**·75**	1·69	3·60	1·86	4·91
5 ×3½×½	·498	13 6	3·36	2·60	1·79	3·42	**·75**	1·70	2·95	1·53	4·00
5 ×3½×⅜	·371	10·3	3·41	2·65	1·80	3·44	**·76**	1·72	2·24	1·17	3·03
5 ×3 ×½	·496	12·7	3·26	2·26	1·66	3·32	**·64**	1·66	2·86	1·12	3·73
5 ×3 ×⅜	·372	9·7	3·31	2·30	1·67	3·35	**·65**	1·68	2·19	·86	2·85
5 ×3 ×5/16	·308	8·1	3·34	2·33	1·68	3·37	**·65**	1·69	1·83	·72	2·38

Each weight per foot is for the shaft only. Weight of connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



STRUTS

Unequal Angles

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Size $d \times b \times t$ inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17
$4 \times 3\frac{1}{2} \times \frac{5}{8}$			35·2	31·3	26·5	21·7	17·7	14·5	12·1	10·1	8·6	*9·2*	*8·0*	*7·0*	*5·4*
$4 \times 3\frac{1}{2} \times \frac{1}{2}$			28·7	25·5	21·6	17·7	14·4	11·8	9·8	8·2	7·0	*7·5*	*6·5*	*5·7*	*4·4*
$4 \times 3\frac{1}{2} \times \frac{3}{8}$			22·0	19·5	16·5	13·5	11·0	9·0	7·5	6·3	5·3	*5·7*	*5·0*	*4·3*	*3·4*
$4 \times 3\frac{1}{2} \times \frac{5}{16}$			18·4	16·4	13·9	11·5	9·3	7·7	6·4	5·3	4·5	*4·9*	*4·2*	*3·7*	*2·9*
$4 \times 3 \times \frac{1}{2}$			24·9	21·0	16·8	13·3	10·6	8·5	7·0	5·9	*6·2*	*5·3*	*4·6*	*4·0*	
$4 \times 3 \times \frac{3}{8}$			19·2	16·3	13·1	10·4	8·3	6·7	5·5	4·6	*4·9*	*4·2*	*3·6*	*3·2*	
$4 \times 3 \times \frac{5}{16}$			16·3	13·8	11·1	8·8	7·0	5·7	4·7	3·9	*4·1*	*3·5*	*3·1*	*2·7*	
$4 \times 2\frac{1}{2} \times \frac{3}{8}$		18·8	15·9	12·4	9·4	7·2	5·6	4·5	*4·6*	*3·8*	*3·3*	*2·8*			
$4 \times 2\frac{1}{2} \times \frac{5}{16}$		15·7	13·2	10·3	7·8	6·0	4·7	3·8	*3·9*	*3·2*	*2·7*	*2·3*			
$4 \times 2\frac{1}{2} \times \frac{1}{4}$		12·8	10·8	8·4	6·4	4·9	3·8	3·1	*3·2*	*2·6*	*2·2*	*1·9*			
$3\frac{1}{2} \times 3 \times \frac{1}{2}$			22·9	19·1	15·2	12·0	9·5	7·7	6·3	*6·6*	*5·6*	*4·8*	*4·1*	*3·6*	
$3\frac{1}{2} \times 3 \times \frac{3}{8}$			17·5	14·6	11·6	9·1	7·3	5·9	4·8	*5·0*	*4·3*	*3·6*	*3·1*	*2·8*	
$3\frac{1}{2} \times 3 \times \frac{5}{16}$			14·6	12·2	9·7	7·6	6·1	4·9	4·0	*4·2*	*3·5*	*3·0*	*2·6*	*2·3*	
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$		17·0	14·2	11·0	8·3	6·3	5·0	4·0	*4·1*	*3·4*	*2·9*				
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$		14·3	12·0	9·2	7·0	5·3	4·2	3·4	*3·4*	*2·8*	*2·4*				
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$		11·6	9·7	7·6	5·8	4·4	3·5	2·8	*2·8*	*2·4*	*2·0*	*1·7*			
$3 \times 2\frac{1}{2} \times \frac{3}{8}$		15·4	12·8	9·8	7·3	5·6	4·4	3·5	*3·6*	*3·0*	*2·5*				
$3 \times 2\frac{1}{2} \times \frac{5}{16}$		13·1	10·8	8·3	6·2	4·7	3·7	3·0	*3·0*	*2·5*	*2·1*				
$3 \times 2\frac{1}{2} \times \frac{1}{4}$		10·5	8·7	6·6	5·0	3·8	3·0	2·4	*2·4*	*2·0*	*1·7*				
$3 \times 2 \times \frac{3}{8}$		12·6	9·2	6·6	4·8	3·6	*3·5*	*2·8*	*2·2*						
$3 \times 2 \times \frac{5}{16}$		10·7	7·8	5·6	4·0	3·0	*2·9*	*2·3*	*1·9*						
$3 \times 2 \times \frac{1}{4}$		8·5	6·3	4·5	3·2	2·4	*2·3*	*1·9*	*1·5*						
$2\frac{1}{2} \times 2 \times \frac{3}{8}$		10·9	7·9	5·6	4·0	3·0	*2·9*	*2·3*	*1·9*						
$2\frac{1}{2} \times 2 \times \frac{5}{16}$		9·1	6·7	4·7	3·4	2·5	*2·5*	*1·9*	*1·6*						
$2\frac{1}{2} \times 2 \times \frac{1}{4}$		7·5	5·5	3·8	2·8	2·1	*2·0*	*1·6*	*1·3*						
$2\frac{1}{2} \times 2 \times \frac{3}{16}$		5·7	4·2	3·0	2·1	1·6	*1·6*	*1·2*	*1·0*						
$2\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{4}$	7·3	4·9	3·1	2·1	*1·8*	*1·3*									
$2\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$	5·5	3·7	2·3	1·6	*1·4*	*1·0*									
$2 \times 1\frac{1}{2} \times \frac{1}{4}$	6·1	4·1	2·6	1·7	*1·5*	*1·1*									
$2 \times 1\frac{1}{2} \times \frac{3}{16}$	4·8	3·2	2·0	1·4	*1·2*	*·92*									

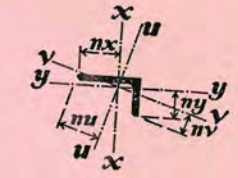
The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut centre to centre of intersections in accordance with clause 30.*c*.(i) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

STRUTS

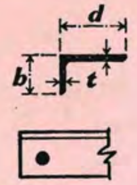
Unequal Angles

DIMENSIONS AND PROPERTIES



Size $d \times b \times t$ inches	Actual Thickness inches	Weight per foot in lbs	Distance in inches				Radius of Gyration		Elastic Modulus		Area in square inches
			nx	*ny*	*nv*	*nu*	Axis *v-v*	Axis *u-u*	Axis *x-x*	Axis *y-y*	
$4 \times 3\frac{1}{2} \times \frac{5}{8}$	·623	14·6	2·71	2·46	1·51	2·80	**·72**	1·41	2·32	1·81	4·30
$4 \times 3\frac{1}{2} \times \frac{1}{2}$	·498	11·9	2·76	2·51	1·49	2·80	**·72**	1·43	1·90	1·49	3·50
$4 \times 3\frac{1}{2} \times \frac{3}{8}$	·374	9·1	2·81	2·56	1·48	2·81	**·72**	1·45	1·47	1·15	2·68
$4 \times 3\frac{1}{2} \times \frac{5}{16}$	·309	7·6	2·83	2·58	1·47	2·82	**·73**	1·46	1·23	·96	2·23
$4 \times 3 \times \frac{1}{2}$	·496	11·0	2·68	2·18	1·46	2·75	**·63**	1·37	1·85	1·09	3·23
$4 \times 3 \times \frac{3}{8}$	·371	8·4	2·73	2·23	1·46	2·77	**·64**	1·39	1·42	·84	2·47
$4 \times 3 \times \frac{5}{16}$	·311	7·1	2·76	2·25	1·46	2·78	**·64**	1·40	1·20	·71	2·09
$4 \times 2\frac{1}{2} \times \frac{3}{8}$	·373	7·8	2·64	1·89	1·35	2·69	**·54**	1·34	1·39	·58	2·29
$4 \times 2\frac{1}{2} \times \frac{5}{16}$	·308	6·5	2·67	1·91	1·36	2·70	**·54**	1·35	1·16	·49	1·91
$4 \times 2\frac{1}{2} \times \frac{1}{4}$	·248	5·3	2·70	1·94	1·37	2·72	**·54**	1·35	·94	·40	1·56
$3\frac{1}{2} \times 3 \times \frac{1}{2}$	·499	10·2	2·38	2·13	1·30	2·45	**·62**	1·23	1·43	1·08	3·00
$3\frac{1}{2} \times 3 \times \frac{3}{8}$	·373	7·8	2·43	2·18	1·29	2·45	**·62**	1·25	1·10	·83	2·29
$3\frac{1}{2} \times 3 \times \frac{5}{16}$	·308	6·5	2·46	2·21	1·29	2·46	**·62**	1·26	·92	·69	1·91
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	·370	7·1	2·35	1·85	1·25	2·40	**·53**	1·19	1·06	·57	2·09
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	·309	6·0	2·38	1·87	1·25	2·41	·53	1·20	·90	·48	1·76
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	·245	4·8	2·41	1·90	1·26	2·42	**·54**	1·21	·72	·39	1·41
$3 \times 2\frac{1}{2} \times \frac{3}{8}$	·372	6·5	2·06	1·80	1·10	2·09	**·52**	1·05	·79	·56	1·91
$3 \times 2\frac{1}{2} \times \frac{5}{16}$	·311	5·5	2·08	1·83	1·10	2·10	**·52**	1·06	·67	·48	1·62
$3 \times 2\frac{1}{2} \times \frac{1}{4}$	·246	4·4	2·11	1·85	1·10	2·11	**·52**	1·07	·54	·38	1·30
$3 \times 2 \times \frac{3}{8}$	·372	5·9	1·97	1·46	1·06	2·02	**·43**	1·00	·77	·37	1·73
$3 \times 2 \times \frac{5}{16}$	·311	5·0	1·99	1·49	1·06	2·03	**·43**	1·01	·66	·31	1·47
$3 \times 2 \times \frac{1}{4}$	·245	4·0	2·02	1·51	1·06	2·05	**·43**	1·02	·53	·25	1·18
$2\frac{1}{2} \times 2 \times \frac{3}{8}$	·367	5·2	1·68	1·42	·94	1·73	**·42**	·86	·53	·35	1·53
$2\frac{1}{2} \times 2 \times \frac{5}{16}$	·306	4·4	1·70	1·45	·94	1·74	**·42**	·87	·45	·30	1·29
$2\frac{1}{2} \times 2 \times \frac{1}{4}$	·246	3·6	1·72	1·47	·93	1·74	**·42**	·88	·37	·25	1·06
$2\frac{1}{2} \times 2 \times \frac{3}{16}$	·181	2·7	1·75	1·50	·93	1·75	**·43**	·89	·28	·19	·79
$2\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{4}$	·249	3·2	1·63	1·13	·83	1·67	**·32**	·83	·36	·14	·94
$2\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$	·183	2·4	1·66	1·15	·84	1·68	**·32**	·84	·27	·11	·71
$2 \times 1\frac{1}{2} \times \frac{1}{4}$	·241	2·7	1·35	1·09	·73	1·38	**·32**	·68	·23	·13	·79
$2 \times 1\frac{1}{2} \times \frac{3}{16}$	·184	2·1	1·37	1·12	·73	1·39	**·32**	·69	·18	·10	·62

Each weight per foot is for the shaft only. Weight of connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



STRUTS

Unequal angles

Single-bolted or single-riveted at ends

SAFE LOADS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Size $d\times b\times t$ inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS													
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**					
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$					*5·0*	*3·8*								
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$				*5·8*	*4·2*	*3·2*								
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$				*4·7*	*3·5*	*2·6*	2·0							
$3\ \times2\frac{1}{2}\times\frac{3}{8}$					*4·4*	*3·3*								
$3\ \times2\frac{1}{2}\times\frac{5}{16}$					*3·7*	*2·8*								
$3\ \times2\frac{1}{2}\times\frac{1}{4}$				*4·1*	*3·0*	*2·2*								
$3\ \times2\ \times\frac{3}{8}$				*3·9*	*2·8*									
$3\ \times2\ \times\frac{5}{16}$			*4·9*	*3·3*	*2·4*									
$3\ \times2\ \times\frac{1}{4}$			*3·9*	*2·7*	*1·9*									
$2\frac{1}{2}\times2\ \times\frac{3}{8}$			*4·9*	*3·3*	*2·4*									
$2\frac{1}{2}\times2\ \times\frac{5}{16}$			*4·1*	*2·8*	2·0									
$2\frac{1}{2}\times2\ \times\frac{1}{4}$			*3·4*	*2·3*	1·6									
$2\frac{1}{2}\times2\ \times\frac{3}{16}$			*2·6*	*1·8*	1·3									
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{1}{4}$		*3·1*	*1·9*											
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{3}{16}$	*3·9*	*2·3*	1·4											
$2\ \times1\frac{1}{2}\times\frac{1}{4}$		*2·6*	*1·6*											
$2\ \times1\frac{1}{2}\times\frac{3}{16}$		*2·0*	*1·2*											

The above safe loads are calculated in accordance with Clause 30.*c*.(i) B.S. 449 : 1959, as amended.

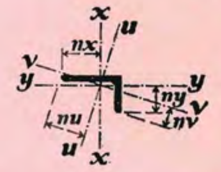
In all cases the values represent the capacity of the angle; loads printed in italics exceed the mild steel black bolt value.

Safe loads are tabulated for L/r values not exceeding 180, where L is the length centre to centre of intersections.

BASED ON
B.S. 449
1959

STRUTS

Unequal angles



DIMENSIONS AND PROPERTIES

Size $d\times b\times t$ inches	Actual Thickness inches	Weight per foot in lbs	Distance in inches				Radius of Gyration		Elastic Modulus		Area in square inches
			nx	*ny*	*nv*	*nu*	Axis *v-v*	Axis *u-u*	Axis *x-x*	Axis *y-y*	
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·370	7·1	2·35	1·85	1·25	2·40	**·53**	1·19	1·06	·57	2·09
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·309	6·0	2·38	1·87	1·25	2·41	**·53**	1·20	·90	·48	1·76
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	4·8	2·41	1·90	1·26	2·42	**·54**	1·21	·72	·39	1·41
$3\ \times2\frac{1}{2}\times\frac{3}{8}$	·372	6·5	2·06	1·80	1·10	2·09	**·52**	1·05	·79	·56	1·91
$3\ \times2\frac{1}{2}\times\frac{5}{16}$	·311	5·5	2·08	1·83	1·10	2·10	**·52**	1·06	·67	·48	1·62
$3\ \times2\frac{1}{2}\times\frac{1}{4}$	·246	4·4	2·11	1·85	1·10	2·11	**·52**	1·07	·54	·38	1·30
$3\ \times2\ \times\frac{3}{8}$	·372	5·9	1·97	1·46	1·06	2·02	**·43**	1·00	·77	·37	1·73
$3\ \times2\ \times\frac{5}{16}$	·311	5·0	1·99	1·49	1·06	2·03	**·43**	1·01	·66	·31	1·47
$3\ \times2\ \times\frac{1}{4}$	·245	4·0	2·02	1·51	1·06	2·05	**·43**	1·02	·53	·25	1·18
$2\frac{1}{2}\times2\ \times\frac{3}{8}$	·367	5·2	1·68	1·42	·94	1·73	**·42**	·86	·53	·35	1·53
$2\frac{1}{2}\times2\ \times\frac{5}{16}$	·306	4·4	1·70	1·45	·94	1·74	**·42**	·87	·45	·30	1·29
$2\frac{1}{2}\times2\ \times\frac{1}{4}$	·246	3·6	1·72	1·47	·93	1·74	**·42**	·88	·37	·25	1·06
$2\frac{1}{2}\times2\ \times\frac{3}{16}$	·181	2·7	1·75	1·50	·93	1·75	**·43**	·89	·28	·19	·79
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{1}{4}$	·249	3·2	1·63	1·13	·83	1·67	**·32**	·83	·36	·14	·94
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{3}{16}$	·183	2·4	1·66	1·15	·84	1·68	**·32**	·84	·27	·11	·71
$2\ \times1\frac{1}{2}\times\frac{1}{4}$	·241	2·7	1·35	1·09	·73	1·38	**·32**	·68	·23	·13	·79
$2\ \times1\frac{1}{2}\times\frac{3}{16}$	·184	2·1	1·37	1·12	·73	1·39	**·32**	·69	·18	·10	·62

Each weight per foot is for the shaft only. Weight of connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

COMPOUND STRUTS

Two Equal Angles back to back
Gusset between Angles
Two or more rivets or bolts in line, or welded, at ends

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Size $d \times b$ inches	SAFE LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
	4	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**24**	**28**	**32**	**36**	**40**	**44**
$8 \times 16\frac{5}{8}$					242	222	200	175	152	115	87·9	68·7	55·1	*56·5*	*46·8*
$8 \times 16\frac{5}{8}$					214	197	177	156	136	103	78·5	61·6	49·3	*50·7*	*42·2*
$8 \times 16\frac{5}{8}$					185	171	154	136	118	89·4	68·3	53·7	43·0	*44·0*	*36·7*
$8 \times 16\frac{5}{8}$					156	144	130	115	101	76·0	58·3	45·9	36·7	*37·6*	*31·3*
$6 \times 12\frac{1}{2}$			163	148	129	108	89·1	73·6	61·5	44·2	*41·2*	*31·8*	*25·4*		
$6 \times 12\frac{1}{2}$			142	129	112	94·1	77·8	64·4	53·8	38·6	*36·0*	*27·9*	*22·3*		
$6 \times 12\frac{1}{2}$			120	109	95·5	80·5	66·7	55·3	46·2	33·2	*31·1*	*24·1*	*19·1*		
$6 \times 12\frac{1}{2}$			96·8	88·5	77·4	65·4	54·2	45·0	37·6	27·1	*25·4*	*19·6*	*15·6*		
$6 \times 12\frac{1}{2}$			73·6	67·4	59·2	50·1	41·8	34·7	29·0	21·0	15·7	*15·2*	*12·1*		
$5 \times 10\frac{1}{2}$			108	91·3	73·5	58·3	46·5	37·8	31·1	*27·6*	*20·5*				
$5 \times 10\frac{1}{2}$			91·6	77·9	63·0	50·2	40·2	32·6	26·9	*23·9*	*17·7*				
$5 \times 10\frac{1}{2}$			74·3	63·4	51·4	41·0	32·9	26·7	22·0	*19·5*	*14·5*				
$5 \times 10\frac{1}{2}$			57·1	49·0	40·0	31·9	25·6	20·9	17·2	*15·3*	*11·3*	*8·8*			
$4 \times 8\frac{3}{8}$		86·6	70·3	53·0	39·6	30·2	23·6	*23·7*	*19·4*	*13·6*					
$4 \times 8\frac{3}{8}$		73·9	60·6	46·1	34·5	26·4	20·7	16·6	*17·0*	*11·9*					
$4 \times 8\frac{3}{8}$		60·1	49·5	37·7	28·4	21·7	17·0	13·6	*14·0*	*9·8*					
$4 \times 8\frac{3}{8}$		46·0	38·0	29·1	21·9	16·8	13·2	10·5	*10·8*	*7·6*					
$3\frac{1}{2} \times 7\frac{3}{8}$		58·8	44·3	31·7	23·2	17·5	*17·0*	*13·5*	*11·0*						
$3\frac{1}{2} \times 7\frac{3}{8}$		48·2	36·5	26·3	19·2	14·5	*14·1*	*11·3*	*9·1*						
$3\frac{1}{2} \times 7\frac{3}{8}$		37·0	28·2	20·4	14·9	11·3	*11·0*	*8·7*	*7·1*						
$3\frac{1}{2} \times 7\frac{3}{8}$		31·5	24·1	17·5	12·8	9·6	7·5	*7·5*	*6·1*						
$3 \times 6\frac{5}{16}$	45·6	35·5	24·3	16·7	12·0	*11·2*	*8·7*	*6·9*							
$3 \times 6\frac{5}{16}$	34·9	27·4	18·9	13·0	9·3	*8·7*	*6·7*	*5·3*							
$3 \times 6\frac{5}{16}$	29·6	23·4	16·3	11·2	8·0	*7·5*	*5·8*	*4·6*							
$3 \times 6\frac{5}{16}$	23·8	19·0	13·3	9·1	6·6	*6·1*	*4·7*	*3·7*							
$2\frac{1}{2} \times 5\frac{5}{16}$	26·9	18·4	11·6	7·7	*6·8*	*5·1*									
$2\frac{1}{2} \times 5\frac{5}{16}$	23·0	15·8	10·1	6·7	*5·9*	*4·4*									
$2\frac{1}{2} \times 5\frac{5}{16}$	18·4	12·6	8·0	5·3	*4·7*	*3·5*									
$2\frac{1}{4} \times 4\frac{13}{16}$	22·1	13·7	8·3	5·5	*4·8*										
$2\frac{1}{4} \times 4\frac{13}{16}$	18·9	11·9	7·3	4·8	*4·2*	*3·1*									
$2\frac{1}{4} \times 4\frac{13}{16}$	15·4	9·6	5·9	3·9	*3·4*	*2·5*									
$2\frac{1}{4} \times 4\frac{13}{16}$	11·7	7·4	4·5	3·0	*2·6*	*1·9*									
$2 \times 4\frac{5}{16}$	15·0	8·5	5·1	*4·2*	*2·9*										
$2 \times 4\frac{5}{16}$	12·4	7·0	4·2	*3·4*	*2·4*										
$2 \times 4\frac{5}{16}$	9·4	5·4	3·2	*2·6*	*1·8*										

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the "effective length" of the strut in accordance with clause 30.*c*.(ii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

COMPOUND STRUTS

Two Equal Angles back to back

COMPOSITION AND PROPERTIES

Composed of Two Equal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
$8 \times 8 \times 1$	·996	102	$\frac{5}{8}$	5·64	30·01	3·61	**2·43**	47·03	31·38
$8 \times 8 \times \frac{7}{8}$	·871	90·0	$\frac{5}{8}$	5·69	26·48	3·59	**2·45**	40·96	27·82
$8 \times 8 \times \frac{3}{4}$	·746	77·8	$\frac{5}{8}$	5·74	22·88	3·56	**2·46**	34·94	24·16
$8 \times 8 \times \frac{5}{8}$	·621	65·4	$\frac{5}{8}$	5·79	19·23	3·54	**2·48**	28·96	20·39
$6 \times 6 \times \frac{7}{8}$	·872	66·2	$\frac{1}{2}$	4·19	19·48	2·74	**1·81**	23·40	15·15
$6 \times 6 \times \frac{3}{4}$	·747	57·4	$\frac{1}{2}$	4·23	16·88	2·72	**1·82**	19·92	13·21
$6 \times 6 \times \frac{5}{8}$	·623	48·4	$\frac{1}{2}$	4·28	14·24	2·69	**1·84**	16·52	11·21
$6 \times 6 \times \frac{1}{2}$	·496	39·0	$\frac{1}{2}$	4·33	11·48	2·67	**1·85**	13·07	9·09
$6 \times 6 \times \frac{3}{8}$	·371	29·6	$\frac{1}{2}$	4·38	8·70	2·64	**1·87**	9·71	6·92
$5 \times 5 \times \frac{3}{4}$	·748	47·2	$\frac{1}{2}$	3·48	13·89	2·32	**1·50**	14·21	8·97
$5 \times 5 \times \frac{5}{8}$	·622	39·8	$\frac{1}{2}$	3·53	11·71	2·29	**1·52**	11·72	7·62
$5 \times 5 \times \frac{1}{2}$	·496	32·2	$\frac{1}{2}$	3·58	9·47	2·27	**1·53**	9·27	6·20
$5 \times 5 \times \frac{3}{8}$	·373	24·6	$\frac{1}{2}$	3·63	7·23	2·24	**1·55**	6·91	4·76
$4 \times 4 \times \frac{3}{4}$	·749	37·0	$\frac{3}{8}$	2·73	10·89	1·87	**1·18**	9·13	5·56
$4 \times 4 \times \frac{5}{8}$	·624	31·4	$\frac{3}{8}$	2·78	9·23	1·85	**1·20**	7·52	4·75
$4 \times 4 \times \frac{1}{2}$	·496	25·4	$\frac{3}{8}$	2·83	7·47	1·82	**1·21**	5·92	3·87
$4 \times 4 \times \frac{3}{8}$	·372	19·4	$\frac{3}{8}$	2·87	5·70	1·80	**1·22**	4·39	2·97
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{8}$	·621	27·0	$\frac{3}{8}$	2·41	7·94	1·65	**1·04**	5·85	3·55
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$	·496	22·0	$\frac{3}{8}$	2·45	6·47	1·62	**1·05**	4·62	2·91
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$	·371	16·8	$\frac{3}{8}$	2·50	4·94	1·60	**1·06**	3·41	2·24
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$	·311	14·2	$\frac{3}{8}$	2·52	4·18	1·58	**1·07**	2·84	1·90
$3 \times 3 \times \frac{1}{2}$	·496	18·6	$\frac{5}{16}$	2·08	5·47	1·40	**·89**	3·40	2·09
$3 \times 3 \times \frac{3}{8}$	·370	14·2	$\frac{5}{16}$	2·12	4·17	1·37	**·90**	2·49	1·61
$3 \times 3 \times \frac{5}{16}$	·309	12·0	$\frac{5}{16}$	2·15	3·53	1·36	**·91**	2·06	1·36
$3 \times 3 \times \frac{1}{4}$	·245	9·6	$\frac{5}{16}$	2·17	2·83	1·34	**·92**	1·62	1·10
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	·372	11·8	$\frac{5}{16}$	1·74	3·47	1·18	**·75**	1·82	1·12
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·77	2·94	1·17	**·76**	1·51	·95
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	·245	8·0	$\frac{5}{16}$	1·79	2·35	1·15	**·76**	1·18	·77
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{8}$	·367	10·4	$\frac{5}{16}$	1·56	3·06	1·08	**·67**	1·48	·88
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·58	2·59	1·07	**·68**	1·23	·75
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{1}{4}$	·246	7·2	$\frac{5}{16}$	1·60	2·11	1·05	**·68**	·98	·62
$2\frac{1}{4} \times 2\frac{1}{4} \times \frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·63	1·58	1·04	**·69**	·71	·46
$2 \times 2 \times \frac{5}{16}$	·308	7·8	$\frac{5}{16}$	1·39	2·29	·97	**·60**	1·00	·59
$2 \times 2 \times \frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·41	1·89	·96	**·60**	·80	·49
$2 \times 2 \times \frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·44	1·41	·94	**·61**	·58	·37

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

COMPOUND STRUTS

Two unequal angles long legs back to back
Gusset between angles

BASED ON
B.S. 449
1959
AS AMENDED

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR MILD STEEL

Size ***d*×*b*** inches	SAFE LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
	6	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**28**	**32**	**36**	**40**	**44**
9× 8⅝		171	149	123	99·5	80·3	65·5	54·3	45·4	38·5	*35·9*	*27·7*			
9× 8⅝		146	126	104	83·6	67·2	54·7	45·2	37·9	*40·2*	*29·9*	*23·2*			
9× 8⅝		123	106	86·3	69·1	55·5	45·2	37·4	31·2	*33·0*	*24·7*	*19·0*			
9× 8⅝		97·8	83·4	67·7	54·0	43·2	35·2	29·0	24·3	*25·7*	*19·1*				
8× 12⅝				187	173	157	139	121	106	91·9	70·5	55·5	44·6	*45·6*	*37·8*
8× 12⅝				162	151	137	121	106	92·5	80·7	62·1	48·7	39·2	*40·0*	*33·4*
8× 12⅝				137	127	116	103	90·2	78·8	68·8	52·9	41·5	33·4	*34·3*	*28·4*
8× 12⅝				110	102	92·2	81·8	71·6	62·3	54·3	41·7	32·7	26·4	*26·9*	*22·4*
8× 8⅝		137	120	100	81·3	65·9	53·9	44·6	37·3	31·7	*29·6*	*22·8*			
8× 8⅝		114	99·7	82·5	66·7	53·9	43·9	36·4	30·5	25·8	*24·1*	*18·6*			
8× 8⅝		91·4	79·1	65·1	52·3	42·1	34·2	28·3	23·7	*25·2*	*18·7*	*14·5*			
7× 7⅝		94·5	78·9	62·9	49·6	39·5	32·0	26·4	*27·6*	*23·3*	*17·3*				
7× 7⅝		75·5	62·5	49·4	38·8	30·8	24·9	20·5	*21·3*	*18·1*	*13·4*				
7× 7⅝	64·2	56·5	46·3	36·4	28·4	22·5	18·2	15·0	*15·6*	*13·2*	*9·7*				
6× 8½		115	103	87·5	72·3	59·2	48·6	40·4	33·9	28·9	*27·0*	*20·8*	*16·5*		
6× 8½		96·1	85·5	72·4	59·4	48·5	39·8	33·1	27·8	23·6	*22·0*	*17·0*			
6× 8½		77·4	68·6	57·8	47·3	38·5	31·5	26·1	21·9	18·7	*17·4*	*13·4*			
6× 7½		84·8	71·1	56·8	44·9	35·8	29·0	23·8	19·9	*21·1*	*15·7*				
6× 7½		68·5	57·0	45·3	35·7	28·4	23·0	18·9	*19·8*	*16·7*	*12·4*				
6× 7½		51·3	42·3	33·4	26·2	20·7	16·8	13·8	*14·4*	*12·2*	*9·0*				
6× 6½	85·3	71·5	55·4	42·0	32·2	25·3	20·4	*20·8*	*17·2*	*14·6*					
6× 6½	68·3	56·5	43·3	32·6	25·0	19·6	15·7	*16·1*	*13·4*	*11·3*					
6× 6½	51·8	42·5	32·3	24·2	18·5	14·5	11·6	*11·9*	*9·8*	*8·3*					
5× 7½		77·5	66·5	54·3	43·4	34·8	28·3	23·4	19·6	*20·8*	*15·4*	*11·9*			
5× 7½		62·6	53·2	43·0	34·3	27·5	22·3	18·3	15·4	*16·3*	*12·1*				
5× 7½		46·9	39·6	31·7	25·2	20·1	16·3	13·4	11·2	*11·9*	*8·8*				
5× 6½	61·6	52·4	41·2	31·5	24·3	19·2	15·4	*15·8*	*13·1*	*11·1*					
5× 6½	46·6	39·2	30·5	23·2	17·8	14·0	11·2	*11·5*	*9·5*	*8·0*					
5× 6½	38·8	32·5	25·2	19·1	14·6	11·5	9·2	*9·4*	*7·8*	*6·6*					

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the "effective length" of the strut in accordance with clause 30.*c*.(ii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

COMPOUND STRUTS

Two unequal angles
Long legs back to back

COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thick-ness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
9 ×4 × ⅞	·872	72·2	⅝	5·56	21·23	**1·61**	2·86	12·83	31·15
9 ×4 × ¾	·745	62·4	⅝	5·61	18·34	**1·58**	2·88	10·67	27·00
9 ×4 × ⅝	·622	52·6	⅝	5·66	15·48	**1·56**	2·89	8·69	22·86
9 ×4 × ½	·495	42·4	⅝	5·72	12·46	**1·53**	2·91	6·74	18·46
8 ×6 × ⅞	·870	78·0	⅝	5·40	22·94	2·58	**2·50**	24·27	26·60
8 ×6 × ¾	·746	67·6	⅝	5·45	19·87	2·56	**2·52**	20·63	23·14
8 ×6 × ⅝	·621	56·8	⅝	5·50	16·71	2·54	**2·54**	17·03	19·54
8 ×6 × ½	·495	45·8	⅝	5·55	13·46	**2·51**	2·55	13·46	15·80
8 ×4 × ¾	·747	57·4	⅝	5·06	16·88	**1·64**	2·55	10·52	21·60
8 ×4 × ⅝	·623	48·4	⅝	5·11	14·24	**1·61**	2·56	8·58	18·30
8 ×4 × ½	·496	39·0	⅝	5·17	11·48	**1·58**	2·58	6·68	14·80
7 ×3½× ⅝	·623	42·0	⅝	4·44	12·36	**1·46**	2·23	6·88	13·84
7 ×3½× ½	·497	34·0	⅝	4·50	10·00	**1·43**	2·25	5·34	11·23
7 ×3½× ⅜	·372	25·8	⅝	4·55	7·59	**1·40**	2·27	3·89	8·55
6 ×4 × ¾	·748	47·2	½	3·93	13·89	**1·73**	1·87	9·77	12·40
6 ×4 × ⅝	·622	39·8	½	3·93	11·71	**1·70**	1·89	7·99	10·51
6 ×4 × ½	·496	32·2	½	4·03	9·47	**1·68**	1·91	6·26	8·54
6 ×3½× ⅝	·620	37·6	½	3·88	11·05	**1·47**	1·90	6·39	10·24
6 ×3½× ½	·497	30·6	½	3·93	8·99	**1·45**	1·91	5·01	8·37
6 ×3½× ⅜	·371	23·2	½	3·99	6·82	**1·42**	1·93	3·65	6·36
6 ×3 × ⅝	·623	35·6	½	3·78	10·47	**1·25**	1·90	5·07	10·00
6 ×3 × ½	·496	28·8	½	3·83	8·47	**1·22**	1·92	3·91	8·12
6 ×3 × ⅜	·373	22·0	½	3·88	6·47	**1·20**	1·93	2·85	6·23
5 ×3½× ⅝	·621	33·4	½	3·31	9·82	**1·55**	1·56	6·28	7·19
5 ×3½× ½	·498	27·2	½	3·36	8·00	**1·52**	1·57	4·94	5·89
5 ×3½× ⅜	·371	20·6	½	3·41	6·06	**1·49**	1·59	3·61	4·49
5 ×3 × ½	·496	25·4	½	3·26	7·47	**1·29**	1·58	3·82	5·72
5 ×3 × ⅜	·372	19·4	½	3·31	5·70	**1·26**	1·60	2·79	4·38
5 ×3 × $\frac{5}{16}$	·308	16·2	½	3·34	4·76	**1·25**	1·60	2·28	3·67

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

COMPOUND STRUTS

Two unequal angles long legs back to back
Gusset between angles

BASED ON
B.S. 449
1959
AS AMENDED

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR MILD STEEL

Size $d \times b$ inches	SAFE LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
	3	4	5	6	7	8	9	10	12	14	16	18	20	22	24
$4 \times 7\frac{3}{8}$				69·1	63·5	56·9	49·9	43·4	32·6	25·0	19·6	15·6	*16·0*	*13·3*	*11·3*
$4 \times 7\frac{3}{8}$				56·7	52·3	47·1	41·5	36·2	27·3	20·9	16·4	13·1	*13·5*	*11·2*	*9·4*
$4 \times 7\frac{3}{8}$				43·5	40·2	36·3	32·1	28·0	21·2	16·2	12·8	10·2	*10·5*	*8·7*	*7·3*
$4 \times 7\frac{3}{8}$				36·4	33·7	30·5	27·0	23·6	17·9	13·7	10·8	8·6	*8·8*	*7·3*	*6·2*
$4 \times 6\frac{3}{8}$				52·6	48·6	43·8	38·8	33·8	25·6	19·6	15·4	12·3	*12·7*	*10·5*	*8·8*
$4 \times 6\frac{3}{8}$				40·3	37·3	33·7	29·9	26·1	19·8	15·2	11·9	9·6	*9·8*	*8·1*	*6·8*
$4 \times 6\frac{3}{8}$				34·2	31·7	28·7	25·5	22·3	17·0	13·1	10·2	8·2	*8·4*	*7·0*	*5·9*
$4 \times 5\frac{3}{8}$			37·6	34·3	30·4	26·2	22·2	18·9	13·8	10·4	*10·2*	*8·0*	*6·6*	*5·4*	
$4 \times 5\frac{3}{8}$			31·2	28·4	24·9	21·4	18·1	15·3	11·2	8·4	*8·1*	*6·5*	*5·3*		
$4 \times 5\frac{3}{8}$			25·2	22·9	20·0	17·1	14·5	12·2	8·9	6·7	*6·5*	*5·2*	*4·2*		
$3\frac{1}{2} \times 6\frac{3}{8}$			49·4	45·2	40·1	34·6	29·5	25·1	18·4	13·9	10·8	*10·8*	*8·8*	*7·3*	
$3\frac{1}{2} \times 6\frac{3}{8}$			37·8	34·7	30·9	26·7	22·9	19·5	14·3	10·8	8·4	*8·4*	*6·8*	*5·7*	
$3\frac{1}{2} \times 6\frac{3}{8}$			31·7	29·2	26·1	22·6	19·4	16·5	12·2	9·2	7·1	*7·1*	*5·8*	*4·8*	
$3\frac{1}{2} \times 5\frac{3}{8}$			34·6	31·8	28·4	24·7	21·1	18·0	13·2	10·0	7·7	*7·7*	*6·3*	*5·3*	
$3\frac{1}{2} \times 5\frac{3}{8}$			29·1	26·8	23·8	20·6	17·6	15·0	11·0	8·3	6·4	*6·4*	*5·2*	*4·3*	
$3\frac{1}{2} \times 5\frac{3}{8}$			23·3	21·3	18·9	16·3	13·9	11·9	8·6	6·5	5·1	*5·0*	*4·1*	*3·4*	
$3 \times 5\frac{5}{16}$		32·2	29·4	25·6	21·6	17·9	14·8	12·4	8·9	*8·3*	*6·4*	*5·1*			
$3 \times 5\frac{5}{16}$		27·3	25·0	21·9	18·5	15·4	12·8	10·7	7·7	*7·2*	*5·5*	*4·4*			
$3 \times 5\frac{5}{16}$		21·9	20·0	17·6	14·8	12·3	10·2	8·5	6·1	*5·7*	*4·4*	*3·5*			
$3 \times 4\frac{5}{16}$		28·9	26·1	22·5	18·8	15·4	12·7	10·6	7·6	*7·1*	*5·5*	*4·3*			
$3 \times 4\frac{5}{16}$		24·3	21·8	18·6	15·4	12·6	10·4	8·6	6·1	*5·7*	*4·4*	*3·5*			
$3 \times 4\frac{5}{16}$		19·4	17·3	14·7	12·1	9·9	8·1	6·7	4·8	*4·5*	*3·4*				
$2\frac{1}{2} \times 4\frac{5}{16}$		23·9	20·4	16·5	13·1	10·5	8·5	7·0	*6·2*	*4·6*					
$2\frac{1}{2} \times 4\frac{5}{16}$		20·4	17·4	14·2	11·3	9·0	7·3	6·0	*5·4*	*4·0*	*3·0*				
$2\frac{1}{2} \times 4\frac{5}{16}$		16·7	14·4	11·8	9·4	7·5	6·1	5·0	*4·5*	*3·3*	*2·5*				
$2\frac{1}{2} \times 4\frac{5}{16}$		12·6	10·9	8·9	7·2	5·7	4·7	3·8	*3·4*	*2·5*	*1·9*				
$2\frac{1}{2} \times 3\frac{5}{16}$	15·8	13·7	10·9	8·4	6·5	5·1	4·1	3·4	*3·0*						
$2\frac{1}{2} \times 3\frac{5}{16}$	11·7	9·9	7·8	6·0	4·6	3·6	2·9	*3·0*	*2·1*						
$2 \times 3\frac{5}{16}$	12·9	10·8	8·3	6·2	4·8	3·7	3·0	*3·1*	*2·1*						
$2 \times 3\frac{5}{16}$	10·1	8·5	6·6	5·0	3·8	3·0	2·4	*2·4*	*1·7*						

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.

Safe loads are calculated for the "effective length" of the strut in accordance with clause 30.*c*.(ii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.

These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

COMPOUND STRUTS

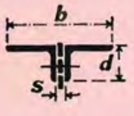
Two unequal angles
Long legs back to back

COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs.	Space between Angles s inches	Distance nx inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis y-y	Axis x-x	Axis y-y	Axis x-x
$4 \times 3\frac{1}{2} \times \frac{5}{8}$	·623	29·2	$\frac{3}{8}$	2·71	8·59	1·59	**1·21**	5·92	4·65
$4 \times 3\frac{1}{2} \times \frac{1}{2}$	·498	23·8	$\frac{3}{8}$	2·76	7·00	1·57	**1·23**	4·67	3·81
$4 \times 3\frac{1}{2} \times \frac{3}{8}$	·374	18·2	$\frac{3}{8}$	2·81	5·35	1·54	**1·24**	3·45	2·93
$4 \times 3\frac{1}{2} \times \frac{5}{16}$	·309	15·2	$\frac{3}{8}$	2·83	4·47	1·53	**1·25**	2·83	2·45
$4 \times 3 \times \frac{1}{2}$	·496	22·0	$\frac{3}{8}$	2·68	6·47	1·32	**1·24**	3·55	3·70
$4 \times 3 \times \frac{3}{8}$	·371	16·8	$\frac{3}{8}$	2·73	4·94	1·30	**1·25**	2·60	2·84
$4 \times 3 \times \frac{5}{16}$	·311	14·2	$\frac{3}{8}$	2·76	4·18	1·28	**1·26**	2·15	2·41
$4 \times 2\frac{1}{2} \times \frac{3}{8}$	·373	15·6	$\frac{3}{8}$	2·64	4·58	**1·06**	1·26	1·91	2·77
$4 \times 2\frac{1}{2} \times \frac{5}{16}$	·308	13·0	$\frac{3}{8}$	2·67	3·83	**1·04**	1·27	1·55	2·32
$4 \times 2\frac{1}{2} \times \frac{1}{4}$	·248	10·6	$\frac{3}{8}$	2·70	3·11	**1·03**	1·28	1·23	1·89
$3\frac{1}{2} \times 3 \times \frac{1}{2}$	·499	20·4	$\frac{3}{8}$	2·38	6·00	1·37	**1·07**	3·54	2·86
$3\frac{1}{2} \times 3 \times \frac{3}{8}$	·373	15·6	$\frac{3}{8}$	2·43	4·58	1·34	**1·08**	2·59	2·20
$3\frac{1}{2} \times 3 \times \frac{5}{16}$	·308	13·0	$\frac{3}{8}$	2·46	3·83	1·33	**1·09**	2·12	1·84
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	·370	14·2	$\frac{3}{8}$	2·35	4·17	1·10	**1·09**	1·88	2·12
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	·309	12·0	$\frac{3}{8}$	2·38	3·53	**1·08**	1·10	1·54	1·79
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	·245	9·6	$\frac{3}{8}$	2·41	2·83	**1·07**	1·11	1·20	1·44
$3 \times 2\frac{1}{2} \times \frac{3}{8}$	·372	13·0	$\frac{5}{16}$	2·06	3·82	1·12	**·92**	1·81	1·57
$3 \times 2\frac{1}{2} \times \frac{5}{16}$	·311	11·0	$\frac{5}{16}$	2·08	3·23	1·11	**·93**	1·49	1·33
$3 \times 2\frac{1}{2} \times \frac{1}{4}$	·246	8·8	$\frac{5}{16}$	2·11	2·59	1·09	**·93**	1·16	1·07
$3 \times 2 \times \frac{3}{8}$	·372	11·8	$\frac{5}{16}$	1·97	3·47	**·89**	·94	1·27	1·54
$3 \times 2 \times \frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·99	2·94	**·87**	·94	1·04	1·31
$3 \times 2 \times \frac{1}{4}$	·245	8·0	$\frac{5}{16}$	2·02	2·35	**·86**	·95	·81	1·06
$2\frac{1}{2} \times 2 \times \frac{3}{8}$	·367	10·4	$\frac{5}{16}$	1·68	3·06	·93	**·76**	1·23	1·07
$2\frac{1}{2} \times 2 \times \frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·70	2·59	·92	**·77**	1·01	·91
$2\frac{1}{2} \times 2 \times \frac{1}{4}$	·246	7·2	$\frac{5}{16}$	1·72	2·11	·90	**·78**	·80	·74
$2\frac{1}{2} \times 2 \times \frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·75	1·58	·89	**·79**	·58	·56
$2\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·63	1·89	**·67**	·79	·51	·72
$2\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·66	1·41	**·65**	·80	·36	·54
$2 \times 1\frac{1}{2} \times \frac{1}{4}$	·241	5·4	$\frac{5}{16}$	1·35	1·59	·71	**·62**	·48	·45
$2 \times 1\frac{1}{2} \times \frac{3}{16}$	·184	4·2	$\frac{5}{16}$	1·37	1·24	·69	**·63**	·36	·35

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.

For explanation of tables, see notes commencing pages 162 and 176



COMPOUND STRUTS

Two unequal angles short legs back to back
Gusset between angles

BASED ON
B.S. 449
1959
AS AMENDED

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR MILD STEEL

Size $d \times b$ inches	SAFE LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
	4	5	6	7	8	9	10	11	12	13	14	16	20	24	28
$4 \times 18\frac{5}{8}$		171	154	134	114	95·9	80·9	68·6	58·7	50·9	44·2	*42·9*	*28·0*		
$4 \times 18\frac{5}{8}$		148	134	117	99·6	84·1	71·0	60·3	51·8	44·6	39·0	*37·8*	*24·5*		
$4 \times 18\frac{5}{8}$		126	114	99·7	85·2	72·0	60·9	51·8	44·4	38·3	33·4	*32·5*	*21·1*		
$4 \times 18\frac{5}{8}$		101	92·3	81·1	69·5	58·8	49·8	42·4	36·4	31·4	27·4	*26·6*	*17·3*		
$6 \times 16\frac{5}{8}$					190	181	170	158	145	133	120	98·6	67·5	48·3	*45·0*
$6 \times 16\frac{5}{8}$					165	157	148	138	127	116	105	86·2	58·9	42·3	*39·5*
$6 \times 16\frac{5}{8}$					139	133	125	117	108	98·7	89·7	73·7	50·6	36·2	*33·9*
$6 \times 16\frac{5}{8}$					112	107	101	94·6	87·5	80·1	72·8	59·9	41·1	29·5	*27·6*
$4 \times 16\frac{5}{8}$		138	126	111	95·3	80·9	68·6	58·4	50·1	43·4	37·8	*36·8*	*23·9*		
$4 \times 16\frac{5}{8}$		117	107	94·4	81·3	69·2	58·8	50·0	42·9	37·2	32·5	*31·6*	*20·6*		
$4 \times 16\frac{5}{8}$		94·4	86·6	76·8	66·3	56·5	48·1	41·0	35·2	30·5	26·6	20·7	*16·9*		
$3\frac{1}{2} \times 14\frac{5}{8}$	104	95·0	82·9	69·9	57·9	48·0	40·1	33·8	28·9	24·8	*27·0*	*20·9*			
$3\frac{1}{2} \times 14\frac{5}{8}$	84·5	77·3	67·8	57·3	47·6	39·5	33·1	27·9	23·8	20·6	*22·3*	*17·2*			
$3\frac{1}{2} \times 14\frac{5}{8}$	64·3	59·0	51·9	44·0	36·7	30·6	25·6	21·6	18·4	15·9	13·8	*13·3*			
$4 \times 12\frac{1}{2}$		116	107	96·1	83·9	72·1	61·6	52·8	45·5	39·5	34·4	27·0	*22·0*		
$4 \times 12\frac{1}{2}$		98·1	91·1	82·2	72·2	62·3	53·5	45·9	39·6	34·4	30·1	23·4	*19·1*		
$4 \times 12\frac{1}{2}$		79·5	74·0	66·9	58·9	51·0	43·8	37·6	32·5	28·2	24·7	19·3	*15·7*		
$3\frac{1}{2} \times 12\frac{1}{2}$		86·4	76·3	65·0	54·3	45·3	37·9	32·1	27·3	23·6	20·5	*19·9*			
$3\frac{1}{2} \times 12\frac{1}{2}$		70·7	62·7	53·6	44·9	37·5	31·4	26·6	22·7	19·6	17·0	*16·5*	*10·7*		
$3\frac{1}{2} \times 12\frac{1}{2}$		54·1	48·3	41·6	35·1	29·4	24·7	20·9	17·9	15·4	13·4	*13·1*	*8·4*		
$3 \times 12\frac{1}{2}$	82·9	71·4	58·4	46·7	37·5	30·6	25·3	21·1	*22·4*	*19·2*	*16·7*	*12·8*			
$3 \times 12\frac{1}{2}$	67·5	58·4	48·0	38·6	31·0	25·3	20·9	17·5	*18·6*	*15·9*	*13·8*	*10·7*			
$3 \times 12\frac{1}{2}$	51·8	45·1	37·2	30·0	24·2	19·7	16·3	13·7	11·6	*12·5*	*10·8*	*8·3*			
$3\frac{1}{2} \times 10\frac{1}{2}$		78·3	70·1	60·6	51·2	43·0	36·1	30·7	26·2	22·6	19·7	*19·2*	*12·5*		
$3\frac{1}{2} \times 10\frac{1}{2}$		64·1	57·6	49·9	42·3	35·5	29·9	25·4	21·8	18·8	16·4	*15·9*	*10·3*		
$3\frac{1}{2} \times 10\frac{1}{2}$		48·8	43·9	38·2	32·5	27·4	23·1	19·6	16·8	14·5	12·6	*12·3*	*7·9*		
$3 \times 10\frac{1}{2}$	60·5	53·1	44·3	36·0	29·2	23·8	19·7	16·5	14·0	*15·1*	*13·1*	*10·1*			
$3 \times 10\frac{1}{2}$	46·6	41·3	34·8	28·4	23·2	19·0	15·7	13·2	11·2	*12·1*	*10·5*	*8·0*			
$3 \times 10\frac{1}{2}$	38·9	34·5	29·0	23·8	19·3	15·8	13·1	11·0	9·3	*10·1*	*8·7*	*6·7*			

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.

Safe loads are calculated for the "effective length" of the strut in accordance with clause 30.*c*.(ii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.

These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

COMPOUND STRUTS

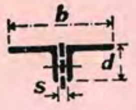
Two unequal angles
Short legs back to back

COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
$9 \times 4 \times \frac{7}{8}$	·872	72·2	$\frac{5}{8}$	3·05	21·23	4·71	**1·01**	50·66	7·05
$9 \times 4 \times \frac{3}{4}$	·745	62·4	$\frac{5}{8}$	3·10	18·34	4·68	**1·02**	43·21	6·13
$9 \times 4 \times \frac{5}{8}$	·622	52·6	$\frac{5}{8}$	3·15	15·48	4·66	**1·03**	36·02	5·22
$9 \times 4 \times \frac{1}{2}$	·495	42·4	$\frac{5}{8}$	3·20	12·46	4·62	**1·04**	28·61	4·25
$8 \times 6 \times \frac{7}{8}$	·870	78·0	$\frac{5}{8}$	4·40	22·94	3·84	**1·74**	40·64	15·72
$8 \times 6 \times \frac{3}{4}$	·746	67·6	$\frac{5}{8}$	4·44	19·87	3·81	**1·75**	34·74	13·71
$8 \times 6 \times \frac{5}{8}$	·621	56·8	$\frac{5}{8}$	4·49	16·71	3·79	**1·77**	28·83	11·61
$8 \times 6 \times \frac{1}{2}$	·495	45·8	$\frac{5}{8}$	4·54	13·46	3·76	**1·78**	22·91	9·41
$8 \times 4 \times \frac{3}{4}$	·747	57·4	$\frac{5}{8}$	3·05	16·88	4·13	**1·05**	34·60	6·07
$8 \times 4 \times \frac{5}{8}$	·623	48·4	$\frac{5}{8}$	3·10	14·24	4·10	**1·06**	28·80	5·17
$8 \times 4 \times \frac{1}{2}$	·496	39·0	$\frac{5}{8}$	3·15	11·48	4·07	**1·07**	22·87	4·21
$7 \times 3\frac{1}{2} \times \frac{5}{8}$	·623	42·0	$\frac{5}{8}$	2·68	12·36	3·63	**·92**	22·32	3·89
$7 \times 3\frac{1}{2} \times \frac{1}{2}$	·497	34·0	$\frac{5}{8}$	2·73	10·00	3·60	**·93**	17·75	3·18
$7 \times 3\frac{1}{2} \times \frac{3}{8}$	·372	25·8	$\frac{5}{8}$	2·78	7·59	3·57	**·94**	13·24	2·44
$6 \times 4 \times \frac{3}{4}$	·748	47·2	$\frac{1}{2}$	2·93	13·89	2·98	**1·11**	19·74	5·88
$6 \times 4 \times \frac{5}{8}$	·622	39·8	$\frac{1}{2}$	2·97	11·71	2·95	**1·13**	16·35	5·00
$6 \times 4 \times \frac{1}{2}$	·496	32·2	$\frac{1}{2}$	3·02	9·47	2·93	**1·14**	12·98	4·08
$6 \times 3\frac{1}{2} \times \frac{5}{8}$	·620	37·6	$\frac{1}{2}$	2·63	11·05	3·03	**·95**	16·26	3·81
$6 \times 3\frac{1}{2} \times \frac{1}{2}$	·497	30·6	$\frac{1}{2}$	2·67	8·99	3·00	**·96**	12·98	3·13
$6 \times 3\frac{1}{2} \times \frac{3}{8}$	·371	23·2	$\frac{1}{2}$	2·72	6·82	2·97	**·98**	9·65	2·39
$6 \times 3 \times \frac{5}{8}$	·623	35·6	$\frac{1}{2}$	2·27	10·47	3·12	**·78**	16·30	2·80
$6 \times 3 \times \frac{1}{2}$	·496	28·8	$\frac{1}{2}$	2·31	8·47	3·09	**·79**	12·94	2·28
$6 \times 3 \times \frac{3}{8}$	·373	22·0	$\frac{1}{2}$	2·36	6·47	3·06	**·80**	9·69	1·76
$5 \times 3\frac{1}{2} \times \frac{5}{8}$	·621	33·4	$\frac{1}{2}$	2·55	9·82	2·49	**·99**	11·58	3·73
$5 \times 3\frac{1}{2} \times \frac{1}{2}$	·498	27·2	$\frac{1}{2}$	2·60	8·00	2·46	**1·00**	9·23	3·07
$5 \times 3\frac{1}{2} \times \frac{3}{8}$	·371	20·6	$\frac{1}{2}$	2·65	6·06	2·43	**1·01**	6·83	2·34
$5 \times 3 \times \frac{1}{2}$	·496	25·4	$\frac{1}{2}$	2·26	7·47	2·54	**·82**	9·17	2·24
$5 \times 3 \times \frac{3}{8}$	·372	19·4	$\frac{1}{2}$	2·30	5·70	2·51	**·84**	6·84	1·73
$5 \times 3 \times \frac{5}{16}$	·308	16·2	$\frac{1}{2}$	2·33	4·76	2·49	**·84**	5·64	1·45

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.

For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STRUTS

Two unequal angles short legs back to back
Gusset between angles

BASED ON
B.S. 449
1959
AS AMENDED

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR MILD STEEL

Size $d\times b$ inches	SAFE LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20
$3\frac{1}{2}\times8\frac{3}{8}$				69·4	62·7	54·7	46·6	39·4	33·3	28·3	24·2	18·3	*17·7*	*14·1*	*11·5*
$3\frac{1}{2}\times8\frac{3}{8}$				56·8	51·5	45·1	38·5	32·6	27·5	23·4	20·1	15·1	*14·7*	*11·8*	*9·5*
$3\frac{1}{2}\times8\frac{3}{8}$				43·7	39·9	35·1	30·2	25·6	21·7	18·5	15·9	12·0	*11·6*	*9·3*	*7·5*
$3\frac{1}{2}\times8\frac{3}{8}$				36·5	33·3	29·4	25·2	21·4	18·2	15·5	13·3	10·0	*9·7*	*7·7*	*6·3*
$3\ \times8\frac{3}{8}$			53·3	47·7	40·5	33·4	27·3	22·4	18·6	15·7	13·3	*12·4*	*9·5*		
$3\ \times8\frac{3}{8}$			40·9	36·7	31·3	25·9	21·2	17·5	14·5	12·2	10·4	*9·6*	*7·4*	*5·9*	
$3\ \times8\frac{3}{8}$			34·7	31·3	26·8	22·3	18·3	15·1	12·5	10·5	8·9	*8·3*	*6·4*	*5·1*	
$2\frac{1}{2}\times8\frac{3}{8}$		38·6	33·8	27·5	21·5	16·7	13·3	10·7	8·7	*9·1*	*7·7*	*5·7*			
$2\frac{1}{2}\times8\frac{3}{8}$		32·4	28·5	23·4	18·3	14·3	11·4	9·1	7·5	*7·8*	*6·6*	*4·9*			
$2\frac{1}{2}\times8\frac{3}{8}$		26·3	23·2	19·0	14·9	11·6	9·2	7·4	6·1	*6·3*	*5·4*	*4·0*			
$3\ \times7\frac{3}{8}$			49·7	44·5	38·0	31·5	25·8	21·2	17·7	14·8	12·6	*11·8*	*9·0*	*7·2*	
$3\ \times7\frac{3}{8}$			38·2	34·5	29·8	24·8	20·4	16·8	14·0	11·8	10·0	*9·4*	*7·2*	*5·7*	
$3\ \times7\frac{3}{8}$			32·0	28·8	24·9	20·7	17·0	14·1	11·7	9·8	8·4	*7·8*	*6·0*	*4·8*	
$2\frac{1}{2}\times7\frac{3}{8}$			31·3	25·9	20·4	16·0	12·7	10·2	8·4	*8·8*	*7·4*	*5·5*			
$2\frac{1}{2}\times7\frac{3}{8}$			26·8	22·2	17·6	13·9	11·0	8·8	7·3	*7·6*	*6·4*	*4·7*			
$2\frac{1}{2}\times7\frac{3}{8}$			21·5	17·8	14·1	11·1	8·8	7·1	5·8	*6·1*	*5·2*	*3·8*			
$2\frac{1}{2}\times6\frac{5}{16}$			29·2	24·4	19·4	15·3	12·2	9·9	8·1	*8·5*	*7·1*	*5·3*			
$2\frac{1}{2}\times6\frac{5}{16}$			24·7	20·6	16·4	13·0	10·3	8·3	6·8	*7·2*	*6·0*	*4·5*			
$2\frac{1}{2}\times6\frac{5}{16}$			20·0	16·8	13·4	10·6	8·4	6·8	5·6	4·7	*5·0*	*3·7*			
$2\ \times6\frac{5}{16}$		26·9	21·2	15·6	11·5	8·7	6·8	*6·8*	*5·5*	*4·6*					
$2\ \times6\frac{5}{16}$		22·8	17·9	13·2	9·7	7·4	5·7	*5·7*	*4·7*	*3·9*					
$2\ \times6\frac{5}{16}$		18·4	14·6	10·9	8·0	6·1	4·7	*4·7*	*3·9*	*3·2*					
$2\ \times5\frac{5}{16}$		23·9	19·0	14·2	10·5	7·9	6·2	*6·2*	*5·0*	*4·2*					
$2\ \times5\frac{5}{16}$		20·4	16·4	12·3	9·1	6·9	5·4	*5·4*	*4·4*	*3·7*	*3·1*				
$2\ \times5\frac{5}{16}$		16·8	13·6	10·3	7·6	5·8	4·5	*4·5*	*3·7*	*3·1*	*2·6*				
$2\ \times5\frac{5}{16}$		12·6	10·2	7·6	5·7	4·3	3·4	*3·4*	*2·8*	*2·3*	*1·9*				
$1\frac{1}{2}\times5\frac{5}{16}$	15·3	11·2	7·3	4·9	3·5	*3·3*	*2·5*								
$1\frac{1}{2}\times5\frac{5}{16}$	11·5	8·6	5·7	3·8	2·7	*2·5*	*1·9*								
$1\frac{1}{2}\times4\frac{5}{16}$	13·1	9·9	6·7	4·5	3·2	*3·0*	*2·3*								
$1\frac{1}{2}\times4\frac{5}{16}$	10·2	7·7	5·2	3·5	2·5	*2·3*	*1·8*								

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the "effective length" of the strut in accordance with clause 30.*c*.(ii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

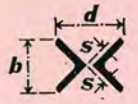
COMPOUND STRUTS

Two unequal angles
Short legs back to back

COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
$4\ \times3\frac{1}{2}\times\frac{5}{8}$	·623	29·2	$\frac{3}{8}$	2·46	8·59	1·91	**1·02**	7·47	3·63
$4\ \times3\frac{1}{2}\times\frac{1}{2}$	·498	23·8	$\frac{3}{8}$	2·51	7·00	1·88	**1·03**	5·92	2·98
$4\ \times3\frac{1}{2}\times\frac{3}{8}$	·374	18·2	$\frac{3}{8}$	2·56	5·35	1·86	**1·05**	4·40	2·30
$4\ \times3\frac{1}{2}\times\frac{5}{16}$	·309	15·2	$\frac{3}{8}$	2·58	4·47	1·84	**1·05**	3·61	1·92
$4\ \times3\ \times\frac{1}{2}$	·496	22·0	$\frac{3}{8}$	2·18	6·47	1·95	**·86**	5·87	2·18
$4\ \times3\ \times\frac{3}{8}$	·371	16·8	$\frac{3}{8}$	2·23	4·94	1·92	**·87**	4·35	1·68
$4\ \times3\ \times\frac{5}{16}$	·311	14·2	$\frac{3}{8}$	2·25	4·18	1·91	**·88**	3·63	1·42
$4\ \times2\frac{1}{2}\times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	1·89	4·58	2·00	**·69**	4·36	1·17
$4\ \times2\frac{1}{2}\times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	1·91	3·83	1·98	**·70**	3·58	·98
$4\ \times2\frac{1}{2}\times\frac{1}{4}$	·248	10·6	$\frac{3}{8}$	1·94	3·11	1·96	**·70**	2·87	·80
$3\frac{1}{2}\times3\ \times\frac{1}{2}$	·499	20·4	$\frac{3}{8}$	2·13	6·00	1·68	**·87**	4·62	2·15
$3\frac{1}{2}\times3\ \times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	2·18	4·58	1·66	**·89**	3·41	1·66
$3\frac{1}{2}\times3\ \times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	2·21	3·83	1·64	**·89**	2·80	1·39
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·370	14·2	$\frac{3}{8}$	1·85	4·17	1·72	**·71**	3·37	1·14
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·309	12·0	$\frac{3}{8}$	1·87	3·53	1·71	**·72**	2·79	·97
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	9·6	$\frac{3}{8}$	1·90	2·83	1·69	**·72**	2·20	·78
$3\ \times2\frac{1}{2}\times\frac{3}{8}$	·372	13·0	$\frac{5}{16}$	1·80	3·82	1·43	**·73**	2·49	1·12
$3\ \times2\frac{1}{2}\times\frac{5}{16}$	·311	11·0	$\frac{5}{16}$	1·83	3·23	1·42	**·73**	2·07	·95
$3\ \times2\frac{1}{2}\times\frac{1}{4}$	·246	8·8	$\frac{5}{16}$	1·85	2·59	1·40	**·74**	1·62	·77
$3\ \times2\ \times\frac{3}{8}$	·372	11·8	$\frac{5}{16}$	1·46	3·47	1·51	**·56**	2·51	·73
$3\ \times2\ \times\frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·49	2·94	1·50	**·56**	2·09	·62
$3\ \times2\ \times\frac{1}{4}$	·245	8·0	$\frac{5}{16}$	1·51	2·35	1·48	**·57**	1·64	·50
$2\frac{1}{2}\times2\ \times\frac{3}{8}$	·367	10·4	$\frac{5}{16}$	1·42	3·06	1·24	**·57**	1·78	·71
$2\frac{1}{2}\times2\ \times\frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·45	2·59	1·23	**·58**	1·47	·60
$2\frac{1}{2}\times2\ \times\frac{1}{4}$	·246	7·2	$\frac{5}{16}$	1·47	2·11	1·22	**·59**	1·18	·50
$2\frac{1}{2}\times2\ \times\frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·50	1·58	1·20	**·59**	·86	·37
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·13	1·89	1·29	**·41**	1·18	·28
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·15	1·41	1·27	**·42**	·86	·21
$2\ \times1\frac{1}{2}\times\frac{1}{4}$	·241	5·4	$\frac{5}{16}$	1·09	1·59	1·02	**·43**	·76	·27
$2\ \times1\frac{1}{2}\times\frac{3}{16}$	·184	4·2	$\frac{5}{16}$	1·12	1·24	1·00	**·43**	·58	·21

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STRUTS

BASED ON
B.S. 449
1959
AS AMENDED

Two Equal Angles Battened

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR MILD STEEL

Size $d \times b$ inches	SAFE LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET														
	4	**6**	**8**	**10**	**12**	**14**	**16**	**20**	**24**	**28**	**32**	**36**	**40**	**45**	**50**
$13\frac{7}{16}\times11\frac{5}{16}$						249	235	201	163	130	104	84·7	69·7	55·8	*57·3*
$13\frac{1}{4}\times11\frac{5}{16}$						220	208	178	145	116	92·8	75·5	62·4	49·9	*51·1*
$13\frac{1}{8}\times11\frac{5}{16}$						191	181	155	126	101	81·1	66·0	54·6	43·6	*44·8*
$12\frac{15}{16}\times11\frac{5}{16}$						160	152	131	107	85·8	69·0	56·2	46·4	37·3	*38·1*
$10\frac{1}{4}\times8\frac{1}{2}$				163	152	137	121	89·5	66·4	50·4	39·3	*39·3*	*32·0*	*25·6*	
$10\frac{1}{16}\times8\frac{1}{2}$				142	132	120	106	78·6	58·4	44·4	34·7	*34·7*	*28·4*	*22·6*	
$9\frac{15}{16}\times8\frac{1}{2}$				120	112	102	89·9	67·2	49·9	38·0	29·7	*29·7*	*24·2*	*19·3*	
$9\frac{3}{4}\times8\frac{1}{2}$				97·1	90·7	82·6	73·1	54·9	40·9	31·2	24·4	*24·3*	*19·9*	*15·8*	
$9\frac{9}{16}\times8\frac{1}{2}$				73·7	69·0	63·0	55·9	42·1	31·4	23·9	18·7	*18·7*	*15·3*	*12·2*	
$8\frac{11}{16}\times7\frac{1}{16}$				108	95·5	81·1	67·8	47·2	34·0	25·5	*24·8*	*19·7*			
$8\frac{1}{2}\times7\frac{1}{16}$				91·8	81·3	69·4	58·0	40·6	29·2	21·9	*21·2*	*17·0*			
$8\frac{5}{16}\times7\frac{1}{16}$				74·6	66·3	56·8	47·6	33·4	24·2	18·1	*17·5*	*14·0*	*11·4*		
$8\frac{1}{8}\times7\frac{1}{16}$				57·2	51·0	43·9	36·9	25·9	18·8	14·1	*13·7*	*10·9*	*8·8*		
$7\frac{1}{16}\times5\frac{11}{16}$			83·9	70·6	56·5	44·7	35·6	23·8	*21·1*	*15·7*					
$6\frac{15}{16}\times5\frac{11}{16}$			71·6	60·6	48·8	38·8	30·9	20·7	*18·3*	*13·6*					
$6\frac{3}{4}\times5\frac{11}{16}$			58·4	49·7	40·2	32·0	25·7	17·1	*15·2*	*11·3*					
$6\frac{9}{16}\times5\frac{11}{16}$			44·9	38·4	31·2	24·9	20·0	13·4	*11·9*	*8·8*	*6·8*				
$6\frac{3}{16}\times4\frac{15}{16}$		65·6	56·0	44·3	33·9	26·2	20·6	*17·0*	*12·0*						
$6\times4\frac{15}{16}$		53·8	46·2	36·8	28·3	21·9	17·3	*14·3*	*10·0*						
$5\frac{7}{8}\times4\frac{15}{16}$		41·3	35·7	28·6	22·1	17·2	13·5	8·9	*7·9*						
$5\frac{3}{4}\times4\frac{15}{16}$		35·0	30·4	24·4	18·9	14·7	11·6	7·6	*6·7*	*5·0*					
$5\frac{1}{4}\times4\frac{1}{4}$		42·4	33·4	24·6	18·2	13·8	10·8	*8·7*							
$5\frac{1}{16}\times4\frac{1}{4}$		32·6	26·0	19·3	14·3	10·9	8·4	*6·9*							
$4\frac{15}{16}\times4\frac{1}{4}$		27·7	22·2	16·5	12·3	9·3	7·3	*5·9*							
$4\frac{7}{8}\times4\frac{1}{4}$		22·3	17·9	13·4	9·9	7·6	5·9	*4·8*	*3·4*						
$4\frac{7}{16}\times3\frac{9}{16}$	29·4	23·7	16·8	11·7	8·4	6·2	*6·1*								
$4\frac{5}{16}\times3\frac{9}{16}$		20·3	14·5	10·1	7·2	5·4	*5·2*								
$4\frac{1}{4}\times3\frac{9}{16}$		16·4	11·7	8·2	5·9	4·4	*4·3*	*2·7*							
$4\frac{1}{16}\times3\frac{3}{16}$	25·0	18·7	12·4	8·4	6·0	*5·6*	*4·3*								
$4\times3\frac{3}{16}$	21·3	16·0	10·7	7·3	5·2	*4·8*	*3·7*								
$3\frac{7}{8}\times3\frac{3}{16}$	17·4	13·2	8·9	6·0	4·3	*4·0*	*3·1*								
$3\frac{13}{16}\times3\frac{3}{16}$	13·1	10·0	6·7	4·6	3·3	*3·0*	*2·3*								
$3\frac{5}{8}\times2\frac{13}{16}$	17·8	12·1	7·6	5·1	*4·5*	*3·3*									
$3\frac{9}{16}\times2\frac{13}{16}$	14·8	10·2	6·4	4·3	*3·8*	*2·8*									
$3\frac{7}{16}\times2\frac{13}{16}$	11·1	7·7	4·9	3·3	*2·9*	*2·1*	*1·6*								

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the "effective length" of the strut in accordance with clause 30.*c*.(ii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line in each angle, or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

COMPOUND STRUTS

Two Equal Angles Battened

COMPOSITION AND PROPERTIES

Composed of Two Equal Angles	Actual Thickness inches	Weight per foot in lbs.	Thickness of Batten Plate *s* inches	Area in square inches	Radius of Gyration			Elastic Modulus		
					Axis *v-v*	Axis *u-u*	Axis *x-x or y-y*	Axis *v-v*	Axis *u-u*	Axis *x-x or y-y*
$8\times8\times1$	·996	102	$\frac{5}{8}$	30·01	**3·06**	4·09	3·61	49·65	74·50	47·03
$8\times8\times\frac{7}{8}$	·871	90·0	$\frac{5}{8}$	26·48	**3·08**	4·03	3·59	44·44	64·71	40·96
$8\times8\times\frac{3}{4}$	·746	77·8	$\frac{5}{8}$	22·88	**3·10**	3·97	3·56	38·96	55·04	34·94
$8\times8\times\frac{5}{8}$	·621	65·4	$\frac{5}{8}$	19·23	**3·12**	3·91	3·54	33·18	45·48	28·96
$6\times6\times\frac{7}{8}$	·872	66·2	$\frac{1}{2}$	19·48	**2·27**	3·14	2·74	23·65	37·42	23·40
$6\times6\times\frac{3}{4}$	·747	57·4	$\frac{1}{2}$	16·88	**2·29**	3·08	2·72	20·90	31·77	19·92
$6\times6\times\frac{5}{8}$	·623	48·4	$\frac{1}{2}$	14·24	**2·31**	3·02	2·69	17·97	26·26	16·52
$6\times6\times\frac{1}{2}$	·496	39·0	$\frac{1}{2}$	11·48	**2·33**	2·96	2·67	14·75	20·69	13·07
$6\times6\times\frac{3}{8}$	·371	29·6	$\frac{1}{2}$	8·70	**2·35**	2·90	2·64	11·36	15·31	9·71
$5\times5\times\frac{3}{4}$	·748	47·2	$\frac{1}{2}$	13·89	**1·89**	2·68	2·32	13·98	22·99	14·21
$5\times5\times\frac{5}{8}$	·622	39·8	$\frac{1}{2}$	11·71	**1·91**	2·62	2·29	12·06	18·92	11·72
$5\times5\times\frac{1}{2}$	·496	32·2	$\frac{1}{2}$	9·47	**1·93**	2·56	2·27	9·98	14·92	9·27
$5\times5\times\frac{3}{8}$	·373	24·6	$\frac{1}{2}$	7·23	**1·95**	2·50	2·24	7·76	11·08	6·91
$4\times4\times\frac{3}{4}$	·749	37·0	$\frac{3}{8}$	10·89	**1·48**	2·20	1·87	8·45	14·82	9·13
$4\times4\times\frac{5}{8}$	·624	31·4	$\frac{3}{8}$	9·23	**1·50**	2·14	1·85	7·37	12·20	7·52
$4\times4\times\frac{1}{2}$	·496	25·4	$\frac{3}{8}$	7·47	**1·52**	2·08	1·82	6·14	9·56	5·92
$4\times4\times\frac{3}{8}$	·372	19·4	$\frac{3}{8}$	5·70	**1·54**	2·02	1·80	4·81	7·06	4·39
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{5}{8}$	·621	27·0	$\frac{3}{8}$	7·94	**1·30**	1·94	1·65	5·43	9·59	5·85
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{1}{2}$	·496	22·0	$\frac{3}{8}$	6·47	**1·32**	1·88	1·62	4·57	7·55	4·62
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{3}{8}$	·371	16·8	$\frac{3}{8}$	4·94	**1·34**	1·81	1·60	3·59	5·55	3·41
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{5}{16}$	·311	14·2	$\frac{3}{8}$	4·18	**1·35**	1·78	1·58	3·08	4·61	2·84
$3\times3\times\frac{1}{2}$	·496	18·6	$\frac{5}{16}$	5·47	**1·12**	1·63	1·40	3·23	5·58	3·40
$3\times3\times\frac{3}{8}$	·370	14·2	$\frac{5}{16}$	4·17	**1·14**	1·57	1·37	2·56	4·08	2·49
$3\times3\times\frac{5}{16}$	·309	12·0	$\frac{5}{16}$	3·53	**1·15**	1·54	1·36	2·19	3·37	2·06
$3\times3\times\frac{1}{4}$	·245	9·6	$\frac{5}{16}$	2·83	**1·16**	1·51	1·34	1·78	2·64	1·62
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·372	11·8	$\frac{5}{16}$	3·47	**·94**	1·38	1·18	1·74	2·98	1·82
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·311	10·0	$\frac{5}{16}$	2·94	**·95**	1·35	1·17	1·51	2·47	1·51
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	8·0	$\frac{5}{16}$	2·35	**·96**	1·32	1·15	1·23	1·92	1·18
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{3}{8}$	·367	10·4	$\frac{5}{16}$	3·06	**·84**	1·28	1·08	1·36	2·45	1·48
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{5}{16}$	·306	8·8	$\frac{5}{16}$	2·59	**·85**	1·25	1·07	1·18	2·02	1·23
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{1}{4}$	·246	7·2	$\frac{5}{16}$	2·11	**·86**	1·22	1·05	·99	1·61	·98
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·58	**·87**	1·18	1·04	·76	1·17	·71
$2\times2\times\frac{5}{16}$	·308	7·8	$\frac{5}{16}$	2·29	**·75**	1·15	·97	·91	1·66	1·00
$2\times2\times\frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·89	**·76**	1·12	·96	·77	1·33	·80
$2\times2\times\frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·41	**·77**	1·09	·94	·59	·97	·58

Each weight per foot is for the shaft only. Weight of batten plates, connections, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

COMPOUND STRUTS

Two Equal Angles back to back
Gusset on back of Angles
Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

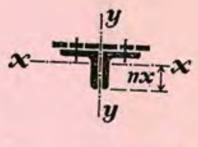
Size $d \times b$ inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	4	6	8	10	12	14	16	20	24	28	32	36	40	44	48
8 × 16 ⅝					255	243	227	187	148	116	92·3	74·6	61·6	*64·0*	*54·2*
8 × 16 ⅝						215	201	167	132	104	82·8	66·9	55·1	*57·5*	*48·7*
8 × 16 ⅝						186	174	145	115	90·5	72·1	58·3	47·9	*50·1*	*42·3*
8 × 16 ⅝						157	147	123	97·8	77·1	61·4	49·8	41·0	*42·8*	*36·2*
6 × 12 ½				160	146	130	112	81·0	59·2	44·7	*43·7*	*34·8*	*28·4*	*23·6*	
6 × 12 ½				139	127	113	97·5	70·8	51·8	39·2	30·5	*30·4*	*24·9*	*20·7*	
6 × 12 ½				118	108	96·3	83·4	60·8	44·7	33·8	26·2	*26·2*	*21·4*	*17·8*	
6 × 12 ½				95·1	87·5	78·0	67·7	49·4	36·4	27·5	21·4	*21·4*	*17·4*	*14·6*	
6 × 12 ½				72·3	66·7	59·7	52·0	38·1	28·0	21·2	16·5	*16·6*	*13·5*	*11·2*	
5 × 10 ½			116	104	89·4	74·3	61·0	41·8	29·9	*28·0*	*21·6*	*17·2*			
5 × 10 ½			97·8	88·4	76·4	63·8	52·5	36·1	25·9	*24·2*	*18·8*	*14·9*			
5 × 10 ½			79·2	71·8	62·2	52·0	42·9	29·6	21·2	*19·8*	*15·4*	*12·2*			
5 × 10 ½			60·7	55·3	48·1	40·4	33·4	23·1	16·6	*15·5*	*12·0*	*9·5*			
4 × 8 ⅜		91·9	80·7	65·8	51·5	40·2	31·9	21·2	*18·6*	*13·9*					
4 × 8 ⅜			69·1	56·9	44·8	35·1	27·8	18·5	*16·3*	*12·1*					
4 × 8 ⅜			56·2	46·4	36·7	28·8	22·8	15·2	*13·4*	*9·9*					
4 × 8 ⅜			43·1	35·7	28·3	22·3	17·7	11·8	*10·4*	*7·6*					
3½ × 7 ⅜		64·1	53·1	40·8	30·7	23·5	18·4	*15·1*	*10·6*						
3½ × 7 ⅜		52·5	43·7	33·6	25·4	19·5	15·3	*12·6*	*8·8*						
3½ × 7 ⅜		40·2	33·6	26·0	19·7	15·1	11·9	*9·7*	*6·8*						
3½ × 7 ⅜		34·2	28·7	22·3	17·0	13·0	10·2	*8·3*	*5·9*						
3 × 6 $\frac{5}{16}$		40·7	30·8	22·1	16·2	12·2	*11·8*	*7·7*							
3 × 6 $\frac{5}{16}$		31·2	23·8	17·2	12·6	9·4	*9·2*	*6·0*							
3 × 6 $\frac{5}{16}$		26·6	20·4	14·8	10·8	8·1	6·3	*5·1*							
3 × 6 $\frac{5}{16}$		21·5	16·6	12·1	8·8	6·7	5·2	*4·2*							
2½ × 5 $\frac{5}{16}$	28·9	22·3	15·2	10·4	7·4	*6·9*	*5·3*								
2½ × 5 $\frac{5}{16}$	24·6	19·2	13·2	9·0	6·4	*6·0*	*4·7*								
2½ × 5 $\frac{5}{16}$	19·6	15·3	10·5	7·2	5·1	*4·8*	*3·7*								
2¼ × 4 $\frac{13}{16}$	24·3	17·3	11·2	7·5	*6·6*	*4·9*	*3·8*								
2¼ × 4 $\frac{13}{16}$	20·7	14·9	9·6	6·5	4·6	*4·3*	*3·3*								
2¼ × 4 $\frac{13}{16}$	16·9	12·1	7·8	5·3	3·7	*3·5*	*2·7*								
2¼ × 4 $\frac{13}{16}$	12·7	9·2	6·0	4·1	2·9	*2·7*	*2·1*								
2 × 4 $\frac{5}{16}$	17·2	11·1	6·8	4·5	*4·0*	*3·0*									
2 × 4 $\frac{5}{16}$	14·2	9·1	5·6	3·7	*3·3*	*2·4*									
2 × 4 $\frac{5}{16}$	10·7	7·0	4·3	2·9	*2·5*	*1·9*									

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut, centre to centre of intersections, in accordance with clause 30.*c*.(iii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line in each angle or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

COMPOUND STRUTS

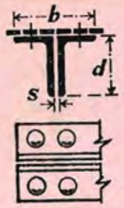
Two Equal Angles back to back



COMPOSITION AND PROPERTIES

Composed of Two Equal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
8 × 8 × 1	·996	102·0	⅝	5·64	30·01	3·61	**2·43**	47·03	31·38
8 × 8 × ⅞	·871	90·0	⅝	5·69	26·48	3·59	**2·45**	40·96	27·82
8 × 8 × ¾	·746	77·8	⅝	5·74	22·88	3·56	**2·46**	34·94	24·16
8 × 8 × ⅝	·621	65·4	⅝	5·79	19·23	3·54	**2·48**	28·96	20·39
6 × 6 × ⅞	·872	66·2	½	4·19	19·48	2·74	**1·81**	23·40	15·15
6 × 6 × ¾	·747	57·4	½	4·23	16·88	2·72	**1·82**	19·92	13·21
6 × 6 × ⅝	·623	48·4	½	4·28	14·24	2·69	**1·84**	16·52	11·21
6 × 6 × ½	·496	39·0	½	4·33	11·48	2·67	**1·85**	13·07	9·09
6 × 6 × ⅜	·371	29·6	½	4·38	8·70	2·64	**1·87**	9·71	6·92
5 × 5 × ¾	·748	47·2	½	3·48	13·89	2·32	**1·50**	14·21	8·97
5 × 5 × ⅝	·622	39·8	½	3·53	11·71	2·29	**1·52**	11·72	7·62
5 × 5 × ½	·496	32·2	½	3·58	9·47	2·27	**1·53**	9·27	6·20
5 × 5 × ⅜	·373	24·6	½	3·63	7·23	2·24	**1·55**	6·91	4·76
4 × 4 × ¾	·749	37·0	⅜	2·73	10·89	1·87	**1·18**	9·13	5·56
4 × 4 × ⅝	·624	31·4	⅜	2·78	9·23	1·85	**1·20**	7·52	4·75
4 × 4 × ½	·496	25·4	⅜	2·83	7·47	1·82	**1·21**	5·92	3·87
4 × 4 × ⅜	·372	19·4	⅜	2·87	5·70	1·80	**1·22**	4·39	2·97
3½ × 3½ × ⅝	·621	27·0	⅜	2·41	7·94	1·65	**1·04**	5·85	3·55
3½ × 3½ × ½	·496	22·0	⅜	2·45	6·47	1·62	**1·05**	4·62	2·91
3½ × 3½ × ⅜	·371	16·8	⅜	2·50	4·94	1·60	**1·06**	3·41	2·24
3½ × 3½ × $\frac{5}{16}$	·311	14·2	⅜	2·52	4·18	1·53	**1·07**	2·84	1·90
3 × 3 × ½	·496	18·6	$\frac{5}{16}$	2·08	5·47	1·40	**·89**	3·40	2·09
3 × 3 × ⅜	·370	14·2	$\frac{5}{16}$	2·12	4·17	1·37	**·90**	2·49	1·61
3 × 3 × $\frac{5}{16}$	·309	12·0	$\frac{5}{16}$	2·15	3·53	1·36	**·91**	2·06	1·36
3 × 3 × ¼	·245	9·6	$\frac{5}{16}$	2·17	2·83	1·34	**·92**	1·62	1·10
2½ × 2½ × ⅜	·372	11·8	$\frac{5}{16}$	1·74	3·47	1·18	**·75**	1·82	1·12
2½ × 2½ × $\frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·77	2·94	1·17	**·76**	1·51	·95
2½ × 2½ × ¼	·245	8·0	$\frac{5}{16}$	1·79	2·35	1·15	**·76**	1·18	·77
2¼ × 2¼ × ⅜	·367	10·4	$\frac{5}{16}$	1·56	3·06	1·08	**·67**	1·48	·88
2¼ × 2¼ × $\frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·58	2·59	1·07	**·68**	1·23	·75
2¼ × 2¼ × ¼	·246	7·2	$\frac{5}{16}$	1·60	2·11	1·05	**·68**	·93	·62
2¼ × 2¼ × $\frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·63	1·58	1·04	**·69**	·71	·46
2 × 2 × $\frac{5}{16}$	·308	7·8	$\frac{5}{16}$	1·39	2·29	·97	**·60**	1·00	·59
2 × 2 × ¼	·249	6·4	$\frac{5}{16}$	1·41	1·89	·96	**·60**	·80	·49
2 × 2 × $\frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·44	1·41	·94	**·61**	·58	·37

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STRUTS

BASED ON
B.S. 449
1959
AS AMENDED

Two Unequal Angles long legs back to back
Gusset on back of Angles

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR MILD STEEL

Size *d*×*b* inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	8	9	10	12	14	16	18	20	24	28	32	36	40	50	60
9 × 8⅝		174	166	146	124	104	86·6	72·5	52·2	39·1	*38·0*	*30·2*			
9 × 8⅝	155	149	142	124	105	87·3	72·4	60·6	43·7	*40·9*	*31·6*	*25·1*			
9 × 8⅝	130	125	119	104	87·3	72·2	59·9	50·0	35·9	*33·6*	*26·1*	*20·7*			
9 × 8⅝	104	99·8	94·5	81·9	68·4	56·5	46·6	38·9	27·9	*26·1*	*20·2*	*16·0*			
8 × 12⅝					188	176	163	148	118	93·3	74·3	60·2	49·5	*40·4*	*28·4*
8 × 12⅝					163	153	142	129	103	81·9	65·2	52·9	43·6	*35·7*	*25·1*
8 × 12⅝					137	129	120	109	87·9	69·7	55·6	45·2	37·1	*30·4*	*21·3*
8 × 12⅝					110	104	95·7	87·0	69·6	55·1	43·9	35·5	29·3	*24·0*	*16·9*
8 × 8⅝		139	133	118	101	84·8	70·9	59·4	43·0	32·2	*31·2*	*24·9*	*20·3*		
8 × 8⅝		116	111	98·1	83·4	69·7	58·1	48·6	35·0	26·2	*25·5*	*20·3*			
8 × 8⅝	97·0	93·3	88·7	77·7	65·7	54·6	45·3	37·9	27·3	*25·6*	*19·8*	*15·7*			
7 × 7⅝	102	96·9	91·0	77·3	63·7	52·1	42·8	35·5	25·4	*23·7*	*18·3*				
7 × 7⅝	81·8	77·5	72·5	61·1	50·0	40·7	33·3	27·6	19·8	*18·4*	*14·2*				
7 × 7⅝	61·6	58·1	54·1	45·3	36·8	29·8	24·4	20·2	14·4	*13·4*	*10·3*				
6 × 8½		116	112	101	88·3	75·2	63·5	53·5	39·0	29·4	*28·5*	*22·7*	*18·6*		
6 × 8½		97·7	93·8	84·3	73·1	61·9	52·0	43·8	31·9	24·0	*23·3*	*18·6*	*15·1*		
6 × 8½		78·7	75·4	67·5	58·3	49·2	41·3	34·7	25·2	18·9	*18·4*	*14·6*	*12·0*		
6 × 7½	91·3	86·9	81·7	69·6	57·5	47·1	38·6	32·1	23·0	*21·5*	*16·6*	*13·1*			
6 × 7½	73·9	70·2	65·8	55·8	45·9	37·5	30·7	25·5	18·2	*17·0*	*13·1*				
6 × 7½	55·6	52·7	49·2	41·4	33·8	27·4	22·5	18·6	13·3	*12·4*	*9·5*				
6 × 6½	80·4	74·2	67·4	53·9	42·6	33·9	27·5	22·6	*20·1*	*14·9*					
6 × 6½	64·1	58·9	53·1	42·1	33·1	26·3	21·2	17·5	*15·4*	*11·4*					
6 × 6½	48·5	44·3	39·9	31·4	24·6	19·5	15·7	12·9	*11·4*	*8·4*					
5 × 7½	82·5	79·1	75·1	65·3	54·9	45·4	37·6	31·4	22·5	*21·0*	*16·3*	*13·0*			
5 × 7½	66·8	63·9	60·4	52·2	43·6	35·9	29·6	24·7	17·7	*16·5*	*12·8*	*10·2*			
5 × 7½	50·3	48·0	45·2	38·7	32·1	26·4	21·7	18·0	12·9	*12·1*	*9·3*	*7·4*			
5 × 6½	58·4	54·2	49·6	40·1	32·0	25·6	20·7	17·1	*15·2*	*11·3*					
5 × 6½	44·0	40·6	37·0	29·6	23·5	18·7	15·2	12·5	*11·1*	*8·2*					
5 × 6½	36·6	33·7	30·6	24·5	19·4	15·4	12·5	10·3	*9·1*	*6·7*					

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut, centre to centre of intersections, in accordance with clause 30.*c*.(iii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line in each angle or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

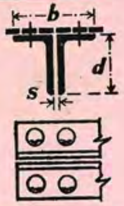
COMPOUND STRUTS

Two Unequal Angles
Long Legs back to back

COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
9 ×4 × ⅞	·872	72·2	⅝	5·56	21·23	**1·61**	2·86	12·83	31·15
9 ×4 × ¾	·745	62·4	⅝	5·61	18·34	**1·58**	2·88	10·67	27·00
9 ×4 × ⅝	·622	52·6	⅝	5·66	15·48	**1·56**	2·89	8·69	22·86
9 ×4 × ½	·495	42·4	⅝	5·72	12·46	**1·53**	2·91	6·74	18·46
8 ×6 × ⅞	·870	78·0	⅝	5·40	22·94	2·58	**2·50**	24·27	26·60
8 ×6 × ¾	·746	67·6	⅝	5·45	19·87	2·56	**2·52**	20·63	23·14
8 ×6 × ⅝	·621	56·8	⅝	5·50	16·71	2·54	**2·54**	17·03	19·54
8 ×6 × ½	·495	45·8	⅝	5·55	13·46	**2·51**	2·55	13·46	15·80
8 ×4 × ¾	·747	57·4	⅝	5·06	16·88	**1·64**	2·55	10·52	21·60
8 ×4 × ⅝	·623	48·4	⅝	5·11	14·24	**1·61**	2·56	8·58	18·30
8 ×4 × ½	·496	39·0	⅝	5·17	11·48	**1·58**	2·58	6·68	14·80
7 ×3½× ⅝	·623	42·0	⅝	4·44	12·36	**1·46**	2·23	6·88	13·84
7 ×3½× ½	·497	34·0	⅝	4·50	10·00	**1·43**	2·25	5·34	11·23
7 ×3½× ⅜	·372	25·8	⅝	4·55	7·59	**1·40**	2·27	3·89	8·55
6 ×4 × ¾	·748	47·2	½	3·93	13·89	**1·73**	1·87	9·77	12·40
6 ×4 × ⅝	·622	39·8	½	3·98	11·71	**1·70**	1·89	7·99	10·51
6 ×4 × ½	·496	32·2	½	4·03	9·47	**1·68**	1·91	6·26	8·54
6 ×3½× ⅝	·620	37·6	½	3·88	11·05	**1·47**	1·90	6·39	10·24
6 ×3½× ½	·497	30·6	½	3·93	8·99	**1·45**	1·91	5·01	8·37
6 ×3½× ⅜	·371	23·2	½	3·99	6·82	**1·42**	1·93	3·65	6·36
6 ×3 × ⅝	·623	35·6	½	3·78	10·47	**1·25**	1·90	5·07	10·00
6 ×3 × ½	·496	28·8	½	3·83	8·47	**1·22**	1·92	3·91	8·12
6 ×3 × ⅜	·373	22·0	½	3·88	6·47	**1·20**	1·93	2·85	6·23
5 ×3½× ⅝	·621	33·4	½	3·31	9·82	**1·55**	1·56	6·28	7·19
5 ×3½× ½	·498	27·2	½	3·36	8·00	**1·52**	1·57	4·94	5·89
5 ×3½× ⅜	·371	20·6	½	3·41	6·06	**1·49**	1·59	3·61	4·49
5 ×3 × ½	·496	25·4	½	3·26	7·47	**1·29**	1·58	3·82	5·72
5 ×3 × ⅜	·372	19·4	½	3·31	5·70	**1·26**	1·60	2·79	4·38
5 ×3 × $\frac{5}{16}$	·308	16·2	½	3·34	4·76	**1·25**	1·60	2·28	3·67

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.



COMPOUND STRUTS

Two Unequal Angles long legs back to back
Gusset on back of Angles
Two or more rivets or bolts in line, or welded, at ends

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Size $d\times b$ inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30
$4\times7\frac{3}{8}$				64·7	53·4	42·2	33·1	26·2	21·2	17·5	*18·2*	*15·4*	*13·2*	*11·5*	
$4\times7\frac{3}{8}$				53·2	44·3	35·2	27·7	22·1	17·8	14·7	*15·3*	*13·0*	*11·1*	*9·6*	*8·4*
$4\times7\frac{3}{8}$				40·9	34·1	27·2	21·5	17·1	13·8	11·4	*11·9*	*10·1*	*8·6*	*7·4*	*6·5*
$4\times7\frac{3}{8}$				34·3	28·8	23·0	18·2	14·5	11·7	9·6	8·0	*8·5*	*7·3*	*6·3*	*5·5*
$4\times6\frac{3}{8}$				49·5	41·3	32·9	25·9	20·7	16·7	13·8	*14·4*	*12·2*	*10·4*	*9·0*	*7·9*
$4\times6\frac{3}{8}$				37·9	31·8	25·4	20·1	16·0	13·0	10·7	8·9	*9·4*	*8·0*	*7·0*	*6·1*
$4\times6\frac{3}{8}$				32·2	27·1	21·7	17·2	13·7	11·1	9·1	7·6	*8·1*	*6·9*	*6·0*	*5·2*
$4\times5\frac{3}{8}$			37·3	31·2	24·1	18·3	14·0	11·0	8·8	*9·0*	*7·5*	*6·3*			
$4\times5\frac{3}{8}$			30·9	25·6	19·7	14·8	11·3	8·8	7·1	*7·3*	*6·0*	*5·1*			
$4\times5\frac{3}{8}$			25·0	20·6	15·7	11·8	9·0	7·0	5·6	*5·8*	*4·8*	*4·0*			
$3\frac{1}{2}\times6\frac{3}{8}$			49·0	41·2	32·0	24·3	18·7	14·7	11·8	*12·0*	*10·1*	*8·4*	*7·2*		
$3\frac{1}{2}\times6\frac{3}{8}$			37·5	31·7	24·8	18·9	14·5	11·4	9·1	*9·3*	*7·7*	*6·6*	*5·6*		
$3\frac{1}{2}\times6\frac{3}{8}$			31·5	26·7	21·0	16·0	12·3	9·6	7·8	*7·9*	*6·6*	*5·6*	*4·8*		
$3\frac{1}{2}\times5\frac{3}{8}$			34·3	29·1	22·8	17·4	13·4	10·6	8·4	*8·6*	*7·2*	*6·1*	*5·2*		
$3\frac{1}{2}\times5\frac{3}{8}$			28·9	24·4	19·1	14·5	11·2	8·7	7·0	*7·2*	*6·0*	*5·0*	*4·3*		
$3\frac{1}{2}\times5\frac{3}{8}$			23·1	19·4	15·1	11·5	8·8	6·9	5·5	*5·6*	*4·7*	*4·0*	*3·4*		
$3\times5\frac{5}{16}$		31·6	29·0	22·4	16·3	12·0	9·0	7·0	*7·0*	*5·7*	*4·7*				
$3\times5\frac{5}{16}$		26·8	24·7	19·2	14·0	10·3	7·8	6·0	*6·0*	*4·9*	*4·1*				
$3\times5\frac{5}{16}$		21·5	19·8	15·4	11·2	8·2	6·2	4·8	*4·8*	*3·9*	*3·3*				
$3\times4\frac{5}{16}$		28·3	25·8	19·5	14·0	10·3	7·7	*7·5*	*6·0*	*4·8*					
$3\times4\frac{5}{16}$		23·8	21·5	16·0	11·5	8·3	6·2	*6·0*	*4·8*	*3·9*					
$3\times4\frac{5}{16}$		18·9	17·1	12·6	8·9	6·5	4·9	*4·7*	*3·8*	*3·1*					
$2\frac{1}{2}\times4\frac{5}{16}$	25·6	23·1	20·0	13·7	9·4	6·7	*6·3*	*4·9*	*3·9*						
$2\frac{1}{2}\times4\frac{5}{16}$	21·7	19·7	17·1	11·9	8·1	5·8	*5·4*	*4·2*	*3·3*						
$2\frac{1}{2}\times4\frac{5}{16}$	17·8	16·2	14·1	9·8	6·8	4·9	*4·5*	*3·5*	*2·8*						
$2\frac{1}{2}\times4\frac{5}{16}$	13·3	12·2	10·7	7·5	5·2	3·7	*3·5*	*2·7*	*2·1*						
$2\frac{1}{2}\times3\frac{5}{16}$	15·0	13·0	10·7	6·8	4·6	*4·1*	*3·0*	*2·3*							
$2\frac{1}{2}\times3\frac{5}{16}$	11·1	9·4	7·6	4·8	3·2	*2·9*	*2·1*								
$2\times3\frac{5}{16}$	12·2	10·1	8·0	5·0	3·3	*2·9*	*2·2*								
$2\times3\frac{5}{16}$	9·5	8·0	6·4	4·0	2·7	*2·4*	*1·7*								

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250.
Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut, centre to centre of intersections, in accordance with clause 30.*c*.(iii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line in each angle or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

COMPOUND STRUTS

Two Unequal Angles
Long Legs back to back

COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
$4\times3\frac{1}{2}\times\frac{5}{8}$	·623	29·2	$\frac{3}{8}$	2·71	8·59	1·59	**1·21**	5·92	4·65
$4\times3\frac{1}{2}\times\frac{1}{2}$	·498	23·8	$\frac{3}{8}$	2·76	7·00	1·57	**1·23**	4·67	3·81
$4\times3\frac{1}{2}\times\frac{3}{8}$	·374	18·2	$\frac{3}{8}$	2·81	5·35	1·54	**1·24**	3·45	2·93
$4\times3\frac{1}{2}\times\frac{5}{16}$	·309	15·2	$\frac{3}{8}$	2·83	4·47	1·53	**1·25**	2·83	2·45
$4\times3\times\frac{1}{2}$	·496	22·0	$\frac{3}{8}$	2·68	6·47	1·32	**1·24**	3·55	3·70
$4\times3\times\frac{3}{8}$	·371	16·8	$\frac{3}{8}$	2·73	4·94	1·30	**1·25**	2·60	2·84
$4\times3\times\frac{5}{16}$	·311	14·2	$\frac{3}{8}$	2·76	4·18	1·28	**1·26**	2·15	2·41
$4\times2\frac{1}{2}\times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	2·64	4·58	**1·06**	1·26	1·91	2·77
$4\times2\frac{1}{2}\times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	2·67	3·83	**1·04**	1·27	1·55	2·32
$4\times2\frac{1}{2}\times\frac{1}{4}$	·248	10·6	$\frac{3}{8}$	2·70	3·11	**1·03**	1·28	1·23	1·89
$3\frac{1}{2}\times3\times\frac{1}{2}$	·499	20·4	$\frac{3}{8}$	2·38	6·00	1·37	**1·07**	3·54	2·86
$3\frac{1}{2}\times3\times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	2·43	4·58	1·34	**1·08**	2·59	2·20
$3\frac{1}{2}\times3\times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	2·46	3·83	1·33	**1·09**	2·12	1·84
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·370	14·2	$\frac{3}{8}$	2·35	4·17	1·10	**1·09**	1·88	2·12
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·309	12·0	$\frac{3}{8}$	2·38	3·53	**1·08**	1·10	1·54	1·79
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	9·6	$\frac{3}{8}$	2·41	2·83	**1·07**	1·11	1·20	1·44
$3\times2\frac{1}{2}\times\frac{3}{8}$	·372	13·0	$\frac{5}{16}$	2·06	3·82	1·12	**·92**	1·81	1·57
$3\times2\frac{1}{2}\times\frac{5}{16}$	·311	11·0	$\frac{5}{16}$	2·08	3·23	1·11	**·93**	1·49	1·33
$3\times2\frac{1}{2}\times\frac{1}{4}$	·246	8·8	$\frac{5}{16}$	2·11	2·59	1·09	**·93**	1·16	1·07
$3\times2\times\frac{3}{8}$	·372	11·8	$\frac{5}{16}$	1·97	3·47	**·89**	·94	1·27	1·54
$3\times2\times\frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·99	2·94	**·87**	·94	1·04	1·31
$3\times2\times\frac{1}{4}$	·245	8·0	$\frac{5}{16}$	2·02	2·35	**·86**	·95	·81	1·06
$2\frac{1}{2}\times2\times\frac{3}{8}$	·367	10·4	$\frac{5}{16}$	1·68	3·06	·93	**·76**	1·23	1·07
$2\frac{1}{2}\times2\times\frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·70	2·59	·92	**·77**	1·01	·91
$2\frac{1}{2}\times2\times\frac{1}{4}$	·246	7·2	$\frac{5}{16}$	1·72	2·11	·90	**·78**	·80	·74
$2\frac{1}{2}\times2\times\frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·75	1·58	·89	**·79**	·53	·56
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·63	1·89	**·67**	·79	·51	·72
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·66	1·41	**·65**	·80	·36	·54
$2\times1\frac{1}{2}\times\frac{1}{4}$	·241	5·4	$\frac{5}{16}$	1·35	1·59	·71	**·62**	·43	·45
$2\times1\frac{1}{2}\times\frac{3}{16}$	·184	4·2	$\frac{5}{16}$	1·37	1·24	·69	**·63**	·36	·35

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

COMPOUND STRUTS

BASED ON
B.S. 449
1959
AS AMENDED

Two Unequal Angles short legs back to back
Gusset on back of Angles

Two or more rivets or bolts in line, or welded, at ends

SAFE LOADS FOR MILD STEEL

Size *d*×*b* inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	5	6	8	10	12	14	16	18	20	22	24	26	28	32	40
4 × 18⅝		169	138	104	78·1	59·8	46·7	*46·8*	*38·2*	*31·8*	*27·0*				
4 × 18⅝		147	120	91·5	68·6	52·5	41·1	33·0	*33·7*	*28·0*	*23·6*				
4 × 18⅝		125	103	78·3	59·0	45·1	35·3	28·3	*29·0*	*24·0*	*20·4*				
4 × 18⅝		101	83·4	64·0	48·2	36·9	28·9	23·2	*23·8*	*19·8*	*16·7*				
6 × 16⅝				186	168	147	125	106	89·4	76·0	65·1	56·1	49·0	*47·5*	*30·8*
6 × 16⅝				161	146	128	109	92·3	78·1	66·4	56·9	49·2	42·8	*41·7*	*27·0*
6 × 16⅝				136	124	109	93·3	79·0	66·9	57·0	48·9	42·2	36·8	*35·8*	*23·3*
6 × 16⅝				110	100	88·2	75·7	64·2	54·4	46·4	39·8	34·5	30·0	*29·1*	*19·0*
4 × 16⅝		137	114	87·8	66·4	50·8	40·0	32·0	*32·8*	*27·3*	*23·0*				
4 × 16⅝		116	97·0	75·1	56·8	43·6	34·3	27·5	*28·1*	*23·4*	*19·8*				
4 × 16⅝		93·8	78·9	61·3	46·6	35·8	28·1	22·6	*23·0*	*19·3*	*16·2*	*13·9*			
3½ × 14⅝	102	93·9	72·4	52·8	38·8	29·3	22·8	*22·8*	*18·6*	*15·5*					
3½ × 14⅝	83·0	76·4	59·4	43·4	32·0	24·2	18·8	*18·8*	*15·3*	*12·8*					
3½ × 14⅝	63·2	58·4	45·7	33·5	24·7	18·7	14·6	*14·6*	*11·9*	*9·8*					
4 × 12½		115	98·3	77·9	59·8	46·2	36·4	29·3	*29·9*	*25·0*	*21·1*	*18·1*			
4 × 12½		97·6	84·1	67·1	51·8	40·2	31·7	25·5	*26·2*	*21·8*	*18·4*	*15·7*			
4 × 12½		79·1	68·5	54·9	42·5	33·0	26·0	20·9	17·2	*17·9*	*15·2*	*13·0*			
3½ × 12½	92·3	85·5	67·3	49·6	36·6	27·7	21·7	*21·6*	*17·7*	*14·8*					
3½ × 12½	75·3	69·9	55·4	41·0	30·3	23·1	18·0	*17·9*	*14·7*	*12·2*					
3½ × 12½	57·5	53·6	43·0	32·1	23·8	18·2	14·2	*14·2*	*11·6*	*9·6*	*8·1*				
3 × 12½	80·3	70·1	48·9	33·8	24·3	*22·7*	*17·6*	*14·0*							
3 × 12½	65·4	57·4	40·3	28·0	20·2	*18·9*	*14·6*	*11·6*							
3 × 12½	50·3	44·3	31·4	21·8	15·7	11·8	*11·4*	*9·0*							
3½ × 10½	83·0	77·6	62·5	46·9	34·9	26·6	20·8	*20·8*	*17·0*	*14·2*	*12·0*				
3½ × 10½		63·5	51·5	38·8	29·0	22·1	17·2	*17·3*	*14·1*	*11·8*	*9·9*				
3½ × 10½		48·3	39·4	29·8	22·3	17·1	13·3	*13·4*	*10·9*	*9·0*	*7·6*				
3 × 10½	58·9	52·3	37·5	26·3	19·0	14·2	*13·8*	*11·0*	*8·9*						
3 × 10½	45·4	40·6	29·6	20·9	15·2	11·4	*11·1*	*8·7*	*7·2*						
3 × 10½	37·9	33·9	24·8	17·5	12·7	9·5	*9·2*	*7·3*	*6·0*						

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut, centre to centre of intersections, in accordance with clause 30.c.(iii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line in each angle or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

COMPOUND STRUTS

Two Unequal Angles
Short Legs back to back

COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
9 × 4 × ⅞	·872	72·2	⅝	3·05	21·23	4·71	**1·01**	50·66	7·05
9 × 4 × ¾	·745	62·4	⅝	3·10	18·34	4·63	**1·02**	43·21	6·13
9 × 4 × ⅝	·622	52·6	⅝	3·15	15·48	4·66	**1·03**	36·02	5·22
9 × 4 × ½	·495	42·4	⅝	3·20	12·46	4·62	**1·04**	28·61	4·25
8 × 6 × ⅞	·870	78·0	⅝	4·40	22·94	3·84	**1·74**	40·64	15·72
8 × 6 × ¾	·746	67·6	⅝	4·44	19·87	3·81	**1·75**	34·74	13·71
8 × 6 × ⅝	·621	56·8	⅝	4·49	16·71	3·79	**1·77**	28·83	11·61
8 × 6 × ½	·495	45·8	⅝	4·54	13·46	3·76	**1·78**	22·91	9·41
8 × 4 × ¾	·747	57·4	⅝	3·05	16·88	4·13	**1·05**	34·60	6·07
8 × 4 × ⅝	·623	48·4	⅝	3·10	14·24	4·10	**1·06**	28·80	5·17
8 × 4 × ½	·496	39·0	⅝	3·15	11·48	4·07	**1·07**	22·87	4·21
7 × 3½ × ⅝	·623	42·0	⅝	2·68	12·36	3·63	**·92**	22·32	3·89
7 × 3½ × ½	·497	34·0	⅝	2·73	10·00	3·60	**·93**	17·75	3·18
7 × 3½ × ⅜	·372	25·8	⅝	2·78	7·59	3·57	**·94**	13·24	2·44
6 × 4 × ¾	·748	47·2	½	2·93	13·89	2·98	**1·11**	19·74	5·88
6 × 4 × ⅝	·622	39·8	½	2·97	11·71	2·95	**1·13**	16·35	5·00
6 × 4 × ½	·496	32·2	½	3·02	9·47	2·93	**1·14**	12·98	4·08
6 × 3½ × ⅝	·620	37·6	½	2·63	11·05	3·03	**·95**	16·26	3·81
6 × 3½ × ½	·497	30·6	½	2·67	8·99	3·00	**·96**	12·93	3·13
6 × 3½ × ⅜	·371	23·2	½	2·72	6·82	2·97	**·98**	9·65	2·39
6 × 3 × ⅝	·623	35·6	½	2·27	10·47	3·12	**·78**	16·30	2·80
6 × 3 × ½	·496	28·8	½	2·31	8·47	3·09	**·79**	12·94	2·28
6 × 3 × ⅜	·373	22·0	½	2·36	6·47	3·06	**·80**	9·69	1·76
5 × 3½ × ⅝	·621	33·4	½	2·55	9·82	2·49	**·99**	11·58	3·73
5 × 3½ × ½	·498	27·2	½	2·60	8·00	2·46	**1·00**	9·23	3·07
5 × 3½ × ⅜	·371	20·6	½	2·65	6·06	2·43	**1·01**	6·83	2·34
5 × 3 × ½	·496	25·4	½	2·26	7·47	2·54	**·82**	9·17	2·24
5 × 3 × ⅜	·372	19·4	½	2·30	5·70	2·51	**·84**	6·84	1·73
5 × 3 × $\frac{5}{16}$	·308	16·2	½	2·33	4·76	2·49	**·84**	5·64	1·45

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

COMPOUND STRUTS

Two Unequal Angles short legs back to back
Gusset on back of Angles

Two or more rivets or bolts in line, or welded, at ends

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Size $d \times b$ inches	SAFE LOADS IN TONS FOR LENGTHS IN FEET BETWEEN INTERSECTIONS														
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
$3\frac{1}{2} \times 8\frac{3}{8}$			68·8	63·1	56·4	49·4	42·9	37·1	32·1	24·6	19·2	15·5	*15·8*	*13·1*	*11·1*
$3\frac{1}{2} \times 8\frac{3}{8}$			56·3	51·8	46·4	40·7	35·4	30·7	26·7	20·4	16·0	12·8	*13·1*	*10·9*	*9·2*
$3\frac{1}{2} \times 8\frac{3}{8}$			43·4	40·1	36·1	31·9	27·8	24·2	21·0	16·1	12·7	10·1	*10·4*	*8·6*	*7·2*
$3\frac{1}{2} \times 8\frac{3}{8}$			36·3	33·5	30·2	26·7	23·2	20·2	17·6	13·5	10·6	8·4	*8·6*	*7·2*	*6·0*
$3 \times 8\frac{3}{8}$		52·1	47·0	40·9	34·7	29·3	24·7	21·0	18·0	13·5	*13·1*	*10·5*	*8·5*		
$3 \times 8\frac{3}{8}$		40·0	36·2	31·6	27·0	22·8	19·2	16·4	14·0	10·6	*10·2*	*8·1*	*6·6*		
$3 \times 8\frac{3}{8}$		34·0	30·9	27·1	23·2	19·6	16·6	14·1	12·1	9·1	*8·8*	*7·0*	*5·7*		
$2\frac{1}{2} \times 8\frac{3}{8}$	36·9	32·3	26·8	21·7	17·6	14·4	11·9	9·9	8·4	*7·8*	*6·0*				
$2\frac{1}{2} \times 8\frac{3}{8}$	31·1	27·3	22·8	18·6	15·1	12·3	10·2	8·5	7·2	*6·7*	*5·2*				
$2\frac{1}{2} \times 8\frac{3}{8}$	25·2	22·2	18·6	15·1	12·2	9·9	8·2	6·9	5·8	*5·4*	*4·2*				
$3 \times 7\frac{3}{8}$		48·6	43·9	38·4	32·7	27·7	23·4	19·9	17·0	12·8	*12·4*	*9·9*	*8·0*		
$3 \times 7\frac{3}{8}$		37·4	34·1	30·0	25·8	21·8	18·5	15·8	13·5	10·2	*9·9*	*7·9*	*6·4*		
$3 \times 7\frac{3}{8}$		31·3	28·5	25·1	21·5	18·3	15·5	13·2	11·3	8·5	*8·2*	*6·6*	*5·4*		
$2\frac{1}{2} \times 7\frac{3}{8}$	34·0	30·1	25·3	20·6	16·8	13·7	11·4	9·5	8·1	*7·5*	*5·8*				
$2\frac{1}{2} \times 7\frac{3}{8}$	28·9	25·7	21·7	17·8	14·5	11·9	9·8	8·3	7·0	*6·5*	*5·0*				
$2\frac{1}{2} \times 7\frac{3}{8}$	23·2	20·6	17·4	14·3	11·7	9·5	7·9	6·6	5·6	*5·2*	*4·0*				
$2\frac{1}{2} \times 6\frac{5}{16}$	31·5	28·1	23·9	19·7	16·1	13·2	11·0	9·2	7·8	*7·3*	*5·6*				
$2\frac{1}{2} \times 6\frac{5}{16}$	26·6	23·8	20·2	16·6	13·6	11·2	9·2	7·8	6·6	*6·1*	*4·7*				
$2\frac{1}{2} \times 6\frac{5}{16}$	21·5	19·2	16·4	13·6	11·1	9·1	7·6	6·4	5·4	*5·0*	*3·9*	*3·1*			
$2 \times 6\frac{5}{16}$	24·7	19·7	15·1	11·7	9·2	7·4	*7·6*	*6·3*	*5·3*						
$2 \times 6\frac{5}{16}$	21·0	16·7	12·8	9·9	7·8	6·2	*6·4*	*5·3*	*4·5*						
$2 \times 6\frac{5}{16}$	17·0	13·6	10·5	8·1	6·4	5·1	4·2	*4·4*	*3·7*						
$2 \times 5\frac{5}{16}$	22·1	17·7	13·7	10·6	8·4	6·7	5·5	*5·7*	*4·9*						
$2 \times 5\frac{5}{16}$	19·0	15·3	11·9	9·2	7·3	5·9	4·8	*5·0*	*4·2*	*3·1*					
$2 \times 5\frac{5}{16}$	15·6	12·8	9·9	7·7	6·1	4·9	4·0	*4·2*	*3·6*	*2·6*					
$2 \times 5\frac{5}{16}$	11·7	9·5	7·4	5·8	4·6	3·7	3·0	*3·1*	*2·6*	*2·0*					
$1\frac{1}{2} \times 5\frac{5}{16}$	9·4	6·6	4·8	3·6	*3·4*	*2·7*	*2·2*								
$1\frac{1}{2} \times 5\frac{5}{16}$	7·3	5·1	3·7	2·8	*2·7*	*2·1*	*1·7*								
$1\frac{1}{2} \times 4\frac{5}{16}$	8·5	6·0	4·4	3·3	*3·2*	*2·5*	*2·1*								
$1\frac{1}{2} \times 4\frac{5}{16}$	6·6	4·7	3·4	2·5	*2·5*	*2·0*	*1·6*								

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 250. Safe loads printed in italics are for ratios of slenderness exceeding 180 and apply to wind forces only.
Safe loads are calculated for the length of strut, centre to centre of intersections, in accordance with clause 30.*c*.(iii) of B.S. 449 : 1959, as amended, and require not less than 2 bolts or rivets in line in each angle or their equivalent in welding.
These safe loads allow for normal eccentricity in the end connection.

BASED ON
B.S. 449
1959

COMPOUND STRUTS

Two Unequal Angles
Short Legs back to back

COMPOSITION AND PROPERTIES

Composed of Two Unequal Angles	Actual Thickness inches	Weight per foot in lbs	Space between Angles *s* inches	Distance *nx* inches	Area in square inches	Radius of Gyration		Elastic Modulus	
						Axis *y-y*	Axis *x-x*	Axis *y-y*	Axis *x-x*
$4 \times 3\frac{1}{2} \times \frac{5}{8}$	·623	29·2	$\frac{3}{8}$	2·46	8·59	1·91	**1·02**	7·47	3·63
$4 \times 3\frac{1}{2} \times \frac{1}{2}$	·498	23·8	$\frac{3}{8}$	2·51	7·00	1·88	**1·03**	5·92	2·98
$4 \times 3\frac{1}{2} \times \frac{3}{8}$	·374	18·2	$\frac{3}{8}$	2·56	5·35	1·86	**1·05**	4·40	2·30
$4 \times 3\frac{1}{2} \times \frac{5}{16}$	·309	15·2	$\frac{3}{8}$	2·58	4·47	1·84	**1·05**	3·61	1·92
$4 \times 3 \times \frac{1}{2}$	·496	22·0	$\frac{3}{8}$	2·18	6·47	1·95	**·86**	5·87	2·18
$4 \times 3 \times \frac{3}{8}$	·371	16·8	$\frac{3}{8}$	2·23	4·94	1·92	**·87**	4·35	1·68
$4 \times 3 \times \frac{5}{16}$	·311	14·2	$\frac{3}{8}$	2·25	4·18	1·91	**·88**	3·63	1·42
$4 \times 2\frac{1}{2} \times \frac{3}{8}$	·373	15·6	$\frac{3}{8}$	1·89	4·58	2·00	**·69**	4·36	1·17
$4 \times 2\frac{1}{2} \times \frac{5}{16}$	·308	13·0	$\frac{3}{8}$	1·91	3·83	1·98	**·70**	3·59	·93
$4 \times 2\frac{1}{2} \times \frac{1}{4}$	·248	10·6	$\frac{3}{8}$	1·94	3·11	1·96	**·70**	2·87	·80
$3\frac{1}{2} \times 3 \times \frac{1}{2}$	·499	20·4	$\frac{3}{8}$	2·13	6·00	1·68	**·87**	4·62	2·15
$3\frac{1}{2} \times 3 \times \frac{3}{8}$	·373	15·6	$\frac{3}{8}$	2·18	4·53	1·66	**·89**	3·41	1·66
$3\frac{1}{2} \times 3 \times \frac{5}{16}$	·308	13·0	$\frac{3}{8}$	2·21	3·83	1·64	**·89**	2·80	1·39
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	·370	14·2	$\frac{3}{8}$	1·85	4·17	1·72	**·71**	3·37	1·14
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	·309	12·0	$\frac{3}{8}$	1·87	3·53	1·71	**·72**	2·79	·97
$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	·245	9·6	$\frac{3}{8}$	1·90	2·83	1·69	**·72**	2·20	·78
$3 \times 2\frac{1}{2} \times \frac{3}{8}$	·372	13·0	$\frac{5}{16}$	1·80	3·82	1·43	**·73**	2·49	1·12
$3 \times 2\frac{1}{2} \times \frac{5}{16}$	·311	11·0	$\frac{5}{16}$	1·83	3·23	1·42	**·73**	2·07	·95
$3 \times 2\frac{1}{2} \times \frac{1}{4}$	·246	8·8	$\frac{5}{16}$	1·85	2·59	1·40	**·74**	1·62	·77
$3 \times 2 \times \frac{3}{8}$	·372	11·8	$\frac{5}{16}$	1·46	3·47	1·51	**·56**	2·51	·73
$3 \times 2 \times \frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·49	2·94	1·50	**·56**	2·09	·62
$3 \times 2 \times \frac{1}{4}$	·245	8·0	$\frac{5}{16}$	1·51	2·35	1·48	**·57**	1·64	·50
$2\frac{1}{2} \times 2 \times \frac{3}{8}$	·367	10·4	$\frac{5}{16}$	1·42	3·06	1·24	**·57**	1·78	·71
$2\frac{1}{2} \times 2 \times \frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·45	2·59	1·23	**·58**	1·47	·60
$2\frac{1}{2} \times 2 \times \frac{1}{4}$	·246	7·2	$\frac{5}{16}$	1·47	2·11	1·22	**·59**	1·18	·50
$2\frac{1}{2} \times 2 \times \frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·50	1·58	1·20	**·59**	·86	·37
$2\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·13	1·89	1·29	**·41**	1·18	·28
$2\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·15	1·41	1·27	**·42**	·86	·21
$2 \times 1\frac{1}{2} \times \frac{1}{4}$	·241	5·4	$\frac{5}{16}$	1·09	1·59	1·02	**·43**	·76	·27
$2 \times 1\frac{1}{2} \times \frac{3}{16}$	·184	4·2	$\frac{5}{16}$	1·12	1·24	1·00	**·43**	·58	·21

Each weight per foot is for the shaft only. Weight of connections, intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing pages 162 and 176.

COLUMNS

SOLID ROUND STEEL

SAFE LOADS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Diameter D inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET												
		8	10	12	14	16	18	20	22	24	26	28	32	36
12	385				931	878	814	743	670	598	533	475	379	308
11½	353·5			885	842	787	723	652	583	517	458	407	323	261
11	323·5			799	755	700	635	568	503	443	391	345	273	220
10½	294·5			718	672	616	552	489	429	376	330	290	229	184
10	267·5			640	593	536	475	415	362	315	275	241	190	153
9½	241		602	565	517	461	403	348	301	261	227	199	156	
9	216·5		532	494	445	390	337	288	247	213	185	162	126	
8½	193		466	426	377	325	277	235	200	172	149	130		
8	171		403	362	314	266	223	188	160	137	118	103		
7½	150·5	374	343	302	255	213	177	148	125	107	92·0	79·9		

Diameter D inches	Weight per foot in lbs	SAFE CONCENTRIC LOADS IN TONS FOR EFFECTIVE LENGTHS IN FEET												
		6	8	9	10	11	12	13	14	16	18	20	22	24
7	131		319	304	287	267	245	224	204	167	137	114	96·0	81·9
6½	113		268	252	234	215	195	176	158	127	104	86·3	72·2	61·2
6	96·5		219	204	186	167	150	133	119	94·7	76·9	63·3	52·9	
5½	81	200	175	159	142	126	111	97·7	86·3	68·3	55·1	45·1		
5	67	160	134	119	104	90·4	78·7	68·7	60·4	47·5	38·2			
4½	54·5	123	97·5	84·1	72·1	61·9	53·3	46·3	40·5	31·6				
4	43	90·5	66·5	55·8	47·0	40·0	34·2	29·5	25·8					
3½	33	61·4	41·7	34·3	28·5	24·0	20·5	17·6						
3	24·5	37·4	23·7	19·2	15·8	13·2								

The above safe loads are tabulated for ratios of slenderness up to, but not exceeding 180. Safe loads are calculated for the "effective lengths" of stanchions in accordance with Table 17 of B.S. 449 : 1959, as amended.

BASED ON
B.S. 449
1959

COLUMNS

SOLID ROUND STEEL

DIMENSIONS AND PROPERTIES

Diameter D	Area	Moment of Inertia	Radius of Gyration	Elastic Modulus
ins	*ins 2*	*ins 4*	*ins*	*ins 3*
12	113·100	1017·9	3·000	169·6
11½	103·870	858·5	2·875	149·3
11	95·033	718·7	2·750	130·6
10½	86·590	596·7	2·625	113·6
10	78·540	490·9	2·500	98·1
9½	70·882	399·8	2·375	84·1
9	63·617	322·1	2·250	71·5
8½	56·745	256·2	2·125	60·2
8	50·265	201·1	2·000	50·2
7½	44·179	155·3	1·875	41·4
7	38·485	117·9	1·750	33·6
6½	33·183	87·6	1·625	26·9
6	28·274	63·6	1·500	21·2
5½	23·758	44·9	1·375	16·3
5	19·635	30·7	1·250	12·2
4½	15·904	20·1	1·125	8·94
4	12·566	12·57	1·000	6·28
3½	9·621	7·37	·875	4·20
3	7·069	3·98	·750	2·65

Each weight per foot is for the shaft only, weight of base, etc., to be added. For explanation of tables, see notes commencing pages 162 and 176.

TIES

Equal Angles

BASED ON
B.S. 449
1959

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Equal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
8×8×1	·996	51·0	1·56	15·01	0	—	13·08	118	—	—
					1	$\frac{15}{16}$	11·95	108	14·07	127
					2	$\frac{15}{16}$	10·78	97·0	13·14	118
					3	$\frac{15}{16}$	—	—	12·20	110
8×8×$\frac{7}{8}$	·871	45·0	1·57	13·24	0	—	11·53	104	—	—
					1	$\frac{15}{16}$	10·54	94·9	12·42	112
					2	$\frac{15}{16}$	9·52	85·7	11·61	104
					3	$\frac{15}{16}$	—	—	10·79	97·1
8×8×$\frac{3}{4}$	·746	38·9	1·58	11·44	0	—	9·96	94·6	—	—
					1	$\frac{15}{16}$	9·11	86·6	10·74	102
					2	$\frac{15}{16}$	8·24	78·2	10·04	95·4
					3	$\frac{15}{16}$	—	—	9·34	88·8
8×8×$\frac{5}{8}$	·621	32·7	1·58	9·61	0	—	8·36	79·4	—	—
					1	$\frac{15}{16}$	7·65	72·7	9·03	85·8
					2	$\frac{15}{16}$	6·93	65·8	8·45	80·3
					3	$\frac{15}{16}$	—	—	7·87	74·7

The above safe loads are calculated for an axial stress of 9·5 tons/inch² for angles up to and including ¾″ thick, and 9·0 tons/inch² for angles over ¾″ thick on the effective areas as specified in clause 42 of B.S. 449: 1959.

BASED ON
B.S. 449
1959

TIES

Equal Angles

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Equal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
6×6×$\frac{7}{8}$	·872	33·1	1·17	9·74	0	—	8·49	76·4	—	—
					1	$\frac{15}{16}$	7·50	67·5	8·92	80·3
					2	$\frac{15}{16}$	—	—	8·10	72·9
6×6×$\frac{3}{4}$	·747	28·7	1·17	8·44	0	—	7·36	69·9	—	—
					1	$\frac{15}{16}$	6·50	61·8	7·74	73·5
					2	$\frac{15}{16}$	—	—	7·04	66·9
6×6×$\frac{5}{8}$	·623	24·2	1·18	7·12	0	—	6·20	58·9	—	—
					1	$\frac{15}{16}$	5·49	52·2	6·54	62·1
					2	$\frac{15}{16}$	—	—	5·95	56·6
6×6×$\frac{1}{2}$	·496	19·5	1·18	5·74	0	—	4·99	47·4	—	—
					1	$\frac{15}{16}$	4·43	42·1	5·28	50·1
					2	$\frac{15}{16}$	—	—	4·81	45·7
6×6×$\frac{3}{8}$	·371	14·8	1·19	4·35	0	—	3·78	35·9	—	—
					1	$\frac{15}{16}$	3·35	31·9	4·00	38·0
					2	$\frac{15}{16}$	—	—	3·65	34·7
5×5×$\frac{3}{4}$	·748	23·6	0·97	6·94	0	—	6·06	57·5	—	—
					1	$\frac{15}{16}$	5·20	49·4	6·24	59·3
					2	$\frac{15}{16}$	—	—	5·54	52·6
5×5×$\frac{5}{8}$	·622	19·9	0·98	5·86	0	—	5·10	48·5	—	—
					1	$\frac{15}{16}$	4·39	41·7	5·27	50·1
					2	$\frac{15}{16}$	—	—	4·69	44·6
5×5×$\frac{1}{2}$	·496	16·1	0·98	4·74	0	—	4·12	39·2	—	—
					1	$\frac{15}{16}$	3·56	33·8	4·27	40·6
					2	$\frac{15}{16}$	—	—	3·81	36·2
5×5×$\frac{3}{8}$	·373	12·3	0·99	3·61	0	—	3·14	29·8	—	—
					1	$\frac{15}{16}$	2·72	25·8	3·26	31·0
					2	$\frac{15}{16}$	—	—	2·91	27·7

Each weight per foot is for angle only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing page 184.

TIES

Equal Angles

BASED ON
B.S. 449
1959

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Equal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$4\times4\times\frac{3}{4}$	·749	18·5	·77	5·44	0	—	4·75	45·1	—	—
					1	$\frac{15}{16}$	3·89	36·9	4·74	45·0
					2	$\frac{15}{16}$	—	—	4·04	38·4
$4\times4\times\frac{5}{8}$	·624	15·7	·78	4·62	0	—	4·03	38·3	—	—
					1	$\frac{15}{16}$	3·31	31·4	4·03	38·3
					2	$\frac{15}{16}$	—	—	3·45	32·7
$4\times4\times\frac{1}{2}$	·496	12·7	·78	3·73	0	—	3·26	30·9	—	—
					1	$\frac{15}{16}$	2·68	25·5	3·27	31·1
					2	$\frac{15}{16}$	—	—	2·80	26·6
$4\times4\times\frac{3}{8}$	·372	9·7	·78	2·85	0	—	2·48	23·6	—	—
					1	$\frac{15}{16}$	2·05	19·5	2·50	23·8
					2	$\frac{15}{16}$	—	—	2·15	20·5
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{5}{8}$	·621	13·5	·68	3·97	0	—	3·47	32·9	—	—
					1	$\frac{15}{16}$	2·74	26·1	3·39	32·2
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{1}{2}$	·496	11·0	·68	3·23	0	—	2·82	26·8	—	—
					1	$\frac{15}{16}$	2·25	21·3	2·77	26·3
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{3}{8}$	·371	8·4	·68	2·47	0	—	2·15	20·4	—	—
					1	$\frac{13}{16}$	1·78	16·9	2·17	20·6
$3\frac{1}{2}\times3\frac{1}{2}\times\frac{5}{16}$	·311	7·1	·69	2·09	0	—	1·82	17·3	—	—
					1	$\frac{13}{16}$	1·51	14·3	1·84	17·4
$3\times3\times\frac{1}{2}$	·496	9·3	·58	2·73	0	—	2·39	22·7	—	—
					1	$\frac{13}{16}$	1·89	17·9	2·33	22·1
$3\times3\times\frac{3}{8}$	·370	7·1	·58	2·09	0	—	1·82	17·3	—	—
					1	$\frac{13}{16}$	1·45	13·8	1·79	17·0
$3\times3\times\frac{5}{16}$	·309	6·0	·58	1·76	0	—	1·54	14·6	—	—
					1	$\frac{13}{16}$	1·23	11·7	1·51	14·4
$3\times3\times\frac{1}{4}$	·245	4·8	·59	1·41	0	—	1·23	11·7	—	—
					1	$\frac{13}{16}$	·99	9·4	1·22	11·5

The above safe loads are calculated for an axial stress of 9·5 tons/inch^2 on the effective areas as specified in clause 42 of B.S. 449: 1959.

BASED ON
B.S. 449
1959

TIES

Equal Angles

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Equal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·372	5·9	·49	1·73	0	—	1·51	14·3	—	—
					1	$\frac{13}{16}$	1·13	10·7	1·43	13·6
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·311	5·0	·49	1·47	0	—	1·28	12·1	—	—
					1	$\frac{13}{16}$	·96	9·1	1·22	11·6
$2\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	4·0	·49	1·18	0	—	1·02	9·6	—	—
					1	$\frac{11}{16}$	·81	7·7	1·01	9·5
					1	$\frac{13}{16}$	·77	7·3	·98	9·2
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{3}{8}$	·367	5·2	·44	1·53	0	—	1·33	12·6	—	—
					1	$\frac{11}{16}$	1·01	9·6	1·28	12·1
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{5}{16}$	·306	4·4	·44	1·29	0	—	1·12	10·7	—	—
					1	$\frac{11}{16}$	·86	8·1	1·08	10·3
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{1}{4}$	·246	3·6	·44	1·06	0	—	·92	8·6	—	—
					1	$\frac{11}{16}$	·70	6·6	·89	8·4
$2\frac{1}{4}\times2\frac{1}{4}\times\frac{3}{16}$	·181	2·7	·44	·79	0	—	·68	6·4	—	—
					1	$\frac{11}{16}$	·53	5·0	·67	6·3
$2\times2\times\frac{5}{16}$	·308	3·9	·39	1·15	0	—	·99	9·4	—	—
					1	$\frac{11}{16}$	·73	6·9	·93	8·8
$2\times2\times\frac{1}{4}$	·249	3·2	·39	·94	0	—	·82	7·7	—	—
					1	$\frac{11}{16}$	·60	5·7	·77	7·3
$2\times2\times\frac{3}{16}$	·183	2·4	·39	·71	0	—	·61	5·8	—	—
					1	$\frac{11}{16}$	·45	4·3	·58	5·5

Each weight per foot is for angle only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing page 184.

TIES

BASED ON
B.S. 449
1959

Unequal Angles

LONG LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
9×4×⅞	·872	36·1	·83	10·62	0	—	10·20	91·8	—	—
					1	$\frac{15}{16}$	9·34	84·1	9·80	88·2
					2	$\frac{15}{16}$	8·47	76·2	8·98	80·8
					3	$\frac{15}{16}$	—	—	8·16	73·5
9×4×¾	·745	31·2	·84	9·17	0	—	8·80	83·6	—	—
					1	$\frac{15}{16}$	8·06	76·6	8·47	80·5
					2	$\frac{15}{16}$	7·32	69·6	7·77	73·9
					3	$\frac{15}{16}$	—	—	7·08	67·2
9×4×⅝	·622	26·3	·84	7·74	0	—	7·41	70·4	—	—
					1	$\frac{15}{16}$	6·80	64·6	7·16	68·0
					2	$\frac{15}{16}$	6·18	58·7	6·57	62·4
					3	$\frac{15}{16}$	—	—	5·99	56·9
9×4×½	·495	21·2	·85	6·23	0	—	5·96	56·6	—	—
					1	$\frac{15}{16}$	5·47	52·0	5·77	54·8
					2	$\frac{15}{16}$	4·98	47·3	5·30	50·4
					3	$\frac{15}{16}$	—	—	4·84	46·0
8×6×⅞	·870	39·0	1·28	11·47	0	—	10·47	94·2	—	—
					1	$\frac{15}{16}$	9·55	85·9	10·65	95·9
					2	$\frac{15}{16}$	8·60	77·4	9·84	88·6
					3	$\frac{15}{16}$	—	—	9·02	81·2
8×6×¾	·746	33·8	1·29	9·93	0	—	9·06	86·1	—	—
					1	$\frac{15}{16}$	8·27	78·6	9·24	87·7
					2	$\frac{15}{16}$	7·46	70·8	8·54	81·1
					3	$\frac{15}{16}$	—	—	7·84	74·5
8×6×⅝	·621	28·4	1·29	8·36	0	—	7·61	72·3	—	—
					1	$\frac{15}{16}$	6·95	66·0	7·77	73·8
					2	$\frac{15}{16}$	6·28	59·6	7·19	68·3
					3	$\frac{15}{16}$	—	—	6·61	62·8
8×6×½	·495	22·9	1·30	6·73	0	—	6·12	58·1	—	—
					1	$\frac{15}{16}$	5·60	53·2	6·27	59·5
					2	$\frac{15}{16}$	5·06	48·0	5·80	55·1
					3	$\frac{15}{16}$	—	—	5·34	50·7

The above safe loads are calculated for an axial stress of 9·5 tons/inch^2 for angles up to and including ¾″ thick and 9·0 tons/inch^2 for angles over ¾″ thick on the effective areas as specified in clause 42 of B.S. 449 : 1959.

BASED ON
B.S. 449
1959

TIES

Unequal Angles

LONG LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
8×4×¾	·747	28·7	·85	8·44	0	—	8·04	76·3	—	—
					1	$\frac{15}{16}$	7·29	69·3	7·74	73·5
					2	$\frac{15}{16}$	6·53	62·1	7·04	66·9
					3	$\frac{15}{16}$	—	—	6·34	60·2
8×4×⅝	·623	24·2	·85	7·12	0	—	6·77	64·3	—	—
					1	$\frac{15}{16}$	6·15	58·4	6·54	62·1
					2	$\frac{15}{16}$	5·52	52·4	5·95	56·6
					3	$\frac{15}{16}$	—	—	5·37	51·0
8×4×½	·496	19·5	·86	5·74	0	—	5·45	51·8	—	—
					1	$\frac{15}{16}$	4·95	47·0	5·28	50·1
					2	$\frac{15}{16}$	4·45	42·3	4·81	45·7
					3	$\frac{15}{16}$	—	—	4·35	41·3
7×3½×⅝	·623	21·0	·74	6·18	0	—	5·88	55·9	—	—
					1	$\frac{15}{16}$	5·26	50·0	5·60	53·2
					2	$\frac{15}{16}$	4·63	43·9	5·01	47·6
7×3½×½	·497	17·0	·75	5·00	0	—	4·75	45·1	—	—
					1	$\frac{15}{16}$	4·25	40·4	4·53	43·1
					2	$\frac{15}{16}$	3·75	35·6	4·07	38·6
7×3½×⅜	·372	12·9	·76	3·79	0	—	3·60	34·2	—	—
					1	$\frac{15}{16}$	3·22	30·6	3·45	32·7
					2	$\frac{15}{16}$	2·84	27·0	3·10	29·4
6×4×¾	·748	23·6	·86	6·94	0	—	6·44	61·2	—	—
					1	$\frac{15}{16}$	5·66	53·8	6·24	59·3
					2	$\frac{15}{16}$	4·86	46·1	5·54	52·6
6×4×⅝	·622	19·9	·86	5·86	0	—	5·43	51·5	—	—
					1	$\frac{15}{16}$	4·78	45·4	5·27	50·1
					2	$\frac{15}{16}$	4·11	39·0	4·69	44·6
6×4×½	·496	16·1	·87	4·74	0	—	4·38	41·6	—	—
					1	$\frac{15}{16}$	3·87	36·7	4·27	40·6
					2	$\frac{15}{16}$	3·33	31·6	3·81	36·2

Each weigh per foot is for angle only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing page 184.

TIES

Unequal Angles

LONG LEG ATTACHED

BASED ON
B.S. 449
1959

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$6\times3\frac{1}{2}\times\frac{5}{8}$	·620	18·8	·75	5·53	0	—	5·19	49·3	—	—
					1	$\frac{15}{16}$	4·56	43·3	4·95	47·0
					2	$\frac{15}{16}$	3·91	37·2	4·36	41·5
$6\times3\frac{1}{2}\times\frac{1}{2}$	·497	15·3	·76	4·50	0	—	4·22	40·1	—	—
					1	$\frac{15}{16}$	3·71	35·3	4·03	38·3
					2	$\frac{15}{16}$	3·19	30·3	3·56	33·9
$6\times3\frac{1}{2}\times\frac{3}{8}$	·371	11·6	·76	3·41	0	—	3·19	30·3	—	—
					1	$\frac{15}{16}$	2·81	26·7	3·06	29·1
					2	$\frac{15}{16}$	2·42	23·0	2·71	25·8
$6\times3\times\frac{5}{8}$	·623	17·8	·63	5·24	0	—	4·99	47·4	—	—
					1	$\frac{13}{16}$	—	—	4·73	44·9
					2	$\frac{13}{16}$	3·90	37·1	4·22	40·1
					1	$\frac{15}{16}$	4·37	41·5	—	—
$6\times3\times\frac{1}{2}$	·496	14·4	·64	4·24	0	—	4·03	38·3	—	—
					1	$\frac{13}{16}$	—	—	3·83	36·4
					2	$\frac{13}{16}$	3·16	30·1	3·43	32·6
					1	$\frac{15}{16}$	3·53	33·6	—	—
$6\times3\times\frac{3}{8}$	·373	11·0	·64	3·24	0	—	3·07	29·2	—	—
					1	$\frac{13}{16}$	—	—	2·93	27·9
					2	$\frac{13}{16}$	2·42	23·0	2·63	25·0
					1	$\frac{15}{16}$	2·70	25·6	—	—
$5\times3\frac{1}{2}\times\frac{5}{8}$	·621	16·7	·75	4·91	0	—	4·53	43·0	—	—
					1	$\frac{15}{16}$	3·87	36·8	4·33	41·1
					2	$\frac{15}{16}$	—	—	3·74	35·6
$5\times3\frac{1}{2}\times\frac{1}{2}$	·498	13·6	·75	4·00	0	—	3·68	35·0	—	—
					1	$\frac{15}{16}$	3·16	30·0	3·53	33·6
					2	$\frac{15}{16}$	—	—	3·07	29·1
$5\times3\frac{1}{2}\times\frac{3}{8}$	·371	10·3	·76	3·03	0	—	2·79	26·5	—	—
					1	$\frac{15}{16}$	2·40	22·8	2·68	25·5
					2	$\frac{15}{16}$	—	—	2·34	22·2

The above safe loads are calculated for an axial stress of 9·5 tons/inch² on the effective areas as specified in clause 42 of B.S. 449 : 1959.

BASED ON
B.S. 449
1959

TIES

Unequal Angles

LONG LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$5\times3\times\frac{1}{2}$	·496	12·7	·64	3·73	0	—	3·50	33·3	—	—
					1	$\frac{13}{16}$	—	—	3·33	31·7
					2	$\frac{13}{16}$	2·61	24·8	2·93	27·8
					1	$\frac{15}{16}$	2·99	28·4	—	—
$5\times3\times\frac{3}{8}$	·372	9·7	·65	2·85	0	—	2·67	25·3	—	—
					1	$\frac{13}{16}$	—	—	2·55	24·2
					2	$\frac{13}{16}$	2·00	19·0	2·25	21·3
					1	$\frac{15}{16}$	2·28	21·7	—	—
$5\times3\times\frac{5}{16}$	·308	8·1	·65	2·38	0	—	2·23	21·1	—	—
					1	$\frac{13}{16}$	—	—	2·13	20·3
					2	$\frac{13}{16}$	1·67	15·9	1·88	17·9
					1	$\frac{15}{16}$	1·91	18·1	—	—
$4\times3\frac{1}{2}\times\frac{5}{8}$	·623	14·6	·72	4·30	0	—	3·84	36·5	—	—
					1	$\frac{15}{16}$	3·15	29·9	3·71	35·3
$4\times3\frac{1}{2}\times\frac{1}{2}$	·498	11·9	·72	3·50	0	—	3·12	29·7	—	—
					1	$\frac{15}{16}$	2·57	24·4	3·03	28·8
$4\times3\frac{1}{2}\times\frac{3}{8}$	·374	9·1	·72	2·68	0	—	2·39	22·7	—	—
					1	$\frac{15}{16}$	1·97	18·7	2·33	22·1
$4\times3\frac{1}{2}\times\frac{5}{16}$	·309	7·6	·73	2·23	0	—	1·99	18·9	—	—
					1	$\frac{15}{16}$	1·65	15·6	1·94	18·5
$4\times3\times\frac{1}{2}$	·496	11·0	·63	3·23	0	—	2·96	28·1	—	—
					1	$\frac{13}{16}$	—	—	2·83	26·9
					1	$\frac{15}{16}$	2·43	23·0	—	—
$4\times3\times\frac{3}{8}$	·371	8·4	·64	2·47	0	—	2·25	21·4	—	—
					1	$\frac{13}{16}$	—	—	2·17	20·6
					1	$\frac{15}{16}$	1·85	17·6	—	—
$4\times3\times\frac{5}{16}$	·311	7·1	·64	2·09	0	—	1·91	18·1	—	—
					1	$\frac{13}{16}$	1·62	15·4	1·84	17·4

Each weight per foot is for angle only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing page 184.

TIES

Unequal Angles

BASED ON
B.S. 449
1959

LONG LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$4\times2\frac{1}{2}\times\frac{3}{8}$	·373	7·8	·54	2·29	0 1 1	— $\frac{13}{16}$ $\frac{15}{16}$	2·14 — 1·75	20·3 — 16·7	— 1·99 —	— 18·9 —
$4\times2\frac{1}{2}\times\frac{5}{16}$	·308	6·5	·54	1·91	0 1	— $\frac{13}{16}$	1·79 1·51	17·0 14·3	— 1·66	— 15·8
$4\times2\frac{1}{2}\times\frac{1}{4}$	·248	5·3	·54	1·56	0 1	— $\frac{13}{16}$	1·45 1·23	13·8 11·7	— 1·36	— 12·9
$3\frac{1}{2}\times3\times\frac{1}{2}$	·499	10·2	·62	3·00	0 1 1	— $\frac{13}{16}$ $\frac{15}{16}$	2·69 — 2·14	25·6 — 20·3	— 2·60 —	— 24·7 —
$3\frac{1}{2}\times3\times\frac{3}{8}$	·373	7·8	·62	2·29	0 1 1	— $\frac{13}{16}$ $\frac{15}{16}$	2·05 — 1·64	19·5 — 15·6	— 1·99 —	— 18·9 —
$3\frac{1}{2}\times3\times\frac{5}{16}$	·308	6·5	·62	1·91	0 1	— $\frac{13}{16}$	1·71 1·42	16·3 13·5	— 1·66	— 15·8
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·370	7·1	·53	2·09	0 1	— $\frac{13}{16}$	1·92 1·58	18·3 15·0	— 1·79	— 17·0
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·309	6·0	·53	1·76	0 1	— $\frac{13}{16}$	1·62 1·34	15·4 12·7	— 1·51	— 14·4
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	4·8	·54	1·41	0 1	— $\frac{13}{16}$	1·30 1·07	12·3 10·2	— 1·22	— 11·5
$3\times2\frac{1}{2}\times\frac{3}{8}$	·372	6·5	·52	1·91	0 1	— $\frac{13}{16}$	1·72 1·37	16·4 13·0	— 1·61	— 15·3
$3\times2\frac{1}{2}\times\frac{5}{16}$	·311	5·5	·52	1·62	0 1	— $\frac{13}{16}$	1·46 1·16	13·8 11·0	— 1·36	— 13·0
$3\times2\frac{1}{2}\times\frac{1}{4}$	·246	4·4	·52	1·30	0 1	— $\frac{13}{16}$	1·17 ·93	11·1 8·8	— 1·10	— 10·4

The above safe loads are calculated for an axial stress of 9·5 tons/inch² on the effective areas as specified in clause 42 of B.S. 449 : 1959.

TIES

Unequal Angles

BASED ON
B.S. 449
1959

LONG LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$3\times2\times\frac{3}{8}$	·372	5·9	·43	1·73	0 1	— $\frac{13}{16}$	1·60 1·26	15·2 12·0	— 1·43	— 13·6
$3\times2\times\frac{5}{16}$	·311	5·0	·43	1·47	0 1	— $\frac{13}{16}$	1·36 1·07	12·9 10·2	— 1·22	— 11·6
$3\times2\times\frac{1}{4}$	·245	4·0	·43	1·18	0 1	— $\frac{13}{16}$	1·08 ·86	10·3 8·1	— ·98	— 9·2
$2\frac{1}{2}\times2\times\frac{3}{8}$	·367	5·2	·42	1·53	0 1	— $\frac{13}{16}$	1·38 1·03	13·1 9·7	— 1·23	— 11·7
$2\frac{1}{2}\times2\times\frac{5}{16}$	·306	4·4	·42	1·29	0 1	— $\frac{13}{16}$	1·17 ·87	11·1 8·2	— 1·05	— 9·9
$2\frac{1}{2}\times2\times\frac{1}{4}$	·246	3·6	·42	1·06	0 1	— $\frac{11}{16}$	·95 ·75	9·0 7·1	— ·89	— 8·4
$2\frac{1}{2}\times2\times\frac{3}{16}$	·181	2·7	·43	·79	0 1	— $\frac{11}{16}$	·71 ·56	6·7 5·3	— ·67	— 6·3
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{1}{4}$	2·49	3·2	·32	·94	0 1	— $\frac{11}{16}$	·88 ·69	8·3 6·5	— ·77	— 7·3
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{3}{16}$	·183	2·4	·32	·71	0 1	— $\frac{11}{16}$	·66 ·52	6·2 4·9	— ·58	— 5·5
$2\times1\frac{1}{2}\times\frac{1}{4}$	·241	2·7	·32	·79	0 1	— $\frac{11}{16}$	·72 ·53	6·8 5·0	— ·63	— 5·9
$2\times1\frac{1}{2}\times\frac{3}{16}$	·184	2·1	·32	·62	0 1	— $\frac{11}{16}$	·56 ·41	5·3 3·9	— ·49	— 4·6

Each weight per foot is for angle only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing page 184.

TIES

Unequal Angles

BASED ON
B.S. 449
1959

SHORT LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
9×4×⅞	·872	36·1	·83	10·62	0	—	7·25	65·3	—	—
					1	$\frac{15}{16}$	5·87	52·8	9·80	88·2
					2	$\frac{15}{16}$	—	—	8·98	80·8
9×4×¾	·745	31·2	·84	9·17	0	—	6·29	59·7	—	—
					1	$\frac{15}{16}$	5·11	48·5	8·47	80·5
					2	$\frac{15}{16}$	—	—	7·77	73·9
9×4×⅝	·622	26·3	·84	7·74	0	—	5·32	50·6	—	—
					1	$\frac{15}{16}$	4·34	41·3	7·16	68·0
					2	$\frac{15}{16}$	—	—	6·57	62·4
9×4×½	·495	21·2	·85	6·23	0	—	4·29	40·8	—	—
					1	$\frac{15}{16}$	3·52	33·4	5·77	54·8
					2	$\frac{15}{16}$	—	—	5·30	50·4
8×6×⅞	·870	39·0	1·28	11·47	0	—	9·37	84·3	—	—
					1	$\frac{15}{16}$	8·29	74·6	10·65	95·9
					2	$\frac{15}{16}$	—	—	9·84	88·6
8×6×¾	·746	33·8	1·29	9·93	0	—	8·12	77·1	—	—
					1	$\frac{15}{16}$	7·19	68·3	9·24	87·7
					2	$\frac{15}{16}$	—	—	8·54	81·1
8×6×⅝	·621	28·4	1·29	8·36	0	—	6·83	64·8	—	—
					1	$\frac{15}{16}$	6·05	57·5	7·77	73·8
					2	$\frac{15}{16}$	—	—	7·19	68·3
8×6×½	·495	22·9	1·30	6·73	0	—	5·50	52·2	—	—
					1	$\frac{15}{16}$	4·88	46·4	6·27	59·6
					2	$\frac{15}{16}$	—	—	5·80	55·1

The above safe loads are calculated for an axial stress of 9·5 tons/inch^2 for angles up to and including ¾″ thick and 9·0 tons/inch^2 for angles over ¾″ thick on the effective areas as specified in Clause 42 of B.S. 449: 1959.

BASED ON
B.S. 449
1959

TIES

Unequal Angles

SHORT LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
8×4×¾	·747	28·7	·85	8·44	0	—	6·06	57·6	—	—
					1	$\frac{15}{16}$	4·94	46·9	7·74	73·5
					2	$\frac{15}{16}$	—	—	7·04	66·9
8×4×⅝	·623	24·2	·85	7·12	0	—	5·12	48·7	—	—
					1	$\frac{15}{16}$	4·19	39·8	6·54	62·1
					2	$\frac{15}{16}$	—	—	5·95	56·6
8×4×½	·496	19·5	·86	5·74	0	—	4·14	39·3	—	—
					1	$\frac{15}{16}$	3·40	32·3	5·28	50·1
					2	$\frac{15}{16}$	—	—	4·81	45·7
7×3½×⅝	·623	21·0	·74	6·18	0	—	4·44	42·2	—	—
					1	$\frac{15}{16}$	3·50	33·2	5·60	53·2
					2	$\frac{15}{16}$	—	—	5·01	47·6
7×3½×½	·497	17·0	·75	5·00	0	—	3·60	34·2	—	—
					1	$\frac{15}{16}$	2·85	27·1	4·53	43·1
					2	$\frac{15}{16}$	—	—	4·07	38·6
7×3½×⅜	·372	12·9	·76	3·79	0	—	2·74	26·0	—	—
					1	$\frac{15}{16}$	2·18	20·7	3·45	32·7
					2	$\frac{15}{16}$	—	—	3·10	29·4
6×4×¾	·748	23·6	·86	6·94	0	—	5·49	52·1	—	—
					1	$\frac{15}{16}$	4·49	42·7	6·24	59·3
					2	$\frac{15}{16}$	—	—	5·54	52·6
6×4×⅝	·622	19·9	·86	5·86	0	—	4·63	44·0	—	—
					1	$\frac{15}{16}$	3·81	36·2	5·27	50·1
					2	$\frac{15}{16}$	—	—	4·69	44·6
6×4×½	·496	16·1	·87	4·74	0	—	3·75	35·6	—	—
					1	$\frac{15}{16}$	3·09	29·4	4·27	40·6
					2	$\frac{15}{16}$	—	—	3·81	36·2

Each weight per foot is for angle only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing page 184.

TIES

BASED ON
B.S. 449
1959

Unequal Angles

SHORT LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
6×3½×⅝	·620	18·8	·75	5·53	0	—	4·19	39·8	—	—
					1	$\frac{15}{16}$	3·31	31·5	4·95	47·0
					2	$\frac{15}{16}$	—	—	4·36	41·5
6×3½×½	·497	15·3	·76	4·50	0	—	3·41	32·4	—	—
					1	$\frac{15}{16}$	2·71	25·8	4·03	38·3
					2	$\frac{15}{16}$	—	—	3·56	33·9
6×3½×⅜	·371	11·6	·76	3·41	0	—	2·59	24·6	—	—
					1	$\frac{15}{16}$	2·07	19·7	3·06	29·1
					2	$\frac{15}{16}$	—	—	2·71	25·8
6×3×⅝	·623	17·8	·63	5·24	0	—	3·75	35·7	—	—
					1	$\frac{13}{16}$	2·93	27·8	4·73	44·9
					2	$\frac{13}{16}$	—	—	4·22	40·1
6×3×½	·496	14·4	·64	4·24	0	—	3·05	28·9	—	—
					1	$\frac{13}{16}$	2·40	22·8	3·83	36·4
					2	$\frac{13}{16}$	—	—	3·43	32·6
6×3×⅜	·373	11·0	·64	3·24	0	—	2·33	22·2	—	—
					1	$\frac{13}{16}$	1·85	17·6	2·93	27·9
					2	$\frac{13}{16}$	—	—	2·63	25·0
5×3½×⅝	·621	16·7	·75	4·91	0	—	3·94	37·4	—	—
					1	$\frac{15}{16}$	3·12	29·6	4·33	41·1
					2	$\frac{15}{16}$	—	—	3·74	35·6
5×3½×½	·498	13·6	·75	4·00	0	—	3·21	30·5	—	—
					1	$\frac{15}{16}$	2·56	24·3	3·53	33·6
					2	$\frac{15}{16}$	—	—	3·07	29·1
5×3½×⅝	·371	10·3	·76	3·03	0	—	2·43	23·1	—	—
					1	$\frac{15}{16}$	1·95	18·5	2·68	25·5
					2	$\frac{15}{16}$	—	—	2·34	22·2

The above safe loads are calculated for an axial stress of 9·5 tons/inch² on the effective areas as specified in Clause 42 of B.S. 449: 1959.

BASED ON
B.S. 449
1959

TIES

Unequal Angles

SHORT LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
5×3×½	·496	12·7	·64	3·73	0	—	2·86	27·2	—	—
					1	$\frac{13}{16}$	2·26	21·5	3·33	31·7
					2	$\frac{13}{16}$	—	—	2·93	27·8
5×3×⅜	·372	9·7	·65	2·85	0	—	2·19	20·8	—	—
					1	$\frac{13}{16}$	1·74	16·5	2·55	24·2
					2	$\frac{13}{16}$	—	—	2·25	21·3
5×3×$\frac{5}{16}$	·308	8·1	·65	2·38	0	—	1·83	17·4	—	—
					1	$\frac{13}{16}$	1·46	13·9	2·13	20·3
					2	$\frac{13}{16}$	—	—	1·88	17·9
4×3½×⅝	·623	14·6	·72	4·30	0	—	3·64	34·6	—	—
					1	$\frac{15}{16}$	2·89	27·4	3·71	35·3
					2	$\frac{15}{16}$	—	—	3·13	29·7
4×3½×½	·498	11·9	·72	3·50	0	—	2·97	28·2	—	—
					1	$\frac{15}{16}$	2·36	22·5	3·03	28·8
					2	$\frac{15}{16}$	—	—	2·56	24·4
4×3½×⅜	·374	9·1	·72	2·68	0	—	2·27	21·6	—	—
					1	$\frac{13}{16}$	1·88	17·9	2·37	22·5
					2	$\frac{13}{16}$	—	—	2·07	19·7
4×3½×$\frac{5}{16}$	·309	7·6	·73	2·23	0	—	1·89	18·0	—	—
					1	$\frac{13}{16}$	1·57	14·9	1·93	18·8
					2	$\frac{13}{16}$	—	—	1·73	16·4
4×3×½	·496	11·0	·63	3·23	0	—	2·64	25·1	—	—
					1	$\frac{13}{16}$	2·09	19·9	2·83	26·9
					2	$\frac{13}{16}$	—	—	2·43	23·1
4×3×⅜	·371	8·4	·64	2·47	0	—	2·02	19·2	—	—
					1	$\frac{13}{16}$	1·61	15·3	2·17	20·6
					2	$\frac{13}{16}$	—	—	1·86	17·7
4×3×$\frac{5}{16}$	·311	7·1	·64	2·09	0	—	1·71	16·2	—	—
					1	$\frac{13}{16}$	1·37	13·0	1·84	17·4
					2	$\frac{13}{16}$	—	—	1·58	15·0

Each weight per foot is for angle only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing page 184.

TIES

BASED ON
B.S. 449
1959

Unequal Angles

SHORT LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$4\times2\frac{1}{2}\times\frac{3}{8}$	·373	7·8	·54	2·29	0 1	— $\frac{13}{16}$	1·78 1·33	16·9 12·6	— 1·99	— 18·9
$4\times2\frac{1}{2}\times\frac{5}{16}$	·308	6·5	·54	1·91	0 1	— $\frac{13}{16}$	1·49 1·12	14·1 10·6	— 1·66	— 15·8
$4\times2\frac{1}{2}\times\frac{1}{4}$	·248	5·3	·54	1·56	0 1	— $\frac{13}{16}$	1·21 ·91	11·5 8·6	— 1·36	— 12·9
$3\frac{1}{2}\times3\times\frac{1}{2}$	·499	10·2	·62	3·00	0 1	— $\frac{13}{16}$	2·54 2·01	24·1 19·1	— 2·60	— 24·7
$3\frac{1}{2}\times3\times\frac{3}{8}$	·373	7·8	·62	2·29	0 1	— $\frac{13}{16}$	1·94 1·54	18·4 14·7	— 1·99	— 18·9
$3\frac{1}{2}\times3\times\frac{5}{16}$	·308	6·5	·62	1·91	0 1	— $\frac{13}{16}$	1·62 1·29	15·4 12·3	— 1·66	— 15·8
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·370	7·1	·53	2·09	0 1	— $\frac{13}{16}$	1·69 1·26	16·0 12·0	— 1·79	— 17·0
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·309	6·0	·53	1·76	0 1	— $\frac{13}{16}$	1·43 1·07	13·5 10·2	— 1·51	— 14·4
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	4·8	·54	1·41	0 1 1	— $\frac{11}{16}$ $\frac{13}{16}$	1·14 ·91 ·86	10·9 8·6 8·2	— 1·25 1·22	— 11·8 11·5
$3\times2\frac{1}{2}\times\frac{3}{8}$	·372	6·5	·52	1·91	0 1	— $\frac{13}{16}$	1·61 1·20	15·3 11·4	— 1·61	— 15·3
$3\times2\frac{1}{2}\times\frac{5}{16}$	·311	5·5	·52	1·62	0 1	— $\frac{13}{16}$	1·36 1·02	12·9 9·7	— 1·36	— 13·0
$3\times2\frac{1}{2}\times\frac{1}{4}$	·246	4·4	·52	1·30	0 1 1	— $\frac{11}{16}$ $\frac{13}{16}$	1·09 ·87 ·82	10·3 8·2 7·8	— 1·13 1·10	— 10·7 10·4

The above safe loads are calculated for an axial stress of 9·5 tons/inch² on the effective areas as specified in Clause 42 of B.S. 449: 1959.

BASED ON
B.S. 449
1959

TIES

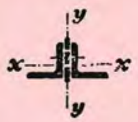
Unequal Angles

SHORT LEG ATTACHED

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of One Unequal Angle		Weight per foot in lbs	Radius of Gyration Axis v-v	Gross Area in square inches	Holes deducted from each Angle		Tie without Lug		Tie with Lug	
Nominal Size	Actual Thickness				No.	Dia.	Effective Area square inches	Safe Load in Tons	Effective Area square inches	Safe Load in Tons
$3\times2\times\frac{3}{8}$	·372	5·9	·43	1·73	0 1	— $\frac{11}{16}$	1·36 ·99	13·0 9·4	— 1·48	— 14·0
$3\times2\times\frac{5}{16}$	·311	5·0	·43	1·47	0 1	— $\frac{11}{16}$	1·16 ·85	11·0 8·0	— 1·26	— 11·9
$3\times2\times\frac{1}{4}$	·245	4·0	·43	1·18	0 1	— $\frac{11}{16}$	·93 ·68	8·8 6·4	— 1·01	— 9·5
$2\frac{1}{2}\times2\times\frac{3}{8}$	·367	5·2	·42	1·53	0 1	— $\frac{11}{16}$	1·26 ·92	12·0 8·7	— 1·28	— 12·1
$2\frac{1}{2}\times2\times\frac{5}{16}$	·306	4·4	·42	1·29	0 1	— $\frac{11}{16}$	1·07 ·78	10·2 7·4	— 1·08	— 10·3
$2\frac{1}{2}\times2\times\frac{1}{4}$	·246	3·6	·42	1·06	0 1	— $\frac{11}{16}$	·87 ·64	8·2 6·1	— ·89	— 8·4
$2\frac{1}{2}\times2\times\frac{3}{16}$	·181	2·7	·43	·79	0 1	— $\frac{11}{16}$	·65 ·48	6·1 4·6	— ·67	— 6·3
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{1}{4}$	·249	3·2	·32	·94	0 1	— $\frac{9}{16}$	·72 ·50	6·8 4·7	— ·80	— 7·6
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{3}{16}$	·183	2·4	·32	·71	0 1	— $\frac{9}{16}$	·54 ·38	5·1 3·6	— ·60	— 5·7
$2\times1\frac{1}{2}\times\frac{1}{4}$	·241	2·7	·32	·79	0 1	— $\frac{9}{16}$	·64 ·45	6·1 4·3	— ·66	— 6·2
$2\times1\frac{1}{2}\times\frac{3}{16}$	·184	2·1	·32	·62	0 1	— $\frac{9}{16}$	·50 ·36	4·7 3·3	— ·51	— 4·8

Each weight per foot is for angle only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing page 184.



TIES

Two Angles
Gusset between angles

BASED ON
B.S. 449
1959

SAFE LOADS IN TONS FOR MILD STEEL

Nominal Thickness of each Angle in inches	Holes Deducted from each Angle		SUM OF LEG-LENGTHS OF EACH ANGLE IN INCHES								
	Number	dia.	16	14	13	12	10½	10	9½	9	8½
1	0	—	270								
	1	15/16	253								
	2	15/16	236								
	3	15/16	220								
7/8	0	—	238	206	191	175					
	1	15/16	224	192	176	161					
	2	15/16	209	177	162	146					
	3	15/16	194	162	147	131					
3/4	0	—	217	189	174	160		132			
	1	15/16	204	175	161	147		119			
	2	15/16	191	162	148	134		105			
	3	15/16	178	149	134	120		—			
5/8	0	—	183	159	147	135	117	111	105	99·5	93·3
	1	15/16	172	148	136	124	106	100	94·0	88·4	82·2
	2	15/16	161	137	125	113	95·2	89·1	82·9	77·3	—
	3	15/16	149	126	114	102	—	—	—	—	—
	1	13/16	173	149	137	126	108	102	95·4	89·9	83·7
	2	13/16	163	140	128	116	98·2	92·1	85·9	80·3	74·1
1/2	0	—		128	118	109	95·0	90·0	85·4	80·5	76·0
	1	15/16		119	110	100	86·1	81·2	76·6	71·6	67·1
	2	15/16		110	101	91·4	77·3	72·3	67·7	62·8	—
	3	15/16		101	91·9	82·6	—	—	—	—	—
	1	13/16		120	111	101	87·3	82·3	77·7	72·8	68·3
	2	13/16		113	103	93·8	79·6	74·7	70·1	65·2	60·6
3/8	0	—				82·6	72·1	68·7	64·7	61·5	57·6
	1	15/16				76·0	65·5	62·0	58·1	54·8	51·0
	2	15/16				69·4	58·8	55·4	—	—	—
	1	13/16				76·9	66·3	62·9	59·0	55·7	51·9
	2	13/16				71·2	60·6	57·1	53·3	50·0	46·1

The above safe loads are calculated for an axial stress of 9·5 tons/inch^2 for angles up to and including ¾″ thick, and 9·0 tons/inch^2 for angles over ¾″ thick on the effective areas as specified in clause 42 of B.S. 449 : 1959.
The radii of gyration of the ties tabulated above may be obtained by reference to tables on pages 468 to 481 inclusive.

BASED ON
B.S. 449
1959

TIES

Two Angles
Gusset between angles

SAFE LOADS IN TONS FOR MILD STEEL

Nominal Thickness of each Angle in inches	Holes Deducted from each Angle		SUM OF LEG-LENGTHS OF EACH ANGLE IN INCHES									
	Number	dia.	8	7½	7	6½	6	5½	5	4½	4	3½
3/4	0	—	103									
	1	15/16	90·1									
	1	13/16	91·9									
	2	13/16	80·3									
5/8	0	—	87·7	81·6	75·4							
	1	13/16	78·1	72·0	65·8							
	2	13/16	68·4	62·4	56·2							
1/2	0	—	71·0	66·5	61·5	57·0	51·9					
	1	13/16	63·3	58·8	53·8	49·3	44·3					
	2	13/16	55·6	51·1	46·1	41·6	36·6					
3/8	0	—	54·2	50·9	46·9	43·6	39·7	36·3	32·9	29·0		
	1	13/16	48·4	45·1	41·2	37·8	33·9	30·6	27·2	23·4		
	2	13/16	42·7	39·3	35·4	32·0	28·2	24·8	21·5	—		
	1	11/16	—	—	—	38·7	34·8	31·4	28·1	24·2		
	2	11/16	—	—	—	33·8	30·0	26·6	23·2	19·4		
5/16	0	—	45·3	42·4	39·7	36·4	33·5	30·7	27·9	24·6	21·8	
	1	13/16	40·5	37·7	34·9	31·6	28·7	25·9	23·1	19·9	—	
	1	11/16	—	—	—	32·3	29·5	26·7	23·9	20·6	17·7	
	2	11/16	—	—	—	28·3	25·4	22·6	19·8	16·6	13·7	
1/4	0	—			31·8	29·6	26·9	24·6	22·4	20·1	17·9	15·1
	1	13/16			28·0	25·8	23·1	20·8	18·6	16·3	—	—
	1	11/16			28·6	26·4	23·7	21·4	19·2	16·9	14·7	11·9
	2	11/16			25·4	23·1	20·5	18·2	16·0	13·7	11·4	8·7
	1	9/16			—	—	—	—	—	17·5	15·2	12·5
3/16	0	—								15·1	13·4	11·7
	1	11/16								12·7	11·0	9·3
	1	9/16								13·1	11·5	9·7

For explanation of tables, see notes commencing pages 162 and 184.

TIES

Two Equal Angles back to back
Gusset on back of Angles

BASED ON
B.S. 449
1959

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of Two Equal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
8×8×1	·996	102·0	⅝	3·61	2·43	30·01	0	—	27·40	247
							1	1 5/16	25·24	227
							2	1 5/16	23·01	207
8×8×⅞	·871	90·0	⅝	3·59	2·45	26·48	0	—	24·16	217
							1	1 5/16	22·27	200
							2	1 5/16	20·32	183
8×8×¾	·746	77·8	⅝	3·56	2·46	22·88	0	—	20·86	198
							1	1 5/16	19·25	183
							2	1 5/16	17·58	167
8×8×⅝	·621	65·4	⅝	3·54	2·48	19·23	0	—	17·51	166
							1	1 5/16	16·16	154
							2	1 5/16	14·77	140

The above safe loads are calculated for an axial stress of 9·5 tons/inch² for angles up to and including ¾″ thick, and 9·0 tons/inch² for angles over ¾″ thick on the effective areas as specified in clause 42 of B.S. 449: 1959.

BASED ON
B.S. 449
1959

TIES

Two Equal Angles back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of Two Equal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
6×6×⅞	·872	66·2	½	2·74	1·81	19·48	0	—	17·79	160
							1	1 5/16	15·89	143
							2	1 3/16	14·44	130
6×6×¾	·747	57·4	½	2·72	1·82	16·88	0	—	15·41	146
							1	1 5/16	13·78	131
							2	1 3/16	12·54	119
6×6×⅝	·623	48·4	½	2·69	1·84	14·24	0	—	12·99	123
							1	1 5/16	11·64	111
							2	1 3/16	10·60	101
6×6×½	·496	39·0	½	2·67	1·85	11·48	0	—	10·46	99·4
							1	1 5/16	9·38	89·1
							2	1 3/16	8·56	81·3
6×6×⅜	·371	29·6	½	2·64	1·87	8·70	0	—	7·91	75·1
							1	1 5/16	7·10	67·5
							2	1 3/16	6·49	61·6

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing page 184.

TIES

Two Equal Angles back to back
Gusset on back of Angles

BASED ON
B.S. 449
1959

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of Two Equal Angles		Weight per foot in lbs	Space between Angles s inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis y-y	Axis x-x		No.	Dia.		
5×5×¾	·748	47·2	½	2·32	1·50	13·89	0 1	— 15/16	12·69 11·05	121 105
5×5×⅝	·622	39·8	½	2·29	1·52	11·71	0 1	— 15/16	10·69 9·33	102 88·7
5×5×½	·496	32·2	½	2·27	1·53	9·47	0 1	— 15/16	8·64 7·56	82·1 71·8
5×5×⅜	·373	24·6	½	2·24	1·55	7·23	0 1	— 15/16	6·58 5·77	62·5 54·8
4×4×¾	·749	37·0	⅜	1·87	1·18	10·89	0 1	— 15/16	9·96 8·30	94·6 78·9
4×4×⅝	·624	31·4	⅜	1·85	1·20	9·23	0 1	— 15/16	8·44 7·06	80·2 67·1
4×4×½	·496	25·4	⅜	1·82	1·21	7·47	0 1	— 15/16	6·82 5·73	64·8 54·4
4×4×⅜	·372	19·4	⅜	1·80	1·22	5·70	0 1	— 15/16	5·20 4·38	49·4 41·6
3½×3½×⅝	·621	27·0	⅜	1·65	1·04	7·94	0 1	— 15/16	7·26 5·88	69·0 55·9
3½×3½×½	·496	22·0	⅜	1·62	1·05	6·47	0 1	— 15/16	5·91 4·81	56·2 45·7
3½×3½×⅜	·371	16·8	⅜	1·60	1·06	4·94	0 1	— 13/16	4·51 3·80	42·8 36·1
3½×3½×5/16	·311	14·2	⅜	1·58	1·07	4·18	0 1	— 13/16	3·81 3·22	36·2 30·6

The above safe loads are calculated for an axial stress of 9·5 tons/inch² on the effective areas as specified in clause 42 of B.S. 449 : 1959.

BASED ON
B.S. 449
1959

TIES

Two Equal Angles back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of Two Equal Angles		Weight per foot in lbs	Space between Angles s inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis y-y	Axis x-x		No.	Dia.		
3×3×½	·496	18·6	5/16	1·40	·89	5·47	0 1	— 13/16	5·00 4·05	47·5 38·5
3×3×⅜	·370	14·2	5/16	1·37	·90	4·17	0 1	— 13/16	3·82 3·11	36·3 29·5
3×3×5/16	·309	12·0	5/16	1·36	·91	3·53	0 1	— 13/16	3·22 2·63	30·6 25·0
3×3×¼	·245	9·6	5/16	1·34	·92	2·83	0 1	— 13/16	2·58 2·11	24·6 20·1
2½×2½×⅜	·372	11·8	5/16	1·18	·75	3·47	0 1	— 13/16	3·16 2·43	30·0 23·1
2½×2½×5/16	·311	10·0	5/16	1·17	·76	2·94	0 1	— 13/16	2·67 2·07	25·4 19·7
2½×2½×¼	·245	8·0	5/16	1·15	·76	2·35	0 1 1	— 11/16 13/16	2·14 1·74 1·66	20·3 16·5 15·8
2¼×2¼×⅜	·367	10·4	5/16	1·03	·67	3·06	0 1	— 11/16	2·78 2·18	26·4 20·7
2¼×2¼×5/16	·306	8·8	5/16	1·07	·68	2·59	0 1	— 11/16	2·35 1·85	22·4 17·6
2¼×2¼×¼	·246	7·2	5/16	1·05	·68	2·11	0 1	— 11/16	1·92 1·52	18·2 14·4
2¼×2¼×3/16	·181	5·4	5/16	1·04	·69	1·58	0 1	— 11/16	1·43 1·14	13·6 10·8
2×2×5/16	·308	7·8	5/16	0·97	·60	2·29	0 1	— 11/16	2·08 1·58	19·8 15·0
2×2×¼	·249	6·4	5/16	0·96	·60	1·89	0 1	— 11/16	1·71 1·30	16·3 12·4
2×2×3/16	·183	4·8	5/16	0·94	·61	1·41	0 1	— 11/16	1·28 ·98	12·2 9·3

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing page 184.

TIES

BASED ON
B.S. 449
1959

Two Unequal Angles long legs back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
9×4×$\frac{7}{8}$	·872	72·2	$\frac{5}{8}$	1·61	2·86	21·23	0	—	16·30	147
							1	$\frac{15}{16}$	13·62	123
9×4×$\frac{3}{4}$	·745	62·4	$\frac{5}{8}$	1·58	2·88	18·34	0	—	14·12	134
							1	$\frac{15}{16}$	11·84	112
9×4×$\frac{5}{8}$	·622	52·6	$\frac{5}{8}$	1·56	2·89	15·48	0	—	11·94	113
							1	$\frac{15}{16}$	10·05	95·5
9×4×$\frac{1}{2}$	·495	42·4	$\frac{5}{8}$	1·53	2·91	12·46	0	—	9·62	91·4
							1	$\frac{15}{16}$	8·13	77·2
8×6×$\frac{7}{8}$	·870	78·0	$\frac{5}{8}$	2·58	2·50	22·94	0	—	20·03	180
							1	$\frac{15}{16}$	17·97	162
							2	$\frac{13}{16}$	16·37	147
8×6×$\frac{3}{4}$	·746	67·6	$\frac{5}{8}$	2·56	2·52	19·87	0	—	17·35	165
							1	$\frac{15}{16}$	15·58	148
							2	$\frac{13}{16}$	14·21	135
8×6×$\frac{5}{8}$	·621	56·8	$\frac{5}{8}$	2·54	2·54	16·71	0	—	14·58	139
							1	$\frac{15}{16}$	13·12	125
							2	$\frac{13}{16}$	11·98	114
8×6×$\frac{1}{2}$	·495	45·8	$\frac{5}{8}$	2·51	2·55	13·46	0	—	11·74	112
							1	$\frac{15}{16}$	10·57	100
							2	$\frac{13}{16}$	9·67	91·8
8×4×$\frac{3}{4}$	·747	57·4	$\frac{5}{8}$	1·64	2·55	16·88	0	—	13·44	128
							1	$\frac{15}{16}$	11·29	107
8×4×$\frac{5}{8}$	·623	48·4	$\frac{5}{8}$	1·61	2·56	14·24	0	—	11·36	108
							1	$\frac{15}{16}$	9·57	90·9
8×4×$\frac{1}{2}$	·496	39·0	$\frac{5}{8}$	1·58	2·58	11·48	0	—	9·16	87·1
							1	$\frac{15}{16}$	7·75	73·6
7×3$\frac{1}{2}$×$\frac{5}{8}$	·623	42·0	$\frac{5}{8}$	1·46	2·23	12·36	0	—	9·84	93·5
							1	$\frac{15}{16}$	8·03	76·3
7×3$\frac{1}{2}$×$\frac{1}{2}$	·497	34·0	$\frac{5}{8}$	1·43	2·25	10·00	0	—	7·97	75·8
							1	$\frac{15}{16}$	6·54	62·1
7×3$\frac{1}{2}$×$\frac{3}{8}$	·372	25·8	$\frac{5}{8}$	1·40	2·27	7·59	0	—	6·06	57·6
							1	$\frac{15}{16}$	4·99	47·4

The above safe loads are calculated for an axial stress of 9·5 tons/inch² for angles up to and including $\frac{3}{4}$″ thick and 9·0 tons/inch² for angles over $\frac{3}{4}$″ thick on the effective areas as specified in Clause 42 of B.S. 449: 1959.

BASED ON
B.S. 449
1959

TIES

Two Unequal Angles long legs back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
6×4×$\frac{3}{4}$	·748	47·2	$\frac{1}{2}$	1·73	1·87	13·89	0	—	11·85	113
							1	$\frac{15}{16}$	9·96	94·6
6×4×$\frac{5}{8}$	·622	39·8	$\frac{1}{2}$	1·70	1·89	11·71	0	—	10·00	95·0
							1	$\frac{15}{16}$	8·43	80·1
6×4×$\frac{1}{2}$	·496	32·2	$\frac{1}{2}$	1·68	1·91	9·47	0	—	8·09	76·8
							1	$\frac{15}{16}$	6·84	65·0
6×3$\frac{1}{2}$×$\frac{5}{8}$	·620	37·6	$\frac{1}{2}$	1·47	1·90	11·05	0	—	9·16	87·0
							1	$\frac{15}{16}$	7·48	71·1
6×3$\frac{1}{2}$×$\frac{1}{2}$	·497	30·6	$\frac{1}{2}$	1·45	1·91	8·99	0	—	7·45	70·8
							1	$\frac{15}{16}$	6·12	58·1
6×3$\frac{1}{2}$×$\frac{3}{8}$	·371	23·2	$\frac{1}{2}$	1·42	1·93	6·82	0	—	5·65	53·7
							1	$\frac{15}{16}$	4·66	44·3
6×3×$\frac{5}{8}$	·623	35·6	$\frac{1}{2}$	1·25	1·90	10·47	0	—	8·33	79·1
							1	$\frac{13}{16}$	6·75	64·1
6×3×$\frac{1}{2}$	·496	28·8	$\frac{1}{2}$	1·22	1·92	8·47	0	—	6·75	64·2
							1	$\frac{13}{16}$	5·51	52·3
6×3×$\frac{3}{8}$	·373	22·0	$\frac{1}{2}$	1·20	1·93	6·47	0	—	5·17	49·1
							1	$\frac{13}{16}$	4·24	40·2
5×3$\frac{1}{2}$×$\frac{5}{8}$	·621	33·4	$\frac{1}{2}$	1·55	1·56	9·82	0	—	8·46	80·4
							1	$\frac{15}{16}$	6·91	65·6
5×3$\frac{1}{2}$×$\frac{1}{2}$	·498	27·2	$\frac{1}{2}$	1·52	1·57	8·00	0	—	6·90	65·5
							1	$\frac{15}{16}$	5·66	53·8
5×3$\frac{1}{2}$×$\frac{3}{8}$	·371	20·6	$\frac{1}{2}$	1·49	1·59	6·06	0	—	5·23	49·7
							1	$\frac{15}{16}$	4·31	40·9
5×3×$\frac{1}{2}$	·496	25·4	$\frac{1}{2}$	1·29	1·58	7·47	0	—	6·23	59·2
							1	$\frac{13}{16}$	5·09	48·3
5×3×$\frac{3}{8}$	·372	19·4	$\frac{1}{2}$	1·26	1·60	5·70	0	—	4·76	45·2
							1	$\frac{13}{16}$	3·91	37·1
5×3×$\frac{5}{16}$	·308	16·2	$\frac{1}{2}$	1·25	1·60	4·76	0	—	3·98	37·8
							1	$\frac{13}{16}$	3·27	31·1

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing page 184.

TIES

BASED ON
B.S. 449
1959

Two Unequal Angles long legs back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR MILD STEEL

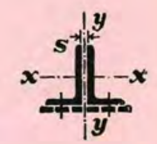
Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
$4\times3\frac{1}{2}\times\frac{5}{8}$	·623	29·2	$\frac{3}{8}$	1·59	1·21	8·59	0	—	7·71	73·2
							1	$\frac{15}{16}$	6·27	59·5
$4\times3\frac{1}{2}\times\frac{1}{2}$	·498	23·8	$\frac{3}{8}$	1·57	1·23	7·00	0	—	6·27	59·6
							1	$\frac{15}{16}$	5·13	48·7
$4\times3\frac{1}{2}\times\frac{3}{8}$	·374	18·2	$\frac{3}{8}$	1·54	1·24	5·35	0	—	4·80	45·6
							1	$\frac{13}{16}$	4·06	38·5
$4\times3\frac{1}{2}\times\frac{5}{16}$	·309	15·2	$\frac{3}{8}$	1·53	1·25	4·47	0	—	4·00	38·0
							1	$\frac{13}{16}$	3·39	32·2
$4\times3\times\frac{1}{2}$	·496	22·0	$\frac{3}{8}$	1·32	1·24	6·47	0	—	5·65	53·7
							1	$\frac{13}{16}$	4·61	43·8
$4\times3\times\frac{3}{8}$	·371	16·8	$\frac{3}{8}$	1·30	1·25	4·94	0	—	4·32	41·0
							1	$\frac{13}{16}$	3·53	33·6
$4\times3\times\frac{5}{16}$	·311	14·2	$\frac{3}{8}$	1·28	1·26	4·18	0	—	3·65	34·7
							1	$\frac{13}{16}$	3·00	28·5
$4\times2\frac{1}{2}\times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	1·06	1·26	4·58	0	—	3·87	36·7
							1	$\frac{13}{16}$	3·01	28·6
$4\times2\frac{1}{2}\times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	1·04	1·27	3·83	0	—	3·23	30·7
							1	$\frac{13}{16}$	2·52	24·0
$4\times2\frac{1}{2}\times\frac{1}{4}$	·248	10·6	$\frac{3}{8}$	1·03	1·28	3·11	0	—	2·63	25·0
							1	$\frac{13}{16}$	2·06	19·6
$3\frac{1}{2}\times3\times\frac{1}{2}$	·499	20·4	$\frac{3}{8}$	1·37	1·07	6·00	0	—	5·37	51·0
							1	$\frac{13}{16}$	4·36	41·5
$3\frac{1}{2}\times3\times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	1·34	1·08	4·58	0	—	4·10	38·9
							1	$\frac{13}{16}$	3·35	31·8
$3\frac{1}{2}\times3\times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	1·33	1·09	3·83	0	—	3·42	32·5
							1	$\frac{13}{16}$	2·80	26·6
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·370	14·2	$\frac{3}{8}$	1·10	1·09	4·17	0	—	3·62	34·4
							1	$\frac{13}{16}$	2·81	26·7
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·309	12·0	$\frac{3}{8}$	1·08	1·10	3·53	0	—	3·06	29·1
							1	$\frac{13}{16}$	2·39	22·7
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	9·6	$\frac{3}{8}$	1·07	1·11	2·83	0	—	2·45	23·3
							1	$\frac{11}{16}$	2·01	19·1
							1	$\frac{13}{16}$	1·92	18·3

The above safe loads are calculated for an axial stress of 9·5 tons/inch² on the effective areas as specified in Clause 42 of B.S. 449: 1959.

BASED ON
B.S. 449
1959

TIES

Two Unequal Angles long legs back to back
Gusset on back of Angles



PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
$3\times2\frac{1}{2}\times\frac{3}{8}$	·372	13·0	$\frac{5}{16}$	1·12	·92	3·82	0	—	3·41	32·4
							1	$\frac{13}{16}$	2·64	25·1
$3\times2\frac{1}{2}\times\frac{5}{16}$	·311	11·0	$\frac{5}{16}$	1·11	·93	3·23	0	—	2·88	27·4
							1	$\frac{13}{16}$	2·24	21·3
$3\times2\frac{1}{2}\times\frac{1}{4}$	·246	8·8	$\frac{5}{16}$	1·09	·93	2·59	0	—	2·31	21·9
							1	$\frac{11}{16}$	1·89	17·9
							1	$\frac{13}{16}$	1·80	17·1
$3\times2\times\frac{3}{8}$	·372	11·8	$\frac{5}{16}$	·89	·94	3·47	0	—	2·95	28·0
							1	$\frac{11}{16}$	2·23	21·2
$3\times2\times\frac{5}{16}$	·311	10·0	$\frac{5}{16}$	·87	·94	2·94	0	—	2·50	23·7
							1	$\frac{11}{16}$	1·91	18·1
$3\times2\times\frac{1}{4}$	·245	8·0	$\frac{5}{16}$	·86	·95	2·35	0	—	2·00	19·0
							1	$\frac{11}{16}$	1·53	14·6
$2\frac{1}{2}\times2\times\frac{3}{8}$	·367	10·4	$\frac{5}{16}$	·93	·76	3·06	0	—	2·69	25·5
							1	$\frac{11}{16}$	2·03	19·3
$2\frac{1}{2}\times2\times\frac{5}{16}$	·306	8·8	$\frac{5}{16}$	·92	·77	2·59	0	—	2·28	21·6
							1	$\frac{11}{16}$	1·73	16·5
$2\frac{1}{2}\times2\times\frac{1}{4}$	·246	7·2	$\frac{5}{16}$	·90	·78	2·11	0	—	1·86	17·6
							1	$\frac{11}{16}$	1·42	13·5
$2\frac{1}{2}\times2\times\frac{3}{16}$	·181	5·4	$\frac{5}{16}$	·89	·79	1·58	0	—	1·39	13·2
							1	$\frac{11}{16}$	1·07	10·1
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{1}{4}$	·249	6·4	$\frac{5}{16}$	·67	·79	1·89	0	—	1·56	14·9
							1	$\frac{9}{16}$	1·15	10·9
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{3}{16}$	·183	4·8	$\frac{5}{16}$	·65	·80	1·41	0	—	1·17	11·1
							1	$\frac{9}{16}$	·87	8·2
$2\times1\frac{1}{2}\times\frac{1}{4}$	·241	5·4	$\frac{5}{16}$	·71	·62	1·59	0	—	1·38	13·1
							1	$\frac{9}{16}$	1·01	9·6
$2\times1\frac{1}{2}\times\frac{3}{16}$	·184	4·2	$\frac{5}{16}$	·69	·63	1·24	0	—	1·07	10·2
							1	$\frac{9}{16}$	·79	7·5

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing page 184.

TIES

Two Unequal Angles short legs back to back

Gusset on back of Angles

BASED ON
B.S. 449
1959

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
$9\times4\times\frac{7}{8}$	·872	72·2	$\frac{5}{8}$	4·71	1·01	21·23	0	—	20·67	186
							1	$\frac{15}{16}$	18·98	171
							2	$\frac{15}{16}$	17·28	156
							3	$\frac{13}{16}$	16·25	146
$9\times4\times\frac{3}{4}$	·745	62·4	$\frac{5}{8}$	4·68	1·02	18·34	0	—	17·84	169
							1	$\frac{15}{16}$	16·40	156
							2	$\frac{15}{16}$	14·94	142
							3	$\frac{13}{16}$	14·06	134
$9\times4\times\frac{5}{8}$	·622	52·6	$\frac{5}{8}$	4·66	1·03	15·48	0	—	15·04	143
							1	$\frac{15}{16}$	13·83	131
							2	$\frac{15}{16}$	12·62	120
							3	$\frac{13}{16}$	11·88	113
$9\times4\times\frac{1}{2}$	·495	42·4	$\frac{5}{8}$	4·62	1·04	12·46	0	—	12·09	115
							1	$\frac{15}{16}$	11·13	106
							2	$\frac{15}{16}$	10·16	96·5
							3	$\frac{13}{16}$	9·57	90·9
$8\times6\times\frac{7}{8}$	·870	78·0	$\frac{5}{8}$	3·84	1·74	22·94	0	—	21·60	194
							1	$\frac{15}{16}$	19·82	178
							2	$\frac{15}{16}$	18·00	162
$8\times6\times\frac{3}{4}$	·746	67·6	$\frac{5}{8}$	3·81	1·75	19·87	0	—	18·70	178
							1	$\frac{15}{16}$	17·17	163
							2	$\frac{15}{16}$	15·60	148
$8\times6\times\frac{5}{8}$	·621	56·8	$\frac{5}{8}$	3·79	1·77	16·71	0	—	15·71	149
							1	$\frac{15}{16}$	14·43	137
							2	$\frac{15}{16}$	13·13	125
$8\times6\times\frac{1}{2}$	·495	45·8	$\frac{5}{8}$	3·76	1·78	13·46	0	—	12·63	120
							1	$\frac{15}{16}$	11·62	110
							2	$\frac{15}{16}$	10·58	101

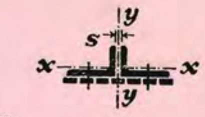
The above safe loads are calculated for an axial stress of 9·5 tons/inch^2 for angles up to and including $\frac{3}{4}''$ thick, and 9·0 tons/inch^2 for angles over $\frac{3}{4}''$ thick on the effective areas as specified in clause 42 of B.S. 449 : 1959.

BASED ON
B.S. 449
1959

TIES

Two Unequal Angles short legs back to back

Gusset on back of Angles



PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
$8\times4\times\frac{3}{4}$	·747	57·4	$\frac{5}{8}$	4·13	1·05	16·88	0	—	16·34	155
							1	$\frac{15}{16}$	14·88	141
							2	$\frac{15}{16}$	13·40	127
$8\times4\times\frac{5}{8}$	·623	48·4	$\frac{5}{8}$	4·10	1·06	14·24	0	—	13·77	131
							1	$\frac{15}{16}$	12·55	119
							2	$\frac{15}{16}$	11·32	108
$8\times4\times\frac{1}{2}$	·496	39·0	$\frac{5}{8}$	4·07	1·07	11·48	0	—	11·08	105
							1	$\frac{15}{16}$	10·11	96·1
							2	$\frac{15}{16}$	9·13	86·7
$7\times3\frac{1}{2}\times\frac{5}{8}$	·623	42·0	$\frac{5}{8}$	3·63	0·92	12·36	0	—	11·96	114
							1	$\frac{15}{16}$	10·74	102
							2	$\frac{15}{16}$	9·51	90·3
$7\times3\frac{1}{2}\times\frac{1}{2}$	·497	34·0	$\frac{5}{8}$	3·60	0·93	10·00	0	—	9·66	91·8
							1	$\frac{15}{16}$	8·69	82·5
							2	$\frac{15}{16}$	7·70	73·1
$7\times3\frac{1}{2}\times\frac{3}{8}$	·372	25·8	$\frac{5}{8}$	3·57	0·94	7·59	0	—	7·32	69·5
							1	$\frac{15}{16}$	6·59	62·6
							2	$\frac{15}{16}$	5·85	55·6
$6\times4\times\frac{3}{4}$	·748	47·2	$\frac{1}{2}$	2·98	1·11	13·89	0	—	13·22	126
							1	$\frac{15}{16}$	11·71	111
							2	$\frac{13}{16}$	10·58	100
$6\times4\times\frac{5}{8}$	·622	39·8	$\frac{1}{2}$	2·95	1·13	11·71	0	—	11·14	106
							1	$\frac{15}{16}$	9·88	93·9
							2	$\frac{13}{16}$	8·94	84·9
$6\times4\times\frac{1}{2}$	·496	32·2	$\frac{1}{2}$	2·93	1·14	9·47	0	—	9·00	85·5
							1	$\frac{15}{16}$	8·00	76·0
							2	$\frac{13}{16}$	7·24	68·8

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.

For explanation of tables, see notes commencing page 184.

TIES

BASED ON
B.S. 449
1959

Two Unequal Angles short legs back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
6×3½×⅝	·620	37·6	½	3·03	0·95	11·05	0 1 2	— 15/16 13/16	10·61 9·38 8·46	101 89·1 80·4
6×3½×½	·497	30·6	½	3·00	0·96	8·99	0 1 2	— 15/16 13/16	8·62 7·63 6·89	81·9 72·5 65·5
6×3½×⅜	·371	23·2	½	2·97	0·93	6·82	0 1 2	— 15/16 13/16	6·52 5·78 5·23	62·0 54·9 49·7
6×3×⅝	·623	35·6	½	3·12	0·78	10·47	0 1 2	— 15/16 13/16	10·15 8·93 8·02	96·4 84·8 76·2
6×3×½	·496	28·8	½	3·09	0·79	8·47	0 1 2	— 15/15 13/16	8·20 7·23 6·50	77·9 68·6 61·8
6×3×⅜	·373	22·0	½	3·06	0·80	6·47	0 1 2	— 15/16 13/16	6·25 5·52 4·97	59·4 52·4 47·3
5×3½×⅝	·621	33·4	½	2·49	0·99	9·82	0 1	— 15/16	9·31 8·05	88·5 76·4
5×3½×½	·498	27·2	½	2·46	1·00	8·00	0 1	— 15/16	7·58 6·56	72·0 62·4
5×3½×⅜	·371	20·6	½	2·43	1·01	6·06	0 1	— 15/16	5·73 4·98	54·5 47·3

The above safe loads are calculated for an axial stress of 9·5 tons/inch² on the effective areas as specified in clause 42 of B.S. 449 : 1959.

BASED ON
B.S. 449
1959

TIES

Two Unequal Angles short legs back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles *s* inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis *y-y*	Axis *x-x*		No.	Dia.		
5×3×½	·496	25·4	½	2·54	0·82	7·47	0 1	— 15/16	7·16 6·17	68·0 58·6
5×3×⅜	·372	19·4	½	2·51	0·84	5·70	0 1	— 15/16	5·46 4·71	51·8 44·8
5×3×5/16	·308	16·2	½	2·49	0·84	4·76	0 1	— 15/16	4·55 3·94	43·3 37·4
4×3½×⅝	·623	29·2	⅜	1·91	1·02	8·59	0 1	— 15/16	7·98 6·65	75·8 63·2
4×3½×½	·498	23·8	⅜	1·88	1·03	7·00	0 1	— 15/16	6·50 5·43	61·7 51·6
4×3½×⅜	·374	18·2	⅜	1·86	1·05	5·35	0 1	— 15/16	4·96 4·16	47·2 39·6
4×3½×5/16	·309	15·2	⅜	1·84	1·05	4·47	0 1	— 13/16	4·14 3·57	39·3 33·9
4×3×½	·496	22·0	⅜	1·95	0·86	6·47	0 1	— 15/16	6·10 5·08	58·0 48·2
4×3×⅜	·371	16·8	⅜	1·92	0·87	4·94	0 1	— 15/16	4·65 3·88	44·2 36·9
4×3×5/16	·311	14·2	⅜	1·91	0·88	4·18	0 1	— 13/16	3·93 3·38	37·4 32·1
4×2½×⅜	·373	15·6	⅜	2·00	0·69	4·58	0 1	— 15/16	4·38 3·63	41·6 34·5
4×2½×5/16	·308	13·0	⅜	1·98	0·70	3·83	0 1	— 13/16	3·65 3·12	34·7 29·6
4×2½×¼	·248	10·6	⅜	1·96	0·70	3·11	0 1	— 13/16	2·97 2·54	28·2 24·1

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.
For explanation of tables, see notes commencing page 184.

TIES

BASED ON
B.S. 449
1959

Two Unequal Angles short legs back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles s inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis y-y	Axis x-x		No.	Dia.		
$3\frac{1}{2}\times3\times\frac{1}{2}$	·499	20·4	$\frac{3}{8}$	1·68	0·87	6·00	0	—	5·59	53·1
							1	$\frac{15}{16}$	4·53	43·0
$3\frac{1}{2}\times3\times\frac{3}{8}$	·373	15·6	$\frac{3}{8}$	1·66	0·89	4·58	0	—	4·27	40·5
							1	$\frac{15}{16}$	3·47	33·0
$3\frac{1}{2}\times3\times\frac{5}{16}$	·308	13·0	$\frac{3}{8}$	1·64	0·89	3·83	0	—	3·56	33·8
							1	$\frac{13}{16}$	2·99	28·4
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{3}{8}$	·370	14·2	$\frac{3}{8}$	1·72	0·71	4·17	0	—	3·96	37·6
							1	$\frac{13}{16}$	3·30	31·3
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{5}{16}$	·309	12·0	$\frac{3}{8}$	1·71	0·72	3·53	0	—	3·34	31·7
							1	$\frac{13}{16}$	2·79	26·5
$3\frac{1}{2}\times2\frac{1}{2}\times\frac{1}{4}$	·245	9·6	$\frac{3}{8}$	1·69	0·72	2·83	0	—	2·68	25·4
							1	$\frac{13}{16}$	2·24	21·3
$3\times2\frac{1}{2}\times\frac{3}{8}$	·372	13·0	$\frac{5}{16}$	1·43	0·73	3·82	0	—	3·57	33·9
							1	$\frac{13}{16}$	2·89	27·4
$3\times2\frac{1}{2}\times\frac{5}{16}$	·311	11·0	$\frac{5}{16}$	1·42	0·73	3·23	0	—	3·02	28·7
							1	$\frac{13}{16}$	2·45	23·3
$3\times2\frac{1}{2}\times\frac{1}{4}$	·246	8·8	$\frac{5}{16}$	1·40	0·74	2·59	0	—	2·42	23·0
							1	$\frac{13}{16}$	1·97	18·7

The above safe loads are calculated for an axial stress of 9·5 tons/inch^2 on the effective areas as specified in clause 42 of B.S. 449 : 1959.

BASED ON
B.S. 449
1959

TIES

Two Unequal Angles short legs back to back
Gusset on back of Angles

PROPERTIES AND SAFE LOADS FOR MILD STEEL

Composed of Two Unequal Angles		Weight per foot in lbs	Space between Angles s inches	Radius of Gyration		Gross Area in square inches	Holes deducted from each Angle		Effective Area of Tie square inches	Safe Load in Tons
Nominal Size	Actual Thickness			Axis y-y	Axis x-x		No.	Dia.		
$3\times2\times\frac{3}{8}$	·372	11·8	$\frac{5}{16}$	1·51	·56	3·47	0	—	3·29	31·2
							1	$\frac{13}{16}$	2·63	25·0
$3\times2\times\frac{5}{16}$	·311	10·0	$\frac{5}{16}$	1·50	·56	2·94	0	—	2·78	26·5
							1	$\frac{13}{16}$	2·23	21·2
$3\times2\times\frac{1}{4}$	·245	8·0	$\frac{5}{16}$	1·48	·57	2·35	0	—	2·22	21·1
							1	$\frac{13}{16}$	1·79	17·0
$2\frac{1}{2}\times2\times\frac{3}{8}$	·367	10·4	$\frac{5}{16}$	1·24	·57	3·06	0	—	2·85	27·1
							1	$\frac{13}{16}$	2·18	20·7
$2\frac{1}{2}\times2\times\frac{5}{16}$	·306	8·8	$\frac{5}{16}$	1·23	·58	2·59	0	—	2·41	22·9
							1	$\frac{13}{16}$	1·85	17·6
$2\frac{1}{2}\times2\times\frac{1}{4}$	·246	7·2	$\frac{5}{16}$	1·22	·59	2·11	0	—	1·97	18·7
							1	$\frac{11}{16}$	1·59	15·1
$2\frac{1}{2}\times2\times\frac{3}{16}$	·181	5·4	$\frac{5}{16}$	1·20	·59	1·58	0	—	1·47	14·0
							1	$\frac{11}{16}$	1·19	11·3
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{1}{4}$	·249	6·4	$\frac{5}{16}$	1·29	·41	1·89	0	—	1·80	17·1
							1	$\frac{11}{16}$	1·43	13·6
$2\frac{1}{2}\times1\frac{1}{2}\times\frac{3}{16}$	·183	4·8	$\frac{5}{16}$	1·27	·42	1·41	0	—	1·34	12·8
							1	$\frac{11}{16}$	1·07	10·2
$2\times1\frac{1}{2}\times\frac{1}{4}$	·241	5·4	$\frac{5}{16}$	1·02	·43	1·59	0	—	1·49	14·1
							1	$\frac{11}{16}$	1·11	10·6
$2\times1\frac{1}{2}\times\frac{3}{16}$	·184	4·2	$\frac{5}{16}$	1·00	·43	1·24	0	—	1·15	11·0
							1	$\frac{11}{16}$	0·87	8·2

Each weight per foot is for angles only. Weights of end connections and intermediate fastenings, etc., to be added.

For explanation of tables, see notes commencing page 184.

SHEARING AND BEARING VALUES FOR MILD STEEL POWER-DRIVEN
SHOP RIVETS

BASED ON
B.S. 449
1959
AS AMENDED
1961

Gross Dia. of Rivet after driving in inches	Area in square inches	Shearing Value @ 6·5 tons/inch^2		SIMPLE BEARING VALUE @ 80% OF 19 TONS/INCH^2 *and* ENCLOSED BEARING VALUE @ 19 TONS/INCH^2 (SEE FOOTNOTE)										
				Thickness in inches of plate passed through or of enclosed plate										
		Single Shear	Double Shear	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8
3/8	·1104	·72	1·44	**1·07**	**1·43**	1·78	2·14							
				1·34	1·78	2·23								
7/16	·1503	·93	1·95	**1·25**	**1·66**	2·08	2·49							
				1·56	2·08	2·60								
1/2	·1963	1·28	2·55	**1·43**	**1·90**	**2·38**	2·85	3·33						
				1·78	**2·38**	2·97	3·56							
9/16	·2485	1·62	3·23	1·60	**2·14**	**2·67**	**3·21**	3·74	4·28					
				2·00	**2·67**	3·34	4·01							
5/8	·3068	1·99	3·99	1·78	**2·38**	**2·97**	**3·56**	4·16	4·75					
				2·23	**2·97**	**3·71**	4·45	5·20						
11/16	·3712	2·41	4·83	1·96	**2·61**	**3·27**	**3·92**	**4·57**	5·23	5·88				
				2·45	**3·27**	**4·08**	4·90	5·71						
3/4	·4418	2·87	5·74	2·14	2·85	**3·56**	**4·28**	**4·99**	**5·70**	6·41	7·13			
				2·67	**3·56**	**4·45**	**5·34**	6·23	7·13					
13/16	·5185	3·37	6·74	2·32	3·09	**3·86**	**4·63**	**5·40**	**6·18**	6·95	7·72			
				2·69	**3·86**	**4·82**	**5·79**	6·75	7·72					
7/8	·6013	3·91	7·82	2·49	3·33	**4·16**	**4·99**	**5·82**	**6·65**	**7·48**	8·31	9·14		
				3·12	**4·16**	**5·20**	**6·23**	**7·27**	8·31	9·35				
15/16	·6903	4·49	8·97	2·67	3·56	4·45	**5·34**	**6·23**	**7·13**	**8·02**	**8·91**	9·80	10·69	
				3·34	4·45	**5·57**	**6·68**	**7·79**	**8·91**	10·02	11·13			
1	·7854	5·11	10·21	2·85	3·80	4·75	**5·70**	**6·65**	**7·60**	**8·55**	**9·50**	10·45	11·40	
				3·56	4·75	**5·94**	**7·13**	**8·31**	**9·50**	10·69	11·88			
1 1/16	·8866	5·76	11·53	3·03	4·04	5·05	**6·06**	**7·07**	**8·08**	**9·08**	**10·09**	**11·10**	12·11	14·13
				3·79	5·05	**6·31**	**7·57**	**8·83**	**10·09**	**11·36**	12·62	13·88		

Upper line of Bearing Values for each diameter of rivet are Simple Bearing Values.
Lower line of Bearing Values for each diameter of rivet are Enclosed Bearing Values.
For areas to be deducted from a bar for one hole, see table on page 154.
For weights of rivets, see page 708.
For explanation of table see Notes on page 187.

BASED ON
B.S. 449
1959
AS AMENDED
1961

SHEARING AND BEARING VALUES FOR MILD STEEL POWER-DRIVEN
FIELD RIVETS

Gross Dia. of Rivet after driving in inches	Area in square inches	Shearing Value @ 6 tons/inch^2		SIMPLE BEARING VALUE @ 80% OF 17·5 TONS/INCH^2 *and* ENCLOSED BEARING VALUE @ 17·5 TONS/INCH^2 (SEE FOOTNOTE)										
				Thickness in inches of plate passed through or of enclosed plate										
		Single Shear	Double Shear	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8
3/8	·1104	·66	1·33	**·98**	**1·31**	1·64	1·97							
				1·23	1·64	2·05								
7/16	·1503	·90	1·80	**1·15**	**1·53**	1·91	2·30							
				1·44	1·91	2·39								
1/2	·1963	1·18	2·36	**1·31**	**1·75**	**2·19**	2·63	3·06						
				1·64	**2·19**	2·73	3·28							
9/16	·2485	1·49	2·98	1·48	**1·97**	**2·46**	**2·95**	3·45	3·94					
				1·85	**2·46**	3·08	3·69							
5/8	·3068	1·84	3·68	1·64	**2·19**	**2·73**	**3·28**	3·83	4·38					
				2·05	**2·73**	**3·42**	4·10	4·79						
11/16	·3712	2·23	4·45	1·80	**2·41**	**3·01**	**3·61**	**4·21**	4·81	5·41				
				2·26	**3·01**	**3·76**	4·51	5·26						
3/4	·4418	2·65	5·30	1·97	2·63	**3·28**	**3·94**	**4·59**	**5·25**	5·91	6·56			
				2·46	**3·28**	**4·10**	**4·92**	5·74	6·56					
13/16	·5185	3·11	6·22	2·13	2·84	**3·55**	**4·27**	**4·98**	**5·69**	6·40	7·11			
				2·67	**3·55**	**4·44**	**5·33**	**6·22**	7·11	8·00				
7/8	·6013	3·61	7·22	2·30	3·06	**3·83**	**4·59**	**5·36**	**6·13**	**6·89**	7·66	8·42		
				2·87	**3·83**	**4·79**	**5·74**	**6·70**	7·66	8·61				
15/16	·6903	4·14	8·28	2·46	3·28	4·10	**4·92**	**5·74**	**6·56**	**7·38**	**8·20**	9·02	9·84	
				3·08	4·10	**5·13**	**6·15**	**7·18**	**8·20**	9·23	10·25			
1	·7854	4·71	9·42	2·63	3·50	4·38	**5·25**	**6·13**	**7·00**	**7·88**	**8·75**	9·63	10·50	
				3·28	4·38	**5·47**	**6·56**	**7·66**	**8·75**	9·84	10·94			
1 1/16	·8866	5·32	10·64	2·79	3·72	4·65	**5·58**	**6·51**	**7·44**	**8·37**	**9·30**	**10·23**	11·16	13·02
				3·49	4·65	**5·81**	**6·97**	**8·13**	**9·30**	**10·46**	11·62	12·78		

Upper line of Bearing Values for each diameter of rivet are Simple Bearing Values.
Lower line of Bearing Values for each diameter of rivet are Enclosed Bearing Values.
For areas to be deducted from a bar for one hole, see table on page 154.
For weights of rivets, see page 708.
For explanation of table see Notes on page 187.

SHEARING AND BEARING VALUES FOR MILD STEEL HAND-DRIVEN RIVETS

BASED ON
B.S. 449
1959
AS AMENDED
1961

Gross Dia. of Rivet after driving in inches	Area in square inches	Shearing Value @ 5·5 tons/inch^2		SIMPLE BEARING VALUE @ 80% OF 16 TONS/INCH^2 *and* ENCLOSED BEARING VALUE @ 16 TONS/INCH^2 (SEE FOOTNOTE)										
				Thickness in inches of plate passed through or of enclosed plate										
		Single Shear	Double Shear	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8
3/8	·1104	·61	1·21	**·90**	**1·20**	1·50	1·80							
				1·13	1·50	1·88								
7/16	·1503	·83	1·65	**1·05**	**1·40**	1·75	2·10							
				1·31	1·75	2·19								
1/2	·1963	1·08	2·16	**1·20**	**1·60**	**2·00**	2·40	2·80						
				1·50	**2·00**	2·50	3·00							
9/16	·2485	1·37	2·73	1·35	**1·80**	**2·25**	**2·70**	3·15	3·60					
				1·69	**2·25**	2·81	3·38							
5/8	·3068	1·69	3·37	1·50	**2·00**	**2·50**	**3·00**	3·50	4·00					
				1·88	**2·50**	**3·13**	3·75	4·38						
11/16	·3712	2·04	4·08	1·65	**2·20**	**2·75**	**3·30**	**3·85**	4·40	4·95				
				2·06	**2·75**	**3·44**	4·13	4·81						
3/4	·4418	2·43	4·86	1·80	2·40	**3·00**	**3·60**	**4·20**	**4·80**	5·40	6·00			
				2·25	**3·00**	**3·75**	**4·50**	5·25	6·00					
13/16	·5185	2·85	5·70	1·95	2·60	**3·25**	**3·90**	**4·55**	**5·20**	5·85	6·50			
				2·44	**3·25**	**4·06**	**4·88**	**5·69**	6·50	7·31				
7/8	·6013	3·31	6·61	2·10	2·80	**3·50**	**4·20**	**4·90**	**5·60**	**6·30**	7·00	7·70		
				2·63	**3·50**	**4·38**	**5·25**	**6·13**	7·00	7·88				
15/16	·6903	3·80	7·59	2·25	3·00	3·75	**4·50**	**5·25**	**6·00**	**6·75**	**7·50**	8·25	9·00	
				2·81	3·75	**4·69**	**5·63**	**6·56**	**7·50**	8·44	9·38			
1	·7854	4·32	8·64	2·40	3·20	4·00	**4·80**	**5·60**	**6·40**	**7·20**	**8·00**	8·80	9·60	
				3·00	4·00	**5·00**	**6·00**	**7·00**	**8·00**	9·00	10·00			
1 1/16	·8866	4·88	9·75	2·55	3·40	4·25	**5·10**	**5·95**	**6·80**	**7·65**	**8·50**	**9·35**	10·20	11·90
				3·19	4·25	**5·31**	**6·38**	**7·44**	**8·50**	**9·56**	10·63	11·69		

Upper line of Bearing Values for each diameter of rivet are Simple Bearing Values.
Lower line of Bearing Values for each diameter of rivet are Enclosed Bearing Values.
For areas to be deducted from a bar for one hole, see table on page 154.
For weights of rivets, see page 708.
For explanation of table see Notes on page 187.

BASED ON
B.S. 449
1959
AS AMENDED
1961

SHEARING AND BEARING VALUES FOR MILD STEEL CLOSE TOLERANCE AND TURNED BOLTS

Dia. of Bolt Shank in inches	Area in square inches	Shearing Value @ 6·0 tons/inch^2		SIMPLE BEARING VALUE @ 80% OF 19 TONS/INCH^2 *and* ENCLOSED BEARING VALUE @ 19 TONS/INCH^2 (SEE FOOTNOTE)									
				Thickness in inches of plate passed through or of enclosed plate									
		Single Shear	Double Shear	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4
3/8	·1104	·66	1·33	**1·07**	1·43	1·78							
				1·34	1·78								
7/16	·1503	·90	1·80	**1·25**	**1·66**	2·08	2·49						
				1·56	2·08	2·60							
1/2	·1963	1·18	2·36	**1·43**	**1·90**	2·38	2·85						
				1·78	2·38	2·97							
9/16	·2485	1·49	2·98	**1·60**	**2·14**	**2·67**	3·21	3·74					
				2·00	**2·67**	3·34	4·01						
5/8	·3068	1·84	3·68	1·78	**2·38**	**2·97**	**3·56**	4·16	4·75				
				2·23	**2·97**	3·71	4·45						
11/16	·3712	2·23	4·45	1·96	**2·61**	**3·27**	**3·92**	4·57	5·23				
				2·45	**3·27**	**4·08**	4·90	5·71					
3/4	·4418	2·65	5·30	2·14	**2·85**	**3·56**	**4·28**	**4·99**	5·70	6·41			
				2·67	**3·56**	**4·45**	5·34	6·23					
13/16	·5185	3·11	6·22	2·32	3·09	**3·86**	**4·63**	**5·40**	**6·18**	6·95	7·72		
				2·89	**3·86**	**4·82**	**5·79**	6·75	7·72				
7/8	·6013	3·61	7·22	2·49	3·33	**4·16**	**4·99**	**5·82**	**6·65**	7·48	8·31		
				3·12	**4·16**	**5·20**	**6·23**	7·27	8·31				
15/16	·6903	4·14	8·28	2·67	3·56	**4·45**	**5·34**	**6·23**	**7·13**	**8·02**	8·91	9·80	
				3·34	**4·45**	**5·57**	**6·68**	**7·79**	8·91	10·02			
1	·7854	4·71	9·42	2·85	3·80	**4·75**	**5·70**	**6·65**	**7·60**	**8·55**	9·50	10·45	
				3·56	**4·75**	**5·94**	**7·13**	**8·31**	9·50	10·69			
1 1/16	·8866	5·32	10·64	3·03	4·04	5·05	**6·06**	**7·07**	**8·08**	**9·08**	**10·09**	11·10	12·11
				3·79	5·05	**6·31**	**7·57**	**8·83**	**10·09**	11·36	12·62		

Upper line of Bearing Values for each diameter of bolt are Simple Bearing Values.
Lower line of Bearing Values for each diameter of bolt are Enclosed Bearing Values.
For areas to be deducted from a bar for one hole, see table on page 154.
For dimensions and weights of bolts, see pages 710 and 712.
For explanation of table see Notes on page 187.

SHEARING AND BEARING VALUES FOR MILD STEEL BLACK BOLTS

BASED ON
B.S. 449
1959
AS AMENDED
1961

Dia. of Bolt Shank in inches	Area in square inches	Shearing Value @ 5·0 tons/inch²		SIMPLE BEARING VALUE @ 80% OF 12·5 TONS/INCH² *and* ENCLOSED BEARING VALUE @ 12·5 TONS/INCH² (SEE FOOTNOTE)										
				Thickness in inches of plate passed through or of enclosed plate										
		Single Shear	Double Shear	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{7}{8}$
$\frac{3}{8}$	·1104	·55	1·10	**·70** **·88**	**·94** 1·17	1·17 1·46	1·41							
$\frac{7}{16}$	·1503	·75	1·50	**·82** **1·03**	**1·09** **1·37**	**1·37** 1·71	1·64 2·05	1·91						
$\frac{1}{2}$	·1963	·98	1·96	·94 **1·17**	**1·25** **1·56**	**1·56** **1·95**	**1·88** 2·34	2·19 2·73	2·50					
$\frac{9}{16}$	·2485	1·24	2·49	1·05 **1·32**	**1·41** **1·76**	**1·76** **2·20**	**2·11** 2·64	**2·46** 3·08	2·81	3·16				
$\frac{5}{8}$	·3068	1·53	3·07	1·17 1·46	**1·56** **1·95**	**1·95** **2·44**	**2·34** **2·93**	**2·73** 3·42	3·13 3·91	3·52				
$\frac{11}{16}$	·3712	1·86	3·71	1·29 1·61	1·72 **2·15**	**2·15** **2·69**	**2·58** **3·22**	**3·01** 3·76	**3·44** 4·30	3·87	4·30			
$\frac{3}{4}$	·4418	2·21	4·42	1·41 1·76	1·88 **2·34**	**2·34** **2·93**	**2·81** **3·52**	**3·28** **4·10**	**3·75** 4·69	**4·22** 5·27	4·69	5·16		
$\frac{13}{16}$	·5185	2·59	5·18	1·52 1·90	2·03 2·54	2·54 **3·17**	**3·05** **3·81**	**3·55** **4·44**	**4·06** **5·08**	**4·57** 5·71	**5·08** 6·35	5·59	6·09	
$\frac{7}{8}$	·6013	3·01	6·01	1·64 2·05	2·19 2·73	2·73 **3·42**	**3·28** **4·10**	**3·83** **4·79**	**4·38** **5·47**	**4·92** 6·15	**5·47** 6·84	6·02	6·56	
$\frac{15}{16}$	·6903	3·45	6·90	1·76 2·20	2·34 2·93	2·93 **3·66**	**3·52** **4·39**	**4·10** **5·13**	**4·69** **5·86**	**5·27** **6·59**	**5·86** 7·32	**6·45** 8·06	7·03	8·20
1	·7854	3·93	7·85	1·88 2·34	2·50 3·13	3·13 3·91	3·75 **4·69**	**4·38** **5·47**	**5·00** **6·25**	**5·63** **7·03**	**6·25** **7·81**	**6·88** 8·59	**7·50** 9·38	8·75
$1\frac{1}{16}$	·8866	4·43	8·87	1·99 2·49	2·66 3·32	3·32 4·15	3·98 **4·98**	**4·65** **5·81**	**5·31** **6·64**	**5·98** **7·47**	**6·64** **8·30**	**7·30** 9·13	**7·97** 9·96	9·30

Upper line of Bearing Values for each diameter of bolt are Simple Bearing Values.
Lower line of Bearing Values for each diameter of bolt are Enclosed Bearing Values.
For areas to be deducted from a bar for one hole, see table on page 154.
For dimensions and weights of bolts, see pages 709, 710 and 711.
For explanation of tables see Notes on page 187.

HIGH STRENGTH FRICTION GRIP BOLTS

TO B.S. 3139 : 1959 PART 1

GENERAL GRADE BOLTS

SHEAR VALUES OF BOLTS PER INTERFACE

Diameter of Bolt Shank in inches	Shear Value without wind tons	Shear Value including wind tons
$\frac{1}{2}$	1·73	2·01
$\frac{5}{8}$	2·75	3·21
$\frac{3}{4}$	4·07	4·75
$\frac{7}{8}$	5·17	6·03
1	6·78	7·91
$1\frac{1}{8}$	8·10	9·45
$1\frac{1}{4}$	10·29	12·00
$1\frac{1}{2}$	14·80	17·26

For dimensions and weights of bolts, see pages 712 and 713.
For explanation of table see page 188.

STRENGTH OF FILLET WELDS
MILD STEEL

PERMISSIBLE LOADS IN TONS PER LINEAR INCH WITH ELECTRODES TO B.S. 639 : 1952

Size of Fillet in inches	Throat Thickness in inches	Load at 7 tons/inch^2 tons	Size of Fillet in inches	Throat Thickness in inches	Load at 7 tons/inch^2 tons
1/4	·177	1·23	11/16	·486	3·40
5/16	·221	1·54	3/4	·530	3·71
3/8	·265	1·85	13/16	·575	4·02
7/16	·309	2·16	7/8	·619	4·33
1/2	·354	2·47	15/16	·663	4·64
9/16	·398	2·78	1	·707	4·94
5/8	·442	3·09			

STRENGTH OF FULL PENETRATION BUTT WELDS
MILD STEEL

PERMISSIBLE LOADS IN TONS PER LINEAR INCH WITH ELECTRODES TO B.S. 639 : 1952

Plate Thickness in inches	Shear at 7 tons/inch^2 tons	Tension or Compression at 9·5 tons/inch^2 tons	Plate Thickness in inches	Shear at 7 tons/inch^2 tons	Tension or Compression at 9·5 tons/inch^2 tons	Tension or Compression at 9·0 tons/inch^2* tons
1/4	1·75	2·37	7/8	6·12	8·31	7·87
5/16	2·18	2·96	1	7·00	9·50	9·00
3/8	2·62	3·56	1¼	8·75	11·87	11·25
7/16	3·06	4·15	1½	10·50	14·25	13·50
1/2	3·50	4·75	1¾	12·25	16·62	15·75
5/8	4·37	5·93	2	14·00	19·00	18·00
3/4	5·25	7·12				

* For material over ¾ in. thick other than rolled I-beams or channels.
NOTE: FOR INCOMPLETE PENETRATION WELDS, THE ABOVE LOADS ARE TO BE MULTIPLIED BY 0·625

AUTOFAB BEAMS

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Size D×B inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS															
		25 ·0308	30 ·0214	35 ·0157	40 ·0120	45 ·0095	50 ·0077	55 ·0064	60 ·0053	65 ·0046	70 ·0039	75 ·0034	80 ·0030	85 ·0027	90 ·0024	95 ·0021	100 ·0019
78×22	456·5				**555†**	**535**	*481*	*438*	*401*	*370*	*344*	*321*	*301*	*283*	*267*	*253*	*241*
	388·5					**447†**	**420**	**381**	*350*	*323*	*300*	*280*	*262*	*247*	*233*	*221*	*210*
	351·9				**450†**	**412**	**371**	*337*	*309*	*285*	*265*	*247*	*232*	*218*	*206*	*195*	*185*
	315·4			**453†**	**402**	*357*	*321*	*292*	*268*	*247*	*230*	*214*	*201*	*189*	*179*	*169*	*161*
	278·8	**456†**	**452**	**387**	*339*	*301*	*271*	*247*	*226*	*209*	*194*	*181*	*170*	*160*	*151*	*143*	*136*
78×18	370·6				**444†**	**436**	**393**	*357*	*327*	*302*	*280*	*262*	*245*	*231*	*218*	*207*	*196*
	340·9			**447†**	**442**	**393**	*353*	*321*	*295*	*272*	*252*	*236*	*221*	*208*	*196*	*186*	*177*
	311·1		**450†**	**448**	**392**	*349*	*314*	*285*	*261*	*241*	*224*	*209*	*196*	*185*	*174*	*165*	*157*
	281·4		**435†**	**391**	*342*	*304*	*273*	*249*	*228*	*210*	*195*	*182*	*171*	*161*	*152*	*144*	*137*
	251·6	**456†**	**388**	*332*	*291*	*259*	*233*	*212*	*194*	*179*	*166*	*155*	*145*	*137*	*129*	*122*	*116*
	221·9	**403**	*336*	*288*	*252*	*224*	*201*	*183*	*168*	*155*	*144*	*134*	*126*	*119*	*112*	*106*	*101*
73×14	293·3		**447†**	**410**	*359*	*319*	*287*	*261*	*239*	*221*	*205*	*192*	*180*	*169*	*160*	*151*	*144*
	270·3	**450†**	**428**	*367*	*321*	*285*	*257*	*233*	*214*	*197*	*183*	*171*	*160*	*151*	*143*	*135*	*128*
	247·4	**451**	**376**	*322*	*282*	*251*	*226*	*205*	*188*	*174*	*161*	*150*	*141*	*133*	*125*	*119*	*113*
	224·4	**388**	*324*	*277*	*243*	*216*	*194*	*177*	*162*	*149*	*139*	*129*	*121*	*114*	*108*	*102*	*97·1*
	185·2	**326**	*272*	*233*	*204*	*181*	*163*	*148*	*136*	*125*	*116*	*109*	*102*	*95·8*	*90·5*	*85·7*	*81·5*
	162·1	*258*	*215*	*184*	*161*	*143*	*129*	*117*	*107*	*99·1*	*92·0*	*85·8*	*80·5*	*75·7*	*71·5*	*67·8*	*64·4*
72×22	443·7				**510†**	**486**	*437*	*397*	*364*	*336*	*312*	*291*	*273*	*257*	*243*	*230*	*219*
	378·3					**411†**	**381**	*347*	*318*	*293*	*272*	*254*	*238*	*224*	*212*	*201*	*191*
	341·7				**414†**	**374**	*337*	*306*	*281*	*259*	*241*	*225*	*210*	*198*	*187*	*177*	*168*
	305·2		**417†**	**416**	**364**	*324*	*291*	*265*	*243*	*224*	*208*	*194*	*182*	*171*	*162*	*153*	*146*
	268·6	**420†**	**409**	*351*	*307*	*273*	*245*	*223*	*205*	*189*	*175*	*164*	*153*	*144*	*136*	*129*	*123*
72×18	360·4				**408†**	**396**	**357**	*324*	*297*	*274*	*255*	*238*	*223*	*210*	*198*	*188*	*178*
	330·7			**411†**	**401**	**356**	*321*	*292*	*267*	*247*	*229*	*214*	*200*	*189*	*178*	*169*	*160*
	300·9		**414†**	**406**	**355**	*316*	*284*	*258*	*237*	*219*	*203*	*190*	*178*	*167*	*158*	*150*	*142*
	271·2	**417†**	**412**	*353*	*309*	*275*	*247*	*225*	*206*	*190*	*177*	*165*	*155*	*146*	*137*	*130*	*124*
	241·4	**420**	*350*	*300*	*262*	*233*	*210*	*191*	*175*	*161*	*150*	*140*	*131*	*123*	*117*	*110*	*105*
	211·7	**362**	*302*	*259*	*226*	*201*	*181*	*165*	*151*	*139*	*129*	*121*	*113*	*106*	*101*	*95·3*	*90·5*
72×14	283·1		**411†**	**371**	*325*	*289*	*260*	*236*	*217*	*200*	*186*	*173*	*162*	*153*	*144*	*137*	*130*
	260·1	**414†**	**386**	*331*	*290*	*258*	*232*	*211*	*193*	*178*	*166*	*155*	*145*	*136*	*129*	*122*	*116*
	237·2	**407**	*339*	*290*	*254*	*226*	*203*	*185*	*169*	*156*	*145*	*136*	*127*	*120*	*113*	*107*	*102*
	214·2	*349*	*291*	*249*	*218*	*194*	*174*	*159*	*145*	*134*	*125*	*116*	*109*	*103*	*96·9*	*91·8*	*87·2*
	176·3	**292**	*243*	*209*	*183*	*162*	*146*	*133*	*122*	*112*	*104*	*97·4*	*91·3*	*85·9*	*81·1*	*76·9*	*73·0*
	153·2	*229*	*191*	*164*	*143*	*127*	*115*	*104*	*95·5*	*88·2*	*81·9*	*76·4*	*71·6*	*67·4*	*63·7*	*60·3*	*57·3*

Generally, tabular loads are based on a flexural stress of (*a*) 10·0 tons/inch² for girders having flange plates up to and including ¾ inch thickness; (*b*) 9·5 tons/inch² for girders having flange plates exceeding ¾ inch thickness.

Tabular loads assume adequate lateral support.

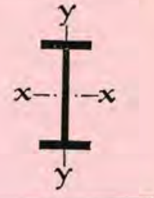
Tabular loads printed in prominent type require a spacing of stiffeners less than 1½ times the depth of the web plate.

Tabular loads marked † are the maximum shear loads for the web and are less than the permissible flexural load.

Tabular loads printed in italics require a spacing of stiffeners 1½ times the depth of the web plate.

BASED ON
B.S. 449
1959
AS AMENDED

AUTOFAB BEAMS



DIMENSIONS AND PROPERTIES

Composed of		Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Area of Web Plate in square inches	Ratio D/T	Size D×B inches
Web Plate	Flange Plates		Axis *x-x*	Axis *y-y*	Axis *y-y*	Axis *x-x*	Axis *y-y*			
74 × ⅝	**22×2**	134·25	148207	3551	5·14	3800	322·8	46·25	39·0	**78×22**
74½×½	**22×1¾**	114·25	129169	3106	5·21	3312	282·4	37·25	44·6	
75 × ½	**22×1½**	103·50	114153	2663	5·07	2927	242·1	37·50	52·0	
75½×½	**22×1¼**	92·75	98934	2219	4·89	2537	201·7	37·75	62·4	
76 × ½	**22×1**	82·00	83513	1775	4·65	2141	161·4	38·00	78·0	
74 × ½	**18×2**	109·00	120876	1945	4·22	3099	216·1	37·00	39·0	**78×18**
74½×½	**18×1¾**	100·25	108816	1702	4·12	2790	189·1	37·25	44·6	
75 × ½	**18×1½**	91·50	96594	1459	3·99	2477	162·1	37·50	52·0	
75½×½	**18×1¼**	82·75	84207	1216	3·83	2159	135·1	37·75	62·4	
76 × ½	**18×1**	74·00	71655	972·8	3·63	1837	108·1	38·00	78·0	
76½×½	**18×¾**	65·25	58936	729·8	3·34	1511	81·1	38·25	104·0	
74½×½	**14×1¾**	86·25	88464	801·1	3·05	2268	114·4	37·25	44·6	**78×14**
75 × ½	**14×1½**	79·50	79035	686·8	2·94	2027	98·1	37·50	52·0	
75½×½	**14×1¼**	72·75	69479	572·5	2·81	1782	81·8	37·75	62·4	
76 × ½	**14×1**	66·00	59796	458·1	2·63	1533	65·4	38·00	78·0	
76½×7/16	**14×¾**	54·47	47653	343·5	2·51	1222	49·1	33·47	104·0	
77 × 7/16	**14×½**	47·69	37667	229·2	2·19	965·8	32·7	33·69	156·0	
68 × ⅝	**22×2**	130·50	124206	3551	5·22	3450	322·8	42·50	36·0	**72×22**
68½×½	**22×1¾**	111·25	103412	3106	5·28	3011	282·4	34·25	41·1	
69 × ½	**22×1½**	100·50	95709	2663	5·15	2659	242·1	34·50	48·0	
69½×½	**22×1¼**	89·75	82821	2219	4·97	2301	201·7	34·75	57·6	
70 × ½	**22×1**	79·00	69746	1775	4·74	1937	161·4	35·00	72·0	
68 × ½	**18×2**	106·00	101325	1945	4·28	2815	216·1	34·00	36·0	**72×18**
68½×½	**18×1¾**	97·25	91136	1702	4·18	2532	189·1	34·25	41·1	
69 × ½	**18×1½**	88·50	80796	1459	4·06	2244	162·1	34·50	48·0	
69½×½	**18×1¼**	79·75	70306	1216	3·90	1953	135·1	34·75	57·6	
70 × ½	**18×1**	71·00	59664	972·7	3·70	1657	108·1	35·00	72·0	
70½×½	**18×¾**	62·25	48868	729·7	3·42	1357	81·1	35·25	96·0	
68½×½	**14×1¾**	83·25	73859	801·0	3·10	2052	114·4	34·25	41·1	**72×14**
69 × ½	**14×1½**	76·50	65883	686·7	3·00	1830	98·1	34·50	48·0	
69½×½	**14×1¼**	69·75	57791	572·4	2·86	1605	81·8	34·75	57·6	
70 × ½	**14×1**	63·00	49581	458·1	2·70	1377	65·4	35·00	72·0	
70½×7/16	**14×¾**	51·84	39428	343·5	2·57	1095	49·1	30·84	96·0	
71 × 7/16	**14×½**	45·06	30942	229·2	2·26	859·5	32·7	31·06	144·0	

All tabular loads on page 490 produce a maximum deflection less than 1/360th of the span.

Loads producing deflection of 1/360th span may be obtained from $W = CI_x$, where C is the coefficient given below the appropriate span and I_x is the inertia of the beam.

Weights per foot are for the girder sections only and do not include any allowance for stiffeners, connections or weld.

Flanges are welded to web by automatic fillet welding.

Autofab beams can be supplied in lengths up to 80 feet (see page 27). Girders exceeding 80 ft. can be fabricated be conventional methods.

For explanation of tables see notes commencing page 172.

AUTOFAB BEAMS

SAFE LOADS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Size **D×B** inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS															
		25 ·0308	**30** ·0214	**35** ·0157	**40** ·0120	**45** ·0095	**50** ·0077	**55** ·0064	**60** ·0053	**65** ·0046	**70** ·0039	**75** ·0034	**80** ·0030	**85** ·0027	**90** ·0024	**95** ·0021	**100** ·0019
66×22	431·0				**465†**	*437*	*394*	*358*	*328*	*303*	*281*	*262*	*246*	*232*	*219*	*207*	*197*
	368·1					**375†**	**344**	*313*	*287*	*265*	*246*	*229*	*215*	*202*	*191*	*181*	*172*
	331·5				**378†**	**337**	*304*	*276*	*253*	*233*	*217*	*202*	*190*	*179*	*169*	*160*	*152*
	295·0		**381†**	**375**	*328*	*291*	*262*	*238*	*219*	*202*	*187*	*175*	*164*	*154*	*146*	*138*	*131*
	258·4	**384†**	**367**	*315*	*275*	*245*	*220*	*200*	*184*	*169*	*157*	*147*	*138*	*130*	*122*	*116*	*110*
66×18	350·2				**372†**	**357**	*321*	*292*	*268*	*247*	*229*	*214*	*201*	*189*	*178*	*169*	*161*
	320·5			**375†**	**361**	*321*	*289*	*262*	*241*	*222*	*206*	*192*	*180*	*170*	*160*	*152*	*144*
	263·9				**283†**	**273**	**246**	**223**	*205*	*189*	*175*	*164*	*154*	*144*	*136*	*129*	*123*
	234·0			**286†**	**265**	**235**	*212*	*193*	*176*	*163*	*151*	*141*	*132*	*125*	*118*	*111*	*106*
	204·0		**288†**	**253**	**222**	*197*	*177*	*161*	*148*	*136*	*127*	*118*	*111*	*104*	*98·6*	*93·4*	*88·7*
	174·0	**290†**	**250**	*214*	*187*	*167*	*150*	*136*	*125*	*115*	*107*	*100*	*93·7*	*88·2*	*83·3*	*78·9*	75·0
66×14	272·9		**375†**	*333*	*291*	*259*	*233*	*212*	*194*	*179*	*167*	*155*	*146*	*137*	*130*	*123*	*117*
	249·9	**378†**	**346**	*297*	*260*	*231*	*208*	*189*	*173*	*160*	*148*	*138*	*130*	*122*	*115*	*109*	*104*
	200·0	**286†**	**286**	**245**	*214*	*191*	*172*	*156*	*143*	*132*	*123*	*114*	*107*	*101*	*95·3*	*90·3*	*85·8*
	176·8	**288†**	**242**	*207*	*181*	*161*	*145*	*132*	*121*	*112*	*104*	*96·6*	*90·6*	*85·3*	*80·5*	*76·3*	*72·5*
	153·7	**248**	*207*	*177*	*155*	*138*	*124*	*113*	*103*	*95·5*	*88·7*	*82·8*	*77·6*	*73·1*	*69·0*	*65·4*	62·1
	130·5	*191*	*159*	*136*	*119*	*106*	*95·3*	*86·7*	*79·5*	*73·3*	*68·1*	*63·6*	*59·6*	*56·1*	*53·0*	*50·2*	47·7
60×22	418·2				*420†*	*390*	*351*	*319*	*293*	*270*	*251*	*234*	*220*	*207*	*195*	185	176
	357·9					**339†**	*308*	*280*	*256*	*237*	*220*	*205*	*192*	*181*	*171*	162	154
	321·3			**342†**	**339**	*301*	*271*	*246*	*226*	*208*	*194*	*181*	*169*	*159*	*151*	143	136
	284·8		**345†**	**334**	*292*	*260*	*234*	*213*	*195*	*180*	*167*	*156*	*146*	*138*	*130*	123	117
	248·2	**348†**	**327**	*280*	*245*	*218*	*196*	*178*	*163*	*151*	*140*	*131*	*123*	*115*	*109*	103	98·0
60×18	340·0				**336†**	**319**	*287*	*261*	*239*	*221*	*205*	*191*	*179*	*169*	*159*	151	143
	310·3			**339†**	**322**	*286*	*257*	*234*	*215*	*198*	*184*	*172*	*161*	*151*	*143*	135	129
	256·3				**256†**	**244**	**220**	*200*	*183*	*169*	*157*	*146*	*137*	*129*	*122*	116	110
	226·3			**259†**	**236**	**210**	*189*	*172*	*158*	*145*	*135*	*126*	*118*	*111*	*105*	99·5	94·5
	196·4		**261†**	**226**	*198*	*176*	*158*	*144*	*132*	*122*	*113*	*105*	*98·8*	*93·0*	*87·8*	83·2	79·0
	166·4	**263†**	**222**	*190*	*166*	*148*	*133*	*121*	*111*	*102*	*95·1*	*88·8*	*83·2*	*78·3*	74·0	70·1	66·6
60×14	262·7		**339†**	*296*	*259*	*230*	*207*	*188*	*173*	*159*	*148*	*138*	*130*	*122*	*115*	109	104
	239·7	**342†**	*307*	*263*	*230*	*205*	*184*	*168*	*154*	*142*	*132*	*123*	*115*	*108*	*102*	97·0	92·2
	192·3	**259†**	**254**	**218**	*191*	*170*	*153*	*139*	*127*	*117*	*109*	*102*	*95·4*	*89·8*	*84·8*	80·3	76·3
	169·2	**257**	**214**	*184*	*161*	*143*	*129*	*117*	*107*	*99·0*	*91·9*	*85·8*	*80·4*	*75·7*	*71·5*	67·7	64·3
	146·0	**219**	*183*	*157*	*137*	*122*	*110*	*99·7*	*91·4*	*84·4*	*78·4*	*73·1*	*68·6*	*64·5*	61·0	57·7	54·9
	122·8	*167*	*139*	*119*	*104*	*92·9*	*83·6*	*76·0*	*69·7*	*64·3*	*59·7*	*55·7*	*52·2*	*49·2*	46·4	44·0	41·8

Generally, tabular loads are based on a flexural stress of (*a*) 10·0 tons/inch² for girders having flange plates up to and including $\frac{3}{4}$ inch thickness; (*b*) 9·5 tons/inch² for girders having flange plates exceeding $\frac{3}{4}$ inch thickness.
Tabular loads assume adequate lateral support.
Tabular loads printed in prominent type require a spacing of stiffeners less than $1\frac{1}{2}$ times the depth of the web plate.
Tabular loads marked † are the maximum shear loads for the web and are less than the permissible flexural load.
Tabular loads printed in italics and in ordinary type require a spacing of stiffeners $1\frac{1}{2}$ times the depth of the web plate.

BASED ON
B.S. 449
1959
AS AMENDED

AUTOFAB BEAMS

DIMENSIONS AND PROPERTIES

Composed of		Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Area of Web Plate in square inches	Ratio **D/T**	Size **D×B** inches
Web Plate	Flange Plates		Axis *x-x*	Axis *y-y*	Axis *y-y*	Axis *x-x*	Axis *y-y*			
$62 \times \frac{5}{8}$	22×2	126·75	102554	3551	5·29	3108	322·8	38·75	33·0	**66×22**
$62\frac{1}{2} \times \frac{1}{2}$	$22 \times 1\frac{3}{4}$	108·25	89657	3106	5·36	2717	282·4	31·25	37·7	
$63 \times \frac{1}{2}$	$22 \times 1\frac{1}{2}$	97·50	79075	2663	5·23	2396	242·1	31·50	44·0	
$63\frac{1}{2} \times \frac{1}{2}$	$22 \times 1\frac{1}{4}$	86·75	68324	2219	5·06	2070	201·7	31·75	52·8	
$64 \times \frac{1}{2}$	22×1	76·00	57401	1775	4·83	1739	161·4	32·00	66·0	
$62 \times \frac{1}{2}$	18×2	103·00	83682	1945	4·35	2536	216·1	31·00	33·0	**66×18**
$62\frac{1}{2} \times \frac{1}{2}$	$18 \times 1\frac{3}{4}$	94·25	75206	1702	4·25	2279	189·1	31·25	37·7	
$63 \times \frac{3}{8}$	$18 \times 1\frac{1}{2}$	77·63	63987	1458	4·33	1939	162·0	23·63	44·0	
$63\frac{1}{2} \times \frac{3}{8}$	$18 \times 1\frac{1}{4}$	68·81	55174	1215	4·20	1672	135·0	23·81	52·8	
$64 \times \frac{3}{8}$	18×1	60·00	46220	972·3	4·03	1401	108·0	24·00	66·0	
$64\frac{1}{2} \times \frac{3}{8}$	$18 \times \frac{3}{4}$	51·19	37125	729·3	3·77	1125	81·0	24·19	88·0	
$62\frac{1}{2} \times \frac{1}{2}$	$14 \times 1\frac{3}{4}$	80·25	60754	801·0	3·16	1841	114·4	31·25	37·7	**66×14**
$63 \times \frac{1}{2}$	$14 \times 1\frac{1}{2}$	73·50	54109	686·7	3·06	1640	98·1	31·50	44·0	
$63\frac{1}{2} \times \frac{3}{8}$	$14 \times 1\frac{1}{4}$	58·81	44691	571·9	3·12	1354	81·7	23·81	52·8	
$64 \times \frac{3}{8}$	14×1	52·00	37769	457·6	2·97	1145	65·4	24·00	66·0	
$64\frac{1}{2} \times \frac{3}{8}$	$14 \times \frac{3}{4}$	45·19	30739	343·3	2·76	931·5	49·0	24·19	88·0	
$65 \times \frac{3}{8}$	$14 \times \frac{1}{2}$	38·38	23598	228·9	2·44	715·1	32·7	24·38	132·0	
$56 \times \frac{5}{8}$	22×2	123·00	83184	3550	5·37	2773	322·8	35·00	30·0	**60×22**
$56\frac{1}{2} \times \frac{1}{2}$	$22 \times 1\frac{3}{4}$	105·25	72851	3106	5·43	2428	282·4	28·25	34·3	
$57 \times \frac{1}{2}$	$22 \times 1\frac{1}{2}$	94·50	64196	2663	5·31	2140	242·0	28·50	40·0	
$57\frac{1}{2} \times \frac{1}{2}$	$22 \times 1\frac{1}{4}$	83·75	55387	2219	5·15	1846	201·7	28·75	48·0	
$58 \times \frac{1}{2}$	22×1	73·00	46424	1775	4·93	1547	161·4	29·00	60·0	
$56 \times \frac{1}{2}$	18×2	100·00	67893	1945	4·41	2263	216·1	28·00	30·0	**60×18**
$56\frac{1}{2} \times \frac{1}{2}$	$18 \times 1\frac{3}{4}$	91·25	60972	1702	4·32	2032	189·1	28·25	34·3	
$57 \times \frac{3}{8}$	$18 \times 1\frac{1}{2}$	75·38	51998	1458	4·40	1733	162·0	21·38	40·0	
$57\frac{1}{2} \times \frac{3}{8}$	$18 \times 1\frac{1}{4}$	66·56	44777	1215	4·27	1493	135·0	21·56	48·0	
$58 \times \frac{3}{8}$	18×1	57·75	37429	972·3	4·10	1248	108·0	21·75	60·0	
$58\frac{1}{2} \times \frac{3}{8}$	$18 \times \frac{3}{4}$	48·94	29954	729·3	3·86	998·5	81·0	21·94	80·0	
$56\frac{1}{2} \times \frac{1}{2}$	$14 \times 1\frac{3}{4}$	77·25	49093	800·9	3·22	1636	114·4	28·25	34·3	**60×14**
$57 \times \frac{1}{2}$	$14 \times 1\frac{1}{2}$	70·50	43658	686·6	3·12	1455	98·1	28·50	40·0	
$57\frac{1}{2} \times \frac{3}{8}$	$14 \times 1\frac{1}{4}$	56·56	36147	571·9	3·18	1205	81·7	21·56	48·0	
$58 \times \frac{3}{8}$	14×1	49·75	30467	457·6	3·03	1016	65·4	21·75	60·0	
$58\frac{1}{2} \times \frac{3}{8}$	$14 \times \frac{3}{4}$	42·94	24688	343·3	2·83	822·9	49·0	21·94	80·0	
$59 \times \frac{3}{8}$	$14 \times \frac{1}{2}$	36·13	18809	228·9	2·52	627·0	32·7	22·13	120·0	

Tabular loads printed in ordinary type produce a deflection exceeding 1/360th of the span.
Loads producing deflection of 1/360th span may be obtained from $W = CI_x$, where C is the coefficient given below the appropriate span and I_x is the inertia of the beam.
Weights per foot are for the girder sections only and do not include any allowance for stiffeners, connections or weld.
Flanges are welded to web by automatic fillet welding.
Autofab beams can be supplied in lengths up to 80 feet (see page 27). Girders exceeding 80 ft. can be fabricated by conventional methods.
For explanation of tables see notes commencing page 172.

AUTOFAB BEAMS

SAFE LOADS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Size D×B inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS															
		20 ·0481	25 ·0308	30 ·0214	35 ·0157	40 ·0120	45 ·0095	50 ·0077	55 ·0064	60 ·0053	65 ·0046	70 ·0039	75 ·0034	80 ·0030	85 ·0027	90 ·0024	100 ·0019
54×22	405·5	→				*375†*	*344*	*310*	*282*	*258*	*238*	*221*	*207*	*194*	182	172	155
	347·7					**303†**	**302**	*272*	*247*	*227*	*209*	*194*	*181*	*170*	160	151	136
	311·1				**306†**	**299**	*266*	*233*	*218*	*199*	*184*	*171*	*160*	*150*	141	133	120
	274·6			**309†**	*295*	*258*	*229*	*206*	*187*	*172*	*159*	*147*	*137*	*129*	121	115	103
	238·0		**312†**	*287*	*246*	*216*	*192*	*172*	*157*	*144*	*133*	*123*	*115*	*108*	101	95·8	86·3
54×18	329·8					**300†**	*281*	*253*	*230*	*211*	*195*	*181*	*169*	*158*	149	140	126
	300·1				**303†**	*284*	*252*	*227*	*206*	*189*	*175*	*162*	*151*	*142*	134	126	113
	248·6					**229†**	**216**	*194*	*176*	*162*	*149*	*139*	*129*	*121*	114	108	97·0
	218·7				**232†**	**209**	*185*	*167*	*152*	*139*	*128*	*119*	*111*	*104*	98·2	92·7	83·5
	188·7		**234†**	**232**	*199*	*174*	*155*	*139*	*127*	*116*	*107*	*99·5*	*92·8*	*87·0*	81·9	77·4	69·6
	158·7	**236†**	**234**	*195*	*167*	*146*	*130*	*117*	*106*	*97·4*	*89·9*	*83·5*	*77·9*	73·0	68·7	64·9	58·4
54×14	252·5			**303†**	*260*	*228*	*202*	*182*	*166*	*152*	*140*	*130*	*121*	*114*	107	101	91·1
	229·5		**306†**	*270*	*231*	*202*	*180*	*162*	*147*	*135*	*124*	*116*	*108*	*101*	95·1	89·9	80·9
	184·7		**232†**	**224**	*192*	*168*	*149*	*134*	*122*	*112*	*103*	*95·9*	*89·5*	*83·9*	79·0	74·6	67·1
	161·5	**234†**	**226**	*188*	*161*	*141*	*125*	*113*	*103*	*94·1*	*86·8*	*80·6*	*75·2*	*70·5*	66·4	62·7	56·4
	127·2	**197†**	**184**	**154**	*132*	*115*	*102*	*92·1*	*83·8*	*76·8*	*70·9*	*65·8*	*61·4*	57·6	54·2	51·2	46·1
	103·9	**172**	*137*	*114*	*98·0*	*85·8*	*76·2*	*68·6*	*62·4*	*57·2*	*52·8*	*49·0*	*45·7*	42·9	40·4	38·1	34·3
48×22	392·7	→				*330†*	*299*	*269*	*245*	*224*	*207*	*192*	180	168	158	150	135
	337·5					*267†*	*263*	*237*	*215*	*197*	*182*	*169*	158	148	139	132	118
	300·9				*270†*	*261*	*232*	*208*	*189*	*174*	*160*	*149*	139	130	123	116	104
	264·4			*273†*	*256*	*224*	*199*	*179*	*163*	*149*	*138*	*128*	120	112	105	99·6	89·7
	227·8		*276†*	*249*	*214*	*187*	*166*	*150*	*136*	*125*	*115*	*107*	99·8	93·5	88·0	83·2	74·9
48×18	319·6					*264†*	*244*	*220*	*200*	*183*	*169*	*157*	147	137	129	122	110
	289·9				*267†*	*247*	*219*	*197*	*179*	*164*	*152*	*141*	132	123	116	110	98·6
	241·0					**202†**	**188**	*169*	*154*	*141*	*130*	*121*	113	106	99·5	94·0	84·6
	211·0				**205†**	*182*	*161*	*145*	*132*	*121*	*112*	*104*	96·9	90·8	85·5	80·7	72·6
	181·1		**207†**	**202**	*173*	*151*	*134*	*121*	*110*	*101*	*93·1*	*86·4*	80·7	75·6	71·2	67·2	60·5
	151·1	**209†**	**202**	*169*	*145*	*126*	*112*	*101*	*92·0*	*84·3*	*77·8*	72·3	67·5	63·2	59·5	56·2	50·6
48×14	242·3		*267†*	*263*	*225*	*197*	*175*	*158*	*143*	*131*	*121*	*113*	105	98·6	92·8	87·6	78·9
	219·3		*270†*	*233*	*200*	*175*	*155*	*140*	*127*	*117*	*108*	*99·9*	93·3	87·4	82·3	77·8	70·0
	177·0		**205†**	**194**	*166*	*146*	*129*	*116*	*106*	*97·1*	*89·6*	*83·2*	77·7	72·8	68·5	64·7	58·2
	153·9	**207†**	**195**	*163*	*140*	*122*	*109*	*97·7*	*88·8*	*81·4*	*75·1*	*69·8*	65·1	61·0	57·5	54·3	48·8
	120·8	**174†**	**159**	*133*	*114*	*99·6*	*88·5*	*79·7*	*72·4*	*66·4*	*61·3*	56·9	53·1	49·8	46·9	44·3	39·8
	97·5	**147**	*118*	*98·2*	*84·1*	*73·6*	*65·4*	*58·9*	*53·5*	*49·1*	*45·3*	42·1	39·3	36·8	34·6	32·7	29·4

Generally, tabular loads are based on a flexural stress of (*a*) 10·0 tons/inch^2 for girders having flange plates up to and including ¾ inch thickness; (*b*) 9·5 tons/inch^2 for girders having flange plates exceeding ¾ inch thickness.
Tabular loads assume adequate lateral support.
Tabular loads printed in prominent type require a spacing of stiffeners less than 1½ times the depth of the web plate.
Tabular loads marked † are the maximum shear loads for the web and are less than the permissible flexural load.
Tabular loads printed in italics and in ordinary type require a spacing of stiffeners 1½ times the depth of the web plate, except the lines marked → where the intermediate stiffeners are not required.

BASED ON
B.S. 449
1959
AS AMENDED

AUTOFAB BEAMS

DIMENSIONS AND PROPERTIES

Composed of		Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Area of Web Plate in square inches	Ratio D/T	Size D×B inches
Web Plate	Flange Plates		Axis *x-x*	Axis *y-y*	Axis *y-y*	Axis *x-x*	Axis *y-y*			
50 ×⅝	**22×2**	119·25	66028	3550	5·46	2445	322·8	31·25	27·0	**54×22**
50½×½	**22×1¾**	102·25	57940	3106	5·51	2146	282·4	25·25	30·9	
51 ×½	**22×1½**	91·50	51018	2663	5·39	1890	242·0	25·50	36·0	
51½×½	**22×1¼**	80·75	43959	2219	5·24	1628	201·7	25·75	43·2	
52 ×½	**22×1**	70·00	36761	1775	5·04	1362	161·4	26·00	54·0	
50 ×½	**18×2**	97·00	53904	1945	4·48	1996	216·1	25·00	27·0	**54×18**
50½×½	**18×1¾**	88·25	48381	1702	4·39	1792	189·1	25·25	30·9	
51 ×⅜	**18×1½**	73·13	41365	1458	4·47	1532	162·0	19·12	36·0	
51½×⅜	**18×1¼**	64·31	35578	1215	4·35	1318	135·0	19·31	43·2	
52 ×⅜	**18×1**	55·50	29678	972·2	4·19	1099	108·0	19·50	54·0	
52½×⅜	**18×¾**	46·69	23663	729·2	3·95	876·4	81·0	19·69	72·0	
50½×½	**14×1¾**	74·25	38822	800·9	3·28	1438	114·4	25·25	30·9	**54×14**
51 ×½	**14×1½**	67·50	34476	686·5	3·19	1277	98·1	25·50	36·0	
51½×⅜	**14×1¼**	54·31	28620	571·9	3·25	1060	81·7	19·31	43·2	
52 ×⅜	**14×1**	47·50	24059	457·6	3·10	891·1	65·4	19·50	54·0	
52½×$\frac{5}{16}$	**14×¾**	37·41	18656	343·1	3·03	691·0	49·0	16·41	72·0	
53 ×$\frac{5}{16}$	**14×½**	30·56	13895	228·8	2·74	514·6	32·7	16·56	108·0	
44 ×⅝	**22×2**	115·50	51018	3550	5·54	2126	322·8	27·50	24·0	**48×22**
44½×½	**22×1¾**	99·25	44868	3106	5·59	1870	282·4	22·25	27·4	
45 ×½	**22×1½**	88·50	39486	2662	5·49	1645	242·0	22·50	32·0	
45½×½	**22×1¼**	77·75	33983	2219	5·34	1416	201·7	22·75	38·4	
46 ×½	**22×1**	67·00	28358	1775	5·15	1182	161·4	23·00	48·0	
44 ×½	**18×2**	94·00	41661	1944	4·55	1736	216·1	22·00	24·0	**48×18**
44½×½	**18×1¾**	85·25	37378	1701	4·47	1557	189·1	22·25	27·4	
45 ×⅜	**18×1½**	70·88	32048	1458	4·54	1335	162·0	16·88	32·0	
45½×⅜	**18×1¼**	62·06	27537	1215	4·43	1147	135·0	17·06	38·4	
46 ×⅜	**18×1**	53·25	22926	972·2	4·27	955·2	108·0	17·25	48·0	
46½×⅜	**18×¾**	44·44	18213	729·2	4·05	758·9	81·0	17·44	64·0	
44½×½	**14×1¾**	71·25	29888	800·8	3·35	1245	114·4	22·25	27·4	**48×14**
45 ×½	**14×1½**	64·50	26508	686·5	3·26	1105	98·1	22·50	32·0	
45½×⅜	**14×1¼**	52·06	22072	571·9	3·31	919·7	81·7	17·06	38·4	
46 ×⅜	**14×1**	45·25	18507	457·5	3·18	771·1	65·4	17·25	48·0	
46½×$\frac{5}{16}$	**14×¾**	35·53	14340	343·1	3·11	597·5	49·0	14·53	64·0	
47 ×$\frac{5}{16}$	**14×½**	28·69	10601	228·8	2·82	441·7	32·7	14·69	96·0	

Tabular loads printed in ordinary type produce a deflection exceeding 1/360th of the span.
Loads producing deflection of 1/360th span may be obtained from $W = CI_x$, where C is the coefficient given below the appropriate span and I_x is the inertia of the beam.
Weights per foot are for the girder sections only and do not include any allowance for stiffeners, connections or weld.
Flanges are welded to web by automatic fillet welding.
Autofab beams can be supplied in lengths up to 80 feet (see page 27). Girders exceeding 80 ft. can be fabricated by conventional methods.
For explanation of tables see notes commencing page 172.

AUTOFAB BEAMS

SAFE LOADS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Size **D×B** inches	Weight per foot in lbs	SAFE DISTRIBUTED LOADS IN TONS FOR SPANS IN FEET AND DEFLECTION COEFFICIENTS															
		20 ·0481	**25** ·0308	**30** ·0214	**35** ·0157	**40** ·0120	**45** ·0095	**50** ·0077	**55** ·0064	**60** ·0053	**65** ·0046	**70** ·0039	**75** ·0034	**80** ·0030	**85** ·0027	**90** ·0024	**100** ·0019
42×22	380·0	→				*285†*	*255*	*230*	*209*	*191*	177	164	153	144	135	128	115
	327·3	→				*231†*	*225*	*203*	*184*	*169*	156	145	135	127	119	113	101
	290·7	→			*234†*	*223*	*198*	*178*	*162*	*149*	137	127	119	111	105	99·0	89·1
	254·2	→		*237†*	*219*	*192*	*170*	*153*	*139*	*128*	118	109	102	95·8	90·2	85·1	76·6
	217·6	→	*240†*	*213*	*182*	*160*	*142*	*128*	*116*	*106*	98·2	91·2	85·1	79·8	75·1	70·9	63·8
42×18	309·4	→				*228†*	*208*	*188*	*171*	*156*	144	134	125	117	110	104	93·8
	279·7	→			*231†*	*210*	*187*	*168*	*153*	*140*	129	120	112	105	99·0	93·5	84·2
	233·3					**175†**	*161*	*145*	*132*	*121*	111	103	96·5	90·5	85·2	80·4	72·4
	203·4			**178†**	**178**	*155*	*138*	*124*	*113*	*104*	95·6	88·8	82·9	77·7	73·1	69·1	62·2
	173·4		**180†**	**172**	*148*	*129*	*115*	*103*	*93·9*	*86·1*	79·5	73·8	68·9	64·6	60·8	57·4	51·7
	143·4	**182†**	**172**	*144*	*123*	*108*	*95·7*	*86·1*	*78·3*	*71·8*	66·2	61·5	57·4	53·8	50·7	47·8	43·1
42×14	232·1	→	*231†*	*224*	*192*	*168*	*149*	*134*	*122*	*112*	103	95·8	89·4	83·8	78·9	74·5	67·1
	209·1	→	*234†*	*198*	*170*	*149*	*132*	*119*	*108*	*99·0*	91·4	84·9	79·2	74·3	69·9	66·0	59·4
	169·4		**178†**	*165*	*142*	*124*	*110*	*99·3*	*90·3*	*82·7*	76·4	70·9	66·2	62·0	58·4	55·2	49·6
	146·2	**180†**	*166*	*138*	*119*	*104*	*92·3*	*83·1*	*75·5*	*69·2*	63·9	59·3	55·4	51·9	48·9	46·1	41·5
	114·4	**152†**	**135**	*113*	*96·7*	*84·6*	*75·2*	*67·7*	*61·6*	*56·4*	52·1	48·4	45·1	42·3	39·8	37·6	33·9
	91·2	*124*	*99·3*	*82·8*	*71·0*	*62·1*	*55·2*	*49·7*	*45·2*	*41·4*	38·2	35·5	33·1	31·0	29·2	27·6	24·8

Generally, tabular loads are based on a flexural stress of (*a*) 10·0 tons/inch² for girders having flange plates up to and including ¾ inch thickness; (*b*) 9·5 tons/inch² for girders having flange plates exceeding ¾ inch thickness.
Tabular loads assume adequate lateral support.
Tabular loads printed in prominent type require a spacing of stiffeners less than 1½ times the depth of the web plate.
Tabular loads marked † are the maximum shear loads for the web and are less than the permissible flexural load.
Tabular loads printed in italics and in ordinary type require a spacing of stiffeners 1½ times the depth of the web plate, except the lines marked → where the intermediate stiffeners are not required.

BASED ON
B.S. 449
1959
AS AMENDED

AUTOFAB BEAMS

DIMENSIONS AND PROPERTIES

Composed of		Area in square inches	Moment of Inertia		Radius of Gyration	Elastic Modulus		Area of Web Plate in square inches	Ratio $\frac{D}{T}$	Size **D×B** inches
Web Plate	Flange Plates		Axis *x-x*	Axis *y-y*	Axis *y-y*	Axis *x-x*	Axis *y-y*			
38 ×⅝	**22×2**	111·75	38087	3550	5·64	1814	322·7	23·75	21·0	**42×22**
38½×½	**22×1¾**	96·25	33584	3106	5·68	1599	282·4	19·25	24·0	
39 ×½	**22×1½**	85·50	29548	2662	5·58	1407	242·0	19·50	28·0	
39½×½	**22×1¼**	74·75	25408	2219	5·45	1210	201·7	19·75	33·6	
40 ×½	**22×1**	64·00	21161	1775	5·27	1008	161·4	20·00	42·0	
38 ×½	**18×2**	91·00	31110	1944	4·62	1481	216·0	19·00	21·0	**42×18**
38½×½	**18×1¾**	82·25	27910	1701	4·55	1329	189·0	19·25	24·0	
39 ×⅜	**18×1½**	68·63	24007	1458	4·61	1143	162·0	14·63	28·0	
39½×⅜	**18×1¼**	59·81	20613	1215	4·51	981·6	135·0	14·81	33·6	
40 ×⅜	**18×1**	51·00	17132	972·2	4·37	815·8	108·0	15·00	42·0	
40½×⅜	**18×¾**	42·19	13563	729·2	4·16	645·9	81·0	15·19	56·0	
38½×½	**14×1¾**	68·25	22236	800·7	3·43	1059	114·4	19·25	24·0	**42×14**
39 ×½	**14×1½**	61·50	19702	686·4	3·34	938·2	98·1	19·50	28·0	
39½×⅜	**14×1¼**	49·81	16460	571·8	3·39	783·8	81·7	14·81	33·6	
40 ×⅜	**14×1**	43·00	13769	457·5	3·26	655·7	65·4	15·00	42·0	
40½×$\frac{5}{16}$	**14×¾**	33·66	10664	343·1	3·19	507·8	49·0	12·66	56·0	
41 ×$\frac{5}{16}$	**14×½**	26·81	7823	228·8	2·92	372·5	32·7	12·81	84·0	

Tabular loads printed in ordinary type produce a deflection exceeding 1/360th of the span.
Loads producing deflection of 1/360th span may be obtained from $W = CI_x$, where C is the coefficient given below the appropriate span and I_x is the inertia of the beam.
Weights per foot are for the girder sections only and do not include any allowance for stiffeners, connections or weld.
Flanges are welded to web by automatic fillet welding.
Autofab beams can be supplied in lengths up to 80 feet (see page 27). Girders exceeding 80 ft. can be fabricated by conventional methods.
For explanation of tables see notes commencing page 172.

UNIVERSAL BEAMS AS TIES

BASED ON
B.S. 449
1959
AS AMENDED

SAFE LOADS FOR MILD STEEL

Serial Size and Weight/foot	Gross		With holes in flanges				With extra holes in web			
	Area ins^2	Safe Load tons	No.	Dia. ins	Nett Area ins^2	Safe Load tons	No.	Dia. ins	Nett Area ins^2	Safe Load tons
36×16½×260	76·56	727	4	1 1/16	70·44	669	2	1 1/16	68·64	652
230	67·73	643	4	1 1/16	62·37	593	2	1 1/16	60·74	577
36×12 ×194	57·11	543	4	15/16	52·38	498	2	15/16	50·94	484
170	49·98	475	4	15/16	45·85	436	2	15/16	44·57	423
150	44·16	420	4	15/16	40·63	386	2	15/16	39·46	375
135	39·69	377	4	15/16	36·71	349	2	15/16	35·59	338
33×11½×152	44·71	425	4	15/16	40·75	387	2	15/16	39·56	376
130	38·26	363	4	15/16	35·05	333	2	15/16	33·96	323
118	34·69	330	4	15/16	31·91	303	2	15/16	30·87	293
30×10½×132	38·83	369	4	15/16	35·08	333	2	15/16	33·93	322
116	34·13	324	4	15/16	30·94	294	2	15/16	29·88	284
99	29·11	277	4	15/16	26·52	252	2	15/16	25·57	243
27×10 ×114	33·53	319	4	15/16	30·03	285	2	15/16	28·96	275
102	30·01	285	4	15/16	26·91	256	2	15/16	25·94	246
94	27·65	263	4	15/16	24·85	236	2	15/16	23·93	227
84	24·71	235	4	15/16	22·32	212	2	15/16	21·45	204
24×12 ×160	47·05	447	4	15/16	42·42	403	2	15/16	41·05	390
120	35·29	335	4	15/16	31·80	302	2	15/16	30·76	292
100	29·43	280	4	15/16	26·52	252	2	15/16	25·64	244
24× 9 × 94	27·63	262	4	15/16	24·36	231	2	15/16	23·39	222
84	24·71	235	4	15/16	21·81	207	2	15/16	20·93	199
76	22·37	213	4	15/16	19·81	188	2	15/16	18·98	180
68	20·00	190	4	15/16	17·82	169	2	15/16	17·04	162
21×13 ×142	41·78	397	4	1 1/16	37·13	353	2	1 1/16	35·73	339
127	37·38	355	4	1 1/16	33·19	315	2	1 1/16	31·94	303
112	32·97	313	4	1 1/16	29·29	278	2	1 1/16	28·17	268
21× 8¼× 82	24·12	229	4	15/16	20·97	199	2	15/16	20·03	190
73	21·46	204	4	15/16	18·68	177	2	15/16	17·83	169
68	20·02	190	4	15/16	17·45	166	2	15/16	16·64	158
62	18·23	173	4	15/16	15·92	151	2	15/16	15·17	144
55	16·17	154	4	15/16	14·22	135	2	15/16	13·51	128
18× 7½× 66	19·40	184	4	15/16	16·51	157	2	15/16	15·67	149
60	17·64	168	4	15/16	15·03	143	2	15/16	14·25	135
55	16·19	154	4	15/16	13·83	131	2	15/16	13·10	124
50	14·71	140	4	15/16	12·57	119	2	15/16	11·90	113
45	13·23	126	4	15/16	11·35	108	2	15/16	10·72	102
18× 6 × 55	16·18	154	4	15/16	13·39	127	2	15/16	12·60	120
50	14·71	140	4	15/16	12·20	116	2	15/16	11·47	109
45	13·22	126	4	15/16	11·01	105	2	15/16	10·33	98·1

The above safe loads are based on an axial stress of 9·5 tons/inch^2.

BASED ON
B.S. 449
1959
AS AMENDED

UNIVERSAL BEAMS AS TIES

SAFE LOADS FOR MILD STEEL

Serial Size and Weight/foot	Gross		With holes in flanges				With extra holes in web			
	Area ins^2	Safe Load tons	No.	Dia. ins	Nett Area ins^2	Safe Load tons	No.	Dia. ins	Nett Area ins^2	Safe Load tons
16×7 ×50	14·70	140	4	15/16	12·34	117	2	15/16	11·63	110
45	13·24	126	4	15/16	11·13	106	2	15/16	10·48	99·6
40	11·77	112	4	15/16	9·88	93·9	2	15/16	9·30	88·4
36	10·59	101	4	15/16	8·98	85·3	2	15/16	8·42	80·0
16×5½×31	9·12	86·6	4	15/16	7·47	71·0	2	15/16	6·96	66·1
26	7·64	72·6	4	15/16	6·36	60·4	2	15/16	5·89	56·0
16×6 ×50	14·70	140	4	15/16	12·03	114	2	15/16	11·28	107
45	13·23	126	4	15/16	10·86	103	2	15/16	10·17	96·6
40	11·76	112	4	15/16	9·71	92·2	2	15/16	9·07	86·2
15×6 ×45	13·34	126	4	15/16	10·84	103	2	15/16	10·13	96·2
40	11·77	112	4	15/16	9·65	91·7	2	15/16	9·00	85·5
35	10·29	97·8	4	15/16	8·45	80·3	2	15/16	7·88	74·9
14×6¾×45	13·23	126	4	15/16	10·91	104	2	15/16	10·24	97·3
38	11·17	106	4	15/16	9·25	87·9	2	15/16	8·66	82·3
34	10·00	95·0	4	15/16	8·30	78·9	2	15/16	7·76	73·7
30	8·81	83·7	4	15/16	7·37	70·0	2	15/16	6·86	65·2
14×5 ×26	7·64	72·6	4	13/16	6·27	59·6	2	13/16	5·85	55·6
22	6·47	61·5	4	13/16	5·38	51·1	2	13/16	5·00	47·5
12×6½×36	10·59	101	4	15/16	8·56	81·3	2	15/16	7·99	75·9
31	9·12	86·6	4	15/16	7·38	70·1	2	15/16	6·88	65·4
27	7·97	75·7	4	15/16	6·47	61·5	2	15/16	6·02	57·2
12×5 ×32	9·42	89·5	4	13/16	7·63	72·5	2	13/16	7·06	67·1
28	8·23	78·2	4	13/16	6·68	63·5	2	13/16	6·17	58·6
25	7·35	69·8	4	13/16	5·98	56·8	2	13/16	5·52	52·4
12×4 ×22	6·47	61·5	4	13/16	5·09	48·4	2	13/16	4·67	44·4
19	5·62	53·4	4	13/16	4·49	42·7	2	13/16	4·10	39·0
16·5	4·86	46·2	4	13/16	3·99	37·9	2	13/16	3·62	34·4
10×5¾×29	8·53	81·0	4	15/16	6·65	63·2	2	15/16	6·11	58·0
25	7·35	69·8	4	15/16	5·74	54·5	2	15/16	5·27	50·1
21	6·19	58·8	4	15/16	4·91	46·6	2	15/16	4·46	42·4
10×4 ×19	5·61	53·3	4	13/16	4·33	41·1	2	13/16	3·92	37·2
17	4·98	47·3	4	13/16	3·91	37·1	2	13/16	3·52	33·4
15	4·40	41·8	4	13/16	3·53	33·5	2	13/16	3·16	30·0
8×5¼×20	5·88	55·9	4	15/16	4·46	42·4	2	15/16	3·99	37·9
17	5·00	47·5	4	15/16	3·84	36·5	2	15/16	3·41	32·4

The above safe loads are based on an axial stress of 9.5 tons/inch^2.

UNIVERSAL COLUMNS AS TIES

SAFE LOADS FOR MILD STEEL

BASED ON
B.S. 449
1959
AS AMENDED

Serial Size and Weight/foot	Gross		With holes in flanges				With extra holes in web			
	Area ins^2	Safe Load tons	No.	Dia. ins	Nett Area ins^2	Safe Load tons	No.	Dia. ins	Nett Area ins^2	Safe Load tons
14×16 ×426	125·25	1127	4	$1\frac{1}{16}$	112·36	1011	2	$1\frac{1}{16}$	108·38	975
370	108·78	979	4	$1\frac{1}{16}$	97·48	877	2	$1\frac{1}{16}$	93·96	846
314	92·30	831	4	$1\frac{1}{16}$	82·60	743	2	$1\frac{1}{16}$	79·59	716
264	77·63	699	4	$1\frac{1}{16}$	69·39	625	2	$1\frac{1}{16}$	66·83	601
228	67·06	604	4	$1\frac{1}{16}$	59·89	539	2	$1\frac{1}{16}$	57·67	519
193	56·73	539	4	$1\frac{1}{16}$	50·62	481	2	$1\frac{1}{16}$	48·73	463
158	46·47	441	4	$1\frac{1}{16}$	41·42	393	2	$1\frac{1}{16}$	39·87	379
Column Core 320	94·12	847	4	$1\frac{1}{16}$	85·22	767	2	$1\frac{1}{16}$	81·20	731
14×14½×136	39·98	380	4	$1\frac{1}{16}$	35·46	337	2	$1\frac{1}{16}$	34·06	324
119	34·99	332	4	$1\frac{1}{16}$	31·00	295	2	$1\frac{1}{16}$	29·79	283
103	30·26	287	4	$1\frac{1}{16}$	26·80	255	2	$1\frac{1}{16}$	25·75	245
87	25·56	243	4	$1\frac{1}{16}$	22·64	215	2	$1\frac{1}{16}$	21·75	207
12×12 ×190	55·86	503	4	$\frac{15}{16}$	49·35	444	2	$\frac{15}{16}$	47·36	426
161	47·38	450	4	$\frac{15}{16}$	41·81	397	2	$\frac{15}{16}$	40·11	381
133	39·11	372	4	$\frac{15}{16}$	34·47	327	2	$\frac{15}{16}$	33·05	314
106	31·19	296	4	$\frac{15}{16}$	27·49	261	2	$\frac{15}{16}$	26·33	250
92	27·06	257	4	$\frac{15}{16}$	23·85	227	2	$\frac{15}{16}$	22·83	217
79	23·22	221	4	$\frac{15}{16}$	20·46	194	2	$\frac{15}{16}$	19·58	186
65	19·11	182	4	$\frac{15}{16}$	16·84	160	2	$\frac{15}{16}$	16·11	153
10×10 ×112	32·92	313	4	$\frac{15}{16}$	28·24	268	2	$\frac{15}{16}$	26·82	255
89	26·19	249	4	$\frac{15}{16}$	22·45	213	2	$\frac{15}{16}$	21·30	202
72	21·18	201	4	$\frac{15}{16}$	18·15	172	2	$\frac{15}{16}$	17·19	163
60	17·66	168	4	$\frac{15}{16}$	15·10	143	2	$\frac{15}{16}$	14·32	136
49	14·40	137	4	$\frac{15}{16}$	12·31	117	2	$\frac{15}{16}$	11·67	111
8× 8 × 58	17·06	162	4	$\frac{15}{16}$	14·03	133	2	$\frac{15}{16}$	13·07	124
48	14·11	134	4	$\frac{15}{16}$	11·55	110	2	$\frac{15}{16}$	10·79	103
40	11·76	112	4	$\frac{15}{16}$	9·67	91·9	2	$\frac{15}{16}$	8·99	85·4
35	10·30	97·9	4	$\frac{15}{16}$	8·45	80·3	2	$\frac{15}{16}$	7·86	74·7
31	9·12	86·6	4	$\frac{15}{16}$	7·50	71·3	2	$\frac{15}{16}$	6·96	66·1
6× 6 × 25	7·35	69·8	4	$\frac{15}{16}$	5·65	53·7	2	$\frac{15}{16}$	5·05	48·0
20	5·93	56·3	4	$\frac{15}{16}$	4·55	43·2	2	$\frac{15}{16}$	4·07	38·7
15·7	4·62	43·9	4	$\frac{15}{16}$	3·61	34·3	2	$\frac{15}{16}$	3·16	30·0

The above safe loads are based on an axial stress of 9·5 tons/inch^2 for beams having a flange thickness up to and including 1½ inch and 9·0 tons/inch^2 for beams having a flange thickness exceeding 1½ inch.

R.S. JOISTS AND CHANNELS AS TIES

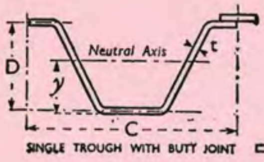
SAFE LOADS FOR MILD STEEL

BASED ON
B.S 449
1959
AS AMENDED

Serial Size and Weight/foot	Gross		With holes in flanges				With extra holes in web			
	Area ins^2	Safe Load tons	No.	Dia. ins	Nett Area ins^2	Safe Load tons	No.	Dia. ins	Nett Area ins^2	Safe Load tons
Joists										
8×4 ×17	5·00	47·5	4	$\frac{11}{16}$	3·88	36·9	2	$\frac{11}{16}$	3·56	33·8
7×4 ×14·5	4·26	40·5	4	$\frac{11}{16}$	3·28	31·2	2	$\frac{11}{16}$	2·99	28·4
6×3½×11·5	3·38	32·1	4	$\frac{9}{16}$	2·65	25·2	2	$\frac{9}{16}$	2·43	23·1
5×3 × 9	2·64	25·1	4	$\frac{9}{16}$	1·96	18·6	2	$\frac{9}{16}$	1·76	16·7
4×2½× 6·5	1·91	18·1	4	$\frac{7}{16}$	1·45	13·8	1	$\frac{7}{16}$	1·38	13·1
3×2 × 4·5	1·32	12·5	4	$\frac{7}{16}$	·93	8·8	1	$\frac{7}{16}$	·86	8·17
Channels										
17×4 ×44	12·94	123	2	$\frac{13}{16}$	11·86	113	2	$\frac{13}{16}$	11·08	105
15×4 ×37	10·88	103	2	$\frac{13}{16}$	9·84	93·5	2	$\frac{13}{16}$	9·17	87·1
12×4 ×31	9·12	86·6	2	$\frac{13}{16}$	8·17	77·6	2	$\frac{13}{16}$	7·52	71·4
12×3½×28	8·23	78·2	2	$\frac{13}{16}$	7·36	69·9	2	$\frac{13}{16}$	6·71	63·7
10×3½×24	7·06	67·1	2	$\frac{13}{16}$	6·19	58·8	2	$\frac{13}{16}$	5·60	53·2
10×3 ×19	5·59	53·1	2	$\frac{13}{16}$	4·89	46·5	2	$\frac{13}{16}$	4·37	41·5
9×3½×22	6·47	61·5	2	$\frac{13}{16}$	5·62	53·4	2	$\frac{13}{16}$	5·07	48·2
9×3 ×17·5	5·15	48·9	2	$\frac{13}{16}$	4·44	42·2	2	$\frac{13}{16}$	3·95	37·5
8×3½×20	5·88	55·9	2	$\frac{13}{16}$	5·06	48·1	2	$\frac{13}{16}$	4·54	43·1
8×3 ×16	4·70	44·7	2	$\frac{13}{16}$	3·99	37·9	2	$\frac{13}{16}$	3·53	33·5
7×3½×18	5·29	50·3	2	$\frac{13}{16}$	4·50	42·8	2	$\frac{13}{16}$	4·01	38·1
7×3 ×14	4·11	39·0	2	$\frac{13}{16}$	3·45	32·8	2	$\frac{13}{16}$	3·03	28·8
6×3½×16	4·71	44·7	2	$\frac{13}{16}$	3·97	37·7	2	$\frac{13}{16}$	3·51	33·3
6×3 ×12	3·53	33·5	2	$\frac{13}{16}$	2·95	28·0	2	$\frac{13}{16}$	2·54	24·1
5×2½×10	2·94	27·9	2	$\frac{13}{16}$	2·35	22·3	2	$\frac{13}{16}$	1·94	18·4
4×2 × 7	2·06	19·6	2	$\frac{11}{16}$	1·65	15·7	1	$\frac{11}{16}$	1·48	14·1
3×1½× 4·5	1·32	12·5	2	$\frac{9}{16}$	1·02	9·7	1	$\frac{9}{16}$	·91	8·6

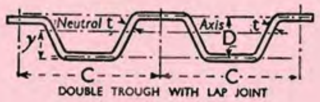
The above safe loads are based on an axial stress of 9·5 tons/inch^2.

PRESSED STEEL TROUGH SECTIONS



SINGLE TROUGH WITH BUTT JOINT

SINGLE TROUGH WITH LAP JOINT

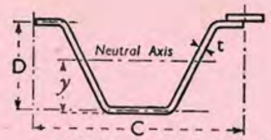


DOUBLE TROUGH WITH LAP JOINT

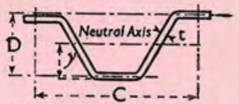
Reference Mark	SECTION			TYPE		Slope of Webs	Area of Section (including cover for Butted Trough)	Weight (including rivets) per sq. ft. covered	Dimension *y*	Minimum Modulus of complete Section (including cover for Butted Trough)	Modulus of Section per foot width
	D	C	*t*	Trough	Joint						
	ins	*ft ins*	*ins*				*sq ins*	*lbs*	*ins*	*ins*^{3}	*ins*^{3}
1	15	3 0	¾	Single	Butt	1 : 2	44·35	50·95	8·68	180·79	60·26
2	15	3 0	⅝	Single	Butt	1 : 2	36·96	42·48	8·61	151·08	50·36
3	15	3 0	½	Single	Butt	1 : 2	29·57	34·10	8·53	121·24	40·41
4	12	2 8	¾	Single	Butt	1 : 2	38·57	49·85	7·13	129·17	48·44
5	12	2 8	⅝	Single	Butt	1 : 2	32·14	41·65	7·06	107·94	40·48
6	12	2 8	½	Single	Butt	1 : 2	25·71	33·45	6·98	86·62	32·48
7	12	2 8	⅜	Single	Butt	1 : 2	19·28	25·26	6·90	65·19	24·45
8	10	2 4	¾	Single	Butt	1 : 2	33·71	49·61	6·11	94·40	40·46
9	10	2 4	⅝	Single	Butt	1 : 2	28·09	41·42	6·04	78·84	33·79
10	10	2 4	½	Single	Butt	1 : 2	22·48	33·23	5·96	63·24	27·10
11	10	2 4	⅜	Single	Butt	1 : 2	16·86	25·05	5·88	47·58	20·39
12	10	2 4	¾	Single	Lap	1 : 2	31·30	45·85	5·58	84·02	36·01
13	10	2 4	⅝	Single	Lap	1 : 2	26·13	38·32	5·54	71·23	30·52
14	10	2 4	½	Single	Lap	1 : 2	20·95	30·76	5·50	57·99	24·85
15	10	2 4	⅜	Single	Lap	1 : 2	15·74	23·17	5·47	44·28	18·98
16	9	2 0	⅝	Single	Butt	1 : 2	24·59	42·37	5·50	60·85	30·42
17	9	2 0	½	Single	Butt	1 : 2	19·67	34·01	5·42	48·78	24·39
18	9	2 0	⅜	Single	Butt	1 : 2	14·75	25·65	5·34	36·69	18·34
19	9	2 0	⅝	Single	Lap	1 : 2	22·94	39·28	5·05	54·45	27·22
20	9	2 0	½	Single	Lap	1 : 2	18·39	31·55	5·01	44·41	22·20
21	9	2 0	⅜	Single	Lap	1 : 2	13·82	23·78	4·97	33·97	16·98

PRESSED STEEL TROUGHING. The tabular loads are based on an extreme fibre stress of 10 tons per square inch and include the weight of the troughing itself.
The areas tabulated are for one complete unit as pressed.
In the case of troughs with "butt" joints the tabulated properties include for the covers.

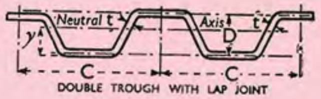
PRESSED STEEL TROUGH SECTIONS



SINGLE TROUGH WITH BUTT JOINT



SINGLE TROUGH WITH LAP JOINT

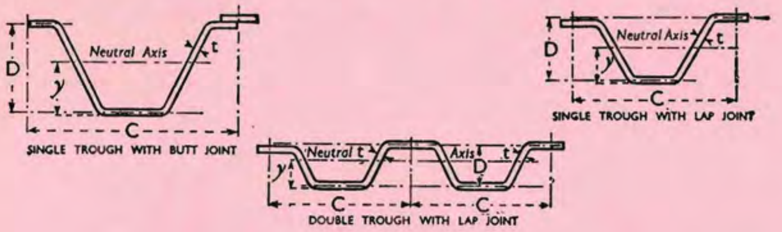


DOUBLE TROUGH WITH LAP JOINT

Reference Mark	DISTRIBUTED SAFE LOADS IN CWTS. PER SQUARE FOOT													
	SPANS IN FEET													
	8	10	12	14	16	18	20	22	24	26	28	30	32	34
1		80·35	55·80	41·00	31·39	24·80	20·09	16·60	13·95	11·89	10·24	8·93	7·85	6·95
2		67·15	46·63	34·26	26·23	20·73	16·79	13·88	11·66	9·94	8·56	7·46	6·56	5·81
3		53·89	37·41	27·49	21·05	16·63	13·48	11·14	9·35	7·98	6·88	5·99	5·26	4·66
4		64·59	44·85	32·95	25·23	19·94	16·15	13·35	11·21	9·55	8·24			
5		53·98	37·48	27·54	21·09	16·66	13·49	11·15	9·36	7·99	6·89			
6		43·31	30·08	22·10	16·91	13·36	10·83	8·95	7·53	6·41	5·53			
7		32·60	22·64	16·63	12·74	10·06	8·15	6·74	5·66	4·83	4·16			
8		53·95	37·46	27·53	21·08	16·65	13·49	11·15						
9		45·05	31·29	22·99	17·60	13·90	11·26	9·31						
10		36·14	25·10	18·44	14·11	11·15	9·04	7·46						
11		27·19	18·88	13·88	10·63	8·39	6·80	5·61						
12		48·01	33·34	24·50	18·75	14·81	12·00	9·93						
13		40·70	28·26	20·76	15·90	12·56	10·18	8·41						
14		33·14	23·01	16·91	12·95	10·23	8·29	6·85						
15		25·30	17·58	12·91	9·89	7·81	6·33	5·23						
16	63·39	40·56	28·18	20·70	15·85	12·51	10·14							
17	50·81	32·53	22·59	16·59	12·70	10·04	8·13							
18	38·21	24·46	16·99	12·48	9·55	7·55	6·11							
19	56·71	36·30	25·21	18·53	14·18	11·20	9·08							
20	46·25	29·60	20·56	15·10	11·56	9·14	7·40							
21	35·39	22·65	15·73	11·55	8·85	6·99	5·66							

PRESSED STEEL TROUGHING. The tabular loads are based on an extreme fibre stress of 10 tons per square inch and include the weight of the troughing itself.
The areas tabulated are for one complete unit as pressed.
In the case of troughs with "butt" joints the tabulated properties include for the covers.

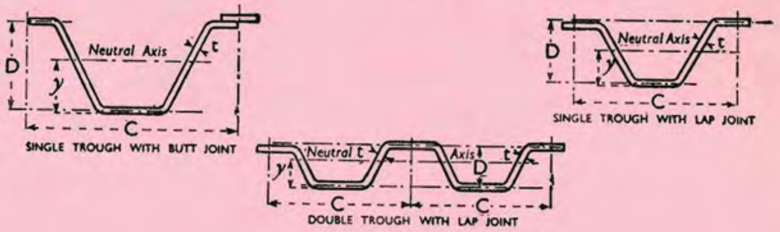
PRESSED STEEL TROUGH SECTIONS



Reference Mark	SECTION D ins	C ft ins	t ins	TYPE Trough	Joint	Slope of Webs	Area of Section (including cover for Butted Trough) sq ins	Weight (including rivets) per sq. ft. covered lbs	Dimension y ins	Minimum Modulus of complete Section (including cover for Butted Trough) ins³	Modulus of Section per foot width ins³
22	7½	2 0	½	Single	Butt	1 : 2	18·74	32·43	4·60	40·76	20·38
23	7½	2 0	⅜	Single	Butt	1 : 2	14·06	24·46	4·52	30·67	15·33
24	7½	2 0	$\frac{5}{16}$	Single	Butt	1 : 2	11·72	20·59	4·48	25·60	12·80
25	7½	2 0	½	Single	Lap	1 : 2	17·47	29·97	4·21	36·81	18·40
26	7½	2 0	⅜	Single	Lap	1 : 2	13·13	22·60	4·18	28·26	14·13
27	7½	2 0	$\frac{5}{16}$	Single	Lap	1 : 2	10·95	18·96	4·16	23·83	11·91
28	7½	2 0	½	Double	Lap	1 : 1	33·58	28·69	4·11	73·38	18·34
29	7½	2 0	⅜	Double	Lap	1 : 2	25·22	21·58	4·06	56·09	14·02
30	7½	2 0	$\frac{5}{16}$	Double	Lap	1 : 2	21·03	18·04	4·04	47·20	11·80
31	6	1 8	⅜	Single	Lap	1 : 2	10·98	22·74	3·41	18·61	11·17
32	6	1 8	$\frac{5}{16}$	Single	Lap	1 : 2	9·16	19·10	3·39	15·73	9·44
33	6	1 8	¼	Single	Lap	1 : 2	7·34	15·48	3·38	12·77	7·66
34	6	1 8	⅜	Double	Lap	1 : 2	20·92	21·51	3·30	36·95	11·08
35	6	1 8	$\frac{5}{16}$	Double	Lap	1 : 2	17·45	18·00	3·28	31·16	9·35
36	6	1 8	¼	Double	Lap	1 : 2	13·97	14·50	3·26	25·24	7·57
37	4	1 4	⅜	Double	Lap	1 : 2	15·98	20·50	2·26	19·09	7·16
38	4	1 4	$\frac{5}{16}$	Double	Lap	1 : 2	13·33	17·14	2·23	16·13	6·07
39	4	1 4	¼	Double	Lap	1 : 2	10·67	13·79	2·21	13·17	4·94
40	5	1 6	⅜	Double	Lap	60°	18·55	21·13	2·79	27·38	9·13
41	5	1 6	$\frac{5}{16}$	Double	Lap	60°	15·47	17·66	2·77	23·14	7·71
42	5	1 6	¼	Double	Lap	60°	12·39	14·20	2·75	18·78	6·26
43	5	2 6	⅜	Single	Butt	1 : 2	15·34	21·12	3·09	25·68	10·27
44	5	2 6	$\frac{5}{16}$	Single	Butt	1 : 2	12·78	17·69	3·05	21·48	8·59
45	5	2 6	¼	Single	Butt	1 : 2	10·22	14·30	3·01	17·25	6·90

PRESSED STEEL TROUGHING. The tabular loads are based on an extreme fibre stress of 10 tons per square inch and include the weight of the troughing itself.
The areas tabulated are for one complete unit as pressed.
In the case of troughs with "butt" joints the tabulated properties include for the covers.

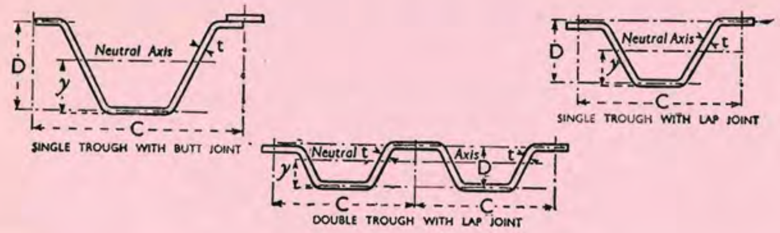
PRESSED STEEL TROUGH SECTIONS



Reference Mark	DISTRIBUTED SAFE LOADS IN CWTS. PER SQUARE FOOT — SPANS IN FEET 6	8	10	12	14	16
22		42·45	27·18	18·88	13·86	10·61
23		31·95	20·45	14·20	10·43	7·99
24		26·68	17·08	11·85	8·71	6·66
25		38·35	24·54	17·04	12·53	9·59
26		29·44	18·84	13·09	9·61	7·36
27		24·83	15·89	11·04	8·10	6·20
28		38·21	24·46	16·99	12·48	9·55
29		29·21	18·70	12·99	9·54	7·30
30		24·59	15·74	10·93	8·03	6·15
31	41·35	23·26	14·89	10·34	7·60	
32	34·96	19·66	12·59	8·74	6·43	
33	28·39	15·96	10·21	7·10	5·21	
34	41·05	23·10	14·78	10·26	7·54	
35	34·63	19·48	12·46	8·65	6·36	
36	28·04	15·78	10·10	7·01	5·15	
37	26·51	14·91	9·55	6·63		
38	22·48	12·64	8·09	5·61		
39	18·30	10·29	6·59	4·58		
40	33·81	19·01	12·18	8·45		
41	28·58	16·08	10·29	7·14		
42	23·19	13·04	8·25	5·80		
43	38·05	21·40	13·70	9·51		
44	31·83	17·90	11·45	7·95		
45	25·56	14·38	9·20	6·39		

PRESSED STEEL TROUGHING. The tabular loads are based on an extreme fibre stress of 10 tons per square inch and include the weight of the troughing itself.
The areas tabulated are for one complete unit as pressed.
In the case of troughs with "butt" joints the tabulated properties include for the covers.

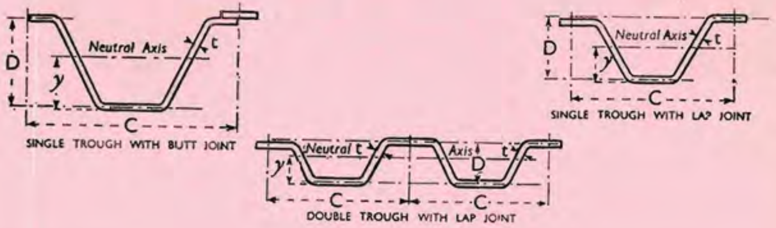
PRESSED STEEL TROUGH SECTIONS



Reference Mark	SECTION			TYPE		Slope of Webs Approx.	Area of Section (including cover for Butted Trough)	Weight (including rivets) per sq. ft. covered	Dimension y	Minimum Modulus of complete Section (including cover for Butted Trough)	Modulus of Section per foot width
	D	C	t	Trough	Joint						
	ins	ft ins	ins				sq ins	lbs	ins	ins³	ins³
700	12	2 6	$\frac{3}{4}$	Single	Butt	70°	38·78	53·82	7·03	136·73	54·69
701	12	2 6	$\frac{5}{8}$	Single	Butt	70°	32·28	44·98	6·95	113·91	45·56
702	12	2 6	$\frac{1}{2}$	Single	Butt	70°	25·78	35·74	6·87	91·17	36·47
703	12	2 6	$\frac{3}{8}$	Single	Butt	70°	19·30	26·92	6·80	68·53	27·41
704	12	2 6	$\frac{3}{4}$	Single	Lap	70°	35·72	49·12	6·38	123·31	49·32
705	12	2 6	$\frac{5}{8}$	Single	Lap	70°	29·78	41·04	6·35	103·95	41·58
706	12	2 6	$\frac{1}{2}$	Single	Lap	70°	23·82	32·73	6·31	84·93	33·97
707	12	2 6	$\frac{3}{8}$	Single	Lap	70°	17·88	24·65	6·28	63·96	25·58
630	10	2 0	$\frac{3}{4}$	Single	Butt	70°	32·30	56·20	6·18	91·00	45·50
631	10	2 0	$\frac{5}{8}$	Single	Butt	70°	26·90	47·03	6·10	75·75	37·87
632	10	2 0	$\frac{1}{2}$	Single	Butt	70°	21·50	37·40	6·02	60·60	30·30
633	10	2 0	$\frac{3}{8}$	Single	Butt	70°	16·13	28·30	5·94	45·50	22·75
600	9	2 0	$\frac{3}{4}$	Single	Butt	70°	31·48	54·86	5·59	82·72	41·36
601	9	2 0	$\frac{5}{8}$	Single	Butt	70°	26·24	45·95	5·52	68·82	34·41
602	9	2 0	$\frac{1}{2}$	Single	Butt	70°	20·99	36·53	5·45	55·05	27·52
603	9	2 0	$\frac{3}{8}$	Single	Butt	70°	15·74	27·60	5·38	41·21	20·60
604	9	2 0	$\frac{3}{4}$	Single	Lap	70°	28·38	48·92	4·95	72·28	36·14
605	9	2 0	$\frac{5}{8}$	Single	Lap	70°	23·72	41·00	4·93	61·19	30·59
606	9	2 0	$\frac{1}{2}$	Single	Lap	70°	19·04	32·79	4·91	49·66	24·83
607	9	2 0	$\frac{3}{8}$	Single	Lap	70°	14·32	24·77	4·89	37·94	18·97
360	6	1 8	$\frac{3}{8}$	Double	Lap	63°	21·23	21·82	3·30	38·33	11·50
361	6	1 8	$\frac{5}{16}$	Double	Lap	63°	17·62	18·25	3·28	32·32	9·70
362	6	1 8	$\frac{1}{4}$	Double	Lap	63°	14·15	14·68	3·26	26·18	7·85

PRESSED STEEL TROUGHING. The tabular loads are based on an extreme fibre stress of 10 tons per square inch and include the weight of the troughing itself.
The areas tabulated are for one complete unit as pressed.
In the case of troughs with "butt" joints the tabulated properties include for the covers.

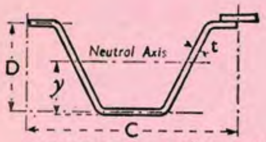
PRESSED STEEL TROUGH SECTIONS



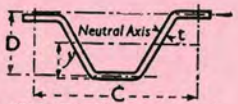
Reference Mark	DISTRIBUTED SAFE LOADS IN CWTS. PER SQUARE FOOT											
	SPANS IN FEET											
	6	8	10	12	14	16	18	20	22	24	26	28
700			72·92	50·64	37·21	28·49	22·51	18·23	15·07	12·66	10·79	9·30
701			60·75	42·19	31·00	23·73	18·75	15·19	12·55	10·55	8·99	7·75
702			48·62	33·77	24·81	18·99	15·01	12·16	10·05	8·44	7·19	6·20
703			36·55	25·38	18·65	14·28	11·28	9·14	7·55	6·34	5·41	4·66
704			65·76	45·67	33·55	25·69	20·30	16·44	13·59	11·42	9·73	8·39
705			55·44	38·50	28·28	21·66	17·11	13·86	11·45	9·62	8·20	7·07
706			45·30	31·46	23·11	17·69	13·98	11·32	9·36	7·86	6·70	5·78
707			34·11	23·69	17·40	13·32	10·53	8·53	7·05	5·92	5·05	4·35
630			60·66	42·11	31·00	23·69	18·75	15·19	12·54			
631			50·50	35·06	27·76	19·69	15·62	12·64	10·50			
632			40·40	28·05	20·62	15·79	12·50	10·10	8·37			
633			30·31	21·06	15·50	10·59	9·37	7·59	6·27			
600		86·17	55·15	38·30	28·14	21·54	17·02	13·79				
601		71·68	45·88	31·86	23·41	17·92	14·16	11·47				
602		57·35	36·70	25·49	18·72	14·34	11·33	9·17				
603		42·92	27·47	19·08	14·02	10·73	8·48	6·87				
604		75·29	48·19	33·46	24·59	18·82	14·87	12·05				
605		63·74	40·79	28·33	20·81	15·93	12·59	10·20				
606		51·73	33·10	22·99	16·89	12·93	10·22	8·28				
607		39·52	25·29	17·57	12·90	9·88	7·81	6·32				
360		23·96	15·33	10·64	7·82	5·99						
361		20·20	12·93	8·98	6·59	5·05						
362		16·35	10·47	7·26	5·34	4·09						

PRESSED STEEL TROUGHING. The tabular loads are based on an extreme fibre stress of 10 tons per square inch and include the weight of the troughing itself.
The areas tabulated are for one complete unit as pressed.
In the case of troughs with "butt" joints the tabulated properties include for the covers.

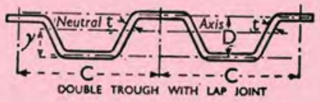
PRESSED STEEL TROUGH SECTIONS



SINGLE TROUGH WITH BUTT JOINT



SINGLE TROUGH WITH LAP JOINT

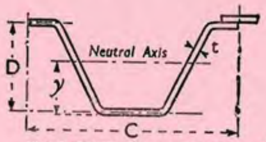


DOUBLE TROUGH WITH LAP JOINT

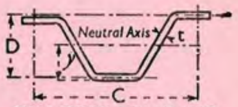
Ref-erence Mark	SECTION			TYPE		Slope of Webs Approx	Area of Section (including cover for Butted Trough)	Weight (including rivets) per sq. ft. covered	Dimension y	Minimum Modulus of complete Section (including cover for Butted Trough)	Modulus of Section per foot width
	D	C		Trough	Joint						
	ins	*ft ins*	*ins*				*sq ins*	*lbs*	*ins*	*ins*^{3}	*ins*^{3}
650	5	1 6	$\frac{3}{8}$	Double	Lap	60°	18·40	21·10	2·78	27·40	9·13
651	5	1 6	$\frac{5}{16}$	Double	Lap	60°	15·40	17·65	2·76	22·80	7·60
652	5	1 6	$\frac{1}{4}$	Double	Lap	60°	12·30	14·20	2·74	18·25	6·08
660	5	1 3	$\frac{1}{2}$	Double	Lap	60°	21·60	29·75	2·82	30·40	12·16
661	5	1 3	$\frac{3}{8}$	Double	Lap	60°	16·20	22·40	2·80	22·80	9·12
662	5	1 3	$\frac{5}{16}$	Double	Lap	60°	13·50	18·72	2·78	19·00	7·60
310	5	1 4	$\frac{3}{8}$	Double	Lap	60°	16·92	21·90	2·78	24·20	9·07
311	5	1 4	$\frac{5}{16}$	Double	Lap	60°	14·10	18·30	2·76	20·20	7·57
312	5	1 4	$\frac{1}{4}$	Double	Lap	60°	11·30	14·70	2·74	16·10	6·04
280	4½	1 6	$\frac{3}{8}$	Double	Lap	65°	18·30	21·00	2·51	26·90	8·97
281	4½	1 6	$\frac{5}{16}$	Double	Lap	65°	15·25	17·55	2·49	22·40	7·47
282	4½	1 6	$\frac{1}{4}$	Double	Lap	65°	12·20	14·10	2·47	17·90	5·97
670	3	1 0	$\frac{3}{8}$	Double	Lap	60°	12·22	20·98	1·77	10·45	5·22
671	3	1 0	$\frac{5}{16}$	Double	Lap	60°	10·18	17·51	1·74	8·86	4·43
672	3	1 0	$\frac{1}{4}$	Double	Lap	60°	8·14	14·04	1·71	7·21	3·60

PRESSED STEEL TROUGHING. The tabular loads are based on an extreme fibre stress of 10 tons per square inch and include the weight of the troughing itself.
The areas tabulated are for one complete unit as pressed.
In the case of troughs with "butt" joints the tabulated properties include for the covers.

PRESSED STEEL TROUGH SECTIONS



SINGLE TROUGH WITH BUTT JOINT



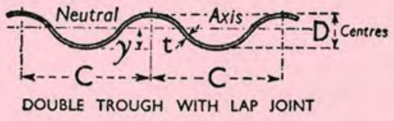
SINGLE TROUGH WITH LAP JOINT

DOUBLE TROUGH WITH LAP JOINT

Ref. erence Mark	DISTRIBUTED SAFE LOADS IN CWTS. PER SQUARE FOOT											
	SPANS IN FEET											
	6	8	10	12	14	16	18	20	22	24	26	28
650	33·81	19·02	12·17	8·45								
651	28·15	15·83	10·13	7·03								
652	22·52	12·67	8·11	5·63								
660	45·04	25·37	16·25	11·26								
661	33·76	19·00	12·16	8·50								
662	28·14	15·87	10·14	7·04								
310	33·62	18·90	12·12	8·40								
311	28·06	15·77	10·12	7·01								
312	22·37	12·56	8·05	5·62								
280	33·25	18·69	12·00	8·31								
281	27·64	15·56	10·00	6·93								
282	22·12	12·43	8·00	5·56								
670	19·33	10·88	6·96									
671	16·41	9·23	5·91									
672	13·33	7·50	4·80									

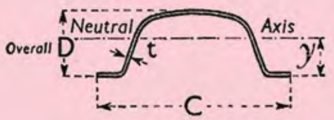
PRESSED STEEL TROUGHING. The tabular loads are based on an extreme fibre stress of 10 tons per square inch and include the weight of the troughing itself.
The areas tabulated are for one complete unit as pressed.
In the case of troughs with "butt" joints the tabulated properties include for the covers.

PRESSED STEEL TROUGH SECTIONS



DOUBLE TROUGH WITH LAP JOINT

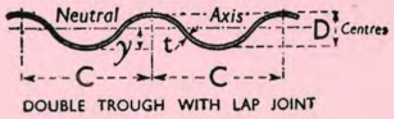
Ref-erence Mark	SECTION			TYPE		Area of Section	Weight (including rivets) per sq. ft. covered	Dimen-sion	Minimum Modulus of Complete Section	Modulus of Section per Foot Width
	D ins	C ft ins	*t* ins	Trough	Joint	sq ins	lbs	*y* ins	ins³	ins³
510	3 1/16	1 0	3/8	Double	Lap	11·25	19·55	1·71	7·92	3·96
511	3 1/16	1 0	5/16	Double	Lap	9·37	16·18	1·70	6·60	3·30
512	3 1/16	1 0	1/4	Double	Lap	7·50	12·99	1·69	5·28	2·64
513	3 1/16	1 0	3/16	Double	Lap	5·62	9·81	1·68	3·96	1·98



60	6	1 6	3/8	—	—	9·2	20·8	3·5	12·7	8·5
61	5 15/16	1 6	5/16	—	—	7·6	17·3	3·4	10·6	7·1
62	5 7/8	1 6	1/4	—	—	6·1	13·9	3·4	8·5	5·7
63	3	1 5	5/16	—	—	6·1	14·6	1·8	3·9	2·8
64	2 15/16	1 5	1/4	—	—	4·9	11·6	1·8	3·1	2·1

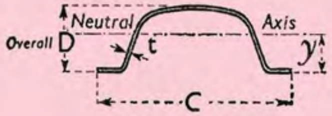
PRESSED STEEL TROUGHING. The tabular loads shown in above tables are based on an extreme fibre stress of 10 tons per square inch and include the weight of the troughing itself.
The areas and Section Moduli tabulated are for one complete unit as pressed.

PRESSED STEEL TROUGH SECTIONS



DOUBLE TROUGH WITH LAP JOINT

Reference Mark	DISTRIBUTED SAFE LOADS IN CWTS. PER SQUARE FOOT					
	SPANS IN FEET					
	6	8	10	12	14	16
510	14·66	8·25	5·28	3·66	2·69	2·06
511	12·22	6·87	4·44	3·05	2·24	1·72
512	9·77	5·50	3·52	2·44	1·79	1·37
513	7·33	4·12	2·64	1·83	1·35	1·03



60	31·4	17·6	11·3	7·8	5·8	4·4
61	26·2	14·7	9·4	6·5	4·8	3·7
62	21·0	11·8	7·6	5·3	3·9	2·9
63	10·2	5·7	3·7	2·6	1·9	1·4
64	8·1	4·6	2·9	2·0	1·5	1·1

PRESSED STEEL TROUGHING. The tabular loads shown in above tables are based on an extreme fibre stress of 10 tons per square inch and include the weight of the troughing itself.
The areas and Section Moduli tabulated are for one complete unit as pressed.

PART VI

Connections

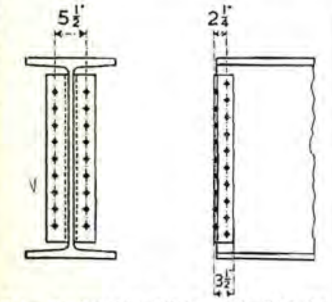
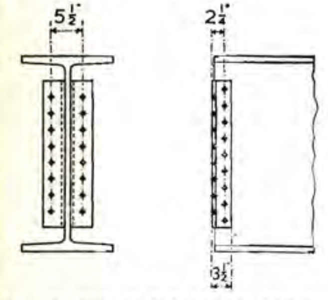
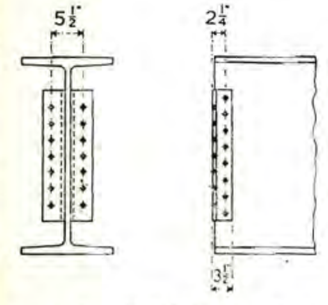
and

Typical Constructional Details

STANDARD END CONNECTIONS

SAFE LOADS ON CONNECTED LEGS OF CLEATS

see page 523 for safe loads on outstanding legs

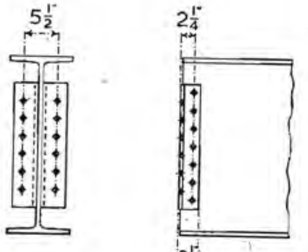
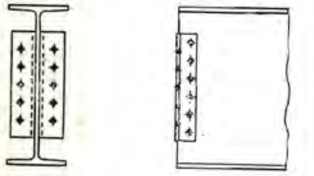
Holes 15/16" dia., Bolts ⅞" dia. Vertical pitch of holes 3 ins. Angle cleats—Mild steel. Weights given do not include bolts or rivets.	Ref.	Serial Size in inches	Wt per foot in lbs	Web thickness in ins	HIGH YIELD STEEL BEAMS		MILD STEEL BEAMS		Friction Grip Bolts
					H.Y.S. Black Bolts	H.Y.S. Power Driven Shop Rivets	M.S. Black Bolts	M.S. Power Driven Shop Rivets	
					tons	*tons*	*tons*	*tons*	*tons*
 2∠s 4"×3½"×½" 2′ 6" lg. Wt. 59·5 lbs.	**A1**	**36×16½**	260	·845	77·9	115	55·6	83·0	95·7
	A2		230	·765	77·4	115	55·6	83·0	95·7
	A2	**36×12**	194	·770	77·9	115	55·6	83·0	95·7
	A3		170	·680	68·8	115	55·6	83·0	95·7
	A4		150	·625	63·3	115	55·6	83·0	95·7
	A4		135	·597	60·4	115	55·6	83·0	95·7
 2∠s 4"×3½"×½" 2′ 3" lg. Wt. 53·5 lbs.	**B1**	**36×16½**	260	·845	69·1	102	49·3	73·6	84·9
	B2		230	·765	68·7	102	49·3	73·6	84·9
	B2	**36×12**	194	·770	69·1	102	49·3	73·6	84·9
	B3		170	·680	61·0	102	49·3	73·6	84·9
	B4		150	·625	56·1	102	49·3	73·6	84·9
	B4		135	·597	53·6	102	49·3	73·6	84·9
	B4	**33×11½**	152	·635	57·0	102	49·3	73·6	84·9
	B5		130	·580	52·1	102	49·3	73·6	84·9
	B5		118	·552	49·6	102	49·3	73·6	84·9
 2∠s 4"×3½"×½" 2′ 0" lg. Wt. 47·6 lbs.	**C1**	**36×16½**	260	·845	60·2	88·9	43·0	64·2	74·0
	C2		230	·765	59·9	88·9	43·0	64·2	74·0
	C2	**36×12**	194	·770	60·2	88·9	43·0	64·2	74·0
	C3		170	·680	53·2	88·9	43·0	64·2	74·0
	C4		150	·625	48·9	88·9	43·0	64·2	74·0
	C4		135	·597	46·7	88·9	43·0	64·2	74·0
	C4	**33×11½**	152	·635	49·7	88·9	43·0	64·2	74·0
	C5		130	·580	45·4	88·9	43·0	64·2	74·0
	C5		118	·552	43·2	88·9	43·0	64·2	74·0
	C4	**30×10½**	132	·615	48·1	88·9	43·0	64·2	74·0
	C5		116	·564	44·1	88·9	43·0	64·2	74·0
	C6		99	·508	*39·8*	88·9	39·8	64·2	74·0
	C5	**27×10**	114	·570	44·6	88·9	43·0	64·2	74·0
	C6		102	·518	*40·5*	88·9	40·5	64·2	74·0
	C6		94	·490	*38·3*	88·7	38·3	62·5	74·0
	C7		84	·462	*36·2*	83·7	36·2	58·9	74·0

Values printed in italics give no advantage over M.S. Black Bolts.

STANDARD END CONNECTIONS

SAFE LOADS ON CONNECTED LEGS OF CLEATS

see page 523 for safe loads on outstanding legs

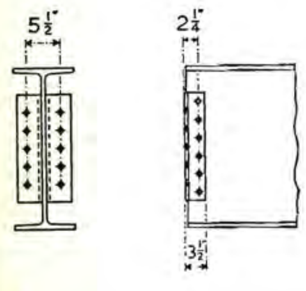
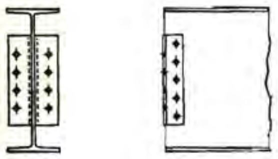
Holes 15/16" dia., Bolts ⅞" dia. Vertical pitch of holes 3 ins. Angle cleats—Mild steel. Weights given do not include bolts or rivets.	Ref.	Serial Size in inches	Wt per foot in lbs	Web thickness in ins	HIGH YIELD STEEL BEAMS		MILD STEEL BEAMS		Friction Grip Bolts
					H.Y.S. Black Bolts	H.Y.S. Power Driven Shop Rivets	M.S. Black Bolts	M.S. Power Driven Shop Rivets	
					tons	*tons*	*tons*	*tons*	*tons*
 2∠s 4"×3½"×7/16" 1′ 9" lg. Wt. 36·8 lbs.	**D1**	**36×16½**	260	·845	46·7	75·8	36·7	54·7	63·1
	D2		230	·765	46·7	75·8	36·7	54·7	63·1
	D2	**36×12**	194	·770	46·7	75·8	36·7	54·7	63·1
	D3		170	·680	45·4	75·8	36·7	54·7	63·1
	D4		150	·625	41·7	75·8	36·7	54·7	63·1
	D4		135	·597	39·8	75·8	36·7	54·7	63·1
	D4	**33×11½**	152	·635	42·4	75·8	36·7	54·7	63·1
	D5		130	·580	38·7	75·8	36·7	54·7	63·1
	D5		118	·552	36·8	75·8	36·7	54·7	63·1
	D4	**30×10½**	132	·615	41·0	75·8	36·7	54·7	63·1
	D5		116	·564	37·6	75·8	36·7	54·7	63·1
	D6		99	·508	*33·9*	75·8	33·9	54·7	63·1
	D5	**27×10**	114	·570	38·0	75·8	36·7	54·7	63·1
	D6		102	·518	*34·6*	75·8	34·6	54·7	63·1
	D6		94	·490	*32·7*	75·7	32·7	53·2	63·1
	D7		84	·462	*30·8*	71·3	30·8	50·2	63·1
	D2	**24×12**	160	·732	46·7	75·8	36·7	54·7	63·1
	D5		120	·556	37·1	75·8	36·7	54·7	63·1
	D7		100	·468	*31·2*	72·3	31·2	50·9	63·1
	D6	**24×9**	94	·516	*34·4*	75·8	34·4	54·7	63·1
	D6		84	·470	*31·4*	72·6	31·4	51·1	63·1
	D7		76	·440	*29·4*	67·9	29·4	47·8	63·1
	D7		68	·416	*27·8*	64·2	27·8	45·2	†
 2∠s 4"×3½"×7/16" 1′ 6" lg. Wt. 31·5 lbs.	**E1**	**36×16½**	260	·845	38·7	62·7	30·3	45·3	52·2
	E2		230	·765	38·7	62·7	30·3	45·3	52·2
	E2	**36×12**	194	·770	38·7	62·7	30·3	45·3	52·2
	E3		170	·680	37·5	62·7	30·3	45·3	52·2
	E4		150	·625	34·5	62·7	30·3	45·3	52·2
	E4		135	·597	33·0	62·7	30·3	45·3	52·2
	E4	**33×11½**	152	·635	35·1	62·7	30·3	45·3	52·2
	E5		130	·580	32·0	62·7	30·3	45·3	52·2
	E5		118	·552	30·5	62·7	30·3	45·3	52·2
	E4	**30×10½**	132	·615	33·9	62·7	30·3	45·3	52·2
	E5		116	·564	31·1	62·7	30·3	45·3	52·2
	E6		99	·508	*28·0*	62·7	28·0	45·3	52·2
	E5	**27×10**	114	·570	31·5	62·7	30·3	45·3	52·2
	E6		102	·518	*28·6*	62·7	28·6	45·3	52·2
	E6		94	·490	*27·0*	62·6	27·0	44·1	52·2
	E7		84	·462	*25·5*	59·0	25·5	41·5	52·2

Values printed in italics give no advantage over M.S. Black Bolts.
† Indicates Friction Grip Bolts value exceeds shear value of M.S. Beam.

STANDARD END CONNECTIONS

SAFE LOADS ON CONNECTED LEGS OF CLEATS

see page 523 for safe loads on outstanding legs

Holes 15/16" dia., Bolts ⅞" dia. Vertical pitch of holes 3 ins. Angle cleats—Mild steel. Weights given do not include bolts or rivets.	Ref.	Serial Size in inches	Wt per foot in lbs	Web thickness in ins	HIGH YIELD STEEL BEAMS		MILD STEEL BEAMS		Friction Grip Bolts
					H.Y.S. Black Bolts	H.Y.S. Power Driven Shop Rivets	M.S. Black Bolts	M.S. Power Driven Shop Rivets	
					tons	*tons*	*tons*	*tons*	*tons*
	**E2**	**24×12**	160	·732	38·7	62·7	30·3	45·3	52·2
	E5		120	·556	30·7	62·7	30·3	45·3	52·2
	E7		100	·468	*25·8*	59·8	25·8	42·1	52·2
	E6	**24×9**	94	·516	*28·5*	62·7	28·5	45·3	52·2
	E6		84	·470	*25·9*	60·0	25·9	42·3	52·2
	E7		76	·440	*24·3*	56·2	24·3	39·6	52·2
	E7		68	·416	*23·0*	53·1	23·0	37·4	52·2
	Ex	**21×13**	142*	·659	36·4	62·7	30·3	45·3	52·2
	Ey		127*	·588	32·5	62·7	30·3	45·3	52·2
	Ez		112*	·527	*29·1*	62·7	29·1	45·3	52·2
	E6	**21×8¼**	82	·502	*27·7*	62·7	27·7	45·1	52·2
	E7		73	·455	*25·1*	58·1	25·1	40·9	52·2
2∠s 4"×3½"×7/16" 1' 6" lg. Wt. 31·5 lbs.	**E7**		68	·430	*23·7*	54·9	23·7	38·7	52·2
	E8		62	·400	*22·1*	51·1	22·1	36·0	†
	E8		55	·376	*20·8*	48·0	20·8	33·8	†
	F3	**33×11½**	152	·635	26·2	42·7	24·0	35·9	41·4
	F4		130	·580	25·4	42·7	24·0	35·9	41·4
	F4		118	·552	24·1	42·7	24·0	35·9	41·4
	**F3**	**30×10½**	132	·615	26·2	42·7	24·0	35·9	41·4
	F4		116	·564	24·7	42·7	24·0	35·9	41·4
	F5		99	·508	*22·2*	42·7	22·2	35·9	41·4
	F4	**27×10**	114	·570	24·9	42·7	24·0	35·9	41·4
	F5		102	·518	*22·7*	42·7	22·7	35·9	41·4
	F5		94	·490	*21·4*	42·7	21·4	34·9	41·4
	F6		84	·462	*20·2*	42·7	20·2	32·9	41·4
	F1	**24×12**	160	·732	26·2	42·7	24·0	35·9	41·4
	F4		120	·556	24·3	42·7	24·0	35·9	41·4
	F6		100	·468	*20·5*	42·7	20·5	33·3	41·4
2∠s 4"×3½"×⅜" 1' 3" lg. Wt.22·75 lbs	**F5**	**24×9**	94	·516	*22·6*	42·7	22·6	35·9	41·4
	F5		84	·470	*20·6*	42·7	20·6	33·5	41·4
	F6		76	·440	*19·2*	42·7	19·2	31·3	41·4
	F6		68	·416	*18·2*	42·1	18·2	29·6	41·4

Values printed in italics give no advantage over M.S. Black Bolts.

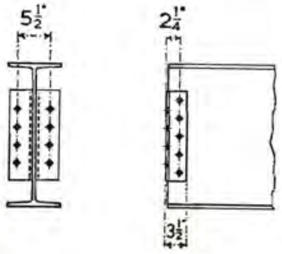
* For Beams of 21 × 13 serial size the Angle Cleats to be 17¾" long sawn or machine flame cut.

† Indicates Friction Grip Bolts value exceeds shear value of M.S. Beam.

STANDARD END CONNECTIONS

SAFE LOADS ON CONNECTED LEGS OF CLEATS

see page 523 for safe loads on outstanding legs

Holes 15/16" dia., Bolts ⅞" dia. Vertical pitch of holes 3 ins. Angle cleats—Mild steel. Weights given do not include bolts or rivets.	Ref.	Serial Size in inches	Wt per foot in lbs	Web thickness in ins	HIGH YIELD STEEL BEAMS		MILD STEEL BEAMS		Friction Grip Bolts
					H.Y.S. Black Bolts	H.Y.S. Power Driven Shop Rivets	M.S. Black Bolts	M.S. Power Driven Shop Rivets	
					tons	*tons*	*tons*	*tons*	*tons*
	**F2**	**21×13**	142	·659	26·2	42·7	24·0	35·9	41·4
	F4		127	·588	25·7	42·7	24·0	35·9	41·4
	F5		112	·527	*23·1*	42·7	23·1	35·9	41·4
	F5	**21×8¼**	82	·502	*22·0*	42·7	22·0	35·8	41·4
	F6		73	·455	*19·9*	42·7	19·9	32·4	41·4
	F6		68	·430	*18·8*	42·7	18·8	30·6	41·4
	F7		62	·400	*17·5*	40·5	17·5	28·5	41·4
	F7		55	·376	*16·4*	38·1	16·4	26·8	41·4
	F6	**18×7½**	66	·450	*19·7*	42·7	19·7	32·1	41·4
	F6		60	·416	*18·2*	42·1	18·2	29·6	41·4
	F7		55	·390	*17·1*	39·5	17·1	27·8	41·4
	F7		50	·358	*15·7*	36·2	15·7	25·5	†
	F8		45	·334	*14·6*	33·8	14·6	23·8	†
2∠s 4"×3½"×⅜" 1' 3" lg. Wt. 22·75 lbs.	**F6**	**18×6**	55	·420	*18·4*	42·5	18·4	29·9	41·4
	F7		50	·389	*17·0*	39·4	17·0	27·7	41·4
	F7		45	·360	*15·7*	36·4	15·7	25·6	†
	G1	**24×12**	160	·732	19·5	31·8	17·9	26·7	30·7
	G3		120	·556	18·1	31·8	17·9	26·7	30·7
	G5		100	·468	*15·2*	31·8	15·2	24·8	30·7
	G4	**24×9**	94	·516	*16·8*	31·8	16·8	26·7	30·7
	G4		84	·470	*15·3*	31·8	15·3	24·9	30·7
	G5		76	·440	*14·3*	31·8	14·3	23·3	30·7
	G5		68	·416	*13·5*	31·3	13·5	22·0	30·7
	**G2**	**21×13**	142	·659	19·5	31·8	17·9	26·7	30·7
	G3		127	·588	19·1	31·8	17·9	26·7	30·7
	G4		112	·527	*17·1*	31·8	17·1	26·7	30·7
	G4	**21×8¼**	82	·502	*16·3*	31·8	16·3	26·6	30·7
	G5		73	·455	*14·8*	31·8	14·8	24·1	30·7
	G5		68	·430	*14·0*	31·8	14·0	22·8	30·7
	G6		62	·400	*13·0*	30·1	13·0	21·2	30·7
	G6		55	·376	*12·2*	28·3	12·2	19·9	30·7
	G5	**18×7½**	66	·450	*14·6*	31·8	14·6	23·8	30·7
2∠s 4"×3½"×⅜" 1' 0" lg. Wt. 18·2 lbs.	**G5**		60	·416	*13·5*	31·3	13·5	22·0	30·7
	G6		55	·390	*12·7*	29·4	12·7	20·7	30·7
	G6		50	·358	*11·6*	26·9	11·6	19·0	30·7
	G7		45	·334	*10·9*	25·1	10·9	17·7	30·7
	G5	**18×6**	55	·420	*13·7*	31·6	13·7	22·2	30·7
	G6		50	·389	*12·6*	29·3	12·6	20·6	30·7
	G6		45	·360	*11·7*	27·1	11·7	19·1	30·7

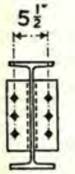
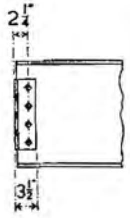
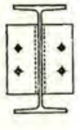
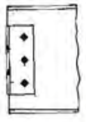
Values printed in italics give no advantage over M.S. Black Bolts.

† Indicates Friction Grip Bolts value exceeds shear value of M.S. Beam.

STANDARD END CONNECTIONS

SAFE LOADS ON CONNECTED LEGS OF CLEATS

see page 523 *for safe loads on outstanding legs*

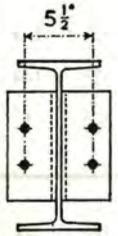
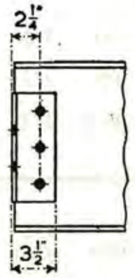
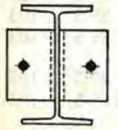
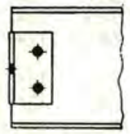
Holes ¹⁵⁄₁₆″ dia., Bolts ⅞″ dia. Vertical pitch of holes 3 ins. Angle cleats—Mild steel. Weights given do not include bolts or rivets.	Ref.	Serial Size in inches	Wt per foot in lbs	Web thickness in ins	HIGH YIELD STEEL BEAMS		MILD STEEL BEAMS		Friction Grip Bolts
					H.Y.S. Black Bolts	H.Y.S. Power Driven Shop Rivets	M.S. Black Bolts	M.S. Power Driven Shop Rivets	
					tons	*tons*	*tons*	*tons*	*tons*
 	**G6**	**16×7**	50	·380	*12·4*	28·6	12·4	20·1	30·7
	G6		45	·346	*11·3*	26·0	11·3	18·3	30·7
	G7		40	·307	*9·9*	23·1	9·9	16·3	†
	G7		36	·299	*9·7*	22·5	9·7	15·8	†
	G6	**16×6**	50	·399	*13·0*	30·0	13·0	21·1	30·7
	G6		45	·368	*12·0*	27·7	12·0	19·5	30·7
	G7		40	·340	*11·1*	25·6	11·1	18·0	30·7
	G8	**16×5½**	31	·272	*8·8*	20·5	8·8	14·4	†
	G8		26	·249	*8·0*	18·7	8·0	13·2	†
	G6	**15×6**	45	·381	*12·4*	28·7	12·4	20·2	30·7
	G6		40	·344	*11·2*	25·9	11·2	18·2	30·7
	G7		35	·306	*9·9*	23·0	9·9	16·2	†
	G6	**14×6¾**	45	·357	*11·6*	26·9	11·6	13·9	30·7
	G7		38	·313	*10·2*	23·6	10·2	16·6	†
	G7		34	·287	*9·3*	21·6	9·3	15·2	†
2∠s 4″×3½″×⅜″ 1′ 0″ lg. Wt. 18·2 lbs.	**G8**		30	·270	*8·7*	20·3	8·7	14·3	†
	G8	**14×5**	26	·257	*8·3*	19·3	8·3	13·6	†‖
	G8		22	·233	*7·5*	17·5	7·5	12·3	†‖
 	**H1**	**18×7½**	66	·450	*9·8*	21·3	9·8	16·0	20·6
	H1		60	·416	*9·0*	21·0	9·0	14·8	20·6
	H2		55	·390	*8·5*	19·7	8·5	13·8	20·6
	H2		50	·358	*7·8*	18·1	7·8	12·7	20·6
	H3		45	·334	*7·2*	16·8	7·2	11·9	20·6
	H1	**18×6**	55	·420	*9·1*	21·2	9·1	14·9	20·6
	H2		50	·389	*8·4*	19·6	8·4	13·8	20·6
	H2		45	·360	*7·8*	18·2	7·8	12·8	20·6
	H2	**16×7**	50	·380	*8·2*	19·2	8·2	13·5	20·6
	H2		45	·346	*7·5*	17·5	7·5	12·3	20·6
	H3		40	·307	*6·6*	15·5	6·6	10·9	20·6
	H3		36	·299	*6·5*	15·1	6·5	10·6	20·6
	H2	**16×6**	50	·399	*8·6*	20·1	8·6	14·2	20·6
	H2		45	·368	*8·0*	18·6	8·0	13·1	20·6
2∠s 4″×3½″×⅜″ 9″ lg. Wt. 13·6 lbs.	**H3**		40	·340	*7·4*	17·2	7·4	12·1	20·6
	H4	**16×5½**	31	·272	*5·9*	13·7	5·9	9·6	20·6
	H4		26	·249	*5·4*	12·6	5·4	8·8	20·6

Values printed in italics give no advantage over M.S. Black Bolts.
† Indicates Friction Grip Bolts value exceeds shear value of M.S. Beam.
‖ Indicates Friction Grip Bolts value exceeds shear value of H.Y.S. Beam.

STANDARD END CONNECTIONS

SAFE LOADS ON CONNECTED LEGS OF CLEATS

see page 523 *for safe loads on outstanding legs*

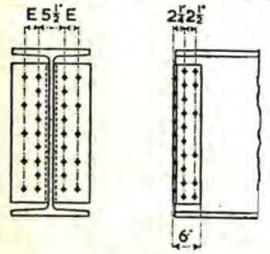
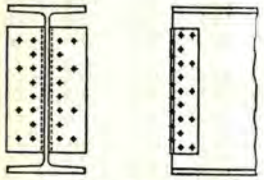
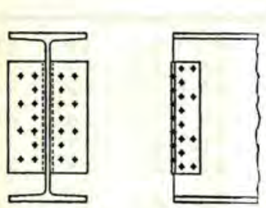
Holes ¹³⁄₁₆″ dia., Bolts ¾″ dia. Vertical pitch of holes 3 ins. Angle cleats—Mild steel. Weights given do not include bolts or rivets.	Ref.	Serial Size in inches	Wt per foot in lbs	Web thickness in ins	HIGH YIELD STEEL BEAMS		MILD STEEL BEAMS		Friction Grip Bolts
					H.Y.S. Black Bolts	H.Y.S. Power Driven Shop Rivets	M.S. Black Bolts	M.S. Power Driven Shop Rivets	
					tons	*tons*	*tons*	*tons*	*tons*
 	**Ha**	**15×6**	45	·381	*7·1*	16·7	7·1	11·7	16·2
	Ha		40	·344	*6·4*	15·0	6·4	10·6	16·2
	Hb		35	·306	*5·7*	13·4	5·7	9·4	16·2
	Ha	**14×6¾**	45	·357	*6·6*	15·6	6·6	11·0	16·2
	Hb		38	·313	*5·8*	13·7	5·8	9·6	16·2
	Hb		34	·287	*5·3*	12·5	5·3	8·8	16·2
	Hc		30	·270	*5·0*	11·8	5·0	8·3	16·2
	Hc	**14×5**	26	·257	*4·8*	11·2	4·8	7·9	16·2
	Hc		22	·233	*4·3*	10·2	4·3	7·1	16·2
	Hb	**12×6½**	36	·305	*5·6*	13·3	5·6	9·3	16·2
	Hc		31	·265	*4·9*	11·6	4·9	8·1	16·2
	Hc		27	·240	*4·4*	10·5	4·4	7·3	16·2
	Ha	**12×5**	32	·350	*6·5*	15·3	6·5	10·8	16·2
	Hb		28	·313	*5·8*	13·7	5·8	9·6	16·2
	Hb		25	·284	*5·3*	12·4	5·3	8·7	16·2
	Hc	**12×4**	22	·260	*4·8*	11·4	4·8	8·0	16·2
	Hc		19	·240	*4·4*	10·5	4·4	7·3	16·2
	Hc		16·5	·230	*4·2*	10·1	4·2	7·0	16·2
	Hb	**10×5¾**	29	·289	*5·4*	12·6	5·4	8·8	16·2
2∠s 4″×3½″×⅜″ 8½″ lg. Wt. 12·9 lbs.	**Hc**		25	·252	*4·7*	11·0	4·7	7·7	†
	Hc		21	·240	*4·4*	10·5	4·4	7·3	†
	Hc	**10×4**	19	·250	*4·6*	10·9	4·6	7·6	†
	Hc		17	·240	*4·4*	10·5	4·4	7·3	†
	Hc		15	·230	*4·2*	10·1	4·2	7·0	†
 	**J1**	**12×5**	32	·350	*3·6*	8·5	3·6	5·9	9·0
	J2		28	·313	*3·2*	7·6	3·2	5·3	9·0
	J2		25	·284	*2·9*	6·9	2·9	4·8	9·0
	J3	**12×4**	22	·260	*2·7*	6·3	2·7	4·4	9·0
	J3		19	·240	*2·4*	5·8	2·4	4·1	9·0
	J3		16·5	·230	*2·3*	5·5	2·3	3·9	9·0
	J2	**10×5¾**	29	·289	*3·0*	7·0	3·0	4·9	9·0
	J3		25	·252	*2·6*	6·1	2·6	4·3	9·0
	J3		21	·240	*2·4*	5·8	2·4	4·1	9·0
	J3	**10×4**	19	·250	*2·6*	6·0	2·6	4·2	9·0
	J3		17	·240	*2·4*	5·8	2·4	4·1	9·0
2∠s 4″×3½″×⅜″ 5½″ lg. Wt. 8·3 lbs.	**J3**		15	·230	*2·3*	5·5	2·3	3·9	9·0
	J3	**8×5¼**	20	·248	*2·5*	6·0	2·5	4·2	9·0
	J3		17	·230	*2·3*	5·5	2·3	3·9	9·0

Values printed in italics give no advantage over M.S. Black Bolts.
† Indicates Friction Grip Bolts value exceeds shear value of M.S. Beam.

STANDARD END CONNECTIONS

SAFE LOADS ON CONNECTED LEGS OF CLEATS

see page 523 for safe loads on outstanding legs

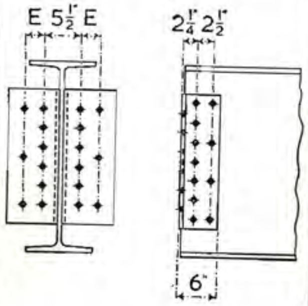
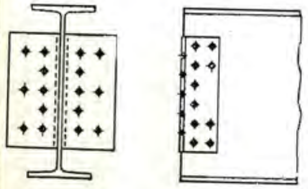
Holes 15/16" dia. Bolts ⅞" dia. Vertical pitch of holes 3 ins. Angle cleats—Mild Steel. Weights given do not include bolts or rivets. Dim E=3" for 8"×6" Angles Dim E=2¼" for 6"×6" Angles	Ref.		Serial Size in inches	Wt per foot in lbs	Web thickness in ins	HIGH YIELD STEEL BEAMS		MILD STEEL BEAMS		Friction Grip Bolts
	8"×6" Angles	6"×6" Angles				H.Y.S. Black Bolts	H.Y.S. Power Driven Shop Rivets	M.S. Black Bolts	M.S. Power Driven Shop Rivets	
						tons	*tons*	*tons*	*tons*	*tons*
 2∠s8"×6"×⅝"2'6"lg.Wt.142·0lbs. 2∠s6"×6"×⅝"2'6"lg.Wt.121·0lbs.	**K1**	**L1**	36×16½	260	·845	117	173	83·9	125	144
	K2	**L2**		230	·765	117	173	83·9	125	144
	K2	**L2**	36×12	194	·770	117	173	83·9	125	144
	K3	**L3**		170	·680	104	173	83·9	125	144
	K4	**L4**		150	·625	95·4	173	83·9	125	†
 2∠s8"×6"×⅝"2'3"lg.Wt.127·8lbs. 2∠s6"×6"×⅝"2'3"lg.Wt.108·9lbs.	**M1**	**N1**	36×16½	260	·845	99·0	146	70·7	105	122
	M2	**N2**		230	·765	98·4	146	70·7	105	122
	M2	**N2**	36×12	194	·770	99·0	146	70·7	105	122
	M3	**N3**		170	·680	87·5	146	70·7	105	122
	M4	**N4**		150	·625	80·4	146	70·7	105	122
	M4	**N4**	33×11½	152	·635	81·7	146	70·7	105	122
	M5	**N5**		130	·580	74·6	146	70·7	105	†
 2∠s8"×6"×⅝"2'0"lg.Wt.113·6lbs. 2∠s6"×6"×⅝"2'0"lg.Wt. 96·8lbs.	**O1**	**P1**	36×16½	260	·845	84·0	124	59·9	89·5	103
	O2	**P2**		230	·765	83·5	124	59·9	89·5	103
	O2	**P2**	36×12	194	·770	84·0	124	59·9	89·5	103
	O3	**P3**		170	·680	74·2	124	59·9	89·5	103
	O4	**P4**		150	·625	68·2	124	59·9	89·5	103
	O4	**P4**	33×11½	152	·635	69·3	124	59·9	89·5	103
	O5	**P5**		130	·580	63·3	124	59·9	89·5	103
	O4	**P4**	30×10½	132	·615	67·1	124	59·9	89·5	103
	O5	**P5**		116	·564	61·5	124	59·9	89·5	†
	O5	**P5**	27×10	114	·570	62·2	124	59·9	89·5	†
	O6	**P6**		102	·518	*56·5*	‖	56·5	†	†
	O6	**P6**		94	·490	*53·5*	‖	53·5	†	†

Values printed in italics give no advantage over Mild Steel Black Bolts.
† Indicates that the value of the bolts or rivets exceeds the shear value of the Mild Steel Beam.
‖ Indicates that the value of the bolts or rivets exceeds the shear value of the High Yield Steel Beam.

STANDARD END CONNECTIONS

SAFE LOADS ON CONNECTED LEGS OF CLEATS

see page 523 for safe loads on outstanding legs

Holes 15/16" dia. Bolts ⅞" dia. Vertical pitch of holes 3 ins. Angle cleats—Mild Steel. Weights given do not include bolts or rivets. Dim E=3" for 8"×6" Angles Dim E=2¼" for 6"×6" Angles	Ref.		Serial Size in inches	Wt per foot in lbs	Web thickness in ins	HIGH YIELD STEEL BEAMS		MILD STEEL BEAMS		Friction Grip Bolts
	8"×6" Angles	6"×6" Angles				H.Y.S. Black Bolts	H.Y.S. Power Driven Shop Rivets	M.S. Black Bolts	M.S. Power Driven Shop Rivets	
						tons	*tons*	*tons*	*tons*	*tons*
 2∠s8"×6"×⅝" 1'9"lg. Wt.99·4lbs. 2∠s6"×6"×⅝" 1'9"lg. Wt.84·7lbs.	**Q2**	**R2**	33×11½	152	·635	59·8	107	51·7	77·2	89·0
	Q3	**R3**		130	·580	54·6	107	51·7	77·2	89·0
	Q2	**R2**	30×10½	132	·615	57·9	107	51·7	77·2	89·0
	Q3	**R3**		116	·564	53·1	107	51·7	77·2	89·0
	Q3	**R3**	27×10	114	·570	53·7	107	51·7	77·2	89·0
	Q4	**R4**		102	·518	*48·8*	107	48·8	77·2	†
	Q4	**R4**		94	·490	*46·1*	107	46·1	75·1	†
	Q1	**R1**	24×12	160	·732	68·9	107	51·7	77·2	89·0
	Q3	**R3**		120	·556	52·3	107	51·7	77·2	†
	Q5	**R5**		100	·468	*44·1*	‖	44·1	†	†
 2∠s8"×6'×⅝" 1'6"lg. Wt.85·2lbs. 2∠s6"×6"×⅝" 1'6"lg. Wt.72·6lbs.	**S3**	**T3**	30×10½	132	·615	50·5	93·4	45·2	67·4	77·7
	S4	**T4**		116	·564	46·4	93·4	45·2	67·4	77·7
	S4	**T4**	27×10	114	·570	46·8	93·4	45·2	67·4	77·7
	S5	**T5**		102	·518	*42·6*	93·4	42·6	67·4	77·7
	S5	**T5**		94	·490	*40·3*	93·2	40·3	65·6	77·7
	S1	**T1**	24×12	160	·732	60·2	93·4	45·2	67·4	77·7
	S4	**T4**		120	·556	45·7	93·4	45·2	67·4	77·7
	S6	**T6**		100	·468	*38·5*	89·0	38·5	62·7	†
	S5	**T5**	24×9	94	·516	*42·4*	93·4	42·4	67·4	†
	S5	**T5**		84	·470	*38·6*	89·4	38·6	62·9	†
	S6	**T6**		76	·440	*36·2*	83·7	36·2	58·9	†
	S2	**T2**	21×13	142*	·659	54·2	93·4	45·2	67·4	77·7
	S4	**T4**		127*	·588	48·3	93·4	45·2	67·4	†
	S5	**T5**		112*	·527	*43·3*	93·4	43·3	†	†

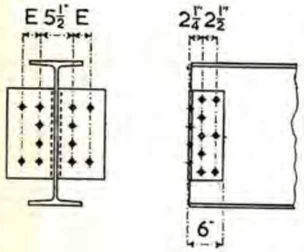
* Indicates that for beams of 21" × 13" serial size, the angle cleats are to be 17¾" long sawn or machine flame cut.
The edge distance on the outstanding leg of 6" × 6" cleats will be slightly less than 1¼" for beams having webs less than ½" thick.

STANDARD END CONNECTIONS

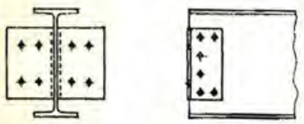
SAFE LOADS ON CONNECTED LEGS OF CLEATS

see page 523 for safe loads on outstanding legs

Holes $\frac{15}{16}''$ dia. Bolts $\frac{7}{8}''$ dia.
Vertical pitch of holes 3 ins.
Angle cleats—Mild Steel.
Weights given do not include bolts or rivets.
Dim E=3″ for 8″×6″ Angles
Dim E=2¼″ for 6″×6″ Angles



2∠s 8″×6″×½″ 1′ 3″ lg. Wt. 57·2 lbs.
2∠s 6″×6″×½″ 1′ 3″ lg. Wt. 48·7 lbs.



2∠s 8″×6″×½″ 1′ 0″ lg. Wt. 45·8 lbs.
2∠s 6″×6″×½″ 1′ 0″ lg. Wt. 39·0 lbs.

Ref.		Serial Size in inches	Wt per foot in lbs	Web thickness in ins	HIGH YIELD STEEL BEAMS		MILD STEEL BEAMS		Friction Grip Bolts
8″×6″ Angles	6″×6″ Angles				H.Y.S. Black Bolts	H.Y.S. Power Driven Shop Rivets	M.S. Black Bolts	M.S. Power Driven Shop Rivets	
					tons	*tons*	*tons*	*tons*	*tons*
U1	**V1**	**21×13**	142	·659	40·1	69·1	33·4	49·9	57·5
U2	**V2**		127	·588	35·8	69·1	33·4	49·9	57·5
U3	**V3**		112	·527	*32·0*	69·1	32·0	49·9	57·5
U3	**V3**	**21×8¼**	82	·502	*30·5*	69·1	30·5	49·7	57·5
U4	**V4**		73	·455	*27·7*	64·0	27·7	45·1	57·5
U4	**V4**		68	·430	*26·1*	60·5	26·1	42·6	†
U5	**V5**		62	·400	*24·3*	56·3	24·3	39·6	†
U4	**V4**	**18×7½**	66	·450	*27·4*	63·3	27·4	44·6	†
U4	**V4**		60	·416	*25·3*	58·5	25·3	41·2	†
U5	**V5**		55	·390	*23·7*	54·9	23·7	38·6	†
U6	**V6**		50	·358	*21·8*	50·4	21·8	35·5	†‖
U4	**V4**	**18×6**	55	·420	*25·5*	59·1	25·5	41·6	†
U5	**V5**		50	·389	*23·7*	54·7	23·7	38·5	†
U6	**V6**		45	·360	*21·9*	50·7	21·9	35·7	†‖
W1	**X1**	**18×7½**	66	·450	*20·2*	46·7	20·2	32·8	42·4
W1	**X1**		60	·416	*18·6*	43·2	18·6	30·4	42·4
W2	**X2**		55	·390	*17·5*	40·5	17·5	28·5	42·4
W2	**X2**		50	·358	*16·0*	37·1	16·0	26·1	†
W1	**X1**	**18×6**	55	·420	*18·8*	43·6	18·8	30·7	42·4
W2	**X2**		50	·389	*17·4*	40·4	17·4	28·4	42·4
W2	**X2**		45	·360	*16·1*	37·3	16·1	26·3	†
W2	**X2**	**16×7**	50	·380	*17·0*	39·4	17·0	27·7	†
W2	**X2**		45	·346	*15·5*	35·9	15·5	25·3	†
W3	**X3**		40	·307	*13·8*	31·8	13·8	22·4	†‖
W3	**X3**		36	·299	*13·4*	31·0	13·4	21·8	†‖
W2	**X2**	**16×6**	50	·399	*17·9*	41·4	17·9	29·1	†
W2	**X2**		45	·368	*16·5*	38·2	16·5	26·9	†
W3	**X3**		40	·340	*15·2*	25·3	15·2	24·8	†
W2	**X2**	**15×6**	45	·381	*17·1*	39·5	17·1	27·8	†
W2	**X2**		40	·344	*15·4*	35·7	15·4	25·1	†
W3	**X3**		35	·306	*13·7*	31·7	13·7	22·3	†‖
W2	**X2**	**14×6¾**	45	·357	*16·0*	37·0	16·0	26·1	†
W3	**X3**		38	·313	*14·0*	32·5	14·0	22·8	†‖
W3	**X3**		34	·287	*12·9*	29·8	12·9	20·9	†‖
W4	**X4**		30	·270	*12·1*	28·0	12·1	19·7	†‖

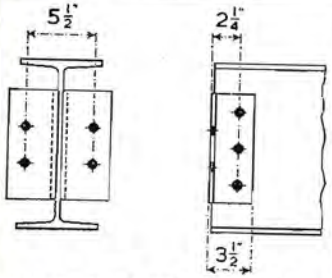
‖ Indicates Friction Grip Bolts Value exceeds the shear value of the H.Y.S. Beam.
† Indicates Friction Grip Bolts Value exceeds the shear value of the M.S. beam.
Values printed in italics give no advantage over Mild Steel Black Bolts.
The edge distance on the outstanding leg of 6″ × 6″ cleats will be slightly less than 1¼″ for beams having webs less than ½″ thick.

STANDARD END CONNECTIONS

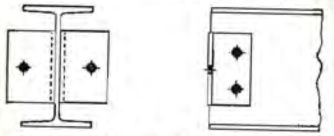
SAFE LOADS ON CONNECTED LEGS OF CLEATS

see table below for safe loads on outstanding legs

Holes $\frac{15}{16}''$ dia., Bolts $\frac{7}{8}''$ dia.
Vertical pitch of holes 3 ins.
Angle cleats—Mild steel.
Weights given do not include bolts or rivets.



2∠s 4″×3½″×⅜″ 9″ lg. Wt. 13·6 lbs.



2∠s 4″×3½″×⅜″ 6″ lg. Wt. 9·1 lbs.

Ref.	Serial Size in inches	Wt per foot in lbs	Web thickness in ins	HIGH YIELD STEEL BEAMS		MILD STEEL BEAMS		Friction Grip Bolts
				H.Y.S. Black Bolts	H.Y.S. Power Driven Shop Rivets	M.S. Black Bolts	M.S. Power Driven Shop Rivets	
				tons	*tons*	*tons*	*tons*	*tons*
Y1	**14×6¾**	45	·357	*7·7*	18·0	7·7	12·7	20·6
Y2		38	·313	*6·8*	15·8	6·8	11·1	20·6
Y2		34	·287	*6·2*	14·5	6·2	10·2	20·6
Y3		30	·270	*5·8*	13·6	5·8	9·5	20·6
Y2	**12×6½**	36	·305	*6·6*	15·4	6·6	10·8	20·6
Y3		31	·265	*5·7*	13·4	5·7	9·4	†
Y3		27	·240	*5·2*	12·1	5·2	8·5	†
Y1	**12×5**	32	·350	*7·6*	17·7	7·6	12·4	20·6
Y2		28	·313	*6·8*	15·8	6·8	11·1	20·6
Y2		25	·284	*6·1*	14·3	6·1	10·1	†
Z1	**10×5¾**	29	·289	*3·5*	8·1	3·5	5·7	11·5
Z2		25	·252	*3·0*	7·0	3·0	4·9	11·5
Z2		21	·240	*2·9*	6·7	2·9	4·7	11·5
Z2	**8×5¼**	20	·248	*3·0*	6·9	3·0	4·9	11·5
Z2		17	·230	*2·7*	6·4	2·7	4·5	†

See footnote on page 522

SAFE LOADS ON OUTSTANDING LEGS

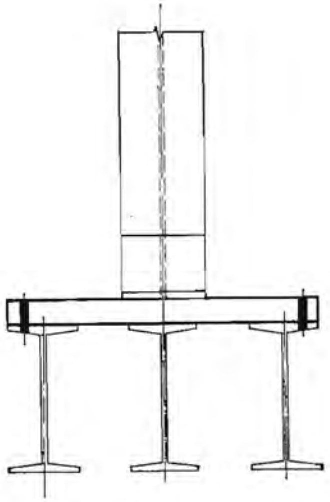
Mild Steel Cleats

Group Reference	Number of Bolts or Rivets	Dia. of Holes ins.	H.Y.S. STEEL						MILD STEEL		Friction Grip Bolts
			Black Bolts			Power Driven Field Rivets			Black Bolts	Power Driven Field Rivets	
			Cleats ⅝″ & ½″ thick	Cleats $\frac{7}{16}''$ thick	Cleats ⅜″ thick	Cleats ⅝″ & ½″ thick	Cleats $\frac{7}{16}''$ thick	Cleats ⅜″ thick			
			tons	*tons*	*tons*	*tons*	*tons*	*tons*	*tons*	*tons*	*tons*
K, L.	28	$\frac{15}{16}''$	118			164			84·3	116	145
M, N.	24	$\frac{15}{16}''$	101			141			72·2	99·4	124
O, P.	22	$\frac{15}{16}''$	92·6			129			66·2	91·1	114
A, Q, R.	18	$\frac{15}{16}''$	75·8			106			54·2	74·5	93·1
B, S, T.	16	$\frac{15}{16}''$	67·4			93·9			48·2	66·2	82·7
C.	14	$\frac{15}{16}''$	58·9			82·2			42·1	58·0	72·4
D, U, V.	12	$\frac{15}{16}''$	50·5	*46·0*		70·4	*68·9*		36·1	49·7	62·0
E.	10	$\frac{15}{16}''$		*38·3*			*57·4*		30·1	41·4	51·7
F, W, X.	8	$\frac{15}{16}''$	33·7		*26·2*	47·0		*39·4*	24·1	33·1	41·4
G.	6	$\frac{15}{16}''$			*19·7*			*29·5*	18·1	24·8	31·0
H, Y.	4	$\frac{15}{16}''$			*13·1*			*19·7*	12·0	16·6	20·7
Z.	2	$\frac{15}{16}''$			*6·5*			*9·8*	6·0	8·2	10·3
H.	4	$\frac{13}{16}''$			*11·2*			*17·1*	8·8	12·4	16·3
J.	2	$\frac{13}{16}''$			*5·6*			*8·5*	4·4	6·2	8·1

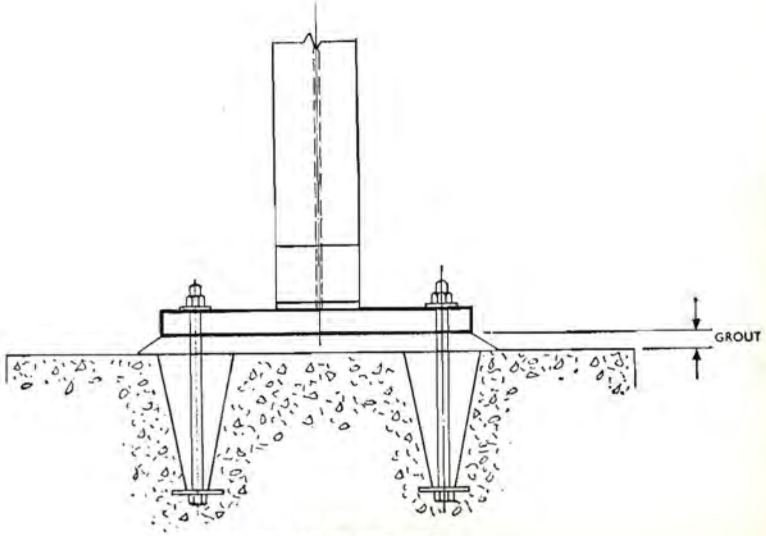
The above safe loads are based on the single shear values for Bolts and Rivets and on a single contact surface for H.S.F.G. Bolts, except where the bearing value in the cleats (in italics) is the criterion. Bearing values of black bolts and rivets on the supporting member should be checked especially in cases where bolts or rivets are common to two connections (e.g. one on either side of the web of a supporting girder).

SLAB BASES

DETAILS



SLAB BASE ON GRILLAGE



TYPICAL SLAB BASE

SLAB BASES

The function of a steel slab base is to distribute, as uniformly as possible, the load imposed by a stanchion to a foundation. If the load is applied concentrically and normal to the foundation, the minimum area of base required is equal to the load divided by the permissible pressure on the foundation; the minimum thickness of the slab and maximum bending stress must be in accordance with Clause 38*b* of B.S. 449 : 1959.

For allowable pressures on concrete foundations, see page 644.

Safe pressures cannot be given for slab bases resting on grillage foundations. A trial size must be chosen to facilitate the calculation of grillage beams required. The base should then be checked to ensure adequacy and suitability to the beams selected.

Tabulated below are the safe concentric loads which bases of the dimensions shown will transmit at the pressures specified.

SAFE LOADS IN TONS

Size of Slab in inches	PERMISSIBLE PRESSURES IN TONS PER SQUARE FOOT									
	15	**20**	**25**	**30**	**35**	**40**	**50**	**64**	**80**	**96**
12×12	15	20	25	30	35	40	50	64	80	96
15×15	23	31	39	46	54	62	78	100	125	150
18×18	33	45	56	67	78	90	112	144	180	216
21×21	45	61	76	91	107	122	153	196	245	294
24×24	60	80	100	120	140	160	200	256	320	384
27×27	75	101	126	151	177	202	253	324	405	486
30×30	93	125	156	187	218	250	312	400	500	600
33×33	113	151	189	226	264	302	378	484	605	726
36×36	135	180	225	270	315	360	450	576	720	864
39×39	158	211	264	316	369	422	528	676	845	1014
42×42	183	245	306	367	428	490	612	784	980	1176
45×45	210	281	351	421	492	562	703	900	1125	1350
48×48	240	320	400	480	560	640	800	1024	1280	1536
54×54	303	405	506	607	708	810	1012	1296	1620	1944
60×60	375	500	625	750	875	1000	1250	1600	2000	2400
66×66	453	605	756	907	1058	1210	1512	1936	2420	2904
72×72	540	720	900	1080	1260	1440	1800	2304	2880	3456

The safe loads in tons and the required thicknesses of slabs in inches for the above range when used in conjunction with various sizes of universal columns are tabulated on pages 526 to 532.

The calculations take into account the nominal size of the universal columns and are not based on serial sizes.

EXAMPLE: A slab base is required to transmit a load of 280 tons from a 12″ × 12″ U.C. at 161 lbs./ft. to concrete foundations having a permissible pressure of 39 tons per sq. ft.
From the above table, at 40 tons per sq. ft., a slab 33″ × 33″ will transmit 302 tons, hence this size of slab will be adequate.
A slab 33″ × 33″ × 2½″ may be selected from the table on page 528; this slab will carry 331 tons.

Bases not included in the range tabulated should be designed in accordance with B.S. 449 : 1959.

SLAB BASES
FOR UNIVERSAL COLUMNS

(ALL CLASSES OF STEEL)

Safe concentric loads in tons. Uniform pressure on foundations

Universal Column Serial Size inches	SIZES OF SLABS IN INCHES															
	12 × 12			15 × 15				18 × 18					21 × 21			
	Thickness			Thickness				Thickness					Thickness			
	5/8	3/4	7/8	3/4	7/8	1	1 1/8	7/8	1	1 1/8	1 1/4	1 3/8	1	1 1/4	1 1/2	1 3/4
14×16×426																
370																
314																
264																
228																
193																
158																
Column Core 320																
14×14½×136													239	374	539	
119													219	342	493	
103													200	312	450	
87													183	286	413	
12×12×190													120	188	271	369
161													118	185	267	364
133													117	183	264	359
106													116	182	262	357
92													116	181	261	356
79													115	180	260	354
65													114	178	257	
10×10×112								85·1	111	140	173	210	79·3	123	178	243
89								84·4	110	139	172	208	78·8	123	177	241
72								84·0	109	138	171	207	78·6	122	176	240
60								83·0	108	137	169	205	77·9	121	175	238
49								82·6	108	136	168	204	77·7	121	174	238
8×8×58				55·9	76·1	99·5	125	53·4	69·8	88·4	109	132	56·1	87·6	126	171
48				54·9	74·8	97·7	123	52·8	69·0	87·3	107	130	55·5	86·8	125	170
40				55·4	75·4	98·4	124	53·1	69·3	87·8	108	130	55·8	87·2	125	170
35				55·0	74·8	97·8	123	52·8	69·0	87·3	107	130	55·6	86·9	125	170
31				55·1	75·0	97·9	123	52·9	69·1	87·4	108	130	55·6	86·9	125	
6×6×25	33·1	47·7	65·0	33·2	45·2	59·0	74·7	36·6	47·8	60·5	74·8	90·5	41·7	65·2	93·8	
20	32·8	47·3	64·4	33·0	44·9	58·7	74·3	36·5	47·6	60·3	74·5	90·1	41·5	64·9	93·5	
15·7	33·3	48·0	65·3	33·3	45·3	59·2	75·0	36·7	48·0	60·7	75·0	90·7	41·8	65·3		

SLAB BASES
FOR UNIVERSAL COLUMNS

(ALL CLASSES OF STEEL)

Safe concentric loads in tons. Uniform pressure on foundations

Universal Column Serial Size inches	SIZES OF SLABS IN INCHES															
	24 × 24					27 × 27						30 × 30				
	Thickness					Thickness						Thickness				
	1	1 1/4	1 1/2	1 3/4	2	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	1 1/2	1 3/4	2	2 1/4	2 1/2
14×16×426	199	311	447	609	796	204	295	401	524	664	819	223	304	397	502	620
370	194	303	437	594	776	201	290	395	516	654	807	221	300	393	497	614
314	189	295	425	579	756	198	285	389	508	643	793	218	297	388	491	606
264	186	290	418	569	744	196	282	384	502	635	784	216	294	384	486	601
228	183	286	413	562	734	194	279	381	497	629	777	214	292	381	483	596
193	167	261	376	512	669	181	261	355	464	588	726	203	277	362	458	566
158	145	228	328	446	583	163	235	321	419	530	655	187	255	333	421	520
Column Core 320	229	358	515	701	916	228	328	446	583	738	912	243	331	432	547	676
14×14½×136	143	223	322	438	572	161	232	316	413	523	646	185	252	329	417	515
119	134	210	303	412	539	154	222	302	395	499		178	243	317	402	496
103	126	197	284	387		147	211	288	376	476		171	233	305	386	477
87	119	185	267	364		140	201	274	359			165	225	294	372	
12×12×190	87·5	136	197	268	350	110	158	215	281	356	440	135	184	240	304	376
161	86·7	135	195	265	346	109	157	214	279	354	437	134	183	239	302	373
133	85·9	134	193	263	343	108	156	212	278	351	434	133	182	238	301	372
106	85·6	133	192	262	342	108	155	212	277	350	433	133	181	237	300	371
92	85·3	133	192	261	341	108	155	211	276	350	432	133	181	237	300	370
79	85·0	132	191	260	340	107	155	211	275	349		133	181	236	299	369
65	84·7	132	190	259		107	154	210	275			132	180	236	298	
10×10×112	63·6	99·4	143	194	254	85·1	122	166	217	275	340	109	148	193	245	303
89	63·4	99·0	142	194	253	84·8	122	166	217	274	339	108	148	193	244	302
72	63·2	98·8	142	193	253	84·6	121	166	216	274		108	147	193	244	301
60	62·8	98·1	141	192	251	84·3	121	165	215	272		108	147	192	243	
49	62·6	97·9	141	192		84·0	121	164	215			108	147	192	243	
8×8×58	48·3	75·4	108	147	193	67·6	97·4	132	173	219		89·6	122	159	201	
48	47·9	74·9	107	146	191	67·2	96·8	132	172	217		89·1	121	158	200	
40	48·1	75·1	108	147		67·4	97·1	132	172			89·4	121	158		
35	47·9	74·9	107	146		67·2	96·8	131	172			89·2	121	158		
31	48·0	75·0	108	147		67·3	96·9	131				89·2	121	158		

SLAB BASES
FOR UNIVERSAL COLUMNS

(ALL CLASSES OF STEEL)

Safe concentric loads in tons. Uniform pressure on foundations

Universal Column Serial Size inches	SIZES OF SLABS IN INCHES														
	33 × 33							36 × 36							
	Thickness							Thickness							
	1¾	2	2¼	2½	2¾	3	3¼	1¾	2	2¼	2½	2¾	3	3¼	3½
14×16×426	248	324	410	507	613	730	857	213	278	352	435	526	626	735	853
370	246	322	407	503	608	724	850	211	276	350	432	523	622	730	847
314	244	318	403	498	602	717	842	210	274	347	428	518	617	724	840
264	242	316	400	494	598	712	836	208	272	345	426	515	614	720	835
228	241	314	398	491	595	708	831	207	271	343	424	513	611	717	831
193	230	301	381	470	569	677	795	200	261	330	408	494	588	690	800
158	215	281	355	439	531	632		188	246	312	385	466	554	650	
Column Core 320	267	348	441	544	659	784	921	226	296	374	462	559	666	782	907
14×14½×136	213	278	352	435	526	626		187	244	309	382	462	550		
119	206	270	341	421	510			182	238	301	372	450	535		
103	200	261	330	408	494			177	231	292	361	437			
87	193	253	320	395				172	225	284	351	425			
12×12×190	163	213	270	333	403	480	563	148	194	245	303	366	436	512	594
161	162	212	268	331	401	477	560	147	193	244	301	365	434	510	591
133	161	211	267	330	399	475	558	147	192	243	300	364	433	508	
106	161	211	267	329	399	474		147	192	243	300	363	432		
92	161	210	266	329	398			147	192	243	300	363	432		
79	161	210	266	328				146	191	242	299	362			
65	160	209	265	328				146	191	242	299				
10×10×112	135	177	224	276	335	398		126	164	208	257	311	370	435	
89	135	176	223	276	334			125	164	208	257	311	370		
72	135	176	223	275				125	164	208	256	310			
60	134	175	222	274				125	163	207	255				
49	134	175	222					125	163	207					

SLAB BASES
FOR UNIVERSAL COLUMNS

(ALL CLASSES OF STEEL)

Safe concentric loads in tons. Uniform pressure on foundations

Universal Column Serial Size inches	SIZES OF SLABS IN INCHES														
	39 × 39								42 × 42						
	Thickness								Thickness						
	2	2¼	2½	2¾	3	3¼	3½	4	2	2¼	2½	2¾	3	3½	4
14×16×426	246	312	385	466	555	651	755	987	223	283	349	423	503	685	895
370	245	310	383	464	552	648	751	982	222	281	348	421	501	682	891
314	243	308	380	460	548	643	746	975	221	280	345	418	498	677	885
264	242	307	379	458	545	640	742	970	220	278	344	416	495	675	881
228	241	305	377	456	543	637	739	966	219	277	343	415	494	672	878
193	233	295	365	441	525	616	715		213	269	331	403	479	653	852
158	222	281	347	420	500	586	680		203	257	318	385	458	624	
Column Core 320	260	329	406	492	586	687	797	1041	234	297	366	443	528	718	938
14×14½×136	220	279	344	416	496	582			202	256	316	382	455	620	
119	215	272	336	407	484	568			198	251	310	375	446		
103	210	265	328	397	472				193	245	303	366	436		
87	204	259	320	387					189	240	296	358	426		
12×12×190	179	227	280	339	404	474	550	718	168	213	263	318	379	516	674
161	179	226	279	338	403	472	548		168	212	262	317	378	514	672
133	178	226	279	337	402	472	547		167	211	261	316	376	512	
106	178	225	278	337	401	471			167	211	261	316	376		
92	178	225	278	336	400				167	211	261	316	376		
79	177	224	277	335					167	211	261	315	376		
65	177	224	277						166	210	259	314			
10×10×112	155	196	243	294	350	410			147	187	231	279	332	453	
89	155	196	242	293	349				147	187	230	279	332		
72	155	196	242	293					147	186	230	278	332		
60	154	195	241						147	186	229	278			
49	154	195							147	186	229				

SLAB BASES
FOR UNIVERSAL COLUMNS

(ALL CLASSES OF STEEL)

Safe concentric loads in tons. Uniform pressure on foundations

Universal Column Serial Size inches	SIZES OF SLABS IN INCHES															
	45 × 45								48 × 48							
	Thickness								Thickness							
	2	2¼	2½	2¾	3	3½	4	4½	2	2¼	2½	2¾	3	3½	4	4½
14×16×426	206	261	322	390	464	632	825	1045	192	243	301	364	433	590	770	975
370	205	260	321	388	462	629	822	1040	192	243	300	363	432	588	768	972
314	204	258	319	386	459	625	817	1034	191	241	298	361	429	585	764	967
264	203	257	318	384	458	623	814	1030	190	241	297	360	428	583	761	964
228	202	256	317	383	456	621	811		189	240	296	358	427	581	759	961
193	197	250	308	373	444	605	790		185	234	289	350	417	567	741	
158	189	240	296	359	427	581			178	226	279	337	401	546	714	
Column Core 320	215	272	334	407	484	659	861	1090	200	253	313	378	450	613	801	1014
14×14½×136	188	238	294	356	424	577			177	224	277	335	399	544		
119	185	234	289	350	416	567			174	221	272	330	393	534		
103	181	229	283	343	408				171	217	267	324	385			
87	178	225	278	336	400				168	213	263	318	379			
12×12×190	159	202	249	302	359	489	639	809	153	193	239	289	344	468	611	774
161	159	201	249	301	358	488	637		152	192	237	288	342	466	609	
133	159	201	248	300	357	486			152	192	237	287	342	465		
106	159	201	248	300	357	486			151	192	237	287	341	465		
92	158	200	247	300	357				151	192	237	286	341			
79	158	200	247	299	356				151	191	236	286	341			
65	158	200	247	299					151	191	236	286				
10×10×112	141	179	221	268	319	434			136	173	213	258	308	419		
89	141	179	221	267	318				136	173	213	258	307			
72	141	179	221	267	318				136	173	213	258	307			
60	141	178	220	266					136	172	212	257				
49	141	178	220						136	172	212					

SLAB BASES
FOR UNIVERSAL COLUMNS

(ALL CLASSES OF STEEL)

Safe concentric loads in tons. Uniform pressure on foundations

Universal Column Serial Size inches	SIZES OF SLABS IN INCHES															
	54 × 54								60 × 60							
	Thickness								Thickness							
	2¼	2½	2¾	3	3½	4	4½	5	2½	2¾	3	3½	4	4½	5	5½
14×16×426	218	270	326	388	529	691	874	1080	248	300	357	487	636	805	993	1202
370	218	269	325	387	527	689	872	1076	247	299	356	485	634	803	991	1199
314	217	268	324	386	525	686	868	1072	247	298	355	484	632	800	988	1195
264	216	267	323	385	524	684	866	1069	246	298	354	483	630	798	985	
228	216	266	322	384	522	682	864		245	297	354	482	629	796	983	
193	211	261	316	376	512	669	846		241	292	347	473	618	782		
158	205	253	306	364	496	648			235	284	338	460	601			
Column Core 320	226	279	337	401	547	714	904	1116	255	309	368	501	654	828	1022	1237
14×14½×136	204	252	305	363	494				234	283	337	459	599			
119	201	248	300	357	487				231	279	333	453				
103	198	244	296	352	479				228	276	328	447				
87	194	240	291	346					225	272	324					
12×12×190	179	221	268	319	434	567	718		209	253	301	410	535	678		
161	179	221	267	318	433	566			208	252	300	409	534	676		
133	178	220	267	317	432	565			208	252	300	408	534			
106	178	220	266	317	432				208	252	300	408				
92	178	220	266	317	432				208	252	300	408				
79	178	220	266	317					208	251	299					
65	178	220	266	316					207	251	299					
10×10×112	163	201	243	290	395				192	233	277	377	493			
89	163	201	243	290	394				192	233	277	377				
72	163	201	243	290					192	232	277					
60	162	201	243						192	232						
49	162	200							192	232						

SLAB BASES FOR UNIVERSAL COLUMNS

(ALL CLASSES OF STEEL)

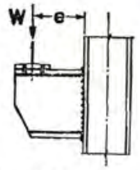
Safe concentric loads in tons. Uniform pressure on foundations

Universal Column Serial Size inches	SIZES OF SLABS IN INCHES															
	66 × 66								72 × 72							
	Thickness								Thickness							
	2½	2¾	3	3½	4	4½	5	5½	2½	2¾	3	3½	4	4½	5	5½
14×16×426	232	281	335	456	595	754	931	1126	220	267	317	432	565	715	883	1068
370	232	281	334	455	594	752	929	1124	220	266	317	431	564	713	881	1066
314	231	280	333	453	592	750	926	1120	219	265	316	430	562	712	879	1063
264	231	279	332	452	591	748	924	1118	219	265	315	429	561	710	877	1061
228	230	279	332	452	590	747	922		218	264	315	429	560	709	876	
193	227	274	327	445	581	735			215	261	311	423	552	699	864	
158	221	268	319	434	567	718			211	255	304	414	541	684		
Column Core 320	238	288	343	467	611	773	955	1155	225	273	325	442	578	731	903	1093
14×14½×136	221	267	318	433	565				210	255	303	413	539			
119	218	264	314	428	559				208	252	300	409	534			
103	215	261	310	423					206	249	297	404				
87	213	258	307	418					204	247	294	400				
12×12×190	200	242	288	392	512	648	800		192	233	277	377	493	624	770	
161	199	241	287	391	511	646			192	232	277	377	492	623		
133	199	241	287	390	510				192	232	276	376	492			
106	199	241	287	390					192	232	276	376	491			
92	199	241	286	390					192	232	276	376				
79	199	240	286						191	232	276	376				
65	198	240	286						191	232	276					
10×10×112	185	224	267	364	475				180	218	259	353	461			
89	185	224	267	364					180	218	259	353				
72	185	224	267						180	217	259					
60	185	224	266						179	217	259					
49	185	224							179	217						

ECCENTRIC LOADS ON WELDED BRACKETS

FOR MILD STEEL TO B.S. 15

Fillet weld to full profile of beam brackets



Load W not on same plane as fillet weld

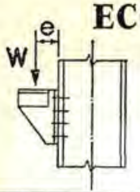
Section of Bracket	Size of fillet in inches	SAFE LOADS IN TONS (**W**) FOR ECCENTRICITY 'e' INCHES											
		4	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**15**	**18**	**21**	**24**
36×16½@260	½									168	153	139	128
36×12 @194	7/16					168	163	157	146	131	117	106	95·7
33×11½@152	⅜						125	120	111	99·1	88·6	79·6	72·1
30×10½@132	⅜						109	105	96·4	84·9	75·2	67·1	60·4
27×10 @114	5/16			91·2	87·6	83·9	80·2	76·6	69·9	61·1	53·8	47·8	42·9
24×12 @160	⅜			108	104	99·8	95·5	91·3	83·3	72·9	64·3	57·2	51·3
24× 9 @ 94	5/16					71·9	68·3	64·9	58·5	50·5	44·1	39·0	34·8
21×13 @142	⅜						83·5	79·8	72·9	63·7	56·2	50·0	44·9
21× 8¼@ 82	¼	60·8	57·9	54·9	51·9	49·0	46·2	43·6	38·9	33·2	28·8	25·3	22·5
18× 7½@ 66	¼		48·5	45·5	42·6	39·9	37·4	35·0	31·0	26·1	22·5	19·7	17·4
18× 6 @ 55	¼		45·5	42·1	39·0	36·2	33·6	31·3	27·3	22·8	19·5	17·0	15·0
16× 7 @ 50	3/16	33·0	30·9	28·8	26·9	25·0	23·3	21·8	19·1	16·1	13·8	12·0	10·6
16× 6 @ 50	3/16	32·6	30·2	27·8	25·6	23·7	21·9	20·4	17·7	14·7	12·6	10·9	9·6
15× 6 @ 45	3/16	30·2	27·9	25·7	23·7	21·8	20·2	18·7	16·3	13·5	11·5	10·0	8·8
14× 6¾@ 45	3/16	29·1	27·0	25·0	23·1	21·4	19·8	18·5	16·1	13·4	11·5	9·9	8·8
12× 6½@ 36	3/16			20·7	19·0	17·5	16·2	15·0	13·0	10·8	9·2	8·0	7·0
12× 5 @ 32	3/16	22·5	20·3	18·3	16·6	15·1	13·8	12·7	10·9	8·9	7·5	6·5	5·7
10× 5¾@ 29	3/16			16·1	14·6	13·4	12·2	11·3	9·6	7·9	6·7	5·8	5·1
8× 5¼@ 20	3/16			11·9	10·7	9·7	8·8	8·1	6·9	5·6	4·7	4·1	3·6
8× 4 @ 17	3/16			10·0	8·8	7·9	7·1	6·5	5·5	4·4	3·7	3·2	2·8

The above safe loads are calculated on the assumption that the stresses due to bending are resisted by the full length of welds, and stresses due to shear by the web welds and part of the flange welds.

The above safe loads do not exceed the shear value of the bracket section.

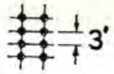
Flanges and web of the bracket should be checked and suitably stiffened if necessary.

Flanges of stanchions should be suitably stiffened against transverse bending.



ECCENTRIC LOADS ON BOLTED BRACKETS

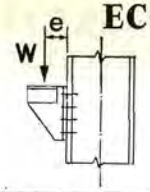
HIGH YIELD STRESS STEEL BLACK BOLTS



Two Vertical Rows
Vertical Pitch 3 inches
c/c of Bolts may vary

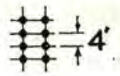
Dia. of Bolt	No. of Horizontal Rows	SAFE LOADS IN TONS (W) FOR ECCENTRICITY 'e' INCHES													
		0	3	6	9	12	15	18	21	24	27	30	33	36	40
1"	2	22·0	15·5	7·74	5·17	3·84	3·08								
	3	33·0	28·4	14·8	9·89	7·44	5·93	4·94	4·24	3·72					
	4	44·0	39·4	23·3	15·5	11·6	9·3	7·74	6·63	5·82	5·17	4·65			
	5	55·0	51·0	36·4	24·3	18·2	14·6	12·1	10·4	9·07	8·08	7·27	6·63	6·05	5·47
	6	66·0	62·6	52·4	34·9	26·2	20·9	17·5	14·9	13·1	11·6	10·5	9·54	8·73	7·85
	7	77·0	74·0	66·9	53·1	35·6	28·5	23·7	20·4	17·8	15·8	14·3	12·9	11·8	10·7
	8	88·0	85·4	78·7	62·1	46·6	35·2	31·0	26·6	23·3	20·7	17·6	16·9	15·5	13·9
	9	99·0	96·6	90·5	78·6	58·9	47·1	39·3	33·6	29·4	26·2	23·6	21·4	19·7	17·7
	10	110	107	102	93·5	72·8	58·2	48·5	41·6	36·4	32·4	29·1	26·5	24·3	21·8
	11	121	119	113	106	88·1	70·4	58·7	50·3	43·9	39·1	35·2	32·0	29·3	26·4
	12	132	130·2	175·2	118	104	83·8	69·8	59·9	52·4	46·6	41·9	38·1	34·9	31·4
7/8"	2	16·8	11·8	5·89	3·94	2·92	2·34								
	3	25·3	21·7	11·3	7·53	5·67	2·51	3·76	3·23	2·83					
	4	33·7	30·1	17·72	11·78	8·86	7·08	5·89	5·05	4·43	3·94	3·54			
	5	42·1	39·1	27·7	18·5	13·9	11·1	9·21	7·92	6·91	6·15	5·53	5·05	4·60	4·16
	6	50·5	47·9	39·8	26·6	19·9	15·9	13·3	11·4	9·96	8·86	7·97	7·26	6·64	5·98
	7	58·9	56·7	51·2	36·2	27·2	21·7	18·1	15·5	13·6	12·0	10·9	9·87	9·03	8·15
	8	67·4	65·3	60·2	47·2	35·4	26·8	23·6	20·2	17·7	15·7	13·4	12·9	11·7	10·6
	9	75·8	73·9	69·3	59·8	44·9	35·9	29·9	25·6	22·4	19·9	17·9	16·3	14·9	13·5
	10	84·2	82·6	78·1	71·5	55·4	44·3	36·9	31·6	27·7	24·6	22·2	20·2	18·5	16·6
	11	92·6	91·1	87·0	81·3	67·0	53·6	44·7	38·3	33·5	29·8	26·8	24·4	22·3	20·1
	12	101	99·7	95·8	90·4	79·7	63·7	53·2	45·6	39·9	35·4	31·9	29·0	26·6	23·9
3/4"	2	12·4	7·26	3·63	2·42	1·80	1·44								
	3	18·54	13·6	6·96	4·64	3·49	2·78	2·32	1·99	1·74					
	4	24·7	21·8	10·9	7·26	5·46	4·36	3·63	3·11	2·73	2·42	2·18			
	5	30·9	28·7	17·1	11·4	8·54	6·82	5·67	4·88	4·25	3·79	3·41	3·11	2·83	2·56
	6	37·1	34·4	24·6	16·4	12·3	9·82	8·19	7·01	6·14	5·46	4·91	4·47	4·09	3·68
	7	43·3	41·6	32·3	22·3	16·7	13·4	11·1	9·55	8·35	7·42	6·68	6·08	5·56	5·02
	8	49·4	47·9	39·3	29·1	21·8	16·5	14·6	12·5	10·9	9·71	8·24	7·94	7·26	6·55
	9	55·6	54·3	46·5	36·9	27·7	22·1	18·4	15·8	13·8	12·3	11·1	10·1	9·22	8·29
5/8"	2	8·6	4·86	2·43	1·62	1·20	·96								
	3	12·9	9·33	4·66	3·11	2·34	1·86	1·55	1·33	1·17					
	4	17·2	14·6	7·32	4·86	3·66	2·92	2·43	2·08	1·83	1·62	1·46			
	5	21·5	18·7	11·4	7·6	5·72	4·57	3·80	3·27	2·85	2·54	2·28	2·08	1·90	1·72
	6	25·8	23·9	16·5	10·9	8·23	6·58	5·49	4·70	4·11	3·66	3·29	3·00	2·74	2·47

NOTE: Where necessary flanges of stanchions and brackets should be suitably stiffened against transverse bending. Webs and seatings of brackets should also be stiffened as necessary.



ECCENTRIC LOADS ON BOLTED BRACKETS

HIGH YIELD STRESS STEEL BLACK BOLTS



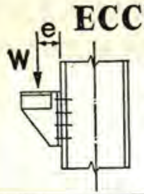
Two Vertical Rows
Vertical Pitch 4 inches
c/c of Bolts may vary

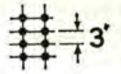
Dia. of Bolt	No. of Horizontal Rows	SAFE LOADS IN TONS (W) FOR ECCENTRICITY 'e' INCHES													
		0	3	6	9	12	15	18	21	24	27	30	33	36	40
1"	2	22·0	19·2	10·4	6·87	5·17	4·13								
	3	33·0	30·2	19·8	13·2	9·89	7·91	6·57	5·64	4·94					
	4	44·0	41·2	31·7	20·7	15·5	12·4	10·4	8·84	7·74	6·92	6·22	5·64	5·17	4·65
	5	55·0	52·7	46·7	32·4	24·3	19·4	16·2	13·9	12·1	10·8	9·71	8·84	8·08	7·27
	6	66·0	64·1	59·0	46·6	34·9	27·9	23·3	19·9	17·5	15·5	13·9	12·7	11·6	10·5
	7	77·0	75·3	70·7	63·1	47·5	38·0	31·7	27·2	23·7	21·1	19·1	17·3	15·8	14·3
	8	88·0	86·5	82·4	76·7	62·1	49·6	41·4	35·5	31·0	27·6	24·9	22·6	20·7	18·6
	9	99·0	97·6	93·5	88·6	78·6	62·9	52·4	44·9	39·3	34·9	31·4	28·6	26·2	23·6
	10	110	108	105	100	93·5	77·4	64·7	55·4	48·5	43·1	38·8	35·3	32·4	29·1
	11	121	120	117	112	106	93·9	78·2	67·0	58·7	52·1	46·9	42·7	39·1	35·2
	12	132	131	128	124	118	110	93·1	79·8	69·8	62·1	55·9	50·8	46·6	41·9
7/8"	2	16·8	14·7	7·88	5·22	3·94	3·14								
	3	25·3	23·1	15·1	10·1	7·53	6·02	5·00	4·29	3·76					
	4	33·7	31·5	23·6	15·8	11·8	9·43	7·88	6·73	5·89	5·27	4·74	4·29	3·94	3·54
	5	42·7	40·3	35·7	24·6	18·5	14·8	12·3	10·5	9·21	8·19	7·39	6·73	6·15	5·53
	6	50·5	49·0	45·2	35·4	26·6	21·3	17·7	15·2	13·3	11·8	10·6	9·65	8·86	7·97
	7	58·9	57·6	54·1	48·2	36·2	28·9	24·1	20·7	18·1	16·1	14·5	13·2	12·0	10·9
	8	67·4	66·2	63·1	58·7	47·3	37·8	31·5	27·0	23·6	20·9	18·9	17·2	15·8	14·2
	9	75·8	74·7	71·6	67·8	59·8	47·8	39·9	34·2	29·9	26·6	23·9	21·8	19·9	17·9
	10	84·2	83·3	80·7	76·8	71·5	59·1	49·2	42·1	36·9	32·8	29·5	26·8	24·6	22·2
	11	92·6	91·8	89·4	85·7	81·3	71·5	59·5	51·0	44·7	39·7	35·8	32·5	29·8	26·8
	12	101	100	98·0	94·6	90·4	83·9	70·8	60·7	53·2	47·3	42·5	38·7	35·4	31·9
3/4"	2	12·4	9·29	4·85	3·22	2·42	1·93								
	3	18·54	15·5	9·28	6·19	4·64	3·71	3·08	2·64	2·32					
	4	24·7	22·0	14·6	9·71	7·28	5·81	4·85	4·14	3·63	3·24	2·92	2·64	2·42	2·18
	5	30·9	29·6	22·5	15·2	11·4	9·09	7·58	6·49	5·67	5·05	4·55	4·14	3·79	3·41
	6	37·1	35·9	29·5	21·8	16·4	13·1	10·9	9·36	8·19	7·28	6·55	5·95	5·46	4·91
	7	43·3	42·3	39·7	29·7	22·3	17·8	14·9	12·7	11·1	9·90	8·92	8·10	7·42	6·68
	8	49·4	48·6	44·1	37·2	29·1	23·3	19·4	16·7	14·6	12·9	11·7	10·6	9·71	8·73
	9	55·6	54·8	51·6	44·2	36·9	29·5	24·6	21·0	18·4	16·4	14·7	13·4	12·3	11·1
5/8"	2	8·6	6·46	3·25	2·15	1·62	1·29								
	3	12·9	10·8	6·22	4·15	3·11	2·48	2·06	1·77	1·55					
	4	17·2	15·3	9·75	6·51	4·88	3·89	3·25	2·78	2·43	2·17	1·95	1·77	1·62	1·46
	5	21·5	20·6	15·2	10·2	7·63	6·09	5·08	4·35	3·80	3·38	3·05	2·78	2·54	2·28
	6	25·8	25·1	20·5	14·6	10·9	8·78	7·32	6·27	5·49	4·88	4·39	3·98	3·66	3·29

NOTE: Where necessary flanges of stanchions and brackets should be suitably stiffened against transverse bending. Webs and seatings of brackets should also be stiffened as necessary.

ECCENTRIC LOADS ON RIVETED BRACKETS

H.Y.S. STEEL POWER DRIVEN SHOP RIVETS





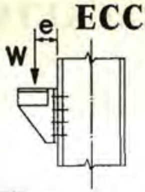
Two Vertical Rows
Vertical Pitch 3 inches
c/c of Rivets may vary

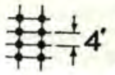
Dia. of Rivet	No. of Hori-zontal Rows	SAFE LOADS IN TONS (W) FOR ECCENTRICITY 'e' INCHES													
		0	3	6	9	12	15	18	21	24	27	30	33	36	40
1″ Nom'l $1\frac{1}{16}$″ Gross	2	31·9	15·9	9·66	6·77	5·17	4·22								
	3	47·9	27·4	17·6	12·6	9·73	7·90	6·62	5·74	5·02					
	4	63·8	39·4	26·4	19·3	15·1	12·3	10·4	8·93	7·82	7·02	6·30			
	5	79·8	54·0	38·4	28·9	22·9	18·8	15·9	13·8	12·2	10·9	9·81	8·93	8·21	7·42
	6	95·8	69·0	51·2	39·7	31·9	26·3	22·6	19·6	17·3	15·6	14·0	12·8	11·8	10·6
	7	112	84·3	64·9	51·4	42·0	35·2	30·2	26·4	23·4	20·9	18·9	17·3	15·9	14·4
	8	127	99·7	78·9	63·8	52·7	44·8	38·6	33·9	30·2	27·1	24·6	22·5	20·7	18·8
	9	144	115	93·4	76·8	64·5	55·1	47·9	42·2	37·6	33·9	30·8	28·2	26·0	23·6
	10	159	130	108	90·4	76·7	65·9	57·8	51·2	45·8	41·3	37·7	34·6	31·9	29·8
	11	176	147	123	104	89·3	77·6	68·3	60·7	54·5	49·4	45·1	41·4	38·3	34·8
	12	191	162	138	118	103	89·7	79·3	70·9	63·8	58·0	53·1	48·8	45·2	41·1
$\frac{7}{8}$″ Nom'l $\frac{15}{16}$″ Gross	2	24·8	12·4	7·52	5·27	4·03	3·28								
	3	37·3	21·3	13·7	9·81	7·57	6·14	5·15	4·47	3·91					
	4	49·7	30·7	20·6	15·0	11·7	9·56	8·07	6·95	6·08	5·46	4·90			
	5	62·1	42·0	29·9	22·5	17·8	14·7	12·4	10·7	9·50	8·44	7·63	6·95	6·39	5·77
	6	74·5	53·7	39·9	30·9	24·4	20·4	17·6	15·3	13·5	12·1	10·9	9·99	9·19	8·25
	7	86·9	65·6	50·5	39·9	32·7	27·4	23·5	20·6	18·2	16·3	14·8	13·5	12·4	11·2
	8	99·4	77·6	61·4	49·7	41·0	34·8	30·1	26·4	23·5	21·1	19·1	17·5	16·1	14·6
	9	112	89·7	72·7	59·8	50·2	42·9	37·3	32·6	29·2	26·4	23·9	21·9	20·2	18·4
	10	124	102	84·1	70·4	59·7	51·3	45	39·8	35·6	32·2	29·3	26·9	24·8	22·5
	11	137	114	95·7	81·1	69·6	60·4	53·2	47·3	42·4	38·4	35·1	32·2	29·8	27·1
	12	149	126	107	92·2	79·8	69·8	61·8	55·1	49·7	45·1	41·3	38·0	35·2	32·0
$\frac{3}{4}$″ Nom'l $\frac{13}{16}$″ Gross	2	18·7	9·34	5·65	3·96	3·03	2·47								
	3	28·0	16·0	15·0	7·37	5·69	4·62	3·87	3·36	2·94					
	4	37·4	23·1	15·5	11·3	8·82	7·19	6·07	5·23	4·57	4·10	3·68			
	5	46·7	31·6	22·5	16·9	13·4	11·0	9·34	8·07	7·14	6·35	5·74	5·23	4·81	4·34
	6	56·0	40·4	29·9	23·2	18·7	15·4	13·2	11·5	10·2	9·10	8·21	7·51	6·91	6·21
	7	65·4	49·3	38·0	30·1	24·6	20·6	17·7	15·5	13·7	12·3	11·1	10·1	9·34	8·45
	8	74·7	58·3	46·2	37·4	30·9	26·2	22·6	19·8	17·7	16·9	14·4	13·2	12·1	10·9
	9	84·1	67·4	54·6	44·9	37·7	32·3	28·0	24·7	21·9	19·8	18·0	16·5	15·2	13·8
$\frac{5}{8}$″ Nom'l $\frac{11}{16}$″ Gross	2	13·4	6·68	4·04	2·83	2·16	1·76								
	3	20·0	11·5	7·38	5·27	4·07	3·30	2·77	2·40	2·10					
	4	26·7	16·5	11·1	8·08	6·31	5·14	4·34	3·74	3·27	2·93	2·63			
	5	33·4	22·6	16·1	12·1	9·58	7·88	6·68	5·77	5·11	4·54	4·10	3·74	3·44	3·10
	6	40·1	28·9	21·4	16·6	13·4	10·9	9·45	8·21	7·28	6·51	5·87	5·37	4·94	4·44

NOTE: Where necessary flanges of stanchions and brackets should be suitably stiffened against transverse bending. Webs and seatings of brackets should also be stiffened as necessary.

ECCENTRIC LOADS ON RIVETED BRACKETS

H.Y.S. STEEL POWER DRIVEN SHOP RIVETS





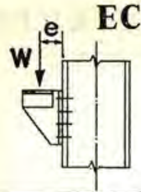
Two Vertical Rows
Vertical Pitch 4 inches
c/c of Rivets may vary

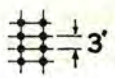
Dia. of Rivet	No. of Hori-zontal Rows	SAFE LOADS IN TONS (W) FOR ECCENTRICITY 'e' INCHES													
		0	3	6	9	12	15	18	21	24	27	30	33	36	40
1″ Nom'l $1\frac{1}{16}$″ Gross	2	31·9	18·7	12·1	8·77	6·78	5·50								
	3	47·9	31·2	21·6	16·0	12·6	10·4	8·77	7·58	6·62					
	4	63·8	44·2	31·9	24·3	19·3	15·9	13·6	11·7	10·4	9·25	8·37	7·66	7·02	6·30
	5	79·8	59·4	45·2	35·5	28·9	24·2	20·7	18·0	15·9	14·3	12·9	11·8	10·9	9·81
	6	95·8	74·8	59·2	47·9	39·7	33·6	29·0	25·5	22·6	20·3	18·4	16·8	15·6	14·0
	7	112	90·3	73·7	60·9	51·4	44·0	38·3	33·9	30·2	27·2	24·8	22·7	21·0	19·0
	8	128	106	88·5	74·7	63·8	55·3	48·5	43·1	38·6	35·0	31·9	29·3	27·1	24·6
	9	144	122	104	88·8	76·8	67·3	59·5	53·1	47·9	43·5	39·8	36·6	33·9	30·8
	10	160	138	119	103	88·8	79·8	71·1	63·8	57·8	52·7	48·4	44·6	41·3	37·7
	11	175	153	134	117	104	92·8	83·2	75·1	68·3	62·5	57·5	53·1	49·4	45·1
	12	192	169	150	132	118	106	95·8	86·9	79·3	72·8	67·2	62·2	58·0	53·1
$\frac{7}{8}$″ Nom'l $\frac{15}{16}$″ Gross	2	24·8	14·5	9·43	6·83	5·27	4·28								
	3	37·3	24·3	16·8	12·5	9·81	8·07	6·83	5·89	5·15					
	4	49·7	34·4	24·8	18·9	15·0	12·4	10·6	9·12	8·07	7·20	6·52	5·96	5·46	4·90
	5	62·1	46·2	35·1	27·6	22·5	18·8	16·1	14·0	12·4	11·1	10·1	9·19	8·44	7·63
	6	74·5	58·2	46·1	37·3	30·9	26·1	22·5	19·8	17·6	15·8	14·3	13·1	12·1	10·9
	7	86·9	70·3	57·3	47·4	39·9	34·2	29·8	26·3	23·5	21·2	19·3	17·7	16·3	14·8
	8	99·4	82·5	68·9	58·1	49·7	43·1	37·8	33·5	30·1	27·3	24·8	22·8	21·1	19·1
	9	112	94·7	80·6	69·1	59·8	52·4	46·3	41·4	37·3	33·8	30·9	28·5	26·4	23·9
	10	124	107	92·4	80·3	70·4	62·1	55·3	49·7	45·0	41·0	37·6	34·7	32·2	29·3
	11	137	119	104	91·7	81·1	72·2	64·7	58·4	53·2	48·6	44·7	41·4	38·4	35·1
	12	149	132	116	103	92·1	82·6	74·5	67·6	61·7	56·6	52·3	48·4	45·1	41·3
$\frac{3}{4}$″ Nom'l $\frac{13}{16}$″ Gross	2	18·7	10·9	7·09	5·13	3·96	3·22								
	3	28·0	18·3	12·7	9·38	7·37	6·07	5·13	4·43	3·87					
	4	37·4	25·9	18·7	14·2	11·3	9·34	7·93	6·86	6·07	5·41	4·90	4·48	4·10	3·68
	5	46·7	34·7	26·4	20·8	16·9	14·2	12·1	10·6	9·34	8·35	7·56	6·91	6·35	5·74
	6	56·0	43·8	34·7	28·0	23·2	19·7	16·9	14·9	13·2	11·9	10·8	9·85	9·10	8·21
	7	65·4	52·9	43·1	35·7	30·1	25·8	22·4	19·8	17·7	15·9	14·5	13·3	12·3	11·1
	8	74·7	62·0	51·8	43·7	37·4	32·4	28·4	25·2	22·6	20·5	18·7	17·1	15·9	14·4
	9	84·1	71·2	60·6	51·9	44·9	39·4	34·9	31·1	28·0	25·5	23·3	21·4	19·8	18·0
$\frac{5}{8}$″ Nom'l $\frac{11}{16}$″ Gross	2	13·4	7·81	5·07	3·67	2·83	2·30								
	3	20·0	13·1	9·05	6·71	5·27	4·34	3·67	3·17	2·77					
	4	26·7	18·5	13·4	10·2	8·08	6·68	5·67	4·90	4·34	3·87	3·50	3·20	2·93	2·63
	5	33·4	24·9	18·9	14·9	12·1	10·1	8·65	7·54	6·68	5·97	5·41	4·94	4·54	4·10
	6	40·1	31·3	24·8	20·0	16·6	14·1	12·1	10·7	9·34	8·51	7·71	7·04	6·51	5·87

NOTE: Where necessary flanges of stanchions and brackets should be suitably stiffened against transverse bending. Webs and seatings of brackets should also be stiffened as necessary.

ECCENTRIC LOADS ON BOLTED BRACKETS

MILD STEEL BLACK BOLTS





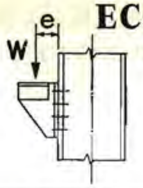
Two Vertical Rows
Vertical Pitch 3 inches
c/c of Bolts may vary

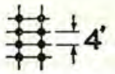
Dia. of Bolt	No. of Horizontal Rows	SAFE LOADS IN TONS (**W**) FOR ECCENTRICITY 'e' INCHES													
		0	3	6	9	12	15	18	21	24	27	30	33	36	40
1"	2	15·7	10·3	5·17	3·45	2·56	2·06								
	3	23·6	18·9	9·89	6·60	4·97	3·96	3·30	2·83	2·48					
	4	31·4	27·2	15·5	10·3	7·76	6·21	5·16	4·42	3·88	3·45	3·10			
	5	39·3	36·5	24·3	16·2	12·1	9·70	8·07	6·95	6·05	5·39	4·85	4·42	4·04	3·65
	6	47·2	44·7	34·9	23·3	17·5	14·0	11·6	10·0	8·73	7·76	6·98	6·36	5·82	5·24
	7	55·0	52·9	44·7	31·7	23·8	19·0	15·8	13·6	11·9	10·6	9·51	8·65	7·92	7·14
	8	62·9	61·0	54·4	41·4	31·0	23·4	20·7	17·7	15·5	13·8	11·7	11·3	10·3	9·31
	9	70·7	69·1	64·4	52·4	39·3	31·4	26·2	22·5	19·6	17·5	15·7	14·3	13·1	11·8
	10	78·6	77·1	72·9	62·3	48·5	38·8	32·3	27·7	24·3	21·6	19·4	17·7	16·2	14·6
	11	86·5	85·1	81·2	71·9	58·7	46·9	39·1	33·5	29·3	26·1	23·5	21·3	19·6	17·6
	12	94·3	93·0	89·5	81·7	69·8	55·9	46·6	39·9	34·9	31·0	27·9	25·4	23·3	20·9
⅞"	2	12·1	7·85	3·93	2·63	·96	·56								
	3	18·1	14·5	7·52	5·02	3·78	3·01	2·51	2·15	1·89					
	4	24·1	20·8	11·8	7·85	5·90	4·72	3·92	3·36	2·95	2·63	2·36			
	5	30·1	27·9	18·4	12·3	9·23	7·38	6·14	5·28	4·60	4·10	3·69	3·36	3·07	2·77
	6	36·1	34·3	26·6	17·7	13·3	10·6	8·85	7·58	6·64	5·90	5·31	4·84	4·43	3·98
	7	42·1	40·5	34·3	24·1	18·1	14·5	12·0	10·3	9·03	8·02	7·23	6·58	6·02	5·43
	8	48·2	46·7	41·7	31·4	23·6	17·8	15·7	13·5	11·8	10·5	8·91	8·58	7·85	7·08
	9	54·2	52·9	49·3	39·8	29·9	23·9	19·9	17·1	14·9	13·3	11·9	10·9	9·97	8·97
	10	60·2	59·0	55·9	47·7	36·9	29·5	24·6	21·1	18·4	16·4	14·8	13·4	12·3	11·1
	11	66·2	65·2	62·2	55·0	44·6	35·7	29·7	25·5	22·3	19·8	17·8	16·2	14·9	13·4
	12	72·2	71·3	68·5	62·6	53·1	42·5	35·4	30·4	26·6	23·6	82·4	19·3	17·7	15·9
¾"	2	8·84	4·85	2·42	1·62	·20	0·96								
	3	13·3	9·10	4·64	3·09	2·33	1·86	1·55	1·33	1·16					
	4	17·7	13·1	7·28	4·84	3·64	2·91	2·42	2·07	1·82	1·62	1·46			
	5	22·1	17·9	11·4	7·59	5·70	4·55	3·79	3·26	2·84	2·53	2·28	2·07	1·89	1·71
	6	26·5	22·9	16·4	10·9	8·19	6·55	5·46	4·68	4·10	3·64	3·28	2·98	2·73	2·46
	7	30·9	28·0	21·6	14·9	11·2	8·92	7·43	6·37	5·57	4·05	4·46	4·06	3·71	3·35
	8	35·4	33·1	26·2	19·4	14·6	11·0	9·70	8·32	7·28	6·48	5·50	5·30	4·84	4·37
	9	39·8	38·3	31·0	24·6	18·4	14·7	12·3	10·5	9·21	8·19	7·37	6·70	6·15	5·53
⅝"	2	6·12	3·25	1·62	1·09	0·81	0·65								
	3	9·18	6·22	3·11	2·07	1·56	1·24	1·04	0·89	0·78					
	4	12·2	9·07	4·88	3·25	2·44	1·95	1·62	1·39	1·22	1·09	0·98			
	5	15·3	12·4	7·63	5·09	3·82	3·05	2·54	2·18	1·90	1·70	1·53	1·39	1·27	1·15
	6	18·4	15·9	11·0	7·32	5·49	4·39	3·66	3·14	2·75	2·44	2·20	2·00	1·83	1·65

NOTE: Where necessary flanges of stanchions and brackets should be suitably stiffened against transverse bending. Webs and seatings of brackets should also be stiffened as necessary.

ECCENTRIC LOADS ON BOLTED BRACKETS

MILD STEEL BLACK BOLTS

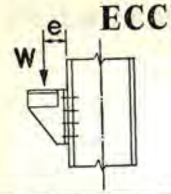




Two Vertical Rows
Vertical Pitch 4 inches
c/c of Bolts may vary

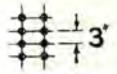
Dia. of Bolt	No. of Horizontal Rows	SAFE LOADS IN TONS (**W**) FOR ECCENTRICITY 'e' INCHES													
		0	3	6	9	12	15	18	21	24	27	30	33	36	40
1"	2	15·7	12·9	6·91	4·58	3·45	2·75								
	3	23·6	21·5	13·2	8·81	6·60	5·28	4·38	3·76	3·30					
	4	31·4	29·4	20·7	13·8	10·4	8·26	6·91	5·90	5·16	4·62	4·15	3·76	3·45	3·10
	5	39·3	37·6	31·1	21·6	16·2	2·9	10·8	9·23	8·07	7·18	6·48	5·90	5·39	4·85
	6	47·2	45·7	40·8	31·0	23·3	18·6	15·5	13·3	11·6	10·4	9·31	8·46	7·76	6·9
	7	55·0	53·8	50·5	42·0	31·7	25·3	21·1	18·1	15·8	14·1	12·7	11·5	10·6	9·51
	8	62·9	61·8	58·9	51·5	41·4	33·1	27·6	23·7	20·7	18·4	16·6	15·1	13·8	12·4
	9	70·7	69·8	66·8	61·2	52·4	41·9	34·9	29·9	26·2	23·3	21·0	19·1	17·5	15·7
	10	78·6	77·7	75·3	71·1	62·3	51·7	43·1	36·9	32·3	28·8	25·9	23·5	21·6	19·4
	11	86·5	85·7	83·4	80·0	71·9	62·6	52·1	44·7	39·1	34·8	31·3	28·4	26·1	23·5
	12	94·3	93·6	91·5	88·3	81·6	73·2	62·1	53·2	46·6	41·4	37·2	33·9	31·0	27·9
⅞"	2	12·0	9·86	5·35	3·55	2·68	2·14								
	3	18·1	16·5	10·0	6·70	5·02	4·01	3·33	2·86	2·51					
	4	24·1	22·5	15·7	10·5	7·88	6·28	5·25	4·48	3·92	3·51	3·16	2·86	2·63	2·36
	5	30·1	28·8	23·8	16·4	12·3	9·82	8·20	7·02	6·14	5·46	4·93	4·48	4·10	3·69
	6	36·1	35·0	31·3	23·6	17·7	14·2	11·8	10·1	8·85	7·88	7·08	6·43	5·90	5·31
	7	42·1	41·2	38·7	32·1	24·1	19·3	16·0	13·8	12·0	10·7	9·65	8·76	8·02	7·23
	8	48·2	47·3	45·1	39·4	31·5	25·2	21·0	18·0	15·7	14·0	12·6	11·4	10·5	9·44
	9	54·2	53·4	51·2	46·9	39·8	31·9	26·6	22·7	19·9	17·7	15·9	14·5	13·3	11·9
	10	60·2	59·5	57·7	54·5	47·7	39·3	32·8	28·1	24·6	21·9	19·7	17·9	16·4	14·8
	11	66·2	65·6	63·9	61·3	55·0	47·9	39·6	34·0	29·7	26·4	23·8	21·6	19·8	17·8
	12	94·3	93·6	91·5	88·3	81·6	73·2	62·1	53·2	46·6	41·4	37·2	33·9	31·0	27·9
¾"	2	8·84	6·21	3·24	2·15	1·62	1·29								
	3	13·3	10·4	6·19	4·13	3·09	2·48	2·06	1·77	1·55					
	4	17·7	14·7	9·70	6·48	4·86	3·88	3·24	2·77	2·42	2·17	1·95	1·77	1·62	1·46
	5	22·1	19·7	15·0	10·1	7·59	6·06	5·06	4·33	3·79	3·37	3·04	2·77	2·53	2·28
	6	26·5	24·8	19·7	14·6	10·9	8·74	7·28	6·24	5·46	4·86	4·37	3·97	3·64	3·28
	7	30·9	30·3	24·47	19·8	14·9	11·9	9·90	8·50	7·43	6·61	5·95	5·41	4·95	4·46
	8	35·4	34·7	29·4	24·8	19·4	15·5	12·9	11·1	9·70	8·63	7·77	7·06	6·48	5·82
	9	39·8	39·2	34·4	30·0	24·6	19·7	16·4	14·0	12·3	10·9	9·83	8·94	8·19	7·37
⅝"	2	6·12	4·30	2·17	1·44	1·09	·87								
	3	9·18	7·18	4·15	2·77	2·07	1·66	1·38	1·18	1·04					
	4	12·2	10·2	6·50	4·34	3·26	2·60	2·17	1·85	1·62	1·45	1·31	1·18	1·09	·98
	5	15·3	13·7	10·4	6·78	5·09	4·06	3·39	2·90	2·54	2·26	2·04	1·85	1·70	1·53
	6	18·4	17·2	13·6	11·0	7·32	5·86	4·88	4·18	3·66	3·26	2·93	2·66	2·44	2·20

NOTE: Where necessary flanges of stanchions and brackets should be suitably stiffened against transverse bending. Webs and seatings of brackets should also be stiffened as necessary.



ECCENTRIC LOADS ON RIVETED BRACKETS

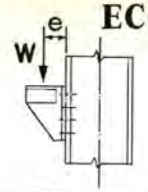
MILD STEEL POWER DRIVEN SHOP RIVETS



Two Vertical Rows
Vertical Pitch 3 inches
c/c of Rivets may vary

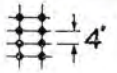
Dia. of Rivet	No. of Horizontal Rows	SAFE LOADS IN TONS (W) FOR ECCENTRICITY 'e' INCHES													
		0	3	6	9	12	15	18	21	24	27	30	33	36	40
1″ Nom'l 1$\frac{1}{16}$″ Gross	2	23·0	11·5	6·98	4·73	3·51	2·82								
	3	34·6	19·8	12·7	9·04	6·81	5·43	4·52	3·88	3·40					
	4	46·1	28·5	19·1	13·9	10·7	8·51	7·08	6·06	5·32	4·73	4·26			
	5	57·6	39·0	27·7	20·9	16·5	13·3	11·1	9·52	8·30	7·39	6·65	6·06	5·53	5·00
	6	69·1	49·8	36·9	28·6	23·0	18·9	15·9	13·6	11·9	10·6	9·58	8·72	7·98	7·18
	7	80·6	60·8	46·8	37·1	30·3	25·4	21·7	18·6	16·3	14·5	13·1	11·9	10·9	9·79
	8	92·2	71·9	56·9	46·1	38·1	32·3	27·9	24·3	21·3	19·9	16·1	15·5	14·2	12·8
	9	103	83·2	67·4	55·5	46·5	39·8	34·6	30·5	26·9	23·9	21·6	19·6	17·9	16·2
	10	115	94·4	77·9	65·3	55·4	47·6	41·7	36·9	33·1	29·6	26·6	24·2	22·2	19·9
	11	126	105	88·8	75·2	64·5	56·0	49·3	43·8	39·3	35·7	32·2	29·3	26·8	24·2
	12	138	117	99·7	85·5	74·0	64·7	57·3	51·2	46·1	41·9	38·3	234·9	31·9	28·7
$\frac{7}{8}$″ Nom'l $\frac{15}{16}$″ Gross	2	17·9	8·98	5·44	3·68	2·73	2·19								
	3	26·9	15·4	9·92	7·04	5·30	4·22	3·52	3·02	2·65					
	4	35·9	22·2	14·9	10·9	8·28	6·62	5·51	4·72	4·14	3·68	3·31			
	5	44·9	30·4	21·6	16·3	12·9	10·4	8·61	7·41	6·46	5·75	5·18	4·72	4·31	3·89
	6	53·8	38·8	28·8	22·3	17·9	14·8	12·4	10·6	9·32	8·28	7·45	6·79	6·21	5·59
	7	62·8	47·4	36·5	28·9	23·6	19·8	16·9	14·5	12·7	11·3	10·1	9·23	8·45	7·62
	8	71·8	56·1	44·4	35·9	29·7	25·2	21·7	18·9	16·6	14·7	12·5	12·1	11·0	9·94
	9	80·8	64·8	52·5	43·2	36·3	31·0	26·9	23·8	20·9	18·6	16·8	15·2	13·9	12·6
	10	89·8	73·6	60·8	50·9	43·2	37·1	32·5	28·8	25·8	23·0	20·7	18·8	17·3	15·5
	11	98·8	82·4	69·2	58·6	50·3	43·7	38·4	34·2	30·7	27·8	25·1	22·8	20·9	18·8
	12	107	91·3	77·7	66·6	57·7	50·5	44·6	39·9	35·9	32·6	29·8	27·1	24·8	22·4
$\frac{3}{4}$″ Nom'l $\frac{13}{16}$″ Gross	2	13·5	6·74	4·14	2·77	2·05	1·65								
	3	20·2	11·6	7·45	5·29	3·98	3·17	2·64	2·27	1·99					
	4	26·9	16·7	11·2	8·16	6·22	4·98	4·14	3·58	3·11	2·77	2·49			
	5	33·7	22·8	16·2	12·2	9·67	7·78	6·47	5·57	4·85	4·32	3·89	3·55	3·23	2·92
	6	40·4	29·2	21·6	16·8	13·5	11·1	9·33	7·99	7·00	6·22	5·60	5·10	4·67	4·20
	7	47·2	35·6	27·4	21·7	17·7	14·9	12·7	10·9	9·52	8·46	7·62	6·94	6·34	5·72
	8	53·9	42·1	33·3	26·9	22·2	18·9	16·3	14·2	12·4	11·1	9·39	9·05	8·27	7·46
	9	60·7	48·7	39·4	32·5	27·2	23·3	20·2	17·8	15·7	14·0	12·6	11·4	10·5	9·45
$\frac{5}{8}$″ Nom'l $\frac{11}{16}$″ Gross	2	9·64	4·82	2·92	1·98	1·47	1·18								
	3	14·5	8·27	5·33	3·79	2·85	2·27	1·90	1·63	1·43					
	4	19·3	11·9	7·98	5·83	4·46	3·57	2·97	2·54	2·23	1·98	1·78			
	5	24·1	16·3	11·6	8·72	6·92	5·58	4·64	3·99	3·48	3·10	2·79	2·54	2·32	2·10
	6	28·9	20·9	15·5	11·9	9·64	7·93	6·69	5·73	5·07	4·46	4·01	3·66	3·35	3·01

NOTE: Where necessary flanges of stanchions and brackets should be suitably stiffened against transverse bending. Webs and seatings of brackets should also be stiffened as necessary.



ECCENTRIC LOADS ON RIVETED BRACKETS

MILD STEEL POWER DRIVEN SHOP RIVETS



Two Vertical Rows
Vertical Pitch 4 inches
c/c of Rivets may vary

Dia. of Rivet	No. of Horizontal Rows	SAFE LOADS IN TONS (W) FOR ECCENTRICITY 'e' INCHES													
		0	3	6	9	12	15	18	21	24	27	30	33	36	40
1″ Nom'l 1$\frac{1}{16}$″ Gross	2	23·0	13·5	8·76	6·28	7·73	3·78								
	3	34·6	22·5	15·6	11·6	9·04	7·24	6·01	5·16	4·52					
	4	46·1	31·9	23·0	17·5	13·9	11·3	9·47	8·09	7·08	6·33	5·69	5·16	4·73	4·26
	5	57·6	42·9	32·6	25·6	20·9	17·5	14·8	12·7	11·1	9·84	8·88	8·09	7·39	6·65
	6	69·1	54·0	42·7	34·6	28·6	24·2	20·9	18·2	16·0	14·2	12·8	11·6	10·6	9·58
	7	80·6	65·2	53·2	44·0	37·1	31·8	27·6	24·4	21·7	19·3	17·4	15·8	14·5	13·0
	8	92·2	76·5	63·9	53·7	46·1	39·9	35·0	31·1	27·9	25·2	22·7	20·6	18·9	17·0
	9	10·37	87·8	74·8	64·1	55·5	48·6	43·0	38·4	34·6	31·4	28·7	26·1	23·7	21·5
	10	115·2	99·2	85·7	74·5	65·3	57·6	51·3	46·1	41·7	38·0	34·9	32·2	29·6	26·6
	11	126	110	96·8	85·1	75·2	67·0	60·0	54·2	49·3	45·1	41·5	38·4	35·7	32·2
	12	138	122	107	95·8	85·4	76·6	69·1	62·7	57·3	52·5	48·5	44·9	41·9	38·3
$\frac{7}{8}$″ Nom'l $\frac{15}{16}$″ Gross	2	18·0	10·5	6·82	4·89	3·68	2·94								
	3	26·9	17·6	12·2	9·02	7·04	5·63	4·68	4·02	3·52					
	4	35·9	24·9	18·0	13·6	10·9	8·82	7·37	6·29	5·51	4·93	4·43	4·02	3·68	3·31
	5	44·9	33·4	25·4	20·0	16·3	13·6	11·5	9·85	8·61	7·66	6·91	6·29	5·75	5·18
	6	53·9	42·1	33·3	26·9	22·3	18·9	16·3	14·2	12·4	11·1	9·94	9·03	8·28	7·45
	7	62·9	50·8	41·4	34·8	28·9	24·8	21·6	19·0	16·9	15·0	13·5	12·3	11·3	10·1
	8	71·8	59·6	49·8	42·0	35·9	31·1	27·3	24·2	21·7	19·6	17·7	16·1	14·9	13·2
	9	80·8	68·5	58·3	50·0	43·2	37·9	33·5	29·9	26·9	24·5	22·4	20·3	18·6	16·8
	10	89·8	77·4	66·8	58·1	50·9	44·9	40·0	35·9	32·5	29·6	27·2	25·1	23·0	20·7
	11	98·8	86·3	75·5	66·3	58·6	52·2	46·8	42·3	38·4	35·2	32·3	29·9	27·8	25·0
	12	107	95·1	84·1	74·7	66·6	59·7	53·9	48·9	44·6	40·9	37·8	35·0	32·6	29·8
$\frac{3}{4}$″ Nom'l $\frac{13}{16}$″ Gross	2	13·5	7·89	5·12	3·67	2·77	2·21								
	3	20·2	13·2	9·13	6·77	5·29	4·23	3·51	3·02	2·64					
	4	27·0	18·7	13·5	10·2	8·16	6·62	5·54	4·73	4·14	3·70	3·33	3·02	2·77	2·49
	5	33·7	25·1	19·1	15·0	12·2	10·2	8·65	7·40	6·47	5·75	5·19	4·73	4·32	3·89
	6	40·4	31·6	25·0	20·2	16·7	14·2	12·2	10·7	9·33	8·30	7·46	6·78	6·22	5·60
	7	47·2	38·1	31·1	25·7	1·7	18·6	16·2	14·3	12·7	11·3	10·2	9·24	8·46	7·62
	8	53·9	44·8	37·4	31·5	27·0	23·4	20·5	18·2	16·3	14·7	13·3	12·1	11·1	9·95
	9	60·7	51·4	43·7	37·5	32·5	28·4	25·1	22·4	20·2	18·4	16·8	15·3	14·0	12·6
$\frac{5}{8}$″ Nom'l $\frac{11}{16}$″ Gross	2	9·64	5·64	3·66	2·63	1·98	1·58								
	3	14·5	9·42	6·53	4·84	3·81	3·13	2·63	2·26	1·98					
	4	19·3	13·4	9·64	7·33	5·83	4·75	3·97	3·39	2·97	2·65	2·39	2·16	1·98	1·78
	5	24·1	17·9	13·6	10·7	8·72	7·30	6·20	5·31	4·64	4·13	3·72	3·39	3·10	2·79
	6	28·9	22·6	17·9	14·5	12·0	10·1	8·75	7·65	6·69	5·95	5·35	4·86	4·46	4·01

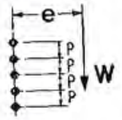
NOTE: Where necessary flanges of stanchions and brackets should be suitably stiffened against transverse bending. Webs and seatings of brackets should also be stiffened as necessary.

RIVET GROUPS

UNDER ECCENTRIC APPLICATION OF LOAD

N = Total No. of rivets in any one vertical row.
W = Permissible load acting with eccentricity 'e'.
f = Permissible load on one rivet by specification.
c = Coefficient as tabulated below.
$W = c \times f$; or knowing W required minimum $c = \frac{W}{f}$

CASE 1



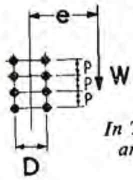
In general $$c = \frac{N}{\sqrt{\left[\frac{6e}{(N+1)p}\right]^2 + 1}}$$

In Table, p = 3

TABLE OF COEFFICIENTS 'c' CASE 1

No. of Rivets N	ECCENTRICITY (INCHES) 1	2	3	6	9	12	15	18	21	24
2	1·67	1·20	·89	·49	·33	·25	·20	·17	·14	·12
3	2·68	2·12	1·66	·95	·65	·49	·40	·33	·28	·25
4	3·71	3·12	2·56	1·54	1·07	·82	·66	·55	·47	·42
5	4·74	4·17	3·54	2·24	1·58	1·21	·98	·82	·71	·62
6	5·77	5·21	4·56	3·02	2·17	1·68	1·36	1·15	·99	·87
7	6·79	6·26	5·6	3·88	2·84	2·21	1·80	1·52	1·31	1·15
8	7·81	7·31	6·67	4·80	3·58	2·81	2·30	1·94	1·68	1·47
9	8·83	8·36	7·72	5·76	4·37	3·46	2·85	2·41	2·08	1·84
10	9·84	9·40	8·78	6·76	5·21	4·17	3·44	2·92	2·53	2·23

CASE 2



$$c = \frac{N}{\sqrt{\left[\frac{1}{2} + \frac{eD}{\frac{1}{3}(N^2-1)p^2 + D^2}\right]^2 + \left[\frac{e(N-1)p}{\frac{1}{3}(N^2-1)p^2 + D^2}\right]^2}}$$

In Table p = 3,
and D = 5½.

TABLE OF COEFFICIENTS 'c' CASE 2

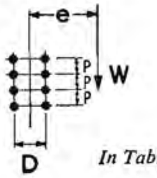
No. of Rivets N	ECCENTRICITY (INCHES) 1	2	3	6	9	12	15	18	21	24
2	3·10	2·52	2·11	1·41	1·05	·86	·70	·60	·53	·47
3	4·91	4·07	3·45	2·32	1·74	1·38	1·15	·98	·86	·76
4	6·83	5·81	4·98	3·36	2·53	2·01	1·67	1·42	1·24	1·10
5	8·83	7·68	6·67	4·62	3·46	2·75	2·28	1·94	1·69	1·49
6	10·87	9·64	8·51	6·01	4·54	3·62	3·00	2·56	2·23	1·97
7	12·93	11·67	10·44	7·55	5·76	4·61	3·83	3·26	2·84	2·52
8	14·99	13·73	12·44	9·16	7·10	5·71	4·75	4·06	3·54	3·14
9	17·05	15·81	14·5	10·99	8·56	6·92	5·78	4·95	4·32	3·83
10	19·12	17·90	16·57	12·85	10·13	8·74	6·91	5·92	5·18	4·60

RIVET GROUPS

UNDER ECCENTRIC APPLICATION OF LOAD

N = Total number of rivets in any one vertical row.
W = Permissible load acting with eccentricity 'e'.
f = Permissible load on one rivet by specification.
c = Coefficient as tabulated below.
$W = c \times f$: or knowing W required minimum $c = \frac{W}{f}$

CASE 3



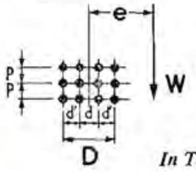
$$c = \frac{N}{\sqrt{\left[\frac{1}{2} + \frac{eD}{\frac{1}{3}(N^2-1)p^2 + D^2}\right]^2 + \left[\frac{e(N-1)p}{\frac{1}{3}(N^2-1)p^2 + D^2}\right]}}$$

In Table p = 3, D = 11½

TABLE OF COEFFICIENTS 'c' CASE 3

No. of rivets N	ECCENTRICITY (INCHES) 1	2	3	6	9	12	15	18	21	24
2	3·44	3·01	2·68	2·00	1·61	1·33	1·14	·99	·89	·80
3	5·22	4·60	4·11	3·09	2·47	2·06	1·76	1·54	1·36	1·23
4	7·05	6·27	5·62	4·26	3·4	2·82	2·41	2·10	1·88	1·67
5	8·94	8·02	7·23	5·50	4·40	3·65	3·11	2·71	2·40	2·15
6	10·87	9·83	8·92	6·84	5·48	4·54	3·87	3·36	2·98	2·66
7	12·83	11·71	10·69	8·28	6·65	5·52	4·70	4·09	3·62	3·23
8	14·82	13·64	12·5	9·81	7·91	6·58	5·61	4·87	4·31	3·85
9	16·82	15·62	14·4	11·43	9·27	7·72	6·59	5·73	5·07	4·54
10	18·85	17·62	16·39	15·13	10·72	8·96	7·66	6·67	5·90	5·2813

CASE 4



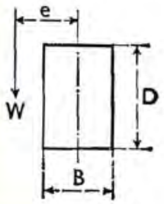
$$c = \frac{N}{\sqrt{\left[\frac{1}{4} + \frac{eD}{\frac{2}{3}(N^2-1)p^2 + D^2 + d^2}\right]^2 + \left[\frac{e(N-1)p}{\frac{2}{3}(N^2-1)p^2 + D^2 + d^2}\right]^2}}$$

In Table p = 3, D = 11½ d′ = 3, d = 5½.

TABLE OF COEFFICIENTS 'c' CASE 4

No. of rivets N	ECCENTRICITY (INCHES) 1	2	3	6	9	12	15	18	21	24
2	6·37	5·28	4·44	3·12	2·39	1·93	1·62	1·40	1·23	1·09
3	9·81	8·25	7·10	4·98	3·82	3·10	2·60	2·25	1·97	1·76
4	13·44	11·48	9·97	7·08	5·45	4·42	3·72	3·21	2·82	2·51
5	17·23	14·90	13·12	9·40	7·30	5·93	4·99	4·30	3·78	3·37
6	21·15	18·63	16·5	12·05	9·37	7·63	6·42	5·54	5·03	4·33
7	25·10	22·47	20·12	14·92	11·68	9·53	8·03	6·93	6·08	5·43
8	29·19	26·43	23·9	18·03	14·20	11·64	9·82	8·48	7·46	6·65
9	33·27	30·47	27·80	21·33	16·95	13·94	11·79	10·19	8·97	8·00
10	37·37	34·56	31·81	24·82	19·89	16·43	13·93	12·07	10·63	9·48

ECCENTRIC LOADS ON WELD GROUPS



All welds
¼″ Fillet

Width B inches	Depth D inches	SAFE LOADS IN TONS (W) FOR ECCENTRICITY 'e' INCHES									
		3	4	5	6	7	8	9	10	11	12
6	3	9·12	7·59	6·49	5·67	5·03	4·52	4·11	3·76	3·47	3·22
	6		13·2	11·5	10·1	9·05	8·18	7·46	6·86	6·34	5·90
	9			17·1	15·2	13·6	12·4	11·3	10·4	9·66	8·99
	12				20·7	18·7	17·1	15·6	14·4	13·4	12·5
	15					24·3	22·2	20·4	18·9	17·6	16·4
8	3		10·2	8·80	7·74	6·91	6·24	5·68	5·22	4·83	4·49
	6		16·3	14·3	12·7	11·5	10·4	9·55	8·81	8·17	7·63
	9			20·3	18·3	16·5	15·1	13·9	12·9	12·0	11·2
	12				24·2	22·1	20·2	18·7	17·3	16·1	15·1
	15					28·0	25·7	23·8	22·1	20·7	19·4
10	3			11·3	10·0	8·97	8·12	7·43	6·84	6·34	5·90
	6			17·2	15·4	14·0	12·7	11·7	10·8	10·1	9·44
	9				21·3	19·4	17·8	16·5	15·3	14·3	13·4
	12					25·3	23·3	21·6	20·1	18·8	17·7
	15						29·1	27·1	25·3	23·7	22·3
	18							32·9	30·8	28·9	27·2
	21								36·5	34·4	32·4
	24									40·1	37·9
12	3				12·5	11·2	10·2	9·35	8·63	8·01	7·47
	6				18·2	16·6	15·2	14·0	13·0	12·1	11·3
	9				24·5	22·4	20·6	19·1	17·8	16·6	15·6
	12					28·5	26·4	24·5	22·9	21·5	20·2
	15						32·5	30·3	28·4	26·7	25·2
	18							36·3	34·1	32·1	30·3
	21								40·1	37·8	35·8
	24									43·8	41·5

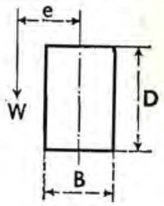
The above safe loads (W) are based on ¼″ fillet weld having a permissible load (F) of 1·23 tons per linear inch.

If larger welds are used, the safe loads above can be increased by multiplying them by F/1·23 where F is the permissible load per linear inch of weld.

ECCENTRIC LOADS ON WELD GROUPS

$$W = \frac{2F(B+D)^2}{\sqrt{36\frac{(B^2+D^2)}{(B+D)^2}e^2+12Be+(B+D)^2}}$$

All welds
¼″ Fillet



Width B inches	Depth D inches	SAFE LOADS IN TONS (W) FOR ECCENTRICITY 'e' INCHES						
		6	7	8	9	10	11	12
14½	6	21·9	20·0	18·4	17·0	15·8	14·8	13·9
	9	28·4	26·1	24·2	22·5	21·0	19·7	18·5
	12		32·6	30·3	28·2	26·5	24·9	23·5
	15				34·3	32·2	30·4	28·7
	18					38·2	36·1	34·2
	21						42·1	39·9
	24							45·9
16	6	24·2	22·1	20·4	18·9	17·6	16·5	15·5
	9		28·4	26·4	24·5	23·0	21·6	20·3
	12			32·6	30·5	28·6	27·0	25·5
	15				36·7	34·5	32·6	30·9
	18					40·7	38·5	36·5
	21						44·6	42·4
	24							48·4

The above safe loads (W) are based on ¼″ fillet weld having a permissible load (F) of 1·23 tons per linear inch.

If larger welds are used, the safe loads above can be increased by multiplying them by F/1·23 where F is the permissible load per linear inch of weld.

BOLTS IN TENSION

BLACK HEXAGON BOLTS AND NUTS TO B.S. 916 : 1953

MILD STEEL BOLTS

Nominal Diameter of Bolt Shank in inches	Net Area at Bottom of Thread in square inches	Allowable Stress in tons per square inch	Safe Load in tons
3/8	·062	6·0	·37
1/2	·112	6·0	·67
5/8	·191	6·0	1·15
3/4	·287	6·0	1·72
7/8	·403	7·0	2·82
1	·532	7·0	3·72
1 1/8	·670	8·0	5·36
1 1/4	·863	8·0	6·90
1 1/2	1·260	8·0	10·08
1 3/4	1·702	8·0	13·62
2	2·249	8·0	17·99

HIGH YIELD STRESS STEEL BOLTS

Nominal Diameter of Bolt Shank in inches	Net Area at Bottom of Thread in square inches	Allowable Stress in tons per square inch	Safe Load in tons
3/8	·062	9·0	·56
1/2	·112	9·0	1·01
5/8	·191	9·0	1·72
3/4	·287	9·0	2·58
7/8	·403	10·5	4·23
1	·532	10·5	5·59
1 1/8	·670	12·0	8·04
1 1/4	·863	12·0	10·36
1 1/2	1·260	12·0	15·12
1 3/4	1·702	12·0	20·42
2	2·249	12·0	26·99

Safe load equals the net area at the bottom of the thread × permissible stress.

RIVETS IN TENSION

MILD STEEL RIVETS

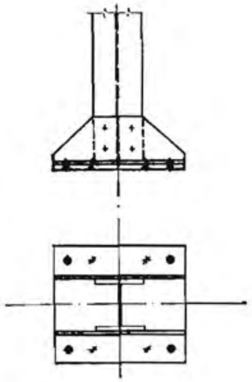
Nominal Diameter of Rivets in inches	Gross Diameter of Rivets after Driving in inches	Gross Area in square inches	Safe Load in tons
3/8	7/16	·1503	·90
1/2	9/16	·2485	1·49
5/8	11/16	·3712	2·23
3/4	13/16	·5185	3·11
7/8	15/16	·6903	4·14
1	1 1/16	·8866	5·32
1 1/8	1 3/16	1·1075	6·65
1 1/4	1 5/16	1·3530	8·12

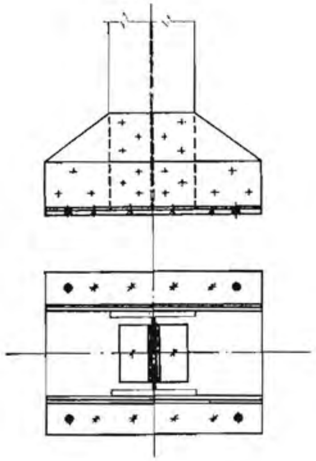
HIGH YIELD STRESS STEEL RIVETS

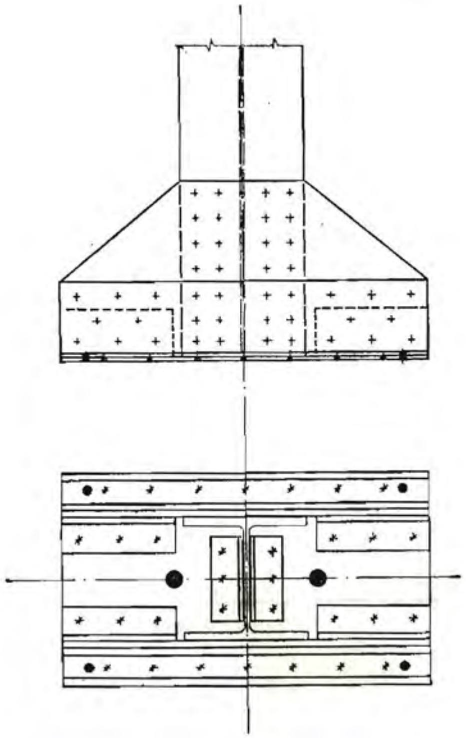
Nominal Diameter of Rivets in inches	Gross Diameter of Rivets after Driving in inches	Gross Area in square inches	Safe Load in tons
3/8	7/16	·1503	1·35
1/2	9/16	·2485	2·24
5/8	11/16	·3712	3·34
3/4	13/16	·5185	4·67
7/8	15/16	·6903	6·21
1	1 1/16	·8866	7·98
1 1/8	1 3/16	1·1075	9·97
1 1/4	1 5/16	1·3530	12·18

The safe load equals the gross area × the permissible stress.

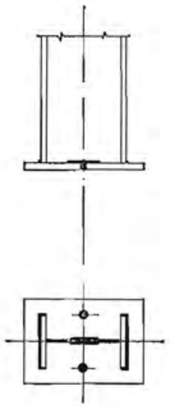
TYPICAL DETAILS OF
STANCHION BASES
RIVETED



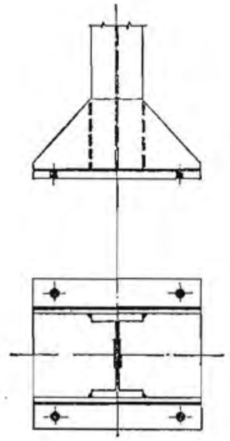


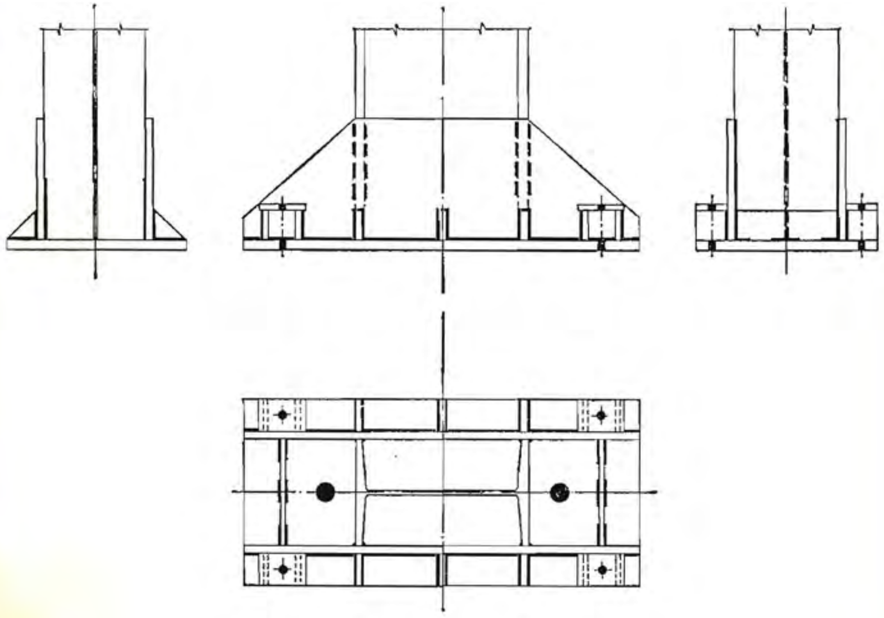


TYPICAL DETAILS OF
STANCHION BASES
WELDED



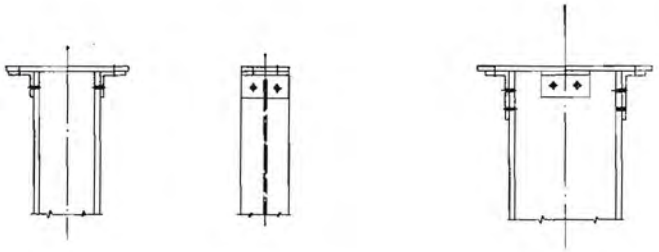
SIMPLE BASES



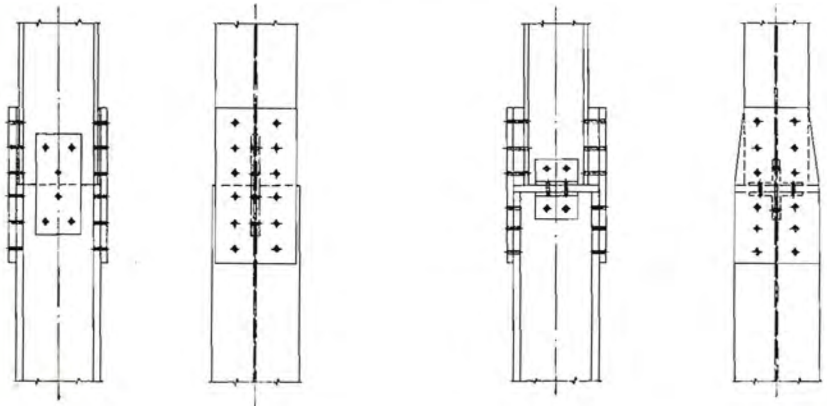


BASE WITH BENDING MOMENT

TYPICAL DETAILS OF
STANCHION CAP AND SPLICE

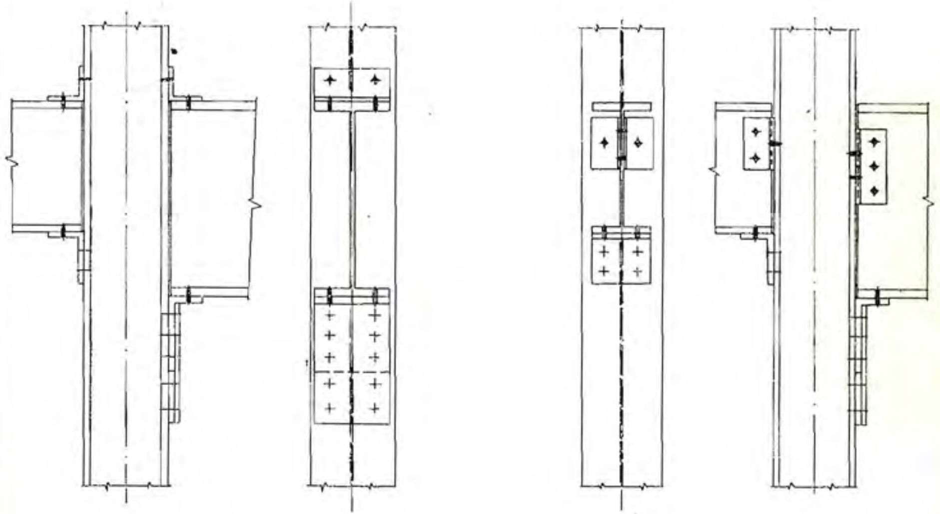


CAP DETAILS

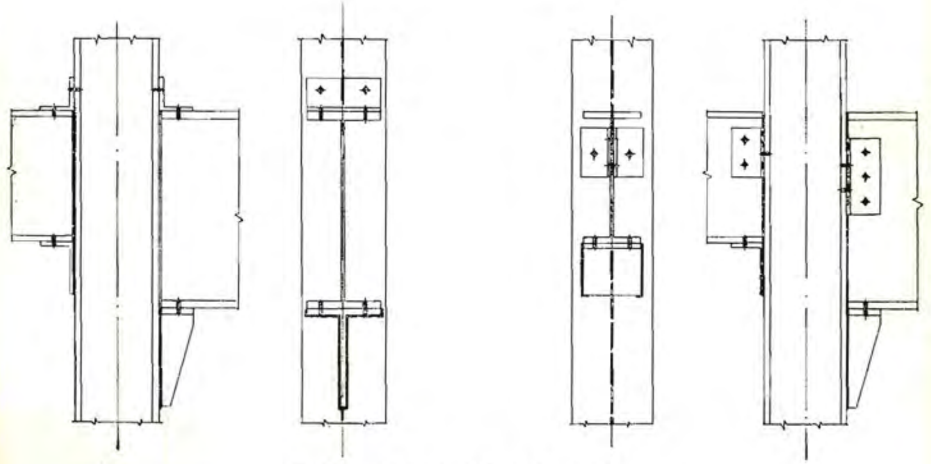


SPLICE DETAILS

TYPICAL BEAM CONNECTIONS
TO STANCHIONS
FOR RIVETED AND WELDED CONSTRUCTION



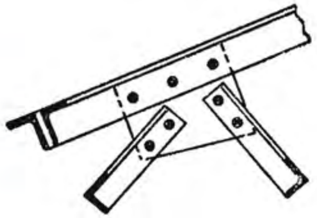
RIVETED CONSTRUCTION DETAILS

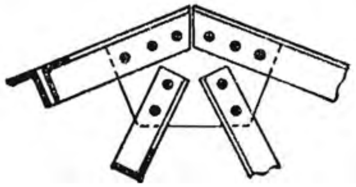


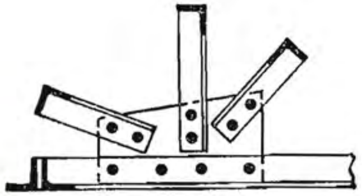
WELDED CONSTRUCTION DETAILS

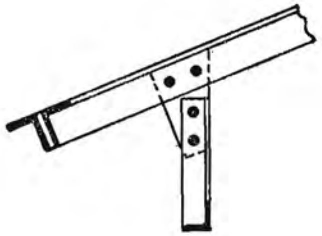
TYPICAL ROOF TRUSS CONNECTIONS

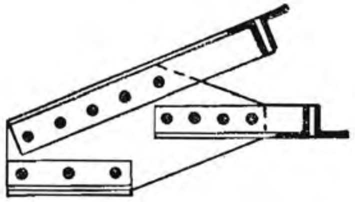
RIVETED OR BOLTED

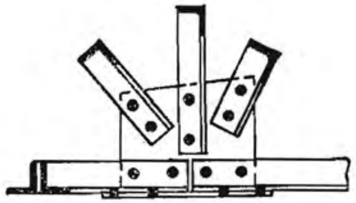






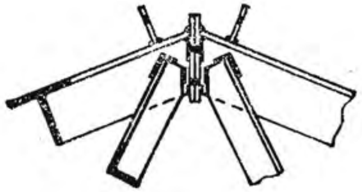


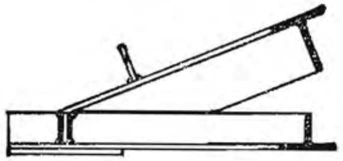


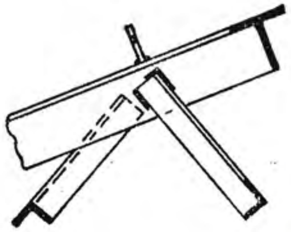


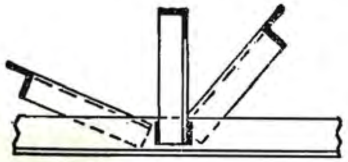
TYPICAL ROOF TRUSS CONNECTIONS

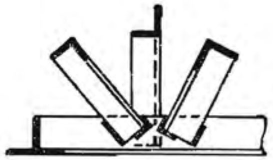
WELDED



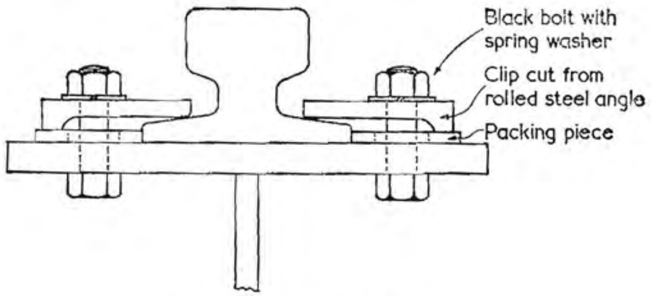




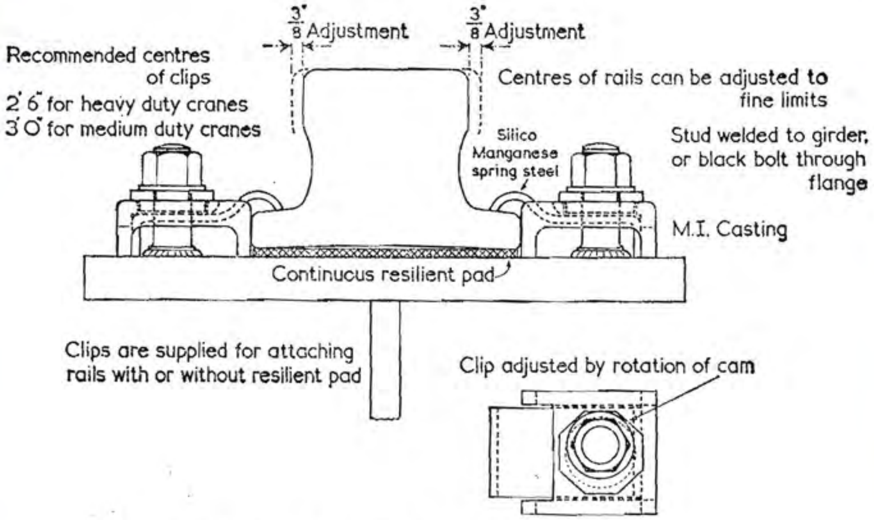




CRANE RAIL FIXING



SIMPLE TYPE OF RAIL CLIP



MOLYNEUX PATENT ADJUSTABLE RAIL CLIP

Manufactured by Molyneux Engineering Co. Ltd., Gloucester. Clips of similar design are available for all crane rail sizes. Acknowledgement is made to Molyneux Engineering Co. Ltd., for permission to reproduce the above information.

PART VII

Design Loads

SUPERIMPOSED LOADS ON FLOORS

Extract from British Standard Code of Practice CP3, Chapter V (1952).
Including Amendment No. 1 of 3rd February, 1958.

TABLE 1. Minimum and alternative minimum imposed loads

In this table, a reference to a floor includes a reference to any part of that floor, to be used as a corridor, and ' slabs ' includes boarding and beams or ribs spaced not further apart than three feet between centres, and ' beams ' means all other beams and ribs.

Loading Class No. (1)	TYPES OF FLOORS (2)	Minimum imposed loads lb./sq. ft. of floor area (3)	Alternative minimum imposed loads*	
			SLABS lb./ft. width (uniformly distributed over span) (4)	BEAMS lb. uniformly distributed over span (5)
30	Floors in dwelling houses of not more than two storeys designed for one occupation.	30	240	1920
40	Floors (other than those of Class No. 30) for residential purposes including dwelling houses of more than one occupation, tenements, hospital wards, bedrooms and private sitting rooms in hotels, dormitories.	40	320	2560
50	Office floors above the entrance floor; floors of light workrooms without storage.	50	400	3200
60	Floors of banking halls; office entrance floors and office floors below entrance floor; floors of classrooms in schools.	60	480	3840
80	Shop floors used for the display and sale of merchandise; workrooms generally; garages for vehicles not exceeding 2½ tons gross weight; places of assembly with fixed seating†, churches and chapels; restaurants; circulation space in machinery halls, power stations, etc., where not occupied by plant or equipment.	80	640	5120
100	Floors of warehouses, workshops, factories and other buildings or parts of buildings of similar category for light-weight loads; office floors for storage and filing purposes; places of assembly without fixed seating (public rooms in hotels, dance halls, etc.).	100	800	6400
150	Floors of warehouses, workshops, factories and other buildings or parts of buildings of similar category for medium-weight loads; floors of garages for vehicles not exceeding 4 tons gross weight.	150	For garage floors only, 1·5 × maximum wheel load but not less than 2,000 lb., considered to be distributed over a floor area 2 ft. 6 in. square.	
200	Floors of warehouses, workshops, factories and other buildings or parts of buildings of similar category for heavy-weight loads; floors of book stores and stationery stores; roofs and pavement lights over basements projecting under the public footpath.	200	—	—

For alternative loads on cantilever balconies the span in Table 1 shall be deemed to be the projection of the cantilever.

* Minimum load for slabs becomes operative at spans of less than 8 ft. Minimum load for beams becomes operative on areas less than 64 sq. ft. Beams, ribs and joists spaced at not more than 3 ft. centres may be calculated for slab loadings.

† Fixed seating implies that the removal of the seating and the use of the space for other purposes is improbable.

SUPERIMPOSED LOADS ON FLOORS

Extract from British Standard Code of Practice CP3, Chapter V (1952).
Including Amendment No. 1 of 3rd February, 1958.

GARAGE FLOORS	Minimum imposed loads lb./sq. ft. of floor area
Floors used only for the parking of passenger vehicles and light vans not exceeding 2½ tons gross weight. Floors used for garages for vehicles not exceeding 2½ tons gross weight.	The worst combination of actual wheel loads. Slabs 80 Beams 50 or the worst combination of actual wheel loads, whichever is the greater.

Examples of loads for basic floor-space occupancies are given in Table 1. They are equivalent uniformly distributed static loads in pounds per square foot of plan area, and they provide for normal effects of impact and acceleration, but not for any special concentrated loads.

The minimum loads in columns 4 and 5 of Table 1 should be used in place of those in column 3, where the former cause higher stresses.

For any occupancy where the prospective imposed load exceeds that given in Table 1, provision should be made for such higher load. Power station floors, for example, should be designed for plant or equipment which may be placed upon them during overhaul.

The alternative loadings given in columns 4 and 5 of Table 1 need not be applied to cantilever beams and slabs.

Clause 4. Balconies, stairs and landings. *a*. Balconies should be designed for the same class of loading as the floor or other space to which they give access.

b. Stairs and landings should be designed for the following imposed loadings, and the corresponding alternative minimum loads need not be considered except for structurally independent cantilever steps, which should be designed to carry a concentrated load of 300 lb. at the unsupported end.

Class of floor served	Imposed load
30	30 lb./sq. ft.
40, 50 and 60	60 lb./sq. ft.
Other classes	100 lb./sq. ft.

Clause 5. Reduction in imposed floor loads. *a*. Except as provided for in *b*, the following reductions in assumed total imposed floor loads may be taken in designing columns, piers, walls, their supports and foundations:—

b. No reduction should be made for the factories and workshops designed for less than 100 lb./sq. ft. or for buildings for storage purposes, warehouses and garages. For factories and workshops designed for 100 lb./sq. ft. or more, the reductions shown in Table 2 may be taken provided that the loading assumed for any column, etc., is not less than it would have been if all floors had been designed for 100 lb./sq. ft. with no reductions.

Where a single span of a beam or girder supports not less than 500 sq. ft. of floor at one general level, the imposed load may in the design of the beam or girder be reduced by 5 per cent. for each 500 sq. ft. supported, subject to a maximum reduction of 25 per cent. This reduction or that given in Table 2, whichever is greater, may be taken into account in the design of columns, etc., supporting such a beam, but should not be made where the floors are used for storage purposes nor in the weight of any plant or machinery which is specifically allowed for.

Table 2. Reductions of total imposed floor loads on columns, etc.

Number of floors carried by member under consideration	% reduction of imposed load on all floors above the member under consideration
1	0
2	10
3	20
4	30
5 or more	40

SUPERIMPOSED LOADS ON ROOFS

Extract from British Standard Code of Practice CP3, Chapter V (1952).
Including Amendment No. 1 of 3rd February 1958.

Clause 6. Imposed Roof loads other than wind loads

(*a*) ***Flat roofs.*** On flat roofs and sloping roofs up to and including 10°, where access (in addition to that necessary for cleaning and repair) is provided to the roof, allowance should be made for imposed load, including a load to provide for loose snow up to 2 feet in depth, of 30 lbs./square foot measured on plan, subject to a minimum load of 240 lbs. uniformly distributed over any foot width of the roof slab or coverings and 1920 lbs. uniformly distributed over the span in the case of all beams.

On flat roofs and sloping roofs up to and including 10°, where no access is provided to the roof (other than that necessary for cleaning and repair), an imposed load of 15 lbs./square foot measured on plan should be allowed for.

(*b*) ***Sloping Roofs.*** On roofs with a slope greater than 10°, and with no access provided to the roof (other than that necessary for cleaning and repair) an imposed load should be allowed for as follows:—

(i) for a roof-slope of 30° or less—15 lbs./square foot measured on plan;

(ii) for a roof slope of 75° or more—no allowance necessary.

For roof slopes between 30° and 75°, the imposed load to be allowed for may be obtained by linear interpolation between 15 lbs./square foot for a 30° roof slope and nil for a 75° roof slope.

(*c*) ***Roof coverings.*** To provide for loads incidental to maintenance, all roof coverings (other than glass) at a slope of less than 45° should be capable of carrying a load of 200 lbs. concentrated on any area 5 inches square at normal stresses.

(*d*) ***Combined effect of imposed load and wind pressure.*** The combined effect, as well as the separate effects, of imposed loads and wind pressures on roofs should be taken into account. Wind pressure on roofs is dealt with on page 563.

Clause 7. Wind pressures

(*a*) ***General.*** The pressures and suctions specified in this clause are given in multiples of a basic pressure *p* (lbs./square foot) which is the equivalent static pressure in the windward direction.

The term 'pressure' is used in the general sense, a negative sign being used to indicate a suction.

WIND LOADS

Extract from British Standard Code of Practice CP3, Chapter V (1952).
Including Amendment No. 1 of 3rd February 1958.

The effect of wind on the structure as a whole is determined by the combined action of the external pressures and suctions acting upon it. Whereas, in some cases, it is sufficient to consider the external pressures, in others—e.g. hangars and sheds, or other buildings with large openings in one or more sides—it is essential to take into account the variations of internal pressure.

(*b*) ***Wind pressures on buildings.*** The basic equivalent wind pressure (*p*) in the windward direction depends on the height of the building above the general ground level and the degree of exposure to wind.

These basic wind pressures are given on page 562.

Local Authorities will usually decide the degree of exposure appropriate to the area within their jurisdiction, having regard to local meteorological records.

For the purpose of deciding the exposure grading, the maximum value for the mean velocity (at an effective height of 40 feet) over a period of one minute should be taken to be the normal wind velocity.

Clause 8. Wind Loads on a building as a whole

A building and its foundations should be designed to resist the combined effects, as well as the separate effects, of imposed loads and the wind loads on vertical surfaces, and the wind loads on the roofs and on any parts of the building above the general roof level, having due regard to the internal pressures. The effect of wind should be calculated on the basis of the pressure given on page 562 corresponding to a height halfway between the eaves and ridge levels of the roof.

This pressure is to be considered as acting uniformly on the full height of the vertical walls. The wind loads on the sloping roofs are to be calculated in accordance with page 563, and the horizontal components of these loads acting half-way up the roof constitute an additional force to be resisted by the stability of the building. The wind loads on projections above the roof are to be added at the appropriate value of *p* for the projection, corresponding to the total height of the projection above ground, and taken into account in calculating the stability of the building as a whole.

The effect of walls and floors in stiffening a building framework against wind forces may be allowed for. Where adequate stiffening is provided by walls or by floors and walls, calculations for the effects of wind, except in regard to wall panels and foundations, need not be made on:—

(*a*) a building or part of a building of which the height(*h*) does not exceed twice the effective width.

(*b*) a section adjoining two parts of an adequately stiffened building if the height of the section exceeds twice its width, but the length of the section does not exceed four times its width.

(*c*) a wing of such a building if it does not project more than twice its own width.

Basic Wind Pressures

The figures given below are obtained from tests based on model experiments on a building with vertical flat walls, the building being rectangular in plan, one face at right angles to the wind and the length of the building greater than its height.

Effective height of building* (ft.)	WIND PRESSURE, p† (lb./sq.ft.)			
	Exposure A (V=45 m.p.h. V^2=2025)	Exposure B (V=54 m.p.h. V^2=2916)	Exposure C (V=63 m.p.h. V^2=3969)	Exposure D (V=72 m.p.h. V^2=5184)
Up to **10**	4	6	8	10
20	5	7	9	12
30	5	8	11	14
40	6	9	12	16
50	7	10	14	18
60	8	11	15	20
80	9	12	17	22
100	9	13	18	24
120	10	14	19	25
140	11	15	21	27
160	11	16	22	28
180	12	17	23	30
200 or more	12	17	24	31

* For intermediate values of height, the pressures may be calculated by linear interpolation.

† For wind velocities other than those for which data are tabulated, the pressure may be calculated from the formula:—

$$p = \frac{V^2}{5184} \times p_{72}$$

where p denotes the pressure corresponding to a velocity of V m.p.h.
V denotes the velocity considered in m.p.h. at an effective height of 40 feet.
p_{72} denotes the pressure corresponding to a velocity of 72 m.p.h. (i.e. to exposure D).

Clause 9. Wind pressure on walls

The external wind pressure acting on the walls of a building which are perpendicular to the assumed direction of the wind may be considered as consisting of two parts, corresponding to a pressure of about $+\frac{1}{2}\,p$ on the windward face and $-\frac{1}{4}\,p$ on the leeward face.

If a building has, on one face, openings which are very large in comparison to those elsewhere, there will be within the building a pressure $\pm\frac{1}{2}\,p$ according to the direction of the wind. Positive pressure will be caused by wind blowing into the openings, and negative pressure by wind blowing normal to the other faces. If opposite faces have large openings, a pressure of $-\frac{1}{2}\,p$ will be produced by wind blowing parallel to these faces. These examples give the greatest internal pressures likely to be met with in most buildings. The internal air pressure due to the effect of normal openings in the walls of the building may be assumed to be within the limits $+0{\cdot}2\ p$ and $-0{\cdot}2\ p$. These pressures may also be adopted for buildings with no openings, but having normal permeability.

The walls of the buildings should therefore be sufficiently strong to resist a total pressure, outwards or inwards, of 0·7 *p* for normal openings, but *p* for very large openings.

The figures given in the preceding two paragraphs are not applicable to buildings with both a ratio of height (to eaves level) to width of building less than one-half and a pitch of roof less than 30°. For such buildings, the walls should be sufficiently strong to resist a total pressure, outwards or inwards, of 0·8 *p*.

Clause 10. Wind pressures on roofs

(*a*) *Flat and pitched roofs*. The wind pressures on roofs, normal to the surface, due to wind blowing at right angles to the eaves, in terms of the unit wind pressures given on page 562, are given in the following table.

Design wind pressures on roofs (wind normal to eaves)

Slope of roof on windward side *	WIND PRESSURE	
	Windward slope †	Leeward slope †
Degrees		
0	−1·00 *p*	−0·75 *p*
10	−0·70 *p*	−0·50 *p*
20	−0·40 *p*	−0·45 *p*
30	−0·10 *p*	−0·45 *p*
40	+0·10 *p*	−0·45 *p*
50	+0·30 *p*	−0·45 *p*
60	+0·40 *p*	−0·45 *p*
70	+0·50 *p*	−0·45 *p*
80	+0·50 *p*	−0·45 *p*
90	+0·50 *p*	−0·50 *p*

* The wind pressures to be assumed over intermediate roof slopes may be interpolated linearly.

† Windward and leeward halves in the case of a flat roof.

(*b*) *Curved Roofs*. The wind pressure on a curved roof due to wind blowing at right angles to the axis of the roof may be computed on the basis that the curved portion is divided into not less than four equal segments. The pressures on each segment may be determined by the values given in Table 4 appropriate to the slopes of the chords of the segments.

(*c*) *Multi-span roofs*. In multi-span roofs in which the spans, heights and slopes are approximately the same and where the windward span gives shelter to the succeeding spans, the spans being adjacent, the following external pressures may be taken in making the general stability calculation:—

(i) On the windward slope of the windward span and the leeward slope of the leeward span, the pressures appropriate to the slopes as given in Table 4.

(ii) On all other roof slopes account should be taken of the effects of wind drag.

(*d*) *Wind drag*. The effect of wind drag measured on the plan area may be taken at 0·05 *p*, where the wind is at right angles to the roof slopes and at 0·025 *p* where it is parallel to the slopes.

Reference should be made direct to the Code of Practice for data on the 'degree of exposure' and on the 'height-width ratio' when considering the stiffening effect of walls and floors.

STANDARD HIGHWAY LOADING FOR BRIDGES

Extract from British Standard 153 : Part 3A : 1954

TYPE HA LOADING

Type HA loading consists of *a* and *b*, or *c*, viz.:

(*a*) A uniformly distributed lane loading. The values for this load per linear foot of traffic lane are given in Table 1.

(*b*) One knife edge load uniformly distributed across the width of the traffic lane. The values of this load are given in Table 2.

(*c*) Two wheel loads each 11¼ tons weight in line transversely spaced at 3 ft. centres and having a contact area of 15 inches × 3 inches, the smaller dimension being in the direction of travel, to be used in the following cases:

(i) Where the member supports a small area of roadway, such that it may be called on to carry the weight of one or two wheels, and where the proportion of distributed load and knife edge load which would be allocated to it is small, as, for instance, in a cantilever deck of less than 4-foot projection.

APPLICATION OF TYPE HA LOADING

(*a*) The knife edge load shall be taken as acting as follows:

On longitudinal girders, stringers, etc. In a direction at right angles to the member.
On cross members. In a direction in line with the member.

(*b*) Where longitudinal members are spaced at less than half the width of the lane the loading to be taken on these members shall be that appropriate to a half lane width.

(*c*) The total end live load shear on any longitudinal beam shall be taken as not less than 6,000 lb per foot width of carriageway supported by the member.

(*d*) No allowance shall be made for impact or dispersal of load in respect of the distributed load or knife edge load.

(*e*) No allowance shall be made for impact under the wheel loads.

(*f*) Dispersal under the wheel loads, where it can occur, shall be taken at 45°.

(*g*) It shall be permissible in considering the effects of the 11¼ ton wheel loads to allow a 25 per cent overstress.

TYPE HB LOADING

Type HB loading is a unit loading representing a single abnormal heavy vehicle.

For details refer to B.S. 153 : Part 3A : 1954.

Table 1 Type HA.

Equivalent Uniformly Distributed Load to be used in conjunction with the knife edge load. See Table 2.

Loaded length (ft.)	U.D.L. for beams per linear foot of lane	U.D.L. for longitudinal slabs per linear foot of lane	U.D.L. for transverse slabs and cross girders per linear ft. of 10ft. lane	Loaded length (ft.)	U.D.L. for beams per linear foot of lane	U.D.L. for longitudinal slabs per linear foot of lane	U.D.L. for transverse slabs and cross girders per linear ft. of 10ft. lane
3	24200	24200	22700	12	4870	3250	2600
4	17000	17000	11800	13	4540	2950	2400
5	12250	12250	7700	14	4210	2700	2300
6	9660	8850	5800	15	3880	2500	2200
7	8280	6550	4600	16	3550	2400	2200
8	7250	5200	3900	17	3220	2300	2200
9	6440	4520	3400	18	2880	2250	2200
10	5800	4000	3100	19	2540	2200	2200
11	5200	3600	2800	20-75	2200	2200	2200

Loaded Length (ft.)	Load lb./lin. ft.	Loaded Length (ft.)	Load lb./lin. ft.	Loaded Length (ft.)	Load lb./lin. ft.	Loaded Length (ft.)	Load lb./lin. ft.	Loaded Length (ft.)	Load lb./lin. ft.
80	2160	210	1380	360	1070	550	935	1600	560
85	2120	220	1350	370	1060	600	910	1700	540
90	2080	230	1320	380	1050	650	880	1800	520
95	2040	240	1290	390	1040	700	860	1900	510
100	2000	250	1265	400	1030	750	835	2000	490
110	1920	260	1240	410	1020	800	810	2100	480
120	1860	270	1210	420	1015	850	790	2200	470
130	1800	280	1190	430	1005	900	770	2300	460
140	1740	290	1165	440	1000	950	750	2400	450
150	1680	300	1145	450	990	1000	730	2500	440
160	1620	310	1130	460	985	1100	690	2600	430
170	1560	320	1115	470	975	1200	660	2700	420
180	1500	330	1105	480	970	1300	630	2800	410
190	1460	340	1090	490	965	1400	600	2900	410
200	1420	350	1080	500	960	1500	580	3000	400

Table 2	**SLABS**	**BEAMS**
Lane width 10 ft. or less	Lane Loading = loading from Table 1 × $W/10$ (W = width of lane) Load/sq. ft. = lane loading from Table 1 × 0·1 Knife edge load, per ft. = 2,700 lbs.	
Lane width over 10 ft.	As above	Lane loading = loading from Table 1 Load/sq. ft. = lane loading from Table 1 ÷ W Knife edge load per ft. = 2,7000 ÷ W (W = width of lane)

WEIGHTS OF FLOORS

Approximate weights for design purposes

CONCRETE FLOORS

Thickness (inches)	WEIGHTS IN LBS./SQ.FT.	
	Solid Concrete	Hollow Concrete (Average Values)
4	48	34
5	60	36
6	72	40
7	84	46
8	96	50
9	108	64
10	120	72

Solid concrete assumed to have normal aggregate, and weigh 144 lbs./cu.ft. For specific types and makes of hollow floors reference should be made to makers' publications.

STEEL FLOORS

STEEL PLATES			OPEN STEEL FLOORING		
Net Thickness on plain (inches)	Weight in lbs./sq.ft.		Thickness (inches)	Weight in lbs./sq.ft.	
	Steel Floor Plates	Steel Cheq. Plates		Light	Heavy
3/16	8·71	9·25	¾	5·8	7·5
¼	11·26	11·75	1	7·1	9·5
5/16	13·81	14·25	1¼	9·0	11·7
⅜	16·36	16·75	1½	11·0	14·0
7/16	18·91	19·5	2	12·0	18·5
½	21·46	22·0			

For lightweight steel decking see page 568, for heavyweight steel decking refer to makers' publications.

TIMBER FLOORS

SOLID TIMBER		1" BOARDS ON JOISTS @ 15 inch centres	
Thickness (ins)	Wt. in lbs./sq.ft.	Size of joists (ins)	Wt. in lbs./sq.ft.
1	3·5	3×2	4·9
3	10·5	4×2	5·4
6	21·0	6×2	6·3
8	28·0	8×2	7·2
9	31·5	9×2	7·7
10	35·0	11×2	8·6

WEIGHTS OF FLOOR, ROOF AND CEILING FINISHES

Approximate weights for design purposes

FLOOR AND ROOF FINISHES

Floor Finish	Nominal Thickness inches	Weight in lbs./sq.ft.
Asphalt	¾	9·0
Boards	1	3·5
Composition floor (Magnesium Oxychloride)		
(Normal Type) Sawdust Filler	1	7·5
(Heavy Duty Type) Mineral Filler	1	11·5
Cork (Compressed)	1	2·0
(Insulation Slabs)	1	1·0
Felt Bituminous Roofing		1·0
Note: For each layer of adhesive add		·3
Glazed Pavement and Roof Lights	2¼ approx.	25·0
Granolithic: Sand, Cement and Granite dust	1	12·5
	1½	18·75
	2	25·0
Linoleum	3/16	1·0
Rubber	¼	2·7
Screed: Sand and Cement 3:1	¾	9·0
	1	12·0
	1½	18·0
	2	24·0
Terazzo	⅝	7·0
Tiling—Cast iron	1	40·0
Tiling—Clay	½	5·8
Tiling—Steel	1	41·0
Wood Block	1	3·75
Wood Block	1¼	4·75

CEILING FINISHES

Ceiling Finish	Common Thickness inches	Weight in lbs./sq.ft.
Plaster		
Acoustic	½	2·0
Anhydrite	½	5·5
Barium Sulphate	½	7·5
Fibrous	⅝	3·0
Gypsum or Lime	½	5·0
Hydraulic Lime or Portland Cement	½	6·0
Note: For Lathing, wood or metal, add		1·25
Plasterboard	⅜	2·0
Note: For setting coat, add		1·0
Many varieties of fireproof ceilings are available For full details makers' publications should be consulted.		3·0–7·0

WEIGHTS OF ROOF AND SIDE COVERINGS

Approximate weights for design purposes

COVERING		Maximum centres of purlins	Maximum centres of side rails	Weight in lbs./sq. ft. when laid
Aluminium Sheet Mansard		5′ 0″	5′ 0″	0·7
Corrugated		6′ 0″	6′ 0″	0·8
Asbestos Cement Combined Sheets		5′ 6″	—	5·6
Corrugated Sheets		4′ 6″	6′ 0″	3·2
Tiles		4′ 6″	6′ 0″	3·1
Galvanised Corrugated Sheets	20 G	6′ 6″	7′ 6″	3·0
	22 G	5′ 9″	6′ 10″	2·5
	24 G	4′ 9″	5′ 10″	2·2
Patent Glazing		11′ 0″	—	6·5
(Double)		11′ 0″	—	10·5
Protected Metal	20 G	6′ 6″	7′ 6″	3·0
	22 G	5′ 9″	6′ 10″	2·5
	24 G	4′ 9″	5′ 10″	2·2
Protected Metal V Beam	20 G	9′ 0″	10′ 0″	3·0
	22 G	8′ 0″	9′ 0″	2·5
	24 G	—	8′ 0″	2·2
Slates on Battens on Rafters		—	—	10–16
Steel Decking (Super load 15·0 lbs./sq. ft.)		7′ 6″	—	5·4
Steel Decking (Super load 15·0 lbs./sq. ft.) *Note: Intermediate weights are available*		20′ 0″	—	8·3
Tiles on Battens on Rafters		—	—	12–20
Woodwool Slabs 1½″–3″ thick		—	—	4–9

For specific types and makes of coverings, reference should be made to makers' publications.

WEIGHTS OF WALLS AND PARTITIONS

Approximate weights for design purposes

CONSTRUCTION		Weight in lbs./sq. ft.
Brick Walls		
4½ in. thick	Plain	48·0
	Plastered one side	54·0
	Plastered both sides	60·0
9 in. thick	Plain	96·0
	Plastered one side	102·0
	Plastered both sides	108·0
11 in. thick	Plain	96·0
cavity	Plastered one side	102·0
	Plastered both sides	108·0
13½ in. thick	Plain	144·0
	Plastered one side	150·0
	Plastered both sides	156·0
15½ in. thick	Plain	144·0
cavity	Plastered one side	150·0
	Plastered both sides	156·0
18 in. thick	Plain	192·0
	Plastered one side	198·0
	Plastered both sides	204·0
Stone walls on facings per inch thick		14·0
Partitions		
Metal Partition —Glazed		5·0
Timber Partition—Glazed		6·0
Hollow blocks, plastered both sides	2 in. thick	23·0
	3 in. thick	28·5
	4 in. thick	34·0
Breeze blocks, solid, plastered both faces	2 in. thick	28·0
	3 in. thick	36·0
	4 in. thick	44·0
Studding with lath and plaster		16·0

For specific types and makes of walls and partitions, reference should be made to makers' publication.

WEIGHTS OF MATERIALS

Approximate weights of materials for estimating dead and superimposed loads

Weights in pounds per cubic foot unless stated otherwise.

Ashes, coal	45
Asphalte, paving	144
Ballast, brick, gravel	112
Bricks and Brickwork	
Bricks, pressed, hard	150
Bricks, fire, paving	150
Bricks, pressed	135
Bricks, common	120
Bricks, inferior, soft	100
Brickwork, pressed	140
Brickwork, ordinary	120
Brickwork, inferior	100
Brickwork, approximation 1 cub. yd. = 1½ tons	
Cement, Portland, loose	90
Cement, mortar	105
Clay, damp, plastic	112
Concrete, breeze	96
Concrete, brick	120
Concrete, stone	144
Earth, dry, loose	72
Earth, moist, packed	96
Earth, dry, rammed	112
Glass, plate	174
Glass, rough or ribbed	168
Glass, sheet	156
Gravel	120
Lime mortar	103
Masonry	
Masonry, Artificial stone	144
Masonry, freestone, dressed	150
Masonry, freestone, rubble	140
Masonry, granite, dressed	165
Masonry, granite, rubble	155
Metals	
Aluminium, cast	160
Aluminium, hammered	172
Brass, cast	527
Brass, rolled	534
Bronze	524
Copper, cast	550
Copper, rolled	558
Iron, cast	450
Iron, wrought	480

Metals (*continued*)	
Lead, cast	708
Lead, sheet	710
Nickel, monel metal	556
Steel, cast	492
Steel, rolled	490
Tin, cast	455
Tin, rolled	462
Zinc	437
Pitch	70
Plaster	96
Plaster of Paris, loose	60
Plaster of Paris, set	80
Sand, dry	100
Sand, wet	125
Slag, for concrete	96
Slate	180
Slating	
Heavy, 14 lbs. super. foot	
Medium, 10 lbs. super. foot	
Light, 6 lbs. super. foot	
Asbestos, 3 lbs. super. foot	
Stones	
Flint	165
Granite	170
Limestone	160
Macadam	150
Marble	165
Sandstone	150
Tar	64
Terra-cotta	112
Tiling, 18 lbs. super. foot	
Timber	
Jarrah, wood paving	60
Fir	32
Larch	35
Oak	60
Pine, pitch	45
Pine, red, yellow	40
Pine, white	30

WEIGHTS OF MATERIALS

Approximate weights of materials for estimating dead and superimposed loads

Weights in pounds per cubic foot unless stated otherwise.

Cereals, etc.	
Barley, in bags	36
Barley, in bulk	40
Flour, in bags	45
Hay, in bales, compressed	24
Hay, not compressed	14
Oats, in bags	27
Oats, in bulk	32
Potatoes, piled	45
Straw, in bales, compressed	19
Wheat, in bags	39
Wheat, in bulk	45
Dry Goods	
Dry goods, piled, average, 2 cwts. per sq. ft. of floor	
Coir, yarn, baled	33
Cotton, piece goods, baled	33
Cotton, piece goods, cased	30
Cotton, raw, compressed hard	36
Cotton, raw, compressed	25
Cotton, not compressed	12
Cotton, tickings, baled	37
Hemp, baled	20
Jute	30
Linen, damask, baled	50
Linen, piece goods, cased	35
Manilla, baled	26
Rope, in coils	32
Wool, compressed	48
Wool, not compressed	13
Wool, piece goods, cased	27
Groceries	
Groceries, piled, average 2½ cwts. per sq. foot of floor	
Bottled goods, in cases	56
Butter	54
Cheese	30
Coffee	40
Fats	58
Fruits, dried in cases	60
Liquids, in barrels	38
Liquids, bottled, in cases	50
Eggs	68
Rice, in bags	58
Salt, coarse, in bags	70
Salt, granulated, piled	48

Groceries (*continued*)	
Soaps, in cases	56
Sugar, in bags	45
Tea, in chests	25
Tinned goods, in cases	60
Miscellaneous	
Bleach, in barrels	32
Cement, in bags	84
Cement, in barrels	73
Clay, china, kaolin	138
Clay, potters', dry	120
Coal, loose	56
Coke, loose	30
Crockery, in crates	40
Glass, in crates	60
Glycerine, in cases	52
Ironmongery, in packages	56
Leather, in bundles	16
Leather, hides, compressed	23
Lime, in barrels	50
Oils, in bulk	56
Oils, in barrels	36
Oils, in drums	45
Paper, printing	40
Paper, writing	60
Petrol	42
Plaster, in barrels	53
Potash	141
Red Lead, dry	132
Rosin, in barrels	48
Rubber	60
Saltpetre	67
Screw-nails, in packages	100
Soda ash, in barrels	62
Soda, caustic, in drums	88
Snow, freshly fallen	6
Snow, wet, compact	20
Starch, in barrels	25
Sulphuric acid	60
Tin, sheet, in boxes	278
Water, fresh	62½
Water, fresh, 10 pounds per gallon	
Water, sea	64
White lead, dry	86
White lead paste, in drums	174
Wire, in coils	74

ANGLES OF REPOSE AND WEIGHTS OF MATERIALS

MATERIAL	Weight in lbs./cubic ft.	Angle of repose
Ashes	40–50	40°
Cement	90	20°
Cement clinker	90	30°
Chalk (in lumps)	70–80	35°–45°
Clay (in lumps)	70	30°
Clay dry	120–140	30°
Clay moist	130–160	45°
Clay wet	130–160	15°
Clinker	65	40°
Coal (in lumps)	56	35°
Coke	35	30°
Copper ore	160–180	35°
Crushed Brick	80–100	35°–40°
Crushed Stone	110–130	35°–40°
Granite	110–130	35°–40°
Gravel (clean)	90–110	35°–40°
Gravel (with sand)	100–110	25°–30°
Haematite iron ore	230	35°
Lead ore	320	35°
Limestones	80–120	35°–45°
Lincolnshire iron ore	110	35°
Magnetite iron ore	250	35°
Manganese ore	160–180	35°
Mud	105–120	0°
Rubblestone	110–120	45°
Salt	60	30°
Sand (dry)	100–120	30°–35°
Sand (moist)	115–125	35°
Sand (wet)	115–130	25°
Sandstones	80–120	35°–45°
Shale	90–120	30°–35°
Shingle	90–110	30°–40°
Slag	90	35°
Vegetable earth, dry	90–100	30°
Vegetable earth, moist	100–110	45°–50°
Vegetable earth, wet	110–120	15°
Zinc ore	160–180	35°

Coefficients of Friction between concrete and earth
clay = 0·2   sand = 0·4   gravel = 0·4

NOTES ON OVERHEAD CRANE GANTRIES

Where possible the actual wheel loads and dimensions of the crane or cranes to be installed should be obtained from the makers. If this information is not available the tables on the following pages, which are based on figures supplied by several manufacturers, may be used for the preliminary design.

The loads given in the tables are the maximum static wheel loads imposed on the gantry rails by the crane wheels when the crane is fully loaded. Due allowance must be made for impact, etc.

British Standard 449 : 1959 states that

'The following allowances shall be deemed to cover all forces set up by vibration, shock from slipping of slings, kinetic action of acceleration and retardation and impact of wheel loads':

(*a*) for loads acting vertically, the maximum static wheel loads shall be increased by the following percentages:

For electric overhead cranes	25 per cent
For hand-operated cranes	10 per cent

(*b*) The horizontal force acting transverse to the rails shall be taken as a percentage of the combined weight of the crab and the load lifted as follows:

For electric overhead cranes	10 per cent
For hand-operated cranes	5 per cent

This force shall be taken into account when considering the lateral rigidity of the rails and their fastenings.

(*c*) Horizontal forces acting along the rails shall be taken as a percentage of the static wheel loads which can occur on the rails, as follows:

For overhead cranes either electric or hand operated	5 per cent

The forces specified in either (*b*) or (*c*) above shall be considered as acting at the rail level and being appropriately transmitted to the supporting systems.

Gantry girders and their vertical supports shall be designed on the assumption that either of the horizontal forces (*b*) or (*c*) may act at the same time as the vertical load.

An increase of 10 per cent on the permissible stresses specified in this standard shall be allowed for the combination of loadings (*a*) and (*b*) in respect of the design of the gantry girders and supporting structures. This increase is not however in addition to that permitted in Clause 13 (B.S.449 : 1959—Stresses due to wind forces).

In special cases, e.g. charging machines, and where more than one crane is in use on the gantry and where high speeds are attained, the above allowances should be reconsidered.

ELECTRIC OVERHEAD TRAVELLING CRANES
MEDIUM DUTY

Approximate Dimensions and Loads.
Wheel loads do not include any allowance for impact, etc.

Load	Span	Weight of Crane	Weight of Crab	Max. Wheel Load	END CARRIAGE		CLEARANCES			Size of Crane Rail
					Length	Wheel Centres	Head-room	End Clear-ance	Min. Hook approach	
tons	feet	tons	tons	tons	ft. ins.	ft. ins.	ft. ins.	ins.	ft. ins.	lbs./yd
2½	30	7·0	1·5	4·0	10 0	8 0	5 6	8	2 6	24
	35	7·5	1·5	4·25	10 6	8 6	5 6	8	2 6	24
	40	9·0	1·5	4·5	10 6	8 6	5 6	8	2 6	24
	45	9·5	1·5	4·75	11 0	9 0	5 6	8	2 6	24
	50	10·0	1·5	5·0	11 6	9 6	5 6	8	2 6	24
5	35	9·0	2·0	6·0	10 6	8 6	6 0	9	2 6	56
	40	10·0	2·0	6·0	10 6	8 6	6 0	9	2 6	56
	45	11·0	2·0	6·5	11 0	9 0	6 0	9	2 6	56
	50	12·5	2·0	7·0	11 6	9 6	6 0	9½	2 6	56
	60	15·0	2·3	7·5	12 6	10 6	6 0	9½	2 6	56
7½	35	11·0	2·2	7·4	11 3	9 0	6 3	10	2 9	56
	40	12·0	2·3	7·6	11 3	9 0	6 3	10	2 9	56
	50	15·0	2·5	8·6	12 3	10 0	6 6	10	2 9	56
	60	17·0	2·8	9·2	13 9	11 6	6 6	10	2 9	56
	70	19·0	2·8	9·8	14 3	12 0	6 6	11½	2 9	56
	80	22·0	3·0	10·5	15 9	13 6	6 6	11½	2 9	56
10	35	12·0	2·8	8·8	11 9	9 6	6 9	9½	2 9	56
	40	13·0	2·8	9·2	11 9	9 6	6 9	10	2 9	56
	50	16·0	3·0	10·0	12 9	10 6	6 9	10	2 9	56
	60	18·0	3·0	10·6	13 9	11 6	6 9	10	2 9	56
	70	21·5	3·0	11·5	13 9	11 6	6 9	11	2 9	56
	80	24·0	3·3	12·5	16 3	14 0	7 0	11	2 9	56
	100	33·0	3·5	14·5	19 0	16 9	7 0	11	2 9	70

ELECTRIC OVERHEAD TRAVELLING CRANES
MEDIUM DUTY

Approximate Dimensions and Loads.
Wheel loads do not include any allowance for impact, etc.

Load	Span	Weight of Crane	Weight of Crab	Max. Wheel Load	END CARRIAGE		CLEARANCES			Size of Crane Rail
					Length	Wheel Centres	Head-room	End Clear-ance	Min. Hook approach	
tons	feet	tons	tons	tons	ft. ins.	ft. ins.	ft. ins.	ins.	ft. ins.	lbs./yd.
15	35	13·0	4·0	12·0	12 9	10 6	7 3	10½	3 0	56
	40	15·4	4·0	12·5	12 9	10 6	7 3	10½	3 0	56
	50	19·0	4·0	13·5	13 0	10 9	7 3	10½	3 0	56
	60	21·0	4·0	14·0	14 0	11 9	7 3	10½	3 0	56
	70	25·0	4·0	15·5	14 0	11 9	7 3	10½	3 0	56
	80	29·0	4·0	16·0	16 3	14 0	7 3	11½	3 0	70
	100	37·0	4·5	19·0	19 0	16 9	7 3	12½	3 0	70
20	40	18·5	4·5	16·0	13 9	11 3	7 9	11½	3 6	56
	50	22·0	5·0	16·8	13 9	11 3	7 9	11½	3 6	56
	60	24·0	5·0	17·5	14 3	11 9	7 9	11½	3 6	70
	70	27·5	5·0	18·5	14 6	12 0	7 9	11½	3 6	70
	80	32·0	5·0	19·8	16 6	14 0	7 9	12	3 6	70
	100	42·0	5·5	23·0	19 3	16 9	7 9	12½	3 6	70
25	40	22·0	6·0	19·0	14 3	11 9	7 9	12	3 3	70
	50	26·0	6·0	20·0	14 3	11 9	7 9	12	3 3	70
	60	28·5	6·0	21·2	14 9	12 3	7 9	12	3 3	70
	70	33·0	6·5	23·0	15 3	12 9	7 9	13	3 3	70
	80	36·0	6·5	24·0	15 10	13 4	7 9	13	3 3	70
	100	46·0	7·0	26·5	19 3	16 9	7 9	13	3 3	70
30	40	24·0	7·0	22·0	14 0	11 6	8 6	12	3 6	70
	50	26·0	7·0	22·5	14 0	11 6	8 6	12	3 6	70
	60	30·0	7·0	24·0	14 6	12 0	8 6	12	3 6	70
	70	36·0	7·0	25·5	14 6	12 0	8 6	12	3 6	70
	80	39·0	7·0	27·0	16 6	14 0	8 6	12	3 6	112
	100	48·0	7·0	30·0	19 0	16 6	8 6	12	3 6	112

For bigger cranes reference should always be made to the manufacturer for loads and dimensions.

OVERHEAD HAND TRAVELLING CRANES
SINGLE GIRDER TYPE

Approximate Dimensions and Loads.
Wheel loads do not include any allowance for impact, etc.

Load	Span	Weight of Crane	Max. Wheel load	END CARRIAGE		CLEARANCES			Size of Crane rail
				Length	Wheel crs.	Head room	End room	Min. hook approach	
tons	feet	tons	tons	ft. ins.	ft. ins.	ft. ins.	inches	ft. ins.	lbs./yd.
1	20	·7	·7	5 6	4 6	2 0	7	1 0	26
	25	·85	·75	5 6	4 6	2 0	7	1 0	26
	30	1·0	·85	5 6	4 6	2 3	7	1 1	26
	35	1·2	·9	5 6	4 6	2 3	7	1 1	26
	40	1·4	·9	5 6	4 6	2 3	7	1 1	26
	50	2·0	1·2	6 0	4 9	3 0	7	1 1	26
2	20	1·0	1·25	5 6	4 6	2 3	7	1 3	26
	25	1·1	1·3	5 6	4 6	2 3	7	1 3	26
	30	1·3	1·35	5 6	4 6	2 3	7	1 3	26
	35	1·5	1·45	5 6	4 6	2 3	7	1 3	26
	40	1·75	1·5	5 6	4 6	2 7	7	1 3	26
	50	2·5	1·7	6 9	5 0	3 3	7½	1 4	26
3	20	1·0	1·75	5 6	4 6	2 6	7	1 3	26
	25	1·2	1·8	5 6	4 6	2 6	7	1 3	26
	30	1·4	1·9	5 6	4 6	2 6	7	1 3	26
	35	1·7	2·0	6 9	5 0	2 9	7½	1 3	26
	40	2·0	2·1	6 9	5 0	3 0	7½	1 4	26
	50	2·9	2·3	6 9	5 0	3 3	7½	1 4	26
5	20	1·3	2·8	7 3	5 6	2 9	7½	1 6	26
	25	1·55	2·9	7 3	5 6	2 9	7½	1 6	26
	30	1·8	3·0	7 3	5 6	2 9	7½	1 6	26
	35	2·2	3·1	7 3	5 6	3 0	7½	1 6	26
	40	2·8	3·2	7 3	5 6	3 3	7½	1 6	26
	50	4·1	3·3	7 3	5 6	3 3	7½	1 6	26
7½	20	1·8	4·1	7 3	5 6	3 0	7½	1 9	40
	25	2·2	4·3	7 3	5 6	3 0	7½	1 9	40
	30	2·5	4·35	7 3	5 6	3 3	7½	1 9	40
	35	3·0	4·5	8 6	6 3	3 7	8½	1 9	40
	40	3·7	4·5	8 6	6 3	3 9	8½	1 9	40
	50	4·7	4·8	8 6	6 3	3 9	8½	1 9	40
10	20	2·5	5·5	8 6	6 4	3 3	8½	2 0	40
	25	2·8	5·6	8 6	6 4	3 6	8½	2 0	40
	30	3·3	5·75	8 6	6 4	3 7	8½	2 0	40
	35	4·0	5·8	9 8	7 6	3 7	9	2 0	40
	40	4·7	6·0	9 8	7 6	3 9	9	2 0	40
	50	6·5	6·3	9 8	7 6	3 9	9	2 0	40

OVERHEAD HAND TRAVELLING CRANES
DOUBLE GIRDER TYPE

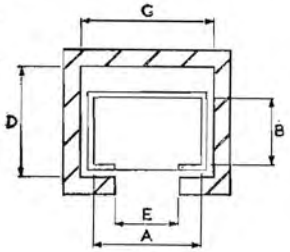
Approximate Dimensions and Loads.
Wheel loads do not include any allowance for impact, etc.

Load	Span	Weight of crane	Max. wheel load	END CARRIAGE		CLEARANCES			Size of crane rail
				Length	Wheel crs.	Head room	End room	Min. hook approach	
tons	feet	tons	tons	ft. ins.	ft. ins.	ft. ins.	inches	ft. ins.	lbs./yd.
1	20	·9	·8	5 6	4 6	2 6	6½	1 0	26
	25	1·1	·9	5 6	4 6	2 6	6½	1 0	26
	30	1·3	·95	5 6	4 6	2 6	6½	1 0	26
	35	1·55	1·0	5 6	4 6	2 9	6½	1 0	26
	40	1·8	1·1	5 6	4 6	3 0	6½	1 0	26
	50	3·0	1·4	5 6	4 6	3 0	6½	1 0	26
2	20	1·2	1·4	5 6	4 6	2 10	7	1 2	26
	25	1·4	1·4	5 6	4 6	2 11	7	1 2	26
	30	1·55	1·5	5 6	4 6	3 0	7	1 2	26
	35	1·9	1·6	5 6	4 6	3 3	7	1 2	26
	40	2·4	1·7	5 6	4 6	3 4	7	1 2	26
	50	3·8	2·2	6 9	5 0	4 2	7½	1 2	26
3	20	1·3	1·9	5 6	4 6	3 2	7	1 3	26
	25	1·55	2·0	5 6	4 6	3 3	7	1 3	26
	30	1·8	2·1	5 6	4 6	3 4	7	1 3	26
	35	2·3	2·2	6 9	5 0	3 6	7½	1 3	26
	40	2·75	2·4	6 9	5 0	3 9	7½	1 3	26
	50	4·0	2·7	6 9	5 0	4 3	7½	1 3	26
5	20	1·7	2·8	7 0	5 3	3 9	7½	1 6	26
	25	2·0	3·1	7 0	5 3	3 9	7½	1 6	26
	30	2·4	3·2	7 0	5 3	4 0	7½	1 6	26
	35	2·8	3·3	7 0	5 3	4 0	7½	1 6	26
	40	3·5	3·6	7 0	5 3	4 3	7½	1 6	26
	50	4·8	4·0	7 0	5 3	4 9	7½	1 6	26
7½	20	2·2	4·1	7 0	5 3	4 3	7½	1 9	40
	25	2·6	4·3	7 0	5 3	4 6	7½	1 9	40
	30	3·0	4·5	7 0	5 3	4 8	7½	1 9	40
	35	3·8	4·7	8 8	6 6	5 0	7½	1 9	40
	40	4·5	4·8	8 8	6 6	5 3	8½	1 9	40
	50	6·0	5·3	8 8	6 6	5 3	8½	1 9	40
10	20	2·7	5·6	8 8	6 6	4 9	8½	1 10	40
	25	3·0	5·8	8 8	6 6	4 9	8½	1 10	40
	30	3·5	6·0	8 8	6 6	5 3	8½	1 10	40
	35	4·2	6·2	8 8	6 6	5 3	8½	1 10	40
	40	4·9	6·5	8 8	6 6	5 6	8½	1 10	40
	50	6·4	6·6	8 8	6 6	5 9	8½	1 10	40

LIFTS AND ESCALATORS

Approximate Dimensions and Loads

LIFTS

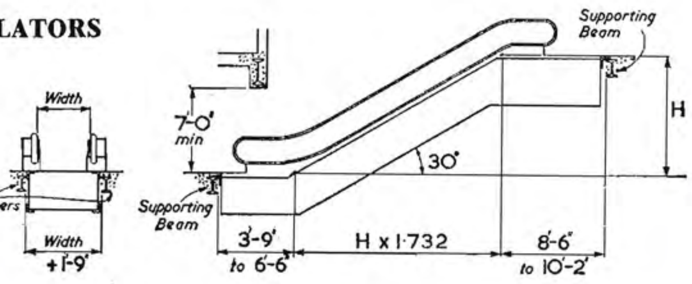


H = Headroom. Height from the top floor level to the underside of motor room floor.

Note. The equivalent dead loads (E.D.L.) given below do not include the weight of the slab for the motor room floor nor for the weight of the controller.

Capacity	Nature of load intended	Internal Dim. of Car		Internal Dim. of Lift Well			H	E.D.L.
		A	B	C	D	E		
lbs	*persons*	*ft ins*	*ft ins*	*ft ins*	*ft ins*	*ft ins*	*ft ins*	*lbs*
600	4	3 5	2 7	5 8	3 9	2 3	12 9	9500
900	6	3 11	3 3	6 2	4 4	2 6	12 9	11400
1200	8	4 8	3 3	6 2	5 9	3 0	14 9	16800
1500	10	5 8	3 3	7 2	5 9	3 0	13 10	23500
2000	13	6 0	3 8	7 8	6 1	3 0	14 0	26800
2500	16	6 8	4 3	8 3	6 8	3 6	14 0	36600
3000	20	6 8	4 9	7 2	6 4	3 6	14 0	38500
3500	Goods	7 8	4 9	9 5	7 2	4 6	14 11	40800
4500	Goods	7 0	8 9	9 5	9 7	6 9	13 3	44400
5000	Goods	8 0	9 7	10 7	10 10	8 0	16 8	45000
6000	Goods	8 0	9 7	10 8	10 10	8 0	14 7	60200
8000	Goods	8 0	9 7	10 9	10 10	8 0	14 11	65100
10000	Goods	8 0	11 7	10 10	12 10	8 0	17 0	82700

ESCALATORS

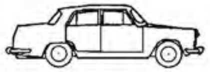


Equivalent Dead Loads on each supporting beam			
Rise H	32 ins wide	40 ins wide	48 ins wide
ft. ins	*lbs*	*lbs*	*lbs*
8 0	13900	15100	16700
10 0	14900	16200	18250
12 0	15900	17350	19750
14 0	17000	18600	21300
16 0	18000	20000	22800

WEIGHTS OF MOTOR VEHICLES

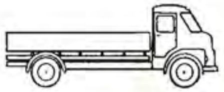
Approximate Dimensions and Loads

SALOON CARS



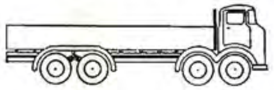
Type	Unloaded Weight	Wheel Centres	Overall Length
	cwts	*ft ins*	*ft ins*
Light	14	7 3	12 0
Medium	25	8 6	15 0
Heavy	40	10 3	17 6

MEDIUM LORRIES



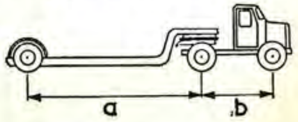
Type	Total Weight	Wheel Centres	Overall Length
	tons	*ft ins*	*ft ins*
1½ ton	3½	9 6	16 0
3 ton	5½	12 0	18 6
5 ton LWB	9	13 0	22 6
5 ton SWB	9	10 0	17 0
7 ton LWB	10½	13 6	24 0
7 ton SWB	10½	12 6	22 6
9 ton LWB	14	17 6	30 0
9 ton SWB	14	13 6	24 0

HEAVY LORRIES



Type	Total Weight	Wheel Centres	Overall Length
	tons	*ft ins*	*ft ins*
16 ton LWB	24	17 0	30 0
16 ton SWB	24	14 9	27 0

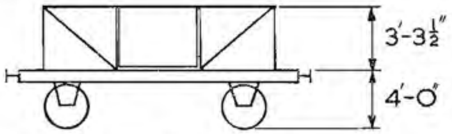
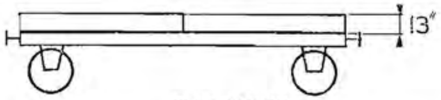
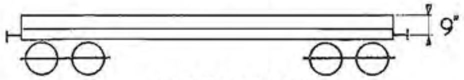
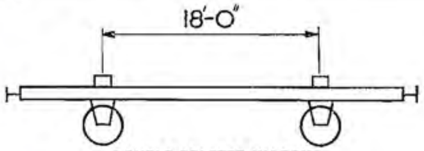
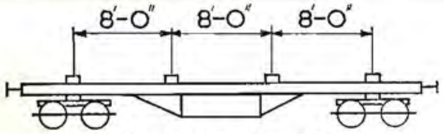
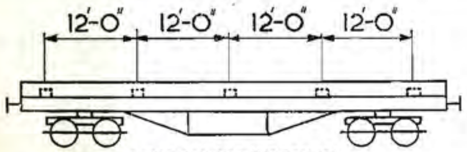
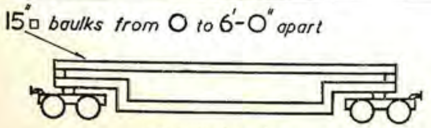
ARTICULATED LORRIES



Type	Total Weight	Wheel Centres		Overall Length
		a	b	
	tons	*ft ins*	*ft ins*	*ft ins*
10 tons	18	23 6	8 0	37 6
18 tons	30	24 6	10 0	40 0
25 tons	40	31 0	10 0	47 0

RAILWAY WAGONS

Approximate Dimensions and Loads

DIAGRAM	Capacity tons	Tare Wt. tons	Loading Lgth. inside	Width inside	Wheels or bogie ctrs.
	tons	*tons*	*ft ins*	*ft ins*	*ft ins*
 GOODS WAGON	13·0	6·0	17 0	7 7¼	8 0
 PLATE WAGON	22·0	10·0	27 0	8 2½	14 0
 BOGIE PLATE WAGON	40·0	20·0	51 10	7 10	40 0
 DOUBLE BOLSTER WAGON	21·0	10·0	18 0 to 30 0	—	15 0
 BOGIE BOLSTER WAGON 'C'	30·0	17·0	45 0	—	35 6
 BOGIE BOLSTER WAGON 'D'	42·0	21·0	52 0	—	40 0
 BO-RAIL FLAT TOP WAGON	50·0	25·0	62 0	8 0	45 0 to 48 0
 FLATROL WAGON	40·0 20·0 20·0 20·0	35·0 28·0 30·0 12·0	40 0 40 0 45 0 20 0	7 6 7 6 7 6 7 6	48 0 48 0 48 0 28 0

WEIGHTS OF ROOF TRUSSES

Due allowance must be made in the design of roof trusses, etc., for the weight of the truss itself. The approximate weights given below are for design purposes only and should not be used for estimating costs, etc.

The weight of steel roof trusses varies between 1¾ lbs. and 3 lbs. per sq. foot of roof area carried (measured on plan).

NORMAL ROOF TRUSSES

Span	No. of panels in each rafter	Truss Centres	Weight
ft ins		*ft ins*	*lbs*
20 0	2	10 0	340
25 0	2	10 0	460
30 0	3	12 6	610
35 0	3	12 6	750
40 0	4	12 6	976
45 0	4	12 6	1210
50 0	4	12 6	1440
55 0	5	15 0	1640
60 0	5	15 0	1930
65 0	6	15 0	2150
70 0	6	15 0	2470
75 0	6	15 0	3080
80 0	6	15 0	3710
90 0	7	20 0	4400
100 0	8	25 0	6220

NORTH LIGHT ROOF TRUSSES

Span	No. of panels in each rafter	Truss Centres	Weight
ft ins		*ft ins*	*lbs*
15 0	2	10 0	270
20 0	3	10 0	410
25 0	3	10 0	620
30 0	4	12 6	787
35 0	4	12 6	1080
40 0	4	12 6	1290

WEIGHTS OF LATTICE AND PLATE GIRDERS

Due allowance must be made in the design of girders, etc. for the weight of the girder itself. The approximate weights given below are for design purposes only and should not be used for estimating costs, etc.

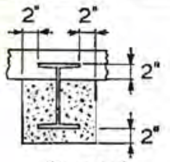
LATTICE GIRDERS

Spans in feet	TOTAL DISTRIBUTED LOAD IN TONS					
	50	**100**	**150**	**200**	**250**	**300**
60	5·0	7·0	9·0	11·0	12·5	14·0
70	6·0	8·0	10·0	12·0	14·0	16·0
80	7·0	9·0	11·0	14·0	17·0	20·0
100	8·0	11·5	15·0	18·0	22·0	26·0
125	10·0	15·0	20·0	25·0	30·0	35·0
150	15·0	21·0	27·0	33·0	39·0	45·0
175	20·0	27·0	34·0	41·0	48·0	55·0
200	25·0	33·0	41·0	49·0	57·0	65·0

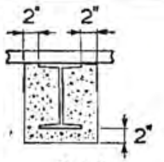
WELDED PLATE GIRDERS

Span in feet	TOTAL DISTRIBUTED LOAD IN TONS					
	50	**100**	**150**	**200**	**250**	**300**
60	5·0	6·5	8·0	9·5	11·0	12·0
70	6·0	8·0	10·0	12·0	13·5	15·0
80	8·0	10·0	12·0	14·0	16·0	18·0
100	12·0	15·0	18·0	21·0	23·5	26·0
125	16·0	21·0	25·0	29·0	33·0	37·0
150	—	27·0	33·0	39·0	45·0	51·0
175	—	35·0	43·0	51·0	59·0	66·0
200	—	—	54·0	63·0	73·0	82·0

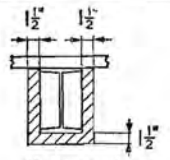
WEIGHTS OF CASED BEAMS



Haunched



Cased

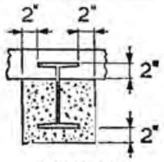


Hollow casing

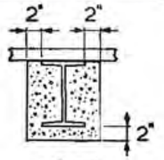
SECTION	HAUNCHED		CASED		HOLLOW CASING	
	Pounds per ft	Tons per ft	Pounds per ft	Tons per ft	Pounds per ft	Tons per ft
36″×16½″×260 lbs U.B.	953	·425	969	·433	398	·178
230 lbs U.B.	919	·410	938	·419	367	·164
36″×12″ ×194 lbs U.B.	741	·331	757	·338	326	·146
170 lbs U.B.	714	·319	732	·327	301	·134
150 lbs U.B.	690	·308	710	·317	280	·125
135 lbs U.B.	673	·300	694	·310	264	·118
33″×11½″×152 lbs U.B.	642	·287	660	·295	274	·122
130 lbs U.B.	616	·275	636	·284	251	·112
118 lbs U.B.	602	·269	623	·278	238	·106
30″×10½″×132 lbs U.B.	545	·243	563	·251	243	·109
116 lbs U.B.	527	·235	546	·244	226	·101
99 lbs U.B.	507	·226	527	·235	208	·093
27″×10″ ×114 lbs U.B.	474	·212	492	·220	215	·096
102 lbs U.B.	460	·205	479	·214	203	·091
94 lbs U.B.	451	·201	471	·210	194	·087
84 lbs U.B.	439	·196	460	·205	184	·082
24″×12″ ×160 lbs U.B.	534	·238	551	·246	258	·115
120 lbs U.B.	488	·218	508	·227	216	·096
100 lbs U.B.	465	·208	487	·217	195	·087
24″× 9″ × 94 lbs U.B.	392	·175	410	·183	185	·083
84 lbs U.B.	380	·170	399	·178	174	·078
76 lbs U.B.	371	·166	390	·174	166	·074
68 lbs U.B.	361	·161	381	·170	157	·070
21″×13″ ×142 lbs U.B.	483	·216	502	·224	231	·103
127 lbs U.B.	466	·208	486	·217	215	·096
112 lbs U.B.	448	·200	470	·210	199	·089
21″× 8¼″× 82 lbs U.B.	330	·147	347	·155	163	·073
73 lbs U.B.	319	·142	337	·150	154	·069
68 lbs U.B.	314	·140	332	·148	148	·066
62 lbs U.B.	306	·137	325	·145	142	·063
55 lbs U.B.	298	·133	317	·142	134	·060
18″× 7½″× 66 lbs U.B.	266	·119	283	·126	137	·061
60 lbs U.B.	259	·116	276	·123	131	·059
55 lbs U.B.	253	·113	271	·121	125	·056
50 lbs U.B.	247	·110	265	·118	120	·054
45 lbs U.B.	241	·108	260	·116	114	·051
18″× 6″ × 55 lbs U.B.	228	·102	243	·109	123	·055
50 lbs U.B.	222	·099	237	·106	118	·053
45 lbs U.B.	216	·096	231	·103	112	·050
16″× 7″ × 50 lbs U.B.	220	·098	237	·106	114	·051
45 lbs U.B.	214	·096	232	·104	108	·048
40 lbs U.B.	208	·093	226	·101	103	·046
36 lbs U.B.	203	·091	222	·099	99	·044

Weights in each case include the weight of the beam plus the weight of the casing, whether solid or hollow, indicated on the diagrams.
Hollow casings have been calculated on the basis of 18 lb/ft².

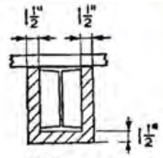
WEIGHTS OF CASED BEAMS



Haunched



Cased

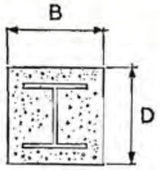


Hollow casing

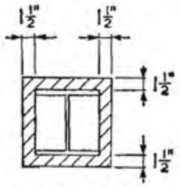
SECTION	HAUNCHED		CASED		HOLLOW CASING	
	Pounds per ft	Tons per ft	Pounds per ft	Tons per ft	Pounds per ft	Tons per ft
16″×6″ ×50 lbs U.B.	205	·092	220	·098	113	·050
45 lbs U.B.	199	·089	214	·096	107	·048
40 lbs U.B.	193	·086	209	·093	102	·046
16″×5½″×31 lbs U.B.	177	·079	193	·086	91	·041
26 lbs U.B.	171	·076	187	·083	86	·038
15″×6″ ×45 lbs U.B.	190	·085	206	·092	105	·047
40 lbs U.B.	184	·082	200	·089	99	·044
35 lbs U.B.	178	·079	195	·087	94	·042
14″×6¾″×45 lbs U.B.	192	·086	208	·093	103	·046
38 lbs U.B.	183	·082	201	·090	95	·042
34 lbs U.B.	178	·080	196	·088	91	·041
30 lbs U.B.	173	·077	191	·085	86	·038
14″×5″ ×26 lbs U.B.	145	·065	161	·072	80	·036
22 lbs U.B.	140	·063	156	·070	75	·033
12″×6½″×36 lbs U.B.	159	·071	176	·079	87	·039
31 lbs U.B.	153	·068	170	·076	82	·037
27 lbs U.B.	148	·066	166	·074	77	·034
12″×5″ ×32 lbs U.B.	135	·060	150	·067	81	·036
28 lbs U.B.	130	·058	145	·065	76	·034
25 lbs U.B.	126	·056	141	·063	73	·033
12″×4″ ×22 lbs U.B.	117	·052	130	·058	69	·031
19 lbs U.B.	113	·050	127	·057	66	·029
16·5 lbs U.B.	109	·049	124	·055	63	·028
10″×5¾″×29 lbs U.B.	124	·055	140	·063	73	·033
25 lbs U.B.	119	·053	136	·061	68	·030
21 lbs U.B.	114	·051	131	·059	64	·029
10″×4″ ×19 lbs U.B.	98	·044	112	·050	60	·027
17 lbs U.B.	95	·042	109	·049	58	·026
15 lbs U.B.	92	·041	107	·048	56	·025
8″×5¼″×20 lbs U.B.	92	·041	108	·048	57	·025
17 lbs U.B.	88	·039	105	·047	53	·024
8″×4″ ×17 lbs R.S.J.	78	·035	92	·041	52	·023
7″×4″ ×14·5 lbs R.S.J.	68	·030	82	·037	46	·021
6″×3½″×11·5 lbs R.S.J.	55	·025	68	·030	39	·017
5″×3″ × 9 lbs R.S.J.	43	·019	55	·025	33	·015
4″×2½″× 6·5 lbs R.S.J.	32	·014	44	·020	27	·012
3″×2″ × 4·5 lbs R.S.J.	22	·010	33	·015	21	·009

Weights in each case include the weight of the beam plus the weight of the casing, whether solid or hollow, indicated on the diagrams.
Hollow casings have been calculated on the basis of 18 lb/ft².

WEIGHTS OF CASED COLUMNS



Fully cased



Hollow casing

SECTION	Size D × B inches	FULLY CASED		HOLLOW CASING	
		Pounds per ft	Tons per ft	Pounds per ft	Tons per ft
14″×16″ ×426 lbs U.C.	22¾×20¾	773	·345	541	·241
370 lbs U.C.	22 ×20½	712	·317	482	·215
314 lbs U.C.	21¼×20¼	652	·291	423	·188
264 lbs U.C.	20½×20¼	602	·268	371	·165
228 lbs U.C.	20 ×20	561	·250	333	·148
193 lbs U.C.	19½×19¾	521	·232	296	·132
158 lbs U.C.	19 ×19¾	487	·217	259	·115
Column Core 320 lbs	21 ×20¾	662	·295	430	·192
14″×14½″×136 lbs U.C.	18¾×18¾	448	·200	233	·104
119 lbs U.C.	18½×18¾	431	·192	215	·096
103 lbs U.C.	18¼×18¾	415	·185	198	·088
87 lbs U.C.	18 ×18½	394	·175	182	·081
12″×12″ ×190 lbs U.C.	18½×16¾	444	·198	280	·125
161 lbs U.C.	18 ×16¾	415	·185	249	·111
133 lbs U.C.	17½×16½	383	·171	219	·097
106 lbs U.C.	17 ×16¼	351	·156	190	·084
92 lbs U.C.	16¾×16¼	337	·150	175	·078
79 lbs U.C.	16½×16¼	324	·144	161	·071
65 lbs U.C.	16¼×16	306	·136	146	·065
10″×10″ ×112 lbs U.C.	15½×14½	304	·135	186	·083
89 lbs U.C.	15 ×14½	280	·125	161	·071
72 lbs U.C.	14½×14¼	257	·114	143	·063
60 lbs U.C.	14¼×14¼	245	·109	130	·058
49 lbs U.C.	14 ×14	231	·103	118	·052
8″× 8″ × 58 lbs U.C.	12¾×12¼	197	·087	118	·052
48 lbs U.C.	12½×12¼	187	·083	107	·047
40 lbs U.C.	12¼×12¼	178	·079	98	·043
35 lbs U.C.	12¼×12¼	175	·078	92	·041
31 lbs U.C.	12 ×12	166	·074	88	·039
6″× 6″ × 25 lbs U.C.	10½×10¼	125	·055	71	·031
20 lbs U.C.	10¼×10¼	119	·053	66	·029
15.7 lbs U.C.	10 ×10	111	·049	61	·027

Weights in each case include the weight of the beam plus the weight of the casing, whether solid or hollow indicated on the diagrams.
Hollow casings have been calculated on the basis of 18 lb/ft^2.

PART VIII

Design Formulæ

RT VIII

Formulæ

TS

pages

590–598

599–600

601

ICIENTS 602–606

S 607–616

618–619

620–622

623–626

7–632

sq. in.

form section beam

N

downward.

ng upward.

ction where the upward left hand sup-
is greater than the algebraic sum of
ads located left of that section.

(shown above base line on diagrams) when
g convexity downward.

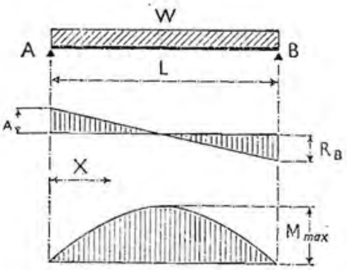
tive when downward.

appropriate values in radians are given, but the signs depend upon which support or which section is being considered, and can be readily ascertained by inspection.

permits, general equations for M_X and i_X at any point of the beam,
he equation to the elastic line (δ_X), have been included.

for Slope. These may be used in evaluating the angle of rotation for rubber
ngs and similar constructional elements.

SIMPLY SUPPORTED BEAM — UNIFORM LOAD ON FULL SPAN



Span $= L$

Total Uniform Load $= W$

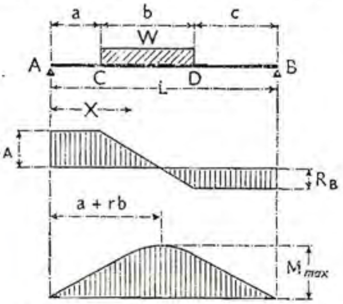
$R_A = R_B = \frac{W}{2}$

at mid-span $\begin{cases} M_{max} = \frac{WL}{8} \\ \delta_{max} = \frac{5}{384} \cdot \frac{WL^3}{EI} \end{cases}$

$i_A = i_B = \frac{WL^2}{24EI}$

at X from A $\begin{cases} M_X = \frac{WX}{2L}(L-X) \\ \delta_X = \frac{WX}{24EIL}(X^3-2X^2L+L^3) \\ i_X = \frac{W}{24EIL}(4X^3-6X^2L+L^3) \end{cases}$

SIMPLY SUPPORTED BEAM — UNIFORM LOAD ON PART OF SPAN



Span $= L$

Total Uniform Load $= W$

Let $r = \frac{0{\cdot}5b+c}{L}$

$R_A = Wr$; $R_B = W(1-r)$

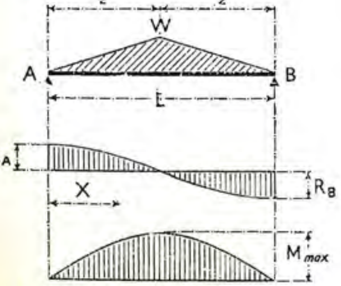
at $X = a+rb$, $M_{max} = Wr(a+0{\cdot}5rb)$

$i_A = \frac{Wr}{6EI}(L^2-c^2-Lbr)$; $i_B = \frac{W(1-r)}{6EI}\left[L^2-a^2-Lb(1-r)\right]$

Equation to elastic line between C and D, i.e. $a \leqslant X \leqslant a+b$

$$\delta_X = \frac{W}{24EIb}\left[X^4-4(a+rb)X^3+6a^2X^2+4\left\{rb\left(L^2-c^2-cb-\frac{b^2}{2}\right)-a^3\right\}X+a^4\right]$$

SIMPLY SUPPORTED BEAM — TRIANGULAR LOAD ON FULL SPAN



Span $= L$

Total Load $= W$

$R_A = R_B = \frac{W}{2}$

at mid-span $\begin{cases} M_{max} = \frac{WL}{6} \\ \delta_{max} = \frac{WL^3}{60EI} \end{cases}$

$i_A = i_B = \frac{5WL^2}{96EI}$

at X from A between A & centre $\begin{cases} M_X = \frac{WX}{6L^2}(3L^2-4X^2) \\ \delta_X = \frac{WX}{480EIL^2}(16X^4-40X^2L^2+25L^4) \\ i_X = \frac{W}{96EIL^2}(16X^4-24X^2L^2+5L^4) \end{cases}$

Formulæ for Beams

NOTATION

L = length of span in inches.
W = total distributed or point load in tons.
W_1 W_2 or Σ = point load in tons. = resultant of point loads in tons.
R_A, R_B, R_C etc. = reaction at A, B, or C etc., in tons.
V = shearing force in tons.
m = applied moment in tons (p. 596) or a coefficient (pp. 597 and 598).
M_x = bending moment in tons ins. } at distance X from the left hand support A.
δ_x = deflection in inches. } at distance X from the left hand support A.
i_x = slope in radians. } at distance X from the left hand support A.
M_A or M_B = end fixing moment in tons ins.
M_{max} = maximum bending moment in tons ins.
$M_{max\ max}$ = absolute maximum bending moment in tons ins.
M_{load} = bending moment under the load in tons ins.
δ_{max} = maximum deflection in inches.
$\delta_{max\ max}$ = absolute maximum deflection in inches.
$\delta_{negative}$ = negative (i.e. upward) deflection in inches.
i_A or i_B = slope at A or at B in radians.
E = modulus of elasticity, 13,000 tons per sq. in.
I = constant moment of inertia of uniform section beam in ins.^{4}

SIGN CONVENTION

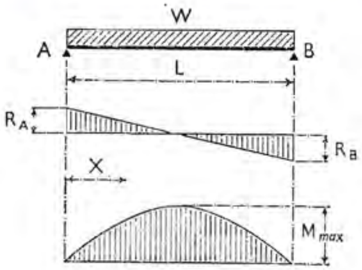
Loads	+ positive when acting downward.
Support Reaction	+ positive when acting upward.
Shearing Force	+ positive on a section where the upward left hand support reaction is greater than the algebraic sum of external loads located left of that section.
Bending Moment	+ positive (shown above base line on diagrams) when causing convexity downward.
Deflection	+ positive when downward.
Slope	appropriate values in radians are given, but the signs depend upon which support or which section is being considered, and can be readily ascertained by inspection.

Where space permits, general equations for M_x and i_x at any point of the beam, and also the equation to the elastic line (δ_x), have been included.

Values for Slope. These may be used in evaluating the angle of rotation for rubber bearings and similar constructional elements.

SIMPLY SUPPORTED BEAM

UNIFORM LOAD ON FULL SPAN



Span $= L$
Total Uniform Load $= W$
$R_A = R_B = \dfrac{W}{2}$

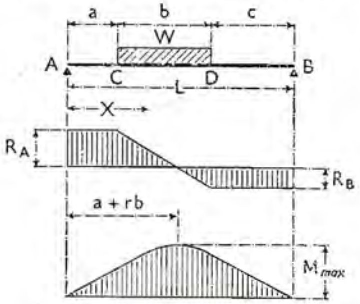
at mid-span $\begin{cases} M_{max} = \dfrac{WL}{8} \\ \delta_{max} = \dfrac{5}{384} \cdot \dfrac{WL^3}{EI} \end{cases}$

$i_A = i_B = \dfrac{WL^2}{24EI}$

at X from A $\begin{cases} M_x = \dfrac{WX}{2L}(L-X) \\ \delta_x = \dfrac{WX}{24EIL}(X^3-2X^2L+L^3) \\ i_x = \dfrac{W}{24EIL}(4X^3-6X^2L+L^3) \end{cases}$

SIMPLY SUPPORTED BEAM

UNIFORM LOAD ON PART OF SPAN



Span $= L$

Total Uniform Load $= W$

Let $r = \dfrac{0{\cdot}5b+c}{L}$

$R_A = Wr$; $R_B = W(1-r)$

at $X = a+rb$, $M_{max} = Wr(a+0{\cdot}5rb)$

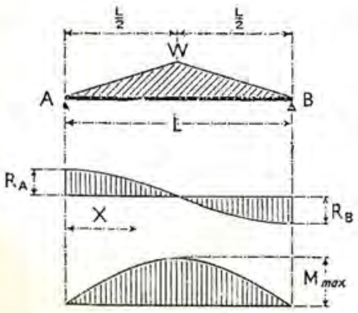
$i_A = \dfrac{Wr}{6EI}(L^2-c^2-Lbr)$; $i_B = \dfrac{W(1-r)}{6EI}\left[L^2-a^2-Lb(1-r)\right]$

Equation to elastic line between C and D, i.e. $a \leqslant X \leqslant a+b$

$$\delta_x = \frac{W}{24EIb}\left[X^4-4(a+rb)X^3+6a^2X^2+4\left\{rb\left(L^2-c^2-cb-\frac{b^2}{2}\right)-a^3\right\}X+a^4\right]$$

SIMPLY SUPPORTED BEAM

TRIANGULAR LOAD ON FULL SPAN



Span $= L$
Total Load $= W$
$R_A = R_B = \dfrac{W}{2}$

at mid-span $\begin{cases} M_{max} = \dfrac{WL}{6} \\ \delta_{max} = \dfrac{WL^3}{60EI} \end{cases}$

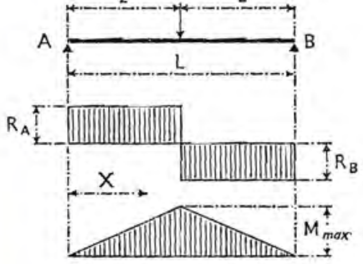
$i_A = i_B = \dfrac{5WL^2}{96EI}$

at X from A between A & centre $\begin{cases} M_x = \dfrac{WX}{6L^2}(3L^2-4X^2) \\ \delta_x = \dfrac{WX}{480EIL^2}(16X^4-40X^2L^2+25L^4) \\ i_x = \dfrac{W}{96EIL^2}(16X^4-24X^2L^2+5L^4) \end{cases}$

Formulæ for Beams

For notation and sign convention see page 590

SIMPLY SUPPORTED BEAM



POINT LOAD AT MID-SPAN

Span $= L$

Point Load $= W$

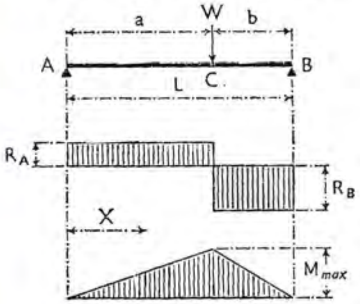
$R_A = R_B = \frac{W}{2}$

at mid-span $\left\{\begin{array}{ll} M_{max} & = \frac{WL}{4} \\ \delta_{max} & = \frac{1}{48} \cdot \frac{WL^3}{EI} \end{array}\right.$

$i_A = i_B = \frac{WL^2}{16EI}$

at X from A between A & centre $\left\{\begin{array}{ll} M_X & = \frac{WX}{2} \\ \delta_X & = \frac{WX}{48EI}(3L^2-4X^2) \\ i_X & = \frac{W}{16EI}(L^2-4X^2) \end{array}\right.$

SIMPLY SUPPORTED BEAM



POINT LOAD AT ANY POSITION

Span $= L$

Point Load $= W$

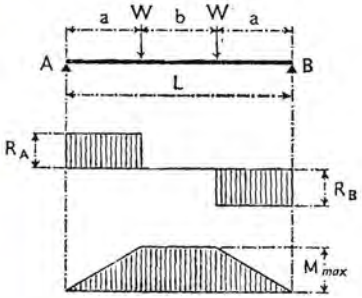
$R_A = \frac{Wb}{L}; \quad R_B = \frac{Wa}{L}$

at C under load $\left\{\begin{array}{ll} M_{max} & = \frac{Wab}{L} \\ \delta_C & = \frac{Wa^2b^2}{3EIL} \end{array}\right.$

$i_A = \frac{Wab}{6EIL}(L+b); \quad i_B = \frac{Wab}{6EIL}(L+a)$

When $a > b$ δ_{max} is at X from A $\left\{\begin{array}{ll} \delta_{max} & = \frac{Wab(L+b)}{27EIL}\sqrt{3a(L+b)} \\ X & = \sqrt{\frac{a(L+b)}{3}} \end{array}\right.$

SIMPLY SUPPORTED BEAM



TWO EQUAL SYMMETRICAL POINT LOADS

Span $= L$

Two Point Loads, each $= W$

$R_A = R_B = W$

M_{max} over length b $= Wa$

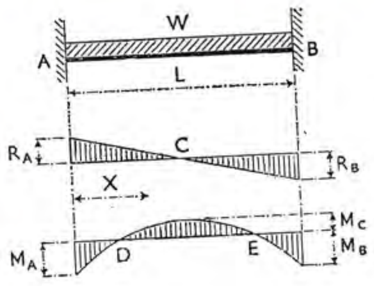
δ_{max} at mid-span $= \frac{Wa}{24EI}(3L^2-4a^2)$

δ under either load $= \frac{Wa^2}{6EI}(3L-4a)$

$i_A = i_B = \frac{Wa}{2EI}(L-a)$

If $a = b = \frac{L}{3}$, $\delta_{max} = \frac{23}{648} \cdot \frac{WL^3}{EI}$

BEAM FIXED AT BOTH ENDS



at 0·211L from either end $M_D = M_E = 0$

UNIFORM LOAD ON FULL SPAN

Span $= L$

Total Uniform Load $= W$

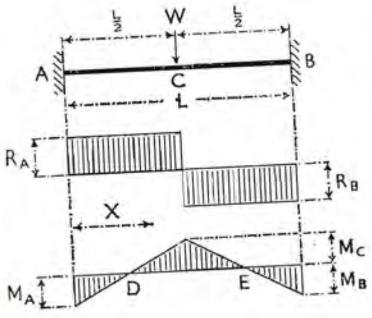
$R_A = R_B = \frac{W}{2}$

$M_A = M_B = -\frac{WL}{12}$

at mid-span $\left\{\begin{array}{ll} M_C & = \frac{WL}{24} \\ \delta_{max} & = \frac{WL^3}{384EI} \end{array}\right.$

at X from A $\left\{\begin{array}{ll} M_X & = -\frac{W}{12L}(L^2-6LX+6X^2) \\ \delta_X & = \frac{WX^2}{24EIL}(L-X)^2 \\ i_X & = \frac{WX}{12EIL}(L^2-3LX+2X^2) \end{array}\right.$

BEAM FIXED AT BOTH ENDS



at 0·25L from either end $M_D = M_E = 0$

POINT LOAD AT MID-SPAN

Span $= L$

Point Load $= W$

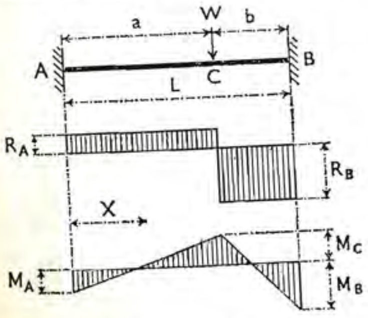
$R_A = R_B = \frac{W}{2}$

$M_A = M_B = -\frac{WL}{8}$

at mid-span $\left\{\begin{array}{ll} M_C & = \frac{WL}{8} \\ \delta_{max} & = \frac{WL^3}{192EI} \end{array}\right.$

at X from A between A & C $\left\{\begin{array}{ll} M_X & = \frac{W}{8}(4X-L) \\ \delta_X & = \frac{WX^2}{48EI}(3L-4X) \\ i_X & = \frac{WX}{8EI}(L-2X) \end{array}\right.$

BEAM FIXED AT BOTH ENDS



POINT LOAD AT ANY POSITION

Span $= L$

Point Load $= W$

$R_A = \frac{Wb^2(L+2a)}{L^3} \quad R_B = \frac{Wa^2(L+2b)}{L^3}$

$M_A = -\frac{Wab^2}{L^2} \quad M_B = -\frac{Wa^2b}{L^2}$

at C, under load, $M_C = \frac{2Wa^2b^2}{L^3}$

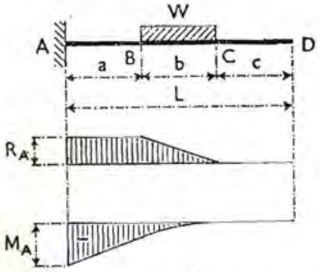
at X from A between A & C $\left\{\begin{array}{ll} M_X & = -\frac{Wab^2}{L^2} + \frac{Wb^2(L+2a)X}{L^3} \\ \delta_X & = \frac{Wb^2X^2[3La-(L+2a)X]}{6EIL^3} \\ i_X & = \frac{Wb^2X[2La-(L+2a)X]}{2EIL^3} \end{array}\right.$

When $a > b$ the maximum deflection is at $X = \frac{2La}{L+2a}$ $\quad \delta_{max} = \frac{2Wa^3b^2}{3EI(L+2a)^2}$

Formulæ for Beams

For notation and sign convention see page 590

CANTILEVER



UNIFORM LOAD ON PART OF SPAN

Span $= L$

Uniform Load $= W$

$R_A = W$

$M_A = -W\left(a+\frac{b}{2}\right)$

$i_C = i_D = \frac{W}{6EI}(3a^2+3ab+b^2)$

$\delta_D = \frac{W}{24EI}\left[8a^3+18a^2b+12ab^2+3b^3+4c(3a^2+3ab+b^2)\right]$

SPECIAL CASE: UNIFORM LOAD ON FULL SPAN

Span $= L = b$

$a = c = 0$

Uniform Load $= W$

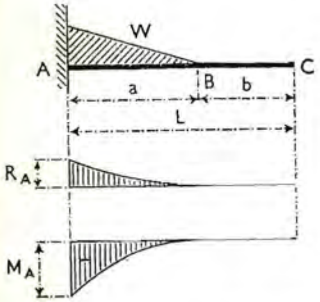
$R_A = W$

$M_A = -\frac{WL}{2}$

$i_D = \frac{WL^2}{6EI}$

$\delta_D = \frac{WL^3}{8EI}$

CANTILEVER



TRIANGULAR LOAD ON PART OF SPAN

Span $= L$

Triangular Load $= W$

$R_A = W$

$M_A = -\frac{Wa}{3}$

$\delta_C = \frac{Wa^2}{15EI}\left(L+\frac{b}{4}\right)$

$i_B = i_C = \frac{Wa^2}{12EI}$

SPECIAL CASE: TRIANGULAR LOAD ON FULL SPAN

Span $= L = a$

$b = 0$

Triangular Load $= W$

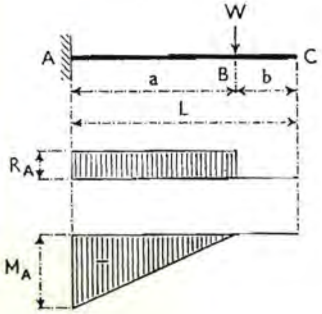
$R_A = W$

$M_A = -\frac{WL}{3}$

$\delta_C = \frac{WL^3}{15EI}$

$i_C = \frac{WL^2}{12EI}$

CANTILEVER



POINT LOAD AT ANY POSITION

Span $= L$

Point Load $= W$

$R_A = W$

$M_A = -Wa$

$\delta_C = \frac{Wa^2}{3EI}\left(L+\frac{b}{2}\right)$

$i_B = i_C = \frac{Wa^2}{2EI}$

SPECIAL CASE: POINT LOAD AT FREE END

Span $= L = a$

$b = 0$

Point Load $= W$

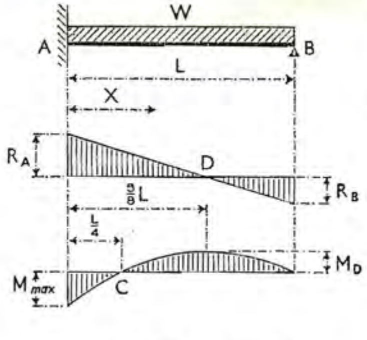
$R_A = W$

$M_A = -WL$

$\delta_C = \frac{WL^3}{3EI}$

$i_C = \frac{WL^2}{2EI}$

PROPPED CANTILEVER



at $\frac{1}{4}L$ from A, $M_C = 0$

UNIFORM LOAD ON FULL SPAN

Span $= L$

Total Uniform Load $= W$

$R_A = \frac{5}{8}W$ $\quad R_B = \frac{3}{8}W$

at A $\quad M_{max} = -\frac{WL}{8}$

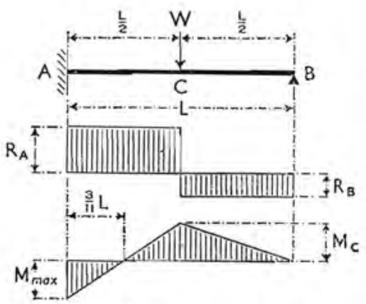
at $\frac{5}{8}L$ from A $\quad M_D = \frac{9}{128}WL$

at 0·5785L from A $\quad \delta_{max} = \frac{WL^3}{185EI}$

at B $\quad i_B = \frac{WL^2}{48EI}$

at X from A $\quad \begin{cases} M_X = -\frac{W}{8L}(L^2-5LX+4X^2) \\ \delta_X = \frac{WX^2}{48EIL}(3L^2-5LX+2X^2) \\ i_X = \frac{WX}{48EIL}(6L^2-15LX+8X^2) \end{cases}$

PROPPED CANTILEVER



at $\frac{3}{11}L$ from A, $M = 0$

POINT LOAD AT MID-SPAN

Span $= L$

Point Load $= W$

$R_A = \frac{11}{16}W$ $\quad R_B = \frac{5}{16}W$

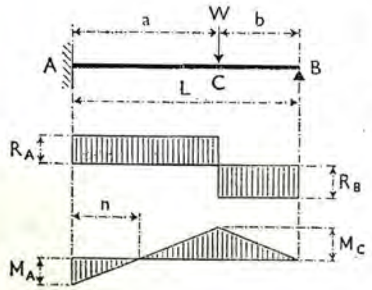
at A $\quad M_{max} = -\frac{3}{16}WL$

at mid-span under load $\quad \begin{cases} M_C = \frac{5}{32}WL \\ \delta_C = \frac{7WL^3}{768EI} \end{cases}$

at 0·5528L from A, $\delta_{max} = \frac{WL^3}{107EI}$

at B $\quad i_B = \frac{WL^2}{32EI}$

PROPPED CANTILEVER



at $n = aL\frac{L+b}{3L^2-b^2}$ from A, $M = 0$

POINT LOAD AT ANY POSITION

Span $= L$

Point Load $= W$

$R_A = \frac{Wb(3L^2-b^2)}{2L^3}$ $\quad R_B = \frac{Wa^2(2L+b)}{2L^3}$

$M_A = -\frac{Wab(L+b)}{2L^2}$ $\quad M_C = \frac{Wa^2b(2L+b)}{2L^3}$

$i_B = \frac{Wa^2b}{4EIL}$

Absolute max deflection is under the load when $a = b\sqrt{2} = 0{\cdot}5858L$ $\quad \delta_{max\ max} = \frac{WL^3}{102EI}$

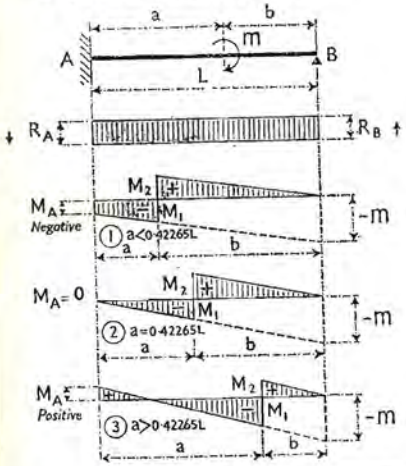
When $a > b\sqrt{2}$ max. deflection is between A and C $\quad \delta_{max} = \frac{Wa^3b}{3EI}\cdot\frac{(L+b)^3}{(3L^2-b^2)^2}$

When $a < b\sqrt{2}$ max deflection is between C and B $\quad \delta_{max} = \frac{Wa^2b}{6EI}\sqrt{\frac{b}{2L+b}}$

Formulæ for Beams

For notation and sign convention see page 590

PROPPED CANTILEVER



MOMENT APPLIED AT ANY POINT

Span $= L$ Applied Moment $= m$

$M_A = \frac{L^2-3b^2}{2L^2}m$ $i_B = \frac{ma}{4EIL}(2b-a)$

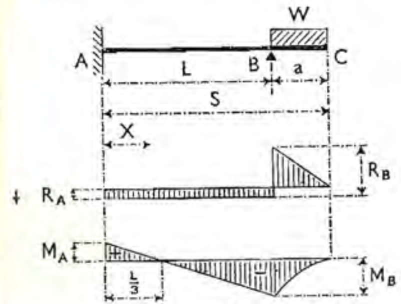
$R_A = -R_B = -\frac{3(L^2-b^2)}{2L^3}m = -\frac{m+M_A}{L}$

$$\begin{cases} M_1 = -\frac{m}{L^3}\left(a^3+\frac{3}{2}a^2b+b^3\right) \\ M_2 = \frac{3\,mab}{L^3}\left(b+\frac{a}{2}\right) = m + M_1 \end{cases}$$

$$\begin{cases} M_1 = -0{\cdot}42265\ m \\ M_2 = 0{\cdot}57735\ m \end{cases}$$

$$\left.\begin{matrix} M_1 = \\ M_2 = \end{matrix}\right\}$$ as for ①

PROPPED CANTILEVER



at $X = \frac{L}{3}$ from A, $M = 0$]

UNIFORM LOAD ON LENGTH BEYOND PROP

Span $= L$ Full Length $= S$

Uniform Load $= W$

$R_A = -\frac{3Wa}{4L}$ $R_B = \frac{W}{L}\left(S-\frac{a}{4}\right)$

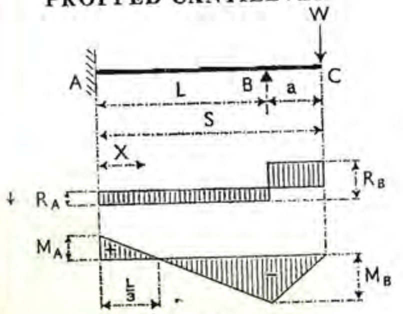
$M_A = \frac{Wa}{4}$ $M_B = -\frac{Wa}{2}$

Deflection at C $= \delta_{max} = \frac{Wa^2S}{8EI}$

Max. Negative Deflection at $X = \frac{2}{3}L$ $\Big\}$ $\delta_{neg} = -\frac{WL^2a}{54EI}$

Slope at C $= i_C = \frac{Wa}{8EI}\left(S+\frac{a}{3}\right)$

PROPPED CANTILEVER



at $X = \frac{L}{3}$ from A, $M = 0$

POINT LOAD AT FREE END

Span $= L$ Full Length $= S$

Point Load $= W$

$R_A = -\frac{3Wa}{2L}$ $R_B = \frac{W}{L}\left(S+\frac{a}{2}\right)$

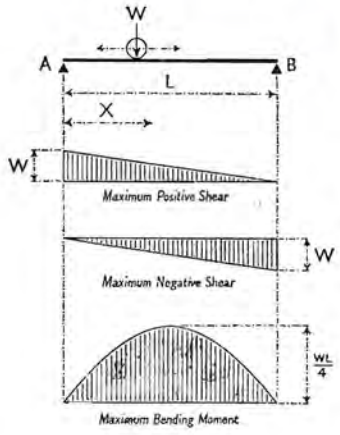
$M_A = \frac{Wa}{2}$ $M_B = -Wa$

Deflection at C $= \delta_{max} = \frac{Wa^2}{4EI}\left(S+\frac{a}{3}\right)$

Max. Negative Deflection at $X = \frac{2}{3}L$ $\Big\}$ $\delta_{neg} = -\frac{WL^2a}{27EI}$

Slope at C $= i_C = \frac{Wa}{4EI}(S+a)$

SIMPLY SUPPORTED BEAM



SINGLE CONCENTRATED MOVING LOAD

Maximum Positive Shear at any section occurs when the load is immediately to the right of the section. Similarly, Maximum Negative Shear occurs when the load is to the left. For a section distance X from A:

Positive $V_{X\,max} = W\frac{L-X}{L}$ | Negative $V_{X\,max} = -W\frac{X}{L}$

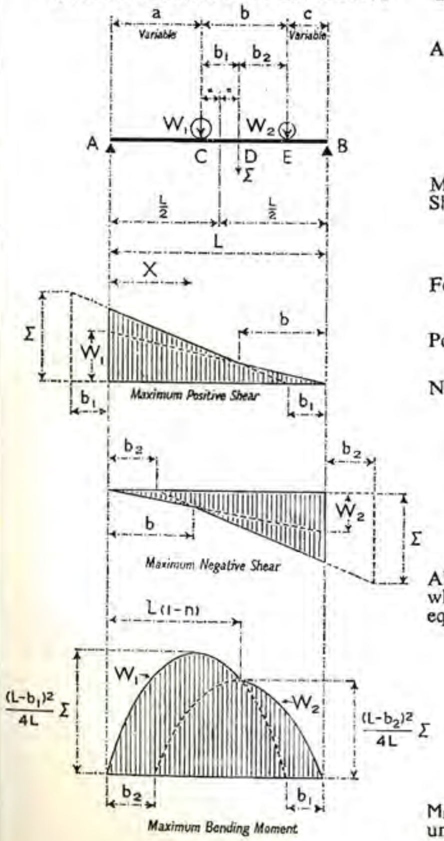
Maximum Bending Moment at any section occurs when the load is over the section. For a section distance X from A:

$$M_{X\,max} = W\frac{X(L-X)}{L}$$

The Absolute Maximum Bending Moment and Deflection occur under the load at mid-span. $\Bigg\}$ $M_{max\,max} = \frac{WL}{4}$ $\delta_{max\,max} = \frac{WL^3}{48EI}$

Maximum end slope at A occurs with the load at $X = 0{\cdot}42265L$ from A. $\Big\}$ $i_{A\,max} = 0{\cdot}06415\frac{WL^2}{EI}$

SIMPLY SUPPORTED BEAM



TWO CONCENTRATED MOVING LOADS

Assume: $W_1 > W_2$ $W_1 + W_2 = \Sigma$ $W_2 = n\Sigma$

Fixed Distance $b = mL$

$b_1 = \frac{W_2}{W_1+W_2}b = nmL$ $b_2 = (m-nm)L$

Maximum Reaction at A and Absolute Maximum Positive Shear occur when W_1 is immediately to the right of A:

$$R_{A\,max} = \text{Positive } V_{max\,max} = W_1 + W_2\ \frac{L-b}{L}$$

For a section distance X from A:

$X \leqslant L-b$ | $L-b \leqslant X$

Positive $V_{max} = \frac{L-X}{L}\Sigma - mW_2$ | Positive $V_{max} = \frac{L-X}{L}W_1$

Note: 1. For $R_{B\,max}$, interchange values of W_1 & W_2 in the formula for $R_{A\,max}$.

2. For Negative Shear, interchange W_1 & W_2 in formulae for Positive Shear, measuring X from B towards A.

3. If $m > \frac{n}{1-n}$ calculate $R_{B\,max}$ & Negative Shear values for W_1 only as single load.

Absolute Maximum Bending Moment occurs under W_1 when that load and the resultant of both loads are equidistant from mid-span (see loading diagram):

$$M_{max\,max} = \frac{(L-b_1)^2}{4L}\Sigma$$

If $m < n$, the Maximum Bending Moment at any section occurs under one of the loads. For a section distance X from A:

$X \leqslant L(1-n)$ | $L(1-n) \leqslant X$

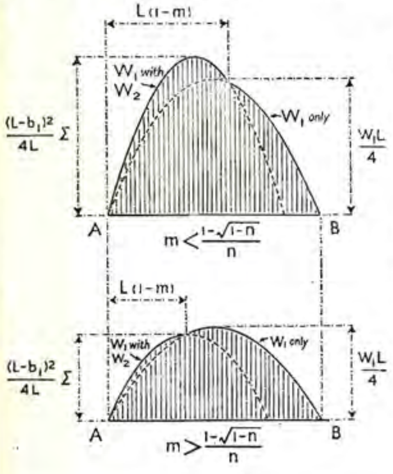
M_{max} under W_1 $= \frac{(L-b_1-X)X}{L}\Sigma$ | M_{max} under W_2 $= \frac{(X-b_2)(L-X)}{L}\Sigma$

[CONTINUED OVERLEAF

Formulæ for Beams

For notation and sign convention see page 590

SIMPLY SUPPORTED BEAM TWO CONCENTRATED MOVING LOADS (*continued*)



If $m > n$, the Maximum Bending Moment at any section always occurs under W_1 (the heavier load), whether W_2 is on or off the span.

For a section distance X from A:

$$X \leqslant L(1-m) \qquad M_{max} = \frac{(L-b_1-X)X}{L}\Sigma$$

$$L(1-m) \leqslant X \qquad M_{max} = \frac{(L-X)X}{L}W_1$$

If $n < m < \frac{1-\sqrt{1-n}}{n}$ the Absolute Maximum Bending Moment occurs under W_1 with W_2 on the span.

If $n < m > \frac{1-\sqrt{1-n}}{n}$ the Absolute Maximum Bending Moment occurs under W_1 at mid-span with W_2 off the span.

Note: When the two loads are equal ($W_1 = W_2$ and $n = \frac{1}{2}$) the critical value of $\frac{1-\sqrt{1-n}}{n} = 0{\cdot}5858$.

SIMPLY SUPPORTED BEAMS CARRYING SEVERAL MOVING CONCENTRATED LOADS

The Maximum Reaction and the Maximum Shear due to several moving concentrated loads occur at one support with one of the loads at that support. The location producing the Absolute Maximum must be found by trial.

The Maximum Bending Moment due to several moving concentrated loads occurs under one of the loads when that load and the gravity centre of all loads are equidistant from mid-span. The Absolute Maximum must be determined by trial.

CONTINUOUS BEAMS

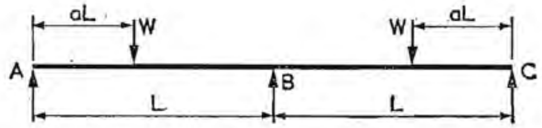
COEFFICIENTS FOR CONCENTRATED LOADS

Reactions: Multiply coefficient by W

All spans equal
Constant moment of inertia
Concentrated load W on span
under consideration

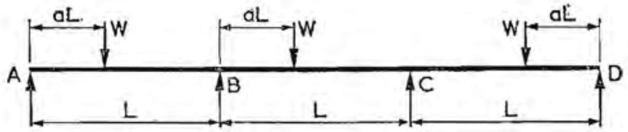
Moments: Multiply coefficient by WL

2 Spans



Load on Span A-B	Values of '*a*'									Load on Span B-C
	·1	·2	·3	·4	·5	·6	·7	·8	·9	
R_A	·8753	·7520	·6318	·5160	·4063	·3040	·2063	·1280	·0573	**R_C**
R_B	·1495	·2960	·4365	·5680	·6875	·7920	·8875	·9440	·9855	**R_B**
R_C	−·0248	−·0480	−·0683	−·0840	−·0938	−·0960	−·0938	−·0720	−·0428	**R_A**
M_B	−·0248	−·0480	−·0683	−·0840	−·0938	−·0960	−·0938	−·0720	−·0428	**M_B**
M_{Load}	·0875	·1504	·1895	·2064	·2031	·1824	·1444	·1024	·0515	**M_{Load}**

3 Spans



Load on Span A-B	Values of '*a*'									Load on Span B-C
	·1	·2	·3	·4	·5	·6	·7	·8	·9	
R_A	·8736	·7488	·6272	·5104	·4000	·2976	·2048	·1232	·0544	**R_D**
R_B	·1594	·3152	·4638	·6016	·7250	·8304	·9142	·9728	1·0026	**R_C**
R_C	−·0396	−·0768	−·1092	−·1344	−·1500	−·1536	−·1428	−·1152	−·0684	**R_B**
R_D	·0066	·0128	·0182	·0224	·0250	·0256	·0238	·0192	·0114	**R_A**
M_B	−·0264	−·0512	−·0728	−·0896	−·1000	−·1024	−·0952	−·0768	−·0456	**M_C**
M_C	·0066	·0128	·0182	·0224	·0250	·0256	·0238	·0192	·0114	**M_B**
M_{Load}	·0874	·1498	·1882	·2042	·2000	·1786	·1434	·0986	·0490	**M_{Load}**

Load on Span B-C	Values of '*a*'								
	·1	·2	·3	·4	·5	·6	·7	·8	·9
R_A	−·0390	−·0640	−·0770	−·0800	−·0750	−·0640	−·0490	−·0320	−·0150
R_B	·9630	·8960	·8050	·6960	·5750	·4480	·3210	·2000	·0910
R_C	·0910	·2000	·3210	·4480	·5750	·6960	·8050	·8960	·9630
R_D	−·0150	−·0320	−·0490	−·0640	−·0750	−·0800	−·0770	−·0640	−·0390
M_B	−·0390	−·0640	−·0770	−·0800	−·0750	−·0640	−·0490	−·0320	− 0150
M_C	−·0150	−·0320	−·0490	−·0640	−·0750	−·0800	−·0770	−·0640	−·0390
M_{Load}	·0534	·1024	·1414	·1664	·1750	·1664	·1414	·1024	·0534

CONTINUOUS BEAMS

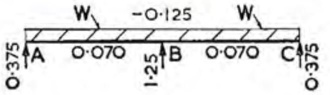
COEFFICIENTS FOR UNIFORMLY DISTRIBUTED LOADS

Reactions: Multiply coefficient by W

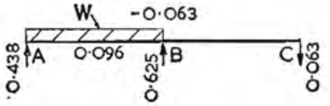
All spans equal to L
Constant moment of inertia
Uniformly Distributed Load
on each loaded span = W

Moments: Multiply coefficient by WL

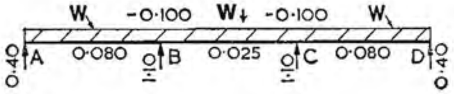
2 Spans



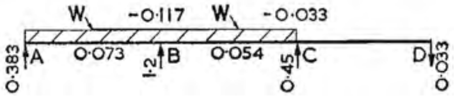
2 Spans



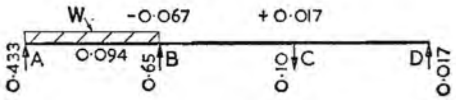
3 Spans



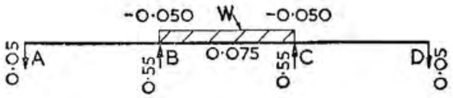
3 Spans



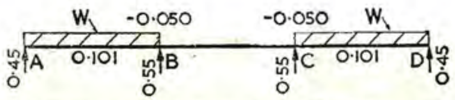
3 Spans



3 Spans



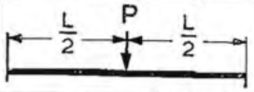
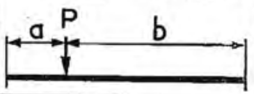
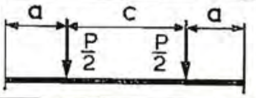
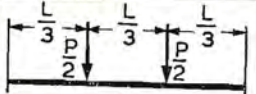
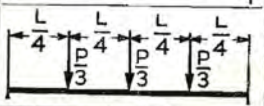
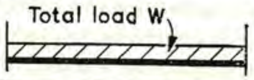
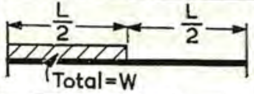
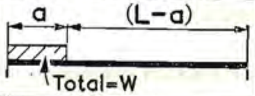
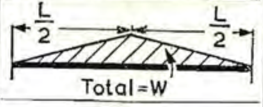
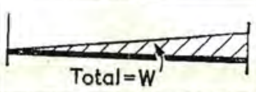
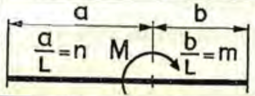
3 Spans



The moment coefficients given above are for the moment at the support and the maximum moment on the span, which is not necessarily at the centre of the span.

FIXED END MOMENTS

For use in analysis by 'Moment Distribution'

Fixing Moment at LH End		LOADING	Fixing Moment at RH End	
BOTH ENDS FIXED	THIS END ONLY FIXED	SPAN = L ALL CASES	BOTH ENDS FIXED	THIS END ONLY FIXED
$\frac{PL}{8}$	$\frac{3PL}{16}$		$\frac{PL}{8}$	$\frac{3PL}{16}$
$\frac{Pab^2}{L^2}$	$\frac{Pab(a+2b)}{2L^2}$		$\frac{Pa^2b}{L^2}$	$\frac{Pab(2a+b)}{2L^2}$
$\frac{Pa(a+c)}{2L}$	$\frac{3Pa(a+c)}{4L}$		$\frac{Pa(a+c)}{2L}$	$\frac{3Pa(a+c)}{4L}$
$\frac{PL}{9}$	$\frac{PL}{6}$		$\frac{PL}{9}$	$\frac{PL}{6}$
$\frac{5PL}{48}$	$\frac{5PL}{32}$		$\frac{5PL}{48}$	$\frac{5PL}{32}$
$\frac{PL}{12}\left(\frac{n+1}{n}\right)$	$\frac{PL}{8}\left(\frac{n+1}{n}\right)$	Total load P in (n - 1) parts  Span divided into n equal parts	$\frac{PL}{12}\left(\frac{n+1}{n}\right)$	$\frac{PL}{8}\left(\frac{n+1}{n}\right)$
$\frac{WL}{12}$	$\frac{WL}{8}$		$\frac{WL}{12}$	$\frac{WL}{8}$
$\frac{11WL}{96}$	$\frac{9WL}{64}$		$\frac{5WL}{96}$	$\frac{7WL}{64}$
$\frac{Wa}{12L^2}(6L^2-8aL+3a^2)$	$\frac{Wa}{8L^2}(2L-a)^2$		$\frac{Wa^2}{12L^2}(4L-3a)$	$\frac{Wa}{8L^2}(2L^2-a^2)$
$\frac{5WL}{48}$	$\frac{5WL}{32}$		$\frac{5WL}{48}$	$\frac{5WL}{32}$
$\frac{WL}{15}$	$\frac{7WL}{60}$		$\frac{WL}{10}$	$\frac{2WL}{15}$
$\frac{Mb}{L^2}(3a-L)$	$\frac{M}{2}(2-6n+3n^2)$		$\frac{Ma}{L^2}(3b-L)$	$\frac{M}{2}(2-6m+3m^2)$

DEFLECTION

The vertical deflection of beams due to live load is limited by B.S.449:1964 to 1/360 of the span, with the proviso that this limit may be exceeded where greater deflection would not impair the strength and efficiency of the structure, lead to damage of finishings or be unsightly.

Purlins and side rails are exempt from this limitation.

In the case of large span beams it is prudent to give consideration to the actual total deflection as well as the deflection/span ratio.

The following table may be used as a guide:

Purlins, etc.	$\frac{1}{200}$ — $\frac{1}{250}$
Beams generally	$\frac{1}{360}$ (due to live load only)
Beams over windows, etc.	$\frac{1}{500}$
Crane girders	$\frac{1}{500}$
Beams carrying sectional tanks, etc.	$\frac{1}{750}$ — $\frac{1}{1000}$
Beams supporting plant *such as paper making machinery presses, etc.*	*Special consideration is required and the allowable deflection should be confirmed with the plant manufacturers.*

No specific reference to deflection of cantilevers is made in B.S.449 but it is reasonable to regard a cantilever as equivalent to a half-beam and limit deflection at the free end due to live load to 1/360 of the projection.

The horizontal deflection of stanchions in single storey buildings is limited by B.S.S.449 to 1/325 of the height with the same proviso as for beams.

No regulations have been made in this country for the deflection of buildings as a whole. The theoretical deflection was limited to 1/600 of the height for a building 900 ft. high in New York.

For deflection coefficients for single- and twin-span ridged portals refer to pages 607 and 620 to 626.

For 1/360 of beam span deflection coefficients, refer to page 169.

Deflection formulae for beams are given on pages 590 to 598.

The deflection at mid-span of a simply supported beam having uniform, symmetrical cross section, carrying a uniformly distributed load over its full length is:

$$\frac{\text{f.L}^2}{433{\cdot}3\text{D}}$$

where f = extreme fibre stress in tons/sq. in.
L = span in feet
D = overall depth in inches

Deflections for the above condition of loading and a fibre stress of 10 tons/sq. in. are tabulated on page 605 for a range of depths and spans. Deflections for any other fibre stress, F, may be obtained *pro rata*, that is, by multiplying the deflection value from the table by the ratio $\frac{\text{F}}{10}$. Deflections for intermediate depths may be found by interpolation. A near approximation to the deflection for beams of intermediate spans may also be assessed by interpolation; exact deflections may be calculated by using the formula $\frac{\text{f.L}^2}{433{\cdot}3\text{D}}$

EXAMPLE: Required the deflection at mid-span of a simply supported beam 21 ft. span, 15 ins. depth and subject to 13·8 tons/sq. in.

From table on page 605.

Average of deflections for 14-in. and 16-in. beams on 20 ft. and 22 ft. spans at 10 tons/sq. in. = (·577 + ·659 + ·698 + ·798) ÷ 4 = ·683 ins.

Deflection of 15-in. beam, 21 ft. span at 13·8 tons/sq. in. = $\cdot683 \times \frac{13{\cdot}8}{10}$ = ·94 in.

The maximum deflections of beams having other systems of loading and end supports may be obtained by using the table on page 605 in conjunction with the upper table on page 606.

EXAMPLE: Required the deflection at mid-span of a 30-in. beam, 40 ft. span, simply supported and carrying a central point load causing a fibre stress of 10·5 tons/sq. in.

From table on page 606, the factor for constant stress = ·8.

From table on page 605, and adjusting for stress, the required deflection $= 1{\cdot}23 \times \frac{10{\cdot}5}{10} \times \cdot8 = 1{\cdot}03$ ins.

The deflection of beams of asymmetrical cross section may be obtained from the table on page 605 by taking D = 2n, where n is the distance from the neutral axis to the extreme fibre at which the stress is measured.

EXAMPLE: Required the deflection of a simply supported beam 36 ins. deep, neutral axis 21 ins. from the extreme fibre stressed to 14·5 tons/sq. in. and carrying a U.D.L. on 40 ft.

D = 2n = 2 × 21 = 42 ins.

From table on page 605, and adjusting for stress, the required deflection $= \cdot879 \times \frac{14{\cdot}5}{10} = 1{\cdot}27$ ins.

If the deflection of a beam is to be restricted to a specified limit, the minimum moment of inertia required to ensure this can be obtained from $\text{I} = \frac{\text{WL}^2}{\text{C}}$ for various systems of loading and end conditions.

where I = minimum moment of inertia, ins.^{4}
W = load in tons.
L = span in feet.
C = tabulated coefficient from lower table, page 606.

DEFLECTION *continued*

The stress in the selected section must also be checked.

EXAMPLE: Required the moment of inertia of a simply supported beam 40 ft. span, carrying a 30 tons central point load and restricted to a deflection of 1/500 of the span.
From table C = 8·67.
Required minimum I = 30 × 40^2 ÷ 8·67 = 5536 ins.^{4}

The deflection $\triangle$ in inches at joints of a simple braced girder may be calculated from:

$$\triangle = \sum \frac{\text{S.U.L.}}{\text{A.E.}}$$

where S = load (tons) in member due to total load on girder
U = load coeff. for member due to unit load applied at joint at which deflection is required and in direction in which deflection is required.
L = length of member (ins.)
A = area of member (ins.^{2})
E = modulus of elasticity (= 13000 tons/sq. in.).

The deflection thus derived does not take account of any stiffness of joints but is based on the assumption that each member is subject only to axial stress.

From the above formula there follows the principle of Reciprocal Deflections which states that the deflection at joint **a** caused by a load W at joint **b** is the same as the deflection at joint **b** produced by moving W to **a**. The principle is applicable to beams, portals and the like and may be demonstrated, for example, by reference to the elastic deflection coefficients on pages 620 to 626.

EXAMPLE: Let a load W_9 be applied at C on twin span ridged portal having ratio H to S = ·5 (page 625) then from table for W_9, horizontal deflection at B = $W_9 \times \cdot 283\ S^3 \times 10^{-3} \div I$

Now apply a horizontal load W_{11}, equal to W_9, at B, then from table for W_{11}, vertical deflection at C = $W_{11} \times \cdot 283\ S^3 \times 10^{-3} \div I$.

DEFLECTION OF SIMPLY SUPPORTED GIRDERS AND BEAMS OF UNIFORM CROSS SECTION

Supporting uniformly distributed load over the full span and stressed to 10 tons per sq. in.

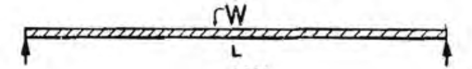
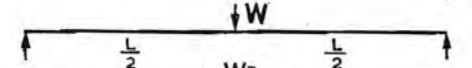
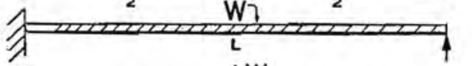
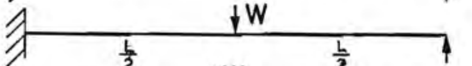
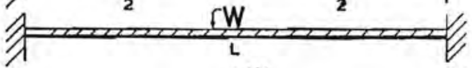
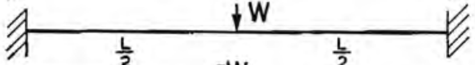
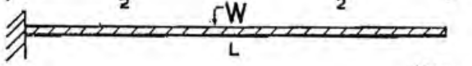
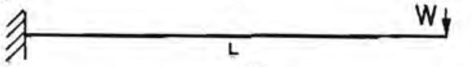
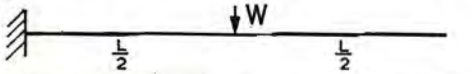
Deflection for any other stress may be obtained pro rata.

	DEFLECTION IN INCHES FOR SPANS IN FEET																
Depth inches*	**10** ·333	**15** ·500	**20** ·667	**25** ·833	**30** 1·00	**35** 1·17	**40** 1·33	**45** 1·50	**50** 1·67	**55** 1·83	**60** 2·00	**65** 2·17	**70** 2·33	**75** 2·50	**80** 2·67	**90** 3·00	**100** 3·33
72	·032	·072	·128	·200	·288	·393	·513	·649	·801	·970	1·15	1·35	1·57	1·80	2·05	2·60	3·21
70	·033	·074	·132	·206	·297	·404	·527	·668	·824	·997	1·19	1·39	1·62	1·85	2·11	2·67	3·30
68	·034	·076	·136	·212	·305	·416	·543	·687	·848	1·03	1·22	1·43	1·66	1·91	2·17	2·75	3·39
66	·035	·079	·140	·219	·315	·428	·559	·708	·874	1·06	1·26	1·48	1·71	1·97	2·24	2·83	3·50
64	·036	·081	·144	·225	·325	·442	·577	·730	·901	1·09	1·30	1·52	1·77	2·03	2·31	2·92	3·61
62	·037	·084	·149	·233	·335	·456	·596	·754	·931	1·13	1·34	1·57	1·82	2·09	2·38	3·01	3·72
60	·038	·087	·154	·240	·346	·471	·615	·779	·962	1·16	1·38	1·62	1·88	2·16	2·46	3·12	3·85
58	·040	·090	·159	·249	·358	·487	·637	·806	·995	1·20	1·43	1·68	1·95	2·24	2·55	3·22	3·98
56	·041	·093	·165	·258	·371	·505	·659	·834	1·03	1·25	1·48	1·74	2·02	2·32	2·64	3·34	4·12
54	·043	·096	·171	·267	·385	·524	·684	·865	1·07	1·29	1·54	1·81	2·09	2·40	2·74	3·46	4·27
52	·044	·100	·178	·277	·399	·544	·710	·899	1·11	1·34	1·60	1·87	2·17	2·50	2·84	3·59	4·44
50	·046	·104	·185	·288	·415	·565	·738	·935	1·15	1·40	1·66	1·95	2·26	2·60	2·95	3·74	4·62
48	·048	·108	·192	·300	·433	·589	·769	·974	1·20	1·45	1·73	2·03	2·36	2·70	3·08	3·89	
46	·050	·113	·201	·314	·452	·615	·803	1·02	1·25	1·52	1·81	2·12	2·46	2·82	3·21	4·06	
44	·052	·118	·210	·328	·472	·642	·839	1·06	1·31	1·59	1·89	2·22	2·57	2·95	3·36		
42	·055	·124	·220	·343	·495	·673	·879	1·11	1·37	1·66	1·98	2·32	2·69	3·09			
40	·058	·130	·231	·361	·519	·707	·923	1·17	1·44	1·75	2·08	2·44	2·83	3·25			
38	·061	·137	·243	·380	·547	·744	·972	1·23	1·52	1·84	2·19	2·57	2·98				
*	**8** ·267	**10** ·333	**12** ·400	**14** ·467	**16** ·533	**18** ·600	**20** ·667	**22** ·733	**24** ·800	**28** ·933	**32** 1·07	**36** 1·20	**40** 1·33	**44** 1·47	**48** 1·60	**52** 1·73	**56** 1·87
36	·041	·064	·092	·126	·164	·208	·256	·310	·369	·503	·656	·831	1·03	1·24	1·48	1·73	2·01
34	·043	·068	·098	·133	·174	·220	·271	·329	·391	·532	·695	·880	1·09	1·31	1·56	1·84	2·13
32	·046	·072	·104	·141	·185	·234	·288	·349	·415	·565	·738	·935	1·15	1·40	1·66	1·95	2·26
30	·049	·077	·111	·151	·197	·249	·308	·372	·443	·603	·788	·997	1·23	1·49	1·77	2·08	2·41
28	·053	·082	·119	·162	·211	·267	·330	·399	·475	·646	·844	1·07	1·32	1·60	1·90	2·23	2·58
26	·057	·089	·128	·174	·227	·288	·355	·430	·511	·696	·909	1·15	1·42	1·72	2·04	2·40	
24	·062	·096	·138	·188	·246	·312	·385	·465	·554	·754	·985	1·25	1·54	1·86	2·22	2·60	
22	·067	·105	·151	·206	·269	·340	·420	·508	·604	·822	1·07	1·36	1·68	2·03	2·42		
20	·074	·115	·166	·226	·295	·374	·462	·558	·665	·905	1·18	1·50	1·85	2·23			
18	·082	·128	·185	·251	·328	·415	·513	·621	·738	1·01	1·31	1·66	2·05				
16	·092	·144	·208	·283	·369	·467	·577	·698	·831	1·13	1·48	1·87	2·31				
14	·105	·165	·237	·323	·422	·534	·659	·798	·949	1·29	1·69	2·14					
12	·123	·192	·277	·377	·492	·623	·769	·931	1·11	1·51	1·97						
10	·148	·231	·332	·452	·591	·748	·923	1·12	1·33	1·81							
8	·185	·288	·415	·565	·738	·935	1·15	1·40	1·66								

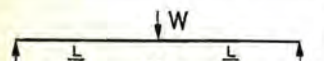
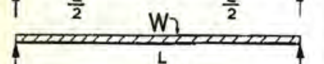
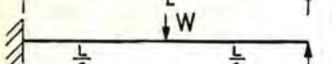
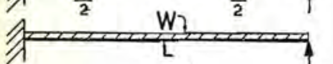
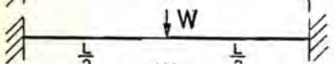
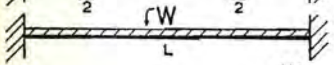
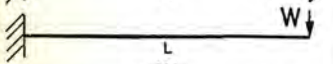
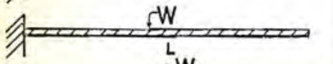
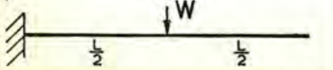
* $\frac{1}{360}$th of each span is given in inches below the respective span.

DEFLECTION OF BEAMS

DEFLECTION COEFFICIENTS FOR TYPICAL LOADING CONDITIONS

If Load Constant	LOADING CONDITION	If Stress Constant
1·0		1·0
1·6		0·8
0·415		0·415
0·716		0·477
0·2		0·3
0·4		0·4
9·6		2·4
25·6		3·2
8·0		2·0

INERTIA OF BEAMS SUBJECT TO VARIOUS LOADING CONDITIONS FOR VARIOUS RATIOS OF DEFLECTION TO SPAN

LOADING CONDITION	RATIO OF SPAN						
	$\frac{1}{200}$	$\frac{1}{240}$	$\frac{1}{250}$	$\frac{1}{360}$	$\frac{1}{500}$	$\frac{1}{750}$	$\frac{1}{1000}$
	21·67	18·06	17·33	12·04	8·67	5·78	4·33
	34·67	28·89	27·73	19·26	13·87	9·24	6·93
	48·45	40·37	38·76	26·92	19·38	12·92	9·69
	83·51	69·59	66·81	46·39	33·40	22·27	16·70
	86·67	72·22	69·33	48·15	34·67	23·11	17·33
	173·33	144·44	138·67	96·30	69·33	46·22	34·67
	1·354	1·128	1·083	0·752	0·542	0·361	0·271
	3·611	3·009	2·889	2·006	1·444	0·963	0·722
	4·333	3·611	3·467	2·407	1·733	1·156	0·867

SINGLE AND DOUBLE SPAN

PORTALS

The formulae, nomograms and coefficients on pages 608 to 626 are based on the 'elastic theory' and apply to symmetrical portals having stanchions of constant moment of inertia and rafters, whether sloping or horizontal, also of constant inertia.

Provision is made for variations in the height-span ratios and also in inertia ratios, except in the case of twin span ridged portals.

On pages 610 to 616, where formulae are given for vertical and horizontal reactions, the direction is indicated on the diagrams and should the calculated value result in a negative answer this implies a change in direction.

Bending moments causing tension at the inside of the frame are considered as positive.

The sign convention for rectangular frames is given on page 618 and for deflection coefficients the convention is given in the footnotes on pages 620 to 626.

For further information on deflection of portal frames reference may be made to Brochure No. 19 (1963) issued by The British Constructional Steelwork Association, Artillery House, Artillery Row, London, S.W.1.

When the 'elastic method' of design is employed, each loading case may be considered separately and the resulting stresses combined as required. When the alternative 'plastic theory' is used, the loads must be combined before the analysis is made and it is not practicable to give formulae covering the virtually infinite number of possible combinations of loading.

For the design of portals by the 'plastic theory' reference may be made to standard textbooks or to Brochures No. 5 (1952) and No. 11 (1957) issued by the B.C.S.A.

Elastic deflection should be checked whether designing 'elastically' or 'plastically' and the coefficients will be found useful for this purpose.

SINGLE SPAN RIDGED PORTALS

PIN BASES

Portals symmetrical about centre line

Stanchions of constant inertia

Rafters of constant inertia

s = Span

h = height

l = length of rafter

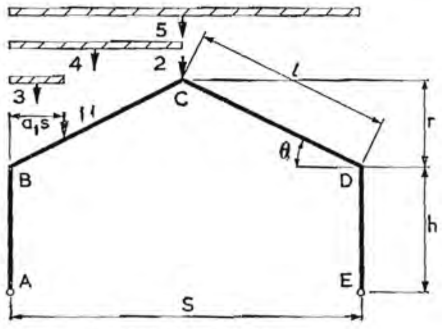
r = rise

c = r/h

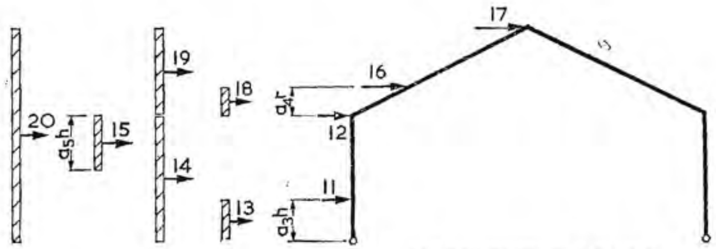
$m = \dfrac{\text{Inertia of Post} \times \text{length BC}}{\text{Inertia of Rafter} \times \text{length AB}}$

$N = \dfrac{1}{m} + 3 + 3c + c^2$

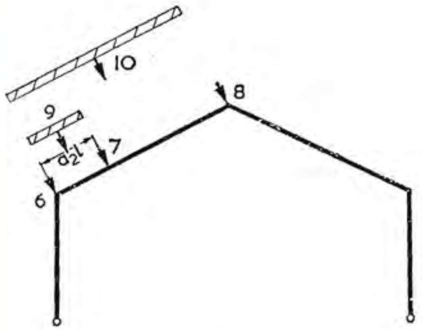
θ = Angle



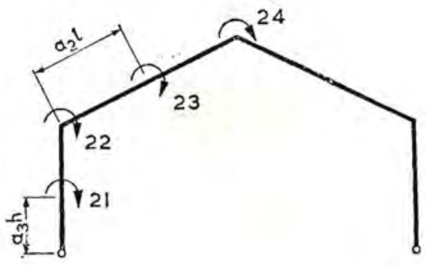
VERTICAL LOADS



HORIZONTAL LOADS



INCLINED LOADS



APPLIED MOMENTS

SINGLE SPAN RIDGED PORTALS

PIN BASES

FORMULAE FOR HORIZONTAL THRUST

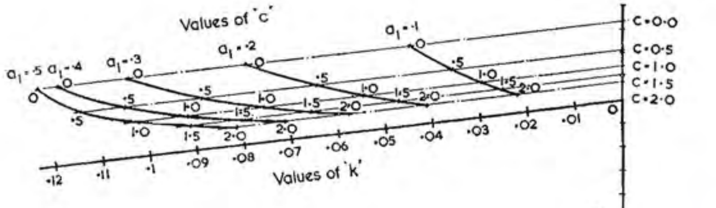
Note: When the loads are applied in the direction shown on the opposite page H_E acts from right to left

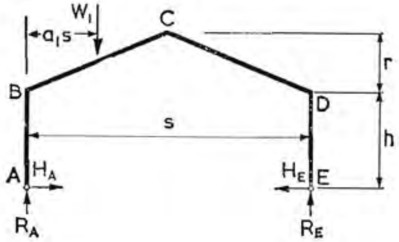
		APPLIED LOADS	VALUE OF H_E
VERTICAL	1	Point Load W at distance $a_1s < \frac{1}{2}s$	$Wa_1s\left(\frac{3}{2}\left[1-a_1\right]+c\left[\frac{3}{4}-a_1^2\right]\right)\div Nh$
	2	Point Load W at centre $a_1 = \frac{1}{2}$	$Ws\left(\frac{3}{8}+\frac{c}{4}\right)\div Nh$
	3	Distributed Load W on length $a_1s < \frac{1}{2}s$	$Wa_1s\left(\left[\frac{3}{4}-\frac{1}{2}a_1\right]+c\left[\frac{3}{8}-\frac{a_1^2}{4}\right]\right)\div Nh$
	4	Distributed Load W on half span $a_1 = \frac{1}{2}$	$Ws\left(\frac{1}{4}+\frac{5c}{32}\right)\div Nh$
	5	Distributed Load W on full span	$Ws\left(\frac{1}{4}+\frac{5c}{32}\right)\div Nh$
INCLINED	6	Point Load W at eaves	$Wh\sin\theta\left[\frac{1}{2m}+\frac{3}{2}+\frac{3}{4}c\right]\div Nh$
	7	Point Load W at distance $a_2l < l$	$W\left[h\sin\theta\left(\frac{1}{2m}+\frac{3}{2}+\frac{3c}{4}\right)+a_2l\left(\frac{3}{2}-\frac{3a_2}{4}\right)+a_2cl\left(\frac{3}{4}-\frac{a_2^2}{4}\right)\right]\div Nh$
	8	Point Load W at ridge $a_2 = 1$	$W\left[h\sin\theta\left(\frac{1}{2m}+\frac{3}{2}+\frac{3c}{4}\right)+\frac{3}{4}l+\frac{1}{2}cl\right]\div Nh$
	9	Distributed Load W along length $a_2l < l$	$W\left[h\sin\theta\left(\frac{1}{2m}+\frac{3}{2}+\frac{3c}{4}\right)+a_2l\left(\frac{3}{4}-\frac{a_2}{4}\right)+a_2cl\left(\frac{3}{8}-\frac{a_2^2}{16}\right)\right]\div Nh$
	10	Distributed Load W along rafter $a_2 = 1$	$W\left[h\sin\theta\left(\frac{1}{2m}+\frac{3}{2}+\frac{3c}{4}\right)+\frac{1}{2}l+\frac{5}{16}cl\right]\div Nh$
HORIZONTAL	11	Point Load W at height $a_3h < h$	$Wa_3\left[\frac{3-a_3^2}{4m}+\frac{3}{2}+\frac{3c}{4}\right]\div N$
	12	Point Load W at eaves $a_3 = 1$	$W\left[\frac{1}{2m}+\frac{3}{2}+\frac{3}{4}c\right]\div N$
	13	Distributed Load W on height $a_3h < h$	$Wa_3\left[\frac{6-a_3^2}{16m}+\frac{3}{4}+\frac{3c}{8}\right]\div N$
	14	Distributed Load W on side $a_3 = 1$	$W\left[\frac{5}{16m}+\frac{3}{4}+\frac{3c}{8}\right]\div N$
	15	Distributed Load W on height a_5h below eaves	$W\left[\frac{8-4a_5^2+a_5^3}{16m}+\left(\frac{3}{2}+\frac{3c}{4}\right)\left(1-\frac{a_5}{2}\right)\right]\div N$
	16	Point Load W at height $a_4r < r$	$W\frac{3}{2}\left[\frac{1}{3m}+1+c\left(\frac{1}{2}+a_4-\frac{a_4^2}{2}\right)+c^2\left(\frac{a_4}{2}-\frac{a_4^3}{6}\right)\right]\div N$
	17	Point Load W at ridge $a_4 = 1$	$\frac{1}{2}W$
	18	Distributed Load W on height $a_4r < r$	$W\left[\frac{1}{2m}+\frac{3}{2}+c\left(\frac{3}{4}+\frac{3a_4}{4}-\frac{a_4^2}{4}\right)+c^2\left(\frac{3a_4}{8}-\frac{a_4^3}{16}\right)\right]\div N$
	19	Distributed Load W on roof $a_4 = 1$	$W\left[\frac{1}{2m}+\frac{3}{2}+\frac{5c}{4}+\frac{5c^2}{16}\right]\div N$
	20	Distributed Load W on full height h+r	$\frac{W}{16(1+c)}\left[\frac{5+8c}{m}+12+30c+20c^2+5c^3\right]\div N$
MOMENT	21	Moment Mu at height $a_3h < h$	$\frac{3}{2}Mu\left[\frac{1}{2m}+1+\frac{c}{2}-\frac{a_3^2}{2m}\right]\div Nh$
	22	Moment Mu at eaves	$Mu\left[\frac{3}{2}+\frac{3c}{4}\right]\div Nh$
	23	Moment Mu at length $a_2l < l$	$\frac{3}{2}Mu\left[1-a_2+\frac{c}{2}-\frac{a_2^2c}{2}\right]\div Nh$
	24	Moment Mu at ridge $a_2 = 1$	Zero

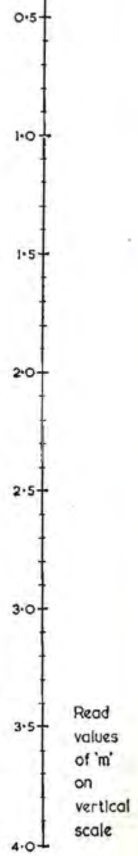
SINGLE SPAN RIDGED PORTALS

PIN BASES

Vertical load W_1 *at distance* $a_1 s < \frac{1}{2}s$







$R_A = W_1[1 - a_1]$ $\quad$ $R_E = W_1 a_1$

$H_A = \frac{W_1 ks}{h}$ $\quad$ $H_E = \frac{W_1 ks}{h}$

$M_B = -W_1 ks$ $\quad$ $M_D = -W_1 ks$

$M_C = -W_1 s\left[k(1 + c) - \frac{a_1}{2}\right]$ $\quad$ $M_A = M_E = 0$

$$c = r/h \quad m = \frac{\text{Stiffness of Post}}{\text{Stiffness of Rafter}} = \frac{\text{Inertia of Post} \times \text{Length BC}}{\text{Inertia of Rafter} \times \text{Length AB}}$$

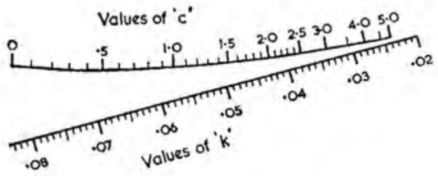
To find 'k' locate intersection of 'c' and 'a_1' on top scale, join to 'm' on vertical scale and read 'k' on the inclined scale.

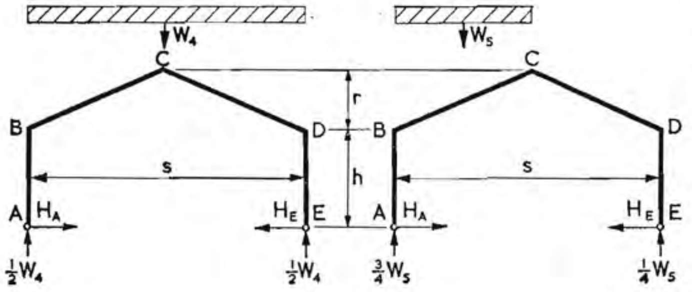
Thrusts and shears in posts and rafters calculated in the usual manner.

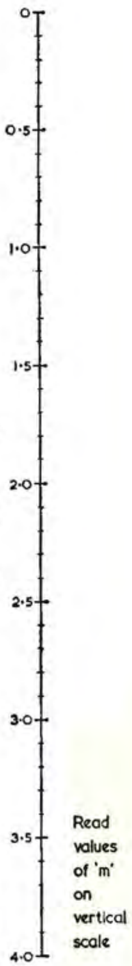
SINGLE SPAN RIDGED PORTALS

PIN BASES

Vertical distributed loads W_4 *and* W_5 *on full and half span*







$H_A = W_4 sk/h = H_E$ $\quad$ $H_A = W_5 sk/h = H_E$

$M_B = -W_4 sk = M_D$ $\quad$ $M_B = -W_5 sk = M_D$

$M_C = -W_4 s[k(1 + c) - \cdot125]$, $\quad$ $M_C = -W_5 s[k(1 + c) - \cdot125]$,

$M_A = M_E = 0$ $\quad$ $M_A = M_E = 0$

$$c = r/h \quad m = \frac{\text{Stiffness of Post}}{\text{Stiffness of Rafter}} = \frac{\text{Inertia of Post} \times \text{Length BC}}{\text{Inertia of Rafter} \times \text{Length AB}}$$

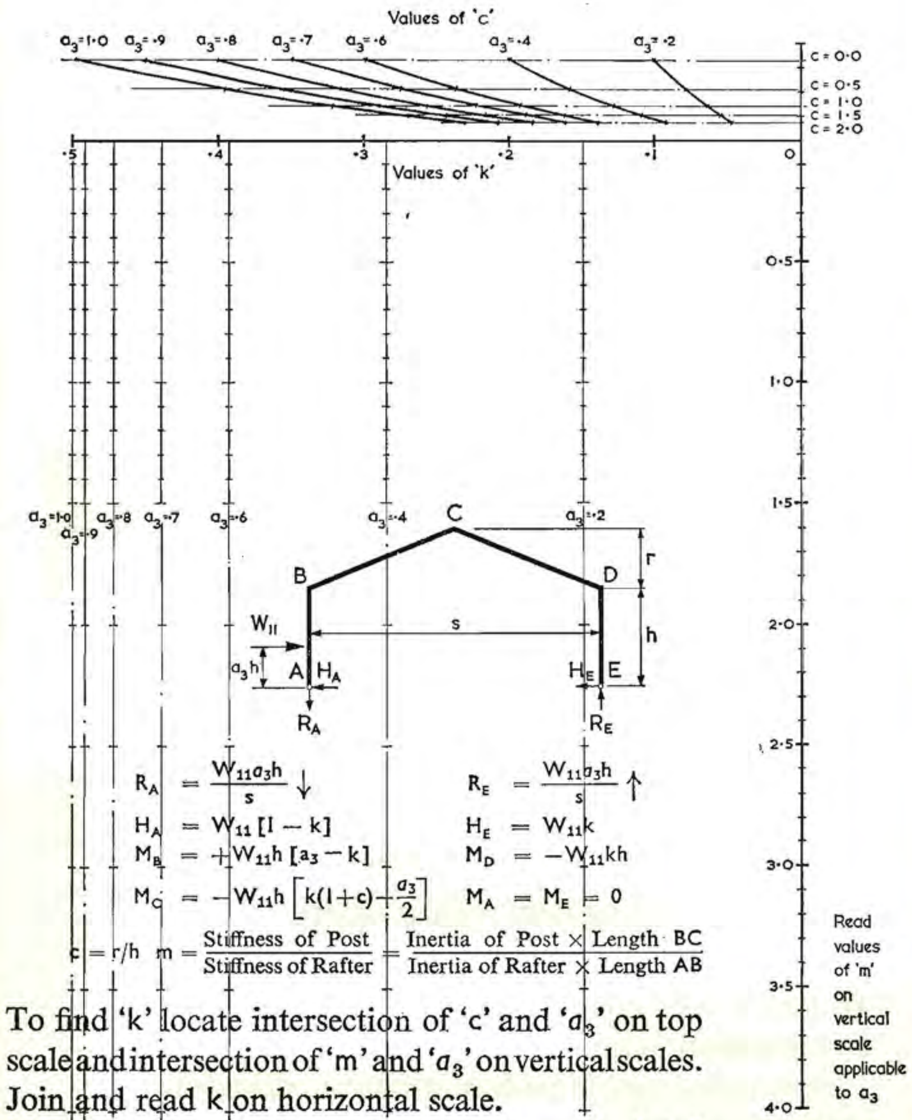
To find 'k' join values of 'c' and 'm' and read 'k' on the inclined scale.

Thrusts and shears in posts and rafters calculated in the usual manner.

SINGLE SPAN RIDGED PORTALS

PIN BASES

Unit horizontal load W_{11} *at height* a_3h



$$R_A = \frac{W_{11}a_3h}{s}\downarrow \qquad R_E = \frac{W_{11}a_3h}{s}\uparrow$$

$$H_A = W_{11}[1 - k] \qquad H_E = W_{11}k$$

$$M_B = +W_{11}h[a_3 - k] \qquad M_D = -W_{11}kh$$

$$M_C = -W_{11}h\left[k(1+c)-\frac{a_3}{2}\right] \qquad M_A = M_E = 0$$

$$c = r/h \quad m = \frac{\text{Stiffness of Post}}{\text{Stiffness of Rafter}} = \frac{\text{Inertia of Post} \times \text{Length BC}}{\text{Inertia of Rafter} \times \text{Length AB}}$$

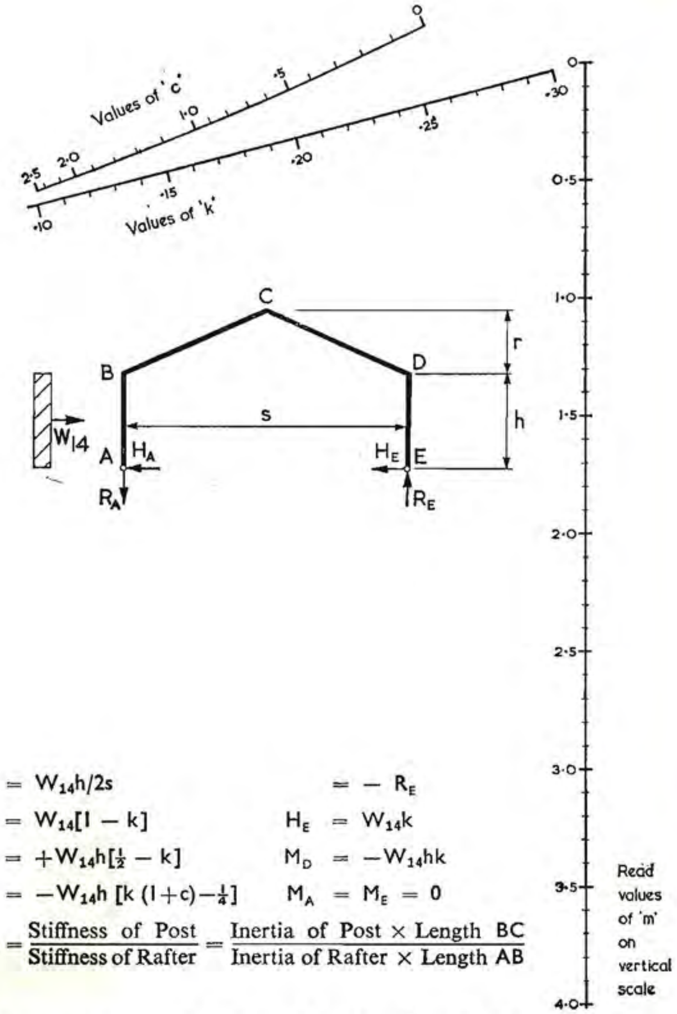
To find 'k' locate intersection of 'c' and 'a_3' on top scale and intersection of 'm' and 'a_3' on vertical scales. Join and read k on horizontal scale.

Thrusts and shears in posts and rafters calculated in the usual manner.

SINGLE SPAN RIDGED PORTALS

PIN BASES

Horizontal distributed load W_{14} *below eaves level*



$$R_A = W_{14}h/2s \qquad = -R_E$$

$$H_A = W_{14}[1 - k] \qquad H_E = W_{14}k$$

$$M_B = +W_{14}h[\tfrac{1}{2} - k] \qquad M_D = -W_{14}hk$$

$$M_C = -W_{14}h\,[k\,(1+c)-\tfrac{1}{4}] \qquad M_A = M_E = 0$$

$$c = r/h \quad m = \frac{\text{Stiffness of Post}}{\text{Stiffness of Rafter}} = \frac{\text{Inertia of Post} \times \text{Length BC}}{\text{Inertia of Rafter} \times \text{Length AB}}$$

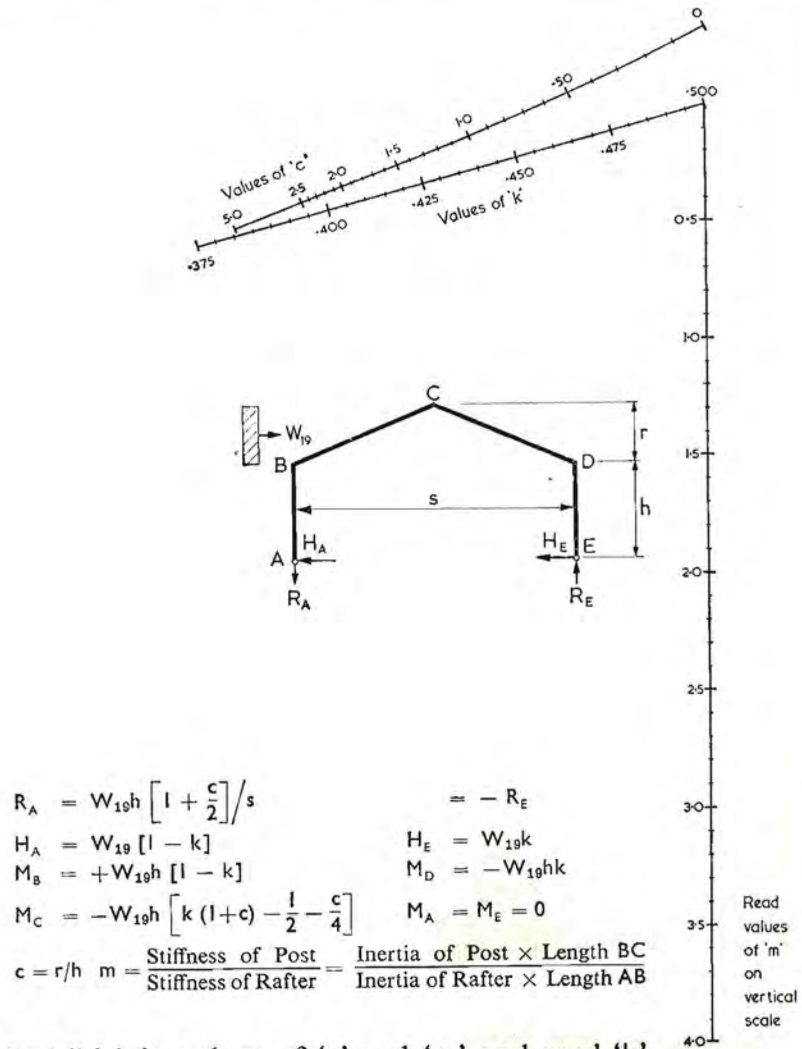
To find 'k' join values of 'c' and 'm'. Read 'k' on the inclined scale.

Thrusts and shears in posts and rafters calculated in the usual manner.

SINGLE SPAN RIDGED PORTALS

PIN BASES

Horizontal distributed load W_{19} *above eaves level*



$R_A = W_{19}h\left[1 + \frac{c}{2}\right]/s \qquad = -R_E$

$H_A = W_{19}[1 - k] \qquad H_E = W_{19}k$

$M_B = +W_{19}h\,[1 - k] \qquad M_D = -W_{19}hk$

$M_C = -W_{19}h\left[k\,(1+c) - \frac{1}{2} - \frac{c}{4}\right] \qquad M_A = M_E = 0$

$c = r/h \quad m = \frac{\text{Stiffness of Post}}{\text{Stiffness of Rafter}} = \frac{\text{Inertia of Post} \times \text{Length BC}}{\text{Inertia of Rafter} \times \text{Length AB}}$

Read values of 'm' on vertical scale

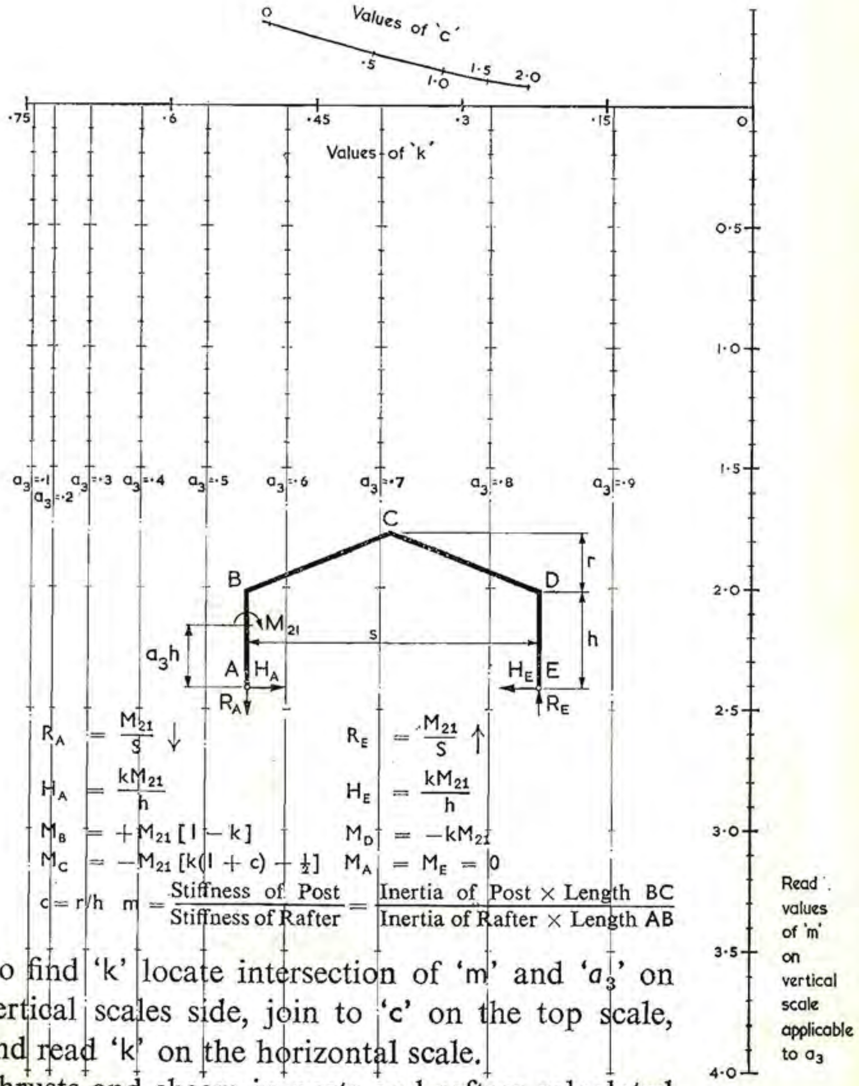
To find 'k' join values of 'c' and 'm' and read 'k' on the inclined scale.

Thrusts and shears in posts and rafters calculated in the usual manner.

SINGLE SPAN RIDGED PORTALS

PIN BASES

Unit moment M_{21} *at height* a_3h



$R_A = \frac{M_{21}}{S}\downarrow \qquad R_E = \frac{M_{21}}{S}\uparrow$

$H_A = \frac{kM_{21}}{h} \qquad H_E = \frac{kM_{21}}{h}$

$M_B = +M_{21}[1 - k] \qquad M_D = -kM_{21}$

$M_C = -M_{21}[k(1 + c) - \frac{1}{2}] \qquad M_A = M_E = 0$

$c = r/h \quad m = \frac{\text{Stiffness of Post}}{\text{Stiffness of Rafter}} = \frac{\text{Inertia of Post} \times \text{Length BC}}{\text{Inertia of Rafter} \times \text{Length AB}}$

Read values of 'm' on vertical scale applicable to a_3

To find 'k' locate intersection of 'm' and 'a_3' on vertical scales side, join to 'c' on the top scale, and read 'k' on the horizontal scale.

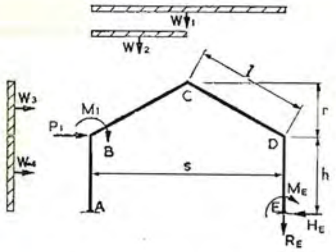
Thrusts and shears in posts and rafters calculated in the usual manner.

SINGLE SPAN RIDGED PORTALS

FIXED BASES

Portals symmetrical about centre line Stanchions of constant inertia

Rafters of constant inertia



s = span
h = height
l = length of rafter
r = rise
c = r/h
$$m = \frac{\text{Inertia of post} \times \text{Length BC}}{\text{Inertia of rafter} \times \text{Length AB}}$$
$Q = 1 + 4m + 6cm + 4c^2m + c^2m^2$
R_E = Reaction at E (if negative acts upwards)
H_E = Thrust at E (if negative acts left to right)
M_E = Moment at E (if negative acts anti-clockwise)
Arch symmetrical about centre line

	R_E	H_E
W_1	$-\frac{W_1}{2}$	$\frac{W_1sm\left(\frac{1}{2}+\frac{5c}{8}+\frac{cm}{8}\right)}{Qh}$
W_2	$-\frac{W_2\left(1+\frac{m}{4}\right)}{4\left(1+\frac{m}{3}\right)}$	$\frac{W_2sm\left(\frac{1}{2}+\frac{5c}{8}+\frac{cm}{8}\right)}{Qh}$
W_3	$-\frac{W_3h\left(\frac{1}{2}+\frac{c}{2}+\frac{cm}{8}\right)}{s\left(1+\frac{m}{3}\right)}$	$\frac{W_3(2+8m+10cm+5c^2m+c^2m^2)}{4Q}$
W_4	$-\frac{W_4h}{6s\left(1+\frac{m}{3}\right)}$	$\frac{W_4(1+3m+2cm)}{4Q}$
P_1	$-\frac{P_1h}{2s\left(1+\frac{m}{3}\right)}$	$\frac{P_1(1+4m+3cm)}{2Q}$
M_1	$-\frac{M_1}{s\left(1+\frac{m}{3}\right)}$	$\frac{3M_1(m+cm)}{Qh}$

FIXING MOMENT M_E

$$-\frac{W_1sm(8+15c+6cm-c^2m)}{48Q}$$

$$-\frac{W_2sm[51+28m+6c(15+14m+2m^2)+c^2m(6+m)]}{288Q\left(1+\frac{m}{3}\right)}$$

$$-\frac{W_3h[12(6+28m+16m^2)+2cm(195+148m)+12c^2m(15+16m+2m^2)+2c^3m^2(6+m)]}{288Q\left(1+\frac{m}{3}\right)}$$

$$-\frac{W_4h[9+35m+18m^2+27cm+21cm^2+2c^2m^2]}{72Q\left(1+\frac{m}{3}\right)}$$

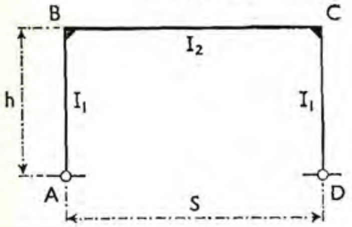
$$-\frac{P_1h[3+14m+8m^2+12cm+10cm^2+c^2m^2]}{12Q\left(1+\frac{m}{3}\right)}$$

$$-\frac{M_1[7m+6m^2+9cm+9cm^2+c^2m^2]}{6Q\left(1+\frac{m}{3}\right)}$$

SINGLE SPAN RECTANGULAR PORTALS

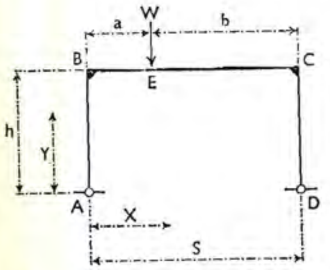
PINNED BASES

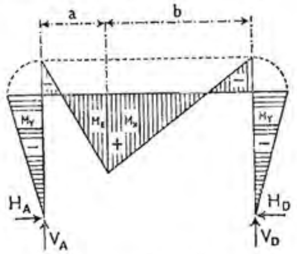
LEGEND



SIGN CONVENTION

Moments	+ positive when causing tension on the inside of the frame.
Vertical Reactions	+ positive when acting upward.
Horizontal Reactions	+ positive when acting inward.





$$M_B = M_C = -\frac{3\ Wab}{G}$$

Maximum Positive Bending Moment (under load)

$$M_E = \frac{Wab}{S}\left(1 - \frac{3S}{G}\right)$$

$$H_A = H_D = \frac{3Wab}{Gh} = -\frac{M_B}{h}$$

$$V_A = \frac{Wb}{S} \qquad V_D = \frac{Wa}{S}$$

For $0 \leqslant X \leqslant a$

$$M_X = V_A X + M_B$$

For $a \leqslant X \leqslant S$

$$M_X = V_D\,(S - X) + M_C$$

$$M_Y = \frac{Y}{h}\,M_B$$

Special Case

For central load

$$\left(a = b = \frac{S}{2}\right)$$

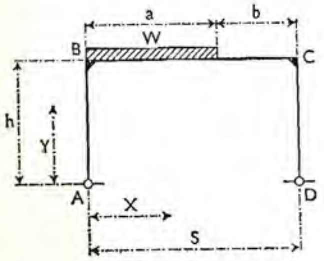
$$M_B = M_C = -\frac{3WS^2}{4G}$$

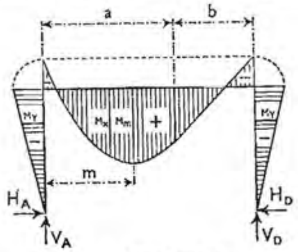
$$H_A = H_D = \frac{3WS^2}{4Gh} = -\frac{M_B}{h}$$

$$V_A = V_D = \frac{W}{2}$$

M_X, M_Y } Formulae as for the general case

$$G = 4h\,\frac{I_2}{I_1} + 6S$$





$$M_B = M_C = -\frac{Wa\,(S + 2b)}{2G}$$

Maximum Positive Bending Moment

$$\text{at } X = m = \frac{a\,(2b + a)}{2S}$$

$$M_m = M_B + \frac{Wm^2}{2a}$$

$$H_A = H_D = \frac{Wa\,(S+2b)}{2Gh} = -\frac{M_B}{h}$$

$$V_A = \frac{2b+a}{2S}W \qquad V_D = \frac{a}{2S}W$$

For $0 \leqslant X \leqslant a$

$$M_X = M_B + X\left(V_A - \frac{WX}{2a}\right)$$

For $a \leqslant X \leqslant S$

$$M_X = V_D\,(S - X) + M_C$$

$$M_Y = \frac{Y}{h}\,M_B$$

Special Case

For full span load

$$\begin{pmatrix} a = S \\ b = 0 \end{pmatrix}$$

$$M_B = M_C = -\frac{WS^2}{2G}$$

$$H_A = H_D = \frac{WS^2}{2Gh} = -\frac{M_B}{h}$$

$$V_A = V_D = \frac{W}{2}$$

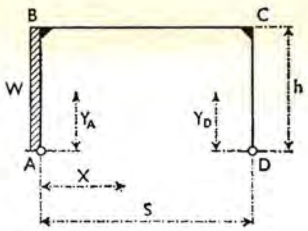
$$M_X = M_B + \frac{WX}{2}\left(1 - \frac{X}{S}\right)$$

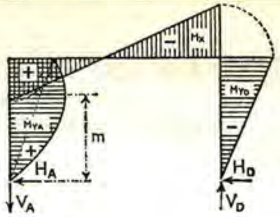
Maximum Positive Bending Moment at Mid Span

$$M_m = M_B + \frac{WS}{8}$$

$$M_Y = \frac{Y}{h}\,M_B$$

$$G = 4h\,\frac{I_2}{I_1} + 6S$$





$$M_B = Wh\left(\frac{1}{2} - \frac{F}{4}\right)$$

$$M_C = -\frac{Wh}{4}F$$

$$F = \frac{6\ I_1S + 5\ I_2h}{6\ I_1S + 4\ I_2h}$$

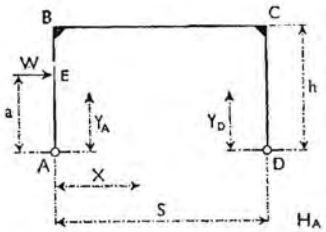
$$H_A = -W\left(1 - \frac{F}{4}\right) \qquad H_D = \frac{WF}{4}$$

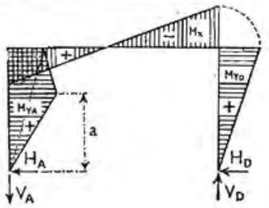
$$V_A = -\frac{Wh}{2S} \qquad V_D = \frac{Wh}{2S}$$

$$M_X = \frac{Wh}{2}\left(1 - \frac{F}{2} - \frac{X}{S}\right)$$

$$M_{Y_A} = WY_A\left(1 - \frac{F}{4} - \frac{Y_A}{2h}\right) \qquad M_{Y_D} = -\frac{WF}{4}Y_D$$

$$M_{Y_A(\max)} = \frac{Wh}{4}\left(2 - F + \frac{F^2}{8}\right),\ \text{when } Y_A = h\left(1 - \frac{F}{4}\right) = m$$





$$M_B = Wa\ (1 - K)$$

$$M_C = -WaK$$

$$K = \frac{3I_1S + I_2\left(3h - \frac{a^2}{h}\right)}{6\ I_1S + 4\ I_2h}$$

$$H_A = -(W - H_D) \qquad H_D = W\frac{a}{h}K$$

$$V_A = -W\frac{a}{S} \qquad V_D = W\frac{a}{S}$$

$$M_X = Wa\left(1 - K - \frac{X}{S}\right)$$

For $0 \leqslant Y_A \leqslant a$ $\qquad M_{Y_D} = -WK\frac{a}{h}Y_D$

$$M_{Y_A} = W\left(1 - \frac{a}{h}K\right)Y_A$$

For $a \leqslant Y_A \leqslant h$

$$M_{Y_A} = Wa\left(1 - \frac{Y_A}{h}K\right)$$

$$M_{Y_A\,(\max)} = Wa\left(1 - \frac{a}{h}K\right)$$

when $Y_A = a$

Special Case

When $\quad a = h$

$$K = \tfrac{1}{2}$$

$$M_B = \frac{Wh}{2} = -M_C$$

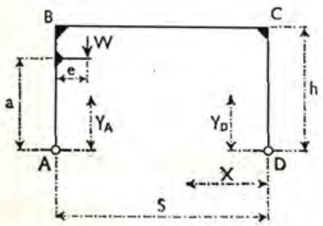
$$H_D = \frac{W}{2} = -H_A$$

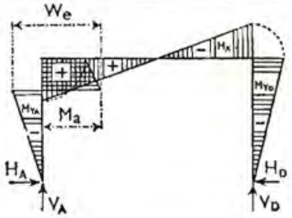
$$V_D = \frac{Wh}{S} = -V_A$$

$$M_X = Wh\left(\frac{1}{2} - \frac{X}{S}\right)$$

$$M_{Y_A} = \frac{W}{2}Y_A$$

$$M_{Y_D} = -\frac{W}{2}Y_D$$





$$M_B = We\ (1 - 3N)$$

$$M_C = -3\ WeN$$

$$N = \frac{I_1S + I_2\left(h - \frac{a^2}{h}\right)}{6\ I_1S + 4\ I_2h}$$

$$H_A = H_D = \frac{3\ We}{h}N$$

$$V_A = W\frac{S - e}{S} \qquad V_D = \frac{We}{S}$$

$$M_X = We\left(\frac{X}{S} - 3N\right)$$

For $0 \leqslant Y_A \leqslant a$, $\quad M_{Y_A} = -\frac{3We}{h}NY_A \qquad M_{Y_D} = -\frac{3We}{h}NY_D$

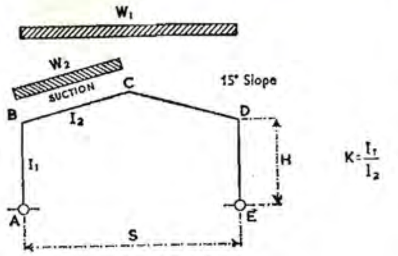
For $Y_A = a$, $\quad M_a = We\left(1 - 3N\frac{a}{h}\right)$

For $a < Y_A \leqslant h$, $\quad M_{Y_A} = We\left(1 - 3N\frac{Y_A}{h}\right)$

SINGLE SPAN RIDGED PORTALS

PINNED BASES

ELASTIC DEFLECTION COEFFICIENTS



LOADING SYSTEMS

Δ	Node	W_1			K = 1			W_1			K = 1·25		
		Ratios of H to S						Ratios of H to S					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	B	*·073*	*·103*	*·128*	*·148*	*·166*	*·182*	*·068*	*·095*	*·117*	*·135*	*·151*	*·165*
	C	0	0	0	0	0	0	0	0	0	0	0	0
	D	·073	·103	·128	·148	·166	·182	·068	·095	·117	·135	·151	·165
Vert. coeff.	C	*·274*	*·386*	*·477*	*·553*	*·619*	*·678*	*·254*	*·354*	*·435*	*·504*	*·563*	*·616*
Actual Deflection		Coefficient × $\frac{W_1S^3}{I_2}$ × 10^{-3}						Coefficient × $\frac{W_1S^3}{I_2}$ × 10^{-3}					

Δ	Node	W_2			K = 1			W_2			K = 1·25		
		Ratios of H to S						Ratios of H to S					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	B	*·238*	*·533*	*·988*	*1·64*	*2·51*	*3·68*	*·234*	*·510*	*·927*	*1·51*	*2·28*	*3·31*
	C	*·304*	*·626*	*1·10*	*1·77*	*2·66*	*3·84*	*·295*	*·596*	*1·03*	*1·63*	*2·42*	*3·46*
	D	*·370*	*·720*	*1·22*	*1·91*	*2·81*	*4·01*	*·356*	*·681*	*1·14*	*1·76*	*2·56*	*3·61*
Vert. coeff.	C	·246	·350	·433	·504	·566	·620	·227	·320	·395	·457	·515	·563
Actual Deflection		Coefficient × $\frac{W_2S^3}{I_2}$ × 10^{-3}						Coefficient × $\frac{W_2S^3}{I_2}$ × 10^{-3}					

To find the deflection in inches at a node, multiply the tabulated coefficient

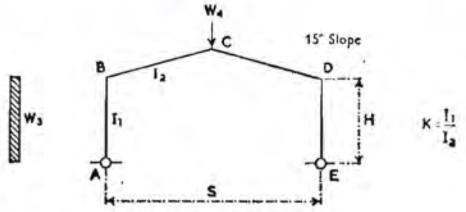
by $\frac{WS^3}{I_2} \times 10^{-3}$ where W is the load in tons,
S is the span in feet,
I_2 is the inertia of the rafter in inches^4.

Deflection is positive when movement is from left to right, and when upward. Negative deflection coefficients are printed in italics.

SINGLE SPAN RIDGED PORTALS

PINNED BASES

ELASTIC DEFLECTION COEFFICIENTS



LOADING SYSTEMS

Δ	Node	W_3			K = 1			W_3			K = 1·25		
		Ratios of H to S						Ratios of H to S					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	B	·355	·901	1·80	3·13	4·97	7·48	·332	·825	1·62	2·79	4·38	6·54
	C	·331	·863	1·75	3·06	4·88	7·38	·309	·791	1·58	2·73	4·31	6·45
	D	·306	·825	1·70	3·00	4·80	7·27	·286	·757	1·53	2·67	4·23	6·36
Vert. coeff.	C	·092	·142	·197	·256	·317	·383	·085	·128	·174	·226	·277	·335
Actual Deflection		Coefficient × $\frac{W_3S^3}{I_2}$ × 10^{-3}						Coefficient × $\frac{W_3S^3}{I_2}$ × 10^{-3}					

Δ	Node	W_4			K = 1			W_4			K = 1·25		
		Ratios of H to S						Ratios of H to S					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	B	*·145*	*·193*	*·232*	*·265*	*·292*	*·317*	*·137*	*·181*	*·216*	*·246*	*·268*	*·292*
	C	0	0	0	0	0	0	0	0	0	0	0	0
	D	·145	·193	·232	·265	·292	·317	·137	·181	·216	·246	·268	·292
Vert. coeff.	C	*·541*	*·723*	*·867*	*·986*	*1·09*	*1·18*	*·511*	*·675*	*·804*	*·911*	*1·01*	*1·09*
Actual Deflection		Coefficient × $\frac{W_4S^3}{I_2}$ × 10^{-3}						Coefficient × $\frac{W_4S^3}{I_2}$ × 10^{-3}					

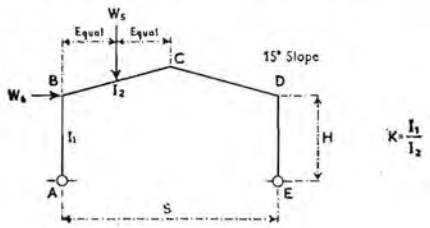
To find the deflection in inches at a node, multiply the tabulated coefficient

by $\frac{WS^3}{I_2} \times 10^{-3}$ where W is the load in tons,
S is the span in feet,
I_2 is the inertia of the rafter in inches^4.

Deflection is positive when movement is from left to right, and when upward. Negative deflection coefficients are printed in italics.

SINGLE SPAN RIDGED PORTALS

PINNED BASES
ELASTIC DEFLECTION COEFFICIENTS



LOADING SYSTEMS

Δ	Node	W_5			$K = 1$			W_5			$K = 1·25$		
		Ratios of H to S						Ratios of H to S					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	**B**	·135	·207	·284	·363	·447	·541	·141	·216	·296	·378	·465	·560
	C	·209	·314	·417	·520	·623	·734	·209	·313	·417	·519	·625	·735
	D	·283	·421	·551	·676	·799	·927	·277	·410	·538	·660	·784	·910
Vert. coeff.	**C**	*·275*	*·398*	*·498*	*·583*	*·657*	*·722*	*·253*	*·363*	*·452*	*·527*	*·594*	*·653*
Actual Deflection		Coefficient × $\frac{W_5S^3}{I_2} \times 10^{-3}$						Coefficient × $\frac{W_5S^3}{I_2} \times 10^{-3}$					

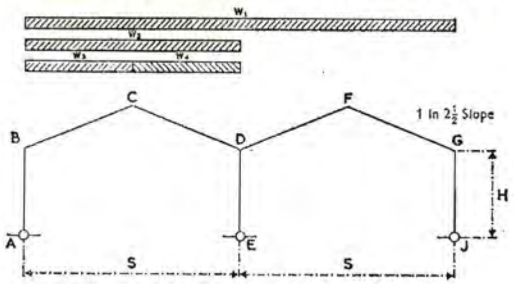
Δ	Node	W_6			$K = 1$			W_6			$K = 1·25$		
		Ratios of H to S						Ratios of H to S					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	**B**	·657	1·63	3·21	5·53	8·69	13·0	·620	1·51	2·94	4·99	7·76	11·5
	C	·618	1·58	3·15	5·46	8·61	12·9	·584	1·47	2·88	4·93	7·69	11·4
	D	·579	1·53	3·09	5·39	8·53	12·8	·547	1·42	2·82	4·86	7·62	11·3
Vert. coeff.	**C**	·145	·193	·232	·265	·292	·317	·137	·181	·216	·246	·268	·292
Actual Deflection		Coefficient × $\frac{W_6S^3}{I_2} \times 10^{-3}$						Coefficient × $\frac{W_6S^3}{I_2} \times 10^{-3}$					

To find the deflection in inches at a node, multiply the tabulated coefficient by $\frac{WS^3}{I_2} \times 10^{-3}$ where *W* is the load in tons, *S* is the span in feet, I_2 is the inertia of the rafter in inches^4.

Deflection is positive when movement is from left to right, and when upward. Negative deflection coefficients are printed in italics.

TWIN SPAN RIDGED PORTALS

PINNED BASES - CONSTANT INERTIA
ELASTIC DEFLECTION COEFFICIENTS



LOADING SYSTEMS

Δ	Node	W_1						W_2					
		Ratios of H to S						Ratios of H to S					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	**B**	*·666*	*1·03*	*1·30*	*1·51*	*1·67*	*1·80*	*·938*	*1·27*	*1·37*	*1·28*	*1·05*	*·710*
	C	*·332*	*·511*	*·645*	*·746*	*·824*	*·889*	*·098*	·041	·329	·734	1·22	1·78
	D	0	0	0	0	0	0	·741	1·35	2·02	2·74	3·49	4·27
	F	·332	·511	·645	·746	·824	·889	·563	1·06	1·62	2·22	2·87	3·56
	G	·666	1·03	1·30	1·51	1·67	1·80	·397	·785	1·24	1·74	2·30	2·90
Vertical coefficient	**C**	*·933*	*1·38*	*1·72*	*1·99*	*2·20*	*2·37*	*2·28*	*3·44*	*4·40*	*5·18*	*5·84*	*6·39*
	F	*·933*	*1·38*	*1·72*	*1·99*	*2·20*	*2·37*	·410	·684	·954	1·21	1·44	1·66
Actual Deflection		Coefficient × $\frac{W_1S^3}{I} \times 10^{-4}$						Coefficient × $\frac{W_2S^3}{I} \times 10^{-4}$					

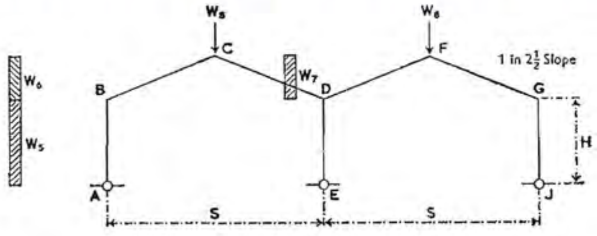
Δ	Node	W_3						W_4					
		Ratios of H to S						Ratios of H to S :					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	**B**	*·10*	*·13*	·078	·492	1·04	1·71	*1·76*	*2·41*	*2·83*	*3·06*	*3·14*	*3·14*
	C	·674	1·17	1·79	2·54	3·37	4·28	*·881*	*1·06*	*1·11*	*1·06*	*·907*	*·700*
	D	1·48	2·46	3·50	4·59	5·73	6·87	·000	·23	·544	·881	1·27	1·68
	F	1·27	2·18	3·14	4·15	5·18	6·25	*·16*	*·052*	·10	·311	·570	·855
	G	1·06	1·87	2·75	3·68	4·67	5·65	*·259*	*·311*	*·285*	*·21*	*·052*	·13
Vertical coefficient	**C**	*2·18*	*3·42*	*4·46*	*5·29*	*6·01*	*6·61*	*2·38*	*3·47*	*4·35*	*5·08*	*5·68*	*6·19*
	F	·518	·726	·907	1·12	1·30	1·48	·311	·648	·985	1·30	1·58	1·84
Actual Deflection		Coefficient × $\frac{W_3S^3}{I} \times 10^{-4}$						Coefficient × $\frac{W_4S^3}{I} \times 10^{-4}$					

To find the deflection in inches at a node, multiply the tabulated coefficient by $\frac{WS^3}{I} \times 10^{-x}$, where *W* is the load in tons, *S* is the span in feet, *I* is the inertia in inches^4, *x* is the appropriate index for each loading case.

Deflection is positive when movement is from left to right, and when upward. Negative deflection coefficients are printed in italics.

TWIN SPAN RIDGED PORTALS

PINNED BASES - CONSTANT INERTIA
ELASTIC DEFLECTION COEFFICIENTS



LOADING SYSTEMS

Δ	Node	W_5						W_6					
		Ratios of H to S						Ratios of H to S					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	B	·279	·644	1·23	2·10	3·30	4·90	·503	1·14	2·17	3·69	5·79	8·56
	C	·226	·567	1·14	1·99	3·18	4·77	·452	1·09	2·12	3·66	5·78	8·58
	D	·172	·489	1·04	1·88	3·06	4·64	·390	1·02	2·06	3·61	5·76	8·59
	F	·154	·458	·993	1·82	2·98	4·55	·346	·947	1·96	3·48	5·58	8·38
	G	·136	·425	·945	1·75	2·90	4·45	·302	·872	1·85	3·33	5·40	8·15
Vertical coefficient	C	·124	·181	·225	·259	·286	·307	·129	·141	·121	·077	·017	*·056*
	F	·042	·076	·112	·151	·193	·237	·102	·175	·255	·341	·434	·533
Actual Deflection		Coefficient × $\frac{W_5S^3}{I}$ × 10^{-3}						Coefficient × $\frac{W_6S^3}{I}$ × 10^{-3}					

Δ	Node	W_7						W_8					
		Ratios of H to S						Ratios of H to S					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	B	·337	·929	1·93	3·43	5·53	8·31	*2·90*	*4·17*	*5·11*	*5·81*	*6·35*	*6·77*
	C	·391	1·02	2·05	3·60	5·73	8·56	*1·45*	*2·07*	*2·54*	*2·88*	*3·14*	*3·34*
	D	·443	1·10	2·17	3·76	5·93	8·80	0	0	0	0	0	0
	F	·428	1·07	2·11	3·66	5·80	8·63	1·45	2·07	2·54	2·88	3·14	3·34
	G	·403	1·02	2·04	3·55	5·66	8·44	2·90	4·17	5·11	5·81	6·35	6·77
Vertical coefficient	C	*·123*	*·205*	*·295*	*·392*	*·494*	*·601*	*3·94*	*5·50*	*6·64*	*7·52*	*8·19*	*8·74*
	F	·048	·101	·170	·250	·341	·440	*3·94*	*5·50*	*6·64*	*7·52*	*8·19*	*8·74*
Actual Deflection		Coefficient × $\frac{W_7S^3}{I}$ × 10^{-3}						Coefficient × $\frac{W_8S^3}{I}$ × 10^{-4}					

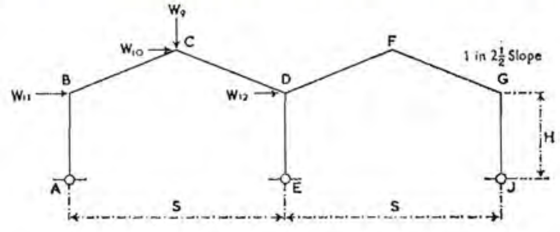
To find the deflection in inches at a node, multiply the tabulated coefficient

by $\frac{WS^3}{I} \times 10^{-x}$, where W is the load in tons,
S is the span in feet,
I is the inertia in inches^4,
x is the appropriate index for each loading case.

Deflection is positive when movement is from left to right, and when upward. Negative deflection coefficients are printed in italics.

TWIN SPAN RIDGED PORTALS

PINNED BASES - CONSTANT INERTIA
ELASTIC DEFLECTION COEFFICIENTS



LOADING SYSTEMS

Δ	Node	W_9						W_{10}					
		Ratios of H to S						Ratios of H to S					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	B	*·210*	*·272*	*·293*	*·283*	*·251*	*·202*	·420	1·04	2·05	3·55	5·64	8·41
	C	*·036*	*·018*	·023	·083	·156	·238	·415	1·04	2·07	3·60	5·71	8·51
	D	·137	·233	·337	·448	·562	·679	·386	1·02	2·06	3·61	5·76	8·59
	F	·109	·189	·277	·371	·469	·575	·340	·938	1·95	3·46	5·57	8·36
	G	·080	·145	·218	·295	·384	·474	·293	·858	1·83	3·31	5·37	8·12
Vertical coefficient	C	*·461*	*·656*	*·811*	*·936*	*1·04*	*1·12*	·036	·018	*·023*	*·083*	*·156*	*·238*
	F	·067	·106	·145	·184	·220	·251	·109	·189	·277	·371	·469	·575
Actual Deflection		Coefficient × $\frac{W_9S^3}{I}$ × 10^{-3}						Coefficient × $\frac{W_{10}S^3}{I}$ × 10^{-3}					

Δ	Node	W_{11}						W_{12}					
		Ratios of H to S						Ratios of H to S					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	B	·511	1·15	2·17	3·67	5·75	8·49	·329	·918	1·92	3·43	5·53	8·31
	C	·420	1·04	2·05	3·55	5·64	8·41	·386	1·02	2·06	3·61	5·76	8·59
	D	·329	·918	1·92	3·43	5·53	8·31	·443	1·11	2·20	3·79	5·99	8·87
	F	·293	·858	1·83	3·31	5·37	8·12	·386	1·02	2·06	3·61	5·76	8·59
	G	·259	·796	1·74	3·18	5·21	7·92	·329	·918	1·92	3·43	5·53	8·31
Vertical coefficient	C	·210	·272	·293	·283	·251	·202	*·137*	*·233*	*·337*	*·448*	*·562*	*·679*
	F	·080	·145	·218	·295	·384	·474	·137	·233	·337	·448	·562	·679
Actual Deflection		Coefficient × $\frac{W_{11}S^3}{I}$ × 10^{-3}						Coefficient × $\frac{W_{12}S^3}{I}$ × 10^{-3}					

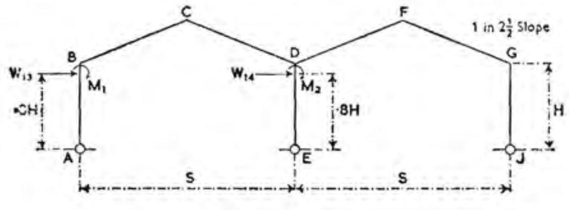
To find the deflection in inches at a node, multiply the tabulated coefficient

by $\frac{WS^3}{I} \times 10^{-x}$, where W is the load in tons,
S is the span in feet,
I is the inertia in inches^4,
x is the appropriate index for each loading case.

Deflection is positive when movement is from left to right, and when upward. Negative deflection coefficients are printed in italics.

TWIN SPAN RIDGED PORTALS

PINNED BASES - CONSTANT INERTIA
ELASTIC DEFLECTION COEFFICIENTS



LOADING SYSTEMS

Δ	Node	W_{13}						W_{14}					
		Ratios of H to S						Ratios of H to S					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	B	·435	1·00	1·90	3·23	5·09	7·55	·280	·796	1·69	3·06	4·97	7·53
	C	·355	·886	1·77	3·08	4·93	7·38	·334	·894	1·84	3·26	5·46	7·85
	D	·272	·770	1·63	2·93	4·76	7·21	·389	·993	1·99	3·46	5·48	8·16
	F	·244	·721	1·56	2·83	4·64	7·06	·334	·894	1·84	3·26	5·46	7·85
	G	·215	·669	1·48	2·73	4·51	6·90	·280	·796	1·69	3·06	4·97	7·53
Vertical coefficient	C	·189	·270	·324	·363	·386	·399	*·130*	*·236*	*·358*	*·490*	*·632*	*·780*
	F	·067	·119	·179	·241	·308	·378	·130	·236	·358	·490	·632	·780
Actual Deflection		Coefficient $\times \frac{W_{13}S^3}{I} \times 10^{-3}$						Coefficient $\times \frac{W_{14}S^3}{I} \times 10^{-3}$					

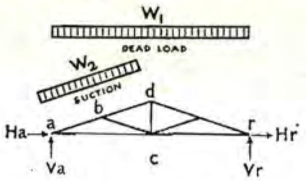
Δ	Node	M_1						M_2					
		Ratios of H to S						Ratios of H to S					
		·2	·3	·4	·5	·6	·7	·2	·3	·4	·5	·6	·7
Horiz. coefficient	B	2·13	3·01	4·12	5·44	6·97	8·71	1·37	2·38	3·55	4·85	6·27	7·85
	C	1·81	2·85	4·10	5·55	7·18	9·02	1·53	2·51	3·63	4·87	6·27	7·83
	D	1·50	2·70	4·07	5·65	7·39	9·31	1·68	2·62	3·68	4·90	6·27	7·78
	F	1·35	2·49	3·86	5·42	7·13	9·05	1·53	2·51	3·63	4·87	6·27	7·83
	G	1·17	2·31	3·63	5·18	6·87	8·76	1·37	2·38	3·55	4·85	6·27	7·85
Vertical coefficient	C	·700	·337	·000	*·285*	*·570*	*·804*	*·337*	*·259*	*·16*	*·05*	*·03*	*·10*
	F	·389	·467	·518	·570	·622	·674	·337	·259	·16	·05	·03	·10
Actual Deflection		Coefficient $\times \frac{M_1S^3}{I} \times 10^{-6}$						Coefficient $\times \frac{M_2S^3}{I} \times 10^{-6}$					

To find the deflection in inches at a node, multiply the tabulated coefficient

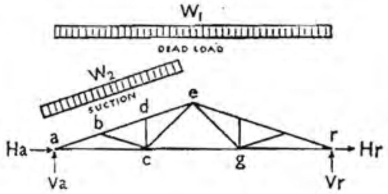
by $\frac{WS^3}{I} \times 10^{-x}$, where W is the load in tons,
S is the span in feet,
I is the inertia in inches^4,
x is the appropriate index for each loading case.

Deflection is positive when movement is from left to right, and when upward. Negative deflection coefficients are printed in italics.

ROOF TRUSSES



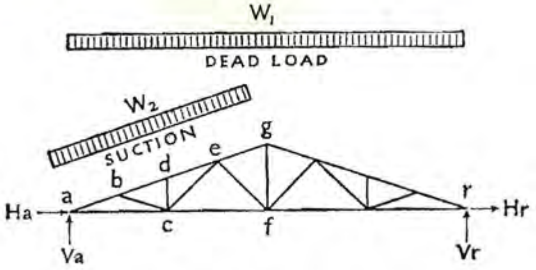
SLOPE	1 : 2			1 : 2½			1 : 3		
Member of Truss	Length Co-efficients	Stress Coefficients		Length Co-efficients	Stress Coefficients		Length Co-efficients	Stress Coefficients	
		Dead Load	Normal Wind Suction		Dead Load	Normal Wind Suction		Dead Load	Normal Wind Suction
a b	·27951	+·839	−·875	·26926	+1·010	−1·15	·26352	+1·186	−1·417
b d	·27951	+·559	−·5	·26926	+ ·673	− ·625	·26352	+ ·791	− ·75
d r	·55902		−·625	·53852		− ·725	·52705		− ·833
a c	·5	−·75	+·894	·5	− ·937	+1·161	·5	−1·125	+1·423
c r	·5	−·75	+·335	·5	− ·937	+ ·487	·5	−1·125	+ ·632
b c	·27951	+·280	−·625	·26926	+ ·337	− ·725	·26352	+ ·395	− ·833
c d	·25	−·25	+·280	·2	− ·25	+ ·269	·16667	− ·25	+ ·264
Reactions									
Va	—	+·5	−·615	—	+ ·5	− ·659	—	+ ·5	− ·685
Vr	—	+·5	−·280	—	+ ·5	− ·269	—	+ ·5	− ·264
Ha = Hr	—	0	+·224	—	0	+ ·186	—	0	+ ·158



SLOPE	1 : 2			1 : 2½			1 : 3		
a b	·18634	+·932	−1·042	·17951	+1·122	−1·358	·17568	+1·318	−1·667
b d	·18634	+·745	− ·792	·17951	+ ·898	−1·008	·17568	+1·054	−1·222
d e	·18634	+·745	− ·958	·17951	+ ·898	−1·142	·17568	+1·054	−1·333
e r	·55902		− ·625	·53852		− ·725	·52705		− ·833
a c	·33333	−·833	+1·081	·33333	−1·042	+1·385	·33333	−1·25	+1·687
c g	·33333	−·5	+ ·335	·33333	− ·625	+ ·487	·33333	− ·75	+ ·632
b c	·18634	+·186	− ·417	·17951	+ ·224	− ·483	·17568	+ ·264	− ·556
c d	·16667	+·167	− ·373	·13333	+ ·167	− ·359	·11111	+ ·167	− ·351
c e	·30046	−·300	+ ·672	·26034	− ·325	+ ·701	·23570	− ·354	+ ·745
g r	·33333	−·833	+ ·335	·33333	−1·042	+ ·487	·33333	−1·25	+ ·632
Reactions									
Va	—	+·5	− ·615	—	+ ·5	− ·659	—	+ ·5	− ·685
Vr	—	+·5	− ·280	—	+ ·5	− ·269	—	+ ·5	− ·264
Ha = Hr	—	0	+ ·224	—	0	+ ·186	—	0	+ ·158

Length coefficient multiplied by span = length of member between intersections.
Stress coefficient multiplied by the respective load = load in member.
Plus indicates compressive stress. Minus indicates tensile stress.
If either of the applied loads is reversed in direction from that indicated on the diagram, the corresponding loads in the members are reversed in sign.
Under dead load, W_1, stress coefficients are symmetrical about mid-span.
Under wind suction W_2, internal members on the right half of the truss carry no stress.
Equal horizontal reactions have been assumed for wind suction.

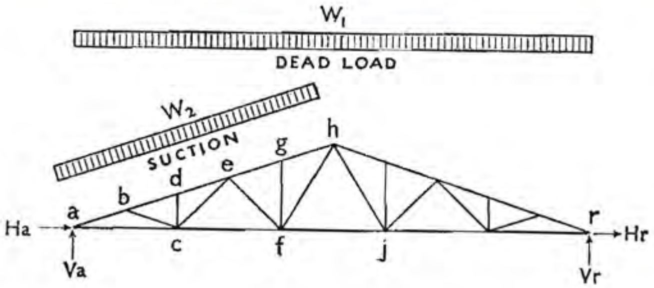
ROOF TRUSSES



SLOPE	1 : 2			1 : 2½			1 : 3		
Member of Truss	Length Co-efficients	Stress Coefficients		Length Co-efficients	Stress Coefficients		Length Co-efficients	Stress Coefficients	
		Dead Load	Normal Wind Suction		Dead Load	Normal Wind Suction		Dead Load	Normal Wind Suction
a b	·13975	+ ·978	−1·125	·13463	+1·178	−1·462	·13176	+1·383	−1·792
b d	·13975	+ ·839	− ·937	·13463	+1·010	−1·2	·13176	+1·186	−1·458
d e	·13975	+ ·839	−1·062	·13463	+1·010	−1·3	·13176	+1·186	−1·542
e g	·13975	+ ·559	− ·562	·13463	+ ·673	− ·675	·13176	+ ·791	− ·792
g r	·55902		− ·625	·53852		− ·725	·52705		− ·833
a c	·25	− ·875	+1·174	·25	−1·094	+1·497	·25	−1·312	+1·818
c f	·25	− ·625	+ ·615	·25	− ·781	+ ·824	·25	− ·937	+1·028
f r	·5		+ ·335	·5		+ ·487	·5		+ ·632
b c	·13975	+ ·140	− ·312	·13463	+ ·168	− ·362	·13176	+ ·198	− ·417
c d	·125	+ ·125	− ·280	·1	+ ·125	− ·269	·08333	+ ·125	− ·264
e f	·22535	+ ·225	− ·504	·19526	+ ·244	− ·526	·17678	+ ·265	− ·559
c e	·22535	− ·225	+ ·504	·19526	− ·244	+ ·526	·17678	− ·265	+ ·559
f g	·25	− ·375	+ ·419	·2	− ·375	+ ·404	·16667	− ·375	+ ·395
Reactions									
Va	—	+ ·5	− ·615	—	+ ·5	− ·659	—	+ ·5	− ·685
Vr	—	+ ·5	− ·280	—	+ ·5	− ·269	—	+ ·5	− ·264
Ha = Hr	—	0	+ ·224	—	0	+ ·186	—	0	+ ·158

Length coefficient multiplied by span = length of member between intersections.
Stress coefficient multiplied by the respective load = load in member.
Plus indicates compressive stress. Minus indicates tensile stress.
If either of the applied loads is reversed in direction from that indicated on the diagram, the corresponding loads in the members are reversed in sign.
Under dead load, W_1, stress coefficients are symmetrical about mid-span.
Under wind suction W_2, internal members on the right half of the truss carry no stress.
Equal horizontal reactions have been assumed for wind suction.

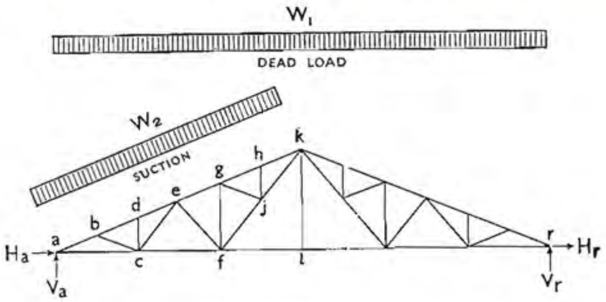
ROOF TRUSSES



SLOPE	1 : 2			1 : 2½			1 : 3		
Member of Truss	Length Co-efficients	Stress Coefficients		Length Co-efficients	Stress Coefficients		Length Co-efficients	Stress Coefficients	
		Dead Load	Normal Wind Suction		Dead Load	Normal Wind Suction		Dead Load	Normal Wind Suction
a b	·11180	+1·006	−1·175	·10770	+1·212	−1·525	·10541	+1·423	−1·867
b d	·11180	+ ·894	−1·025	·10770	+1·077	−1·315	·10541	+1·265	−1·6
d e	·11180	+ ·894	−1·125	·10770	+1·077	−1·395	·10541	+1·265	−1·667
e g	·11180	+ ·671	− ·725	·10770	+ ·808	− ·895	·10541	+ ·949	−1·067
g h	·11180	+ ·671	− ·825	·10770	+ ·808	− ·975	·10541	+ ·949	−1·133
h r	·55902		− ·625	·53852		− ·725	·52705		− ·833
a c	·2	− ·9	+1·230	·2	−1·125	+1·564	·2	−1·35	+1·897
c f	·2	− ·7	+ ·783	·2	− ·875	+1·026	·2	−1·05	+1·265
f j	·2	− ·5	+ ·335	·2	− ·625	+ ·487	·2	− ·75	+ ·632
j r	·4		+ ·335	·4		+ ·487	·4		+ ·632
b c	·11180	+ ·112	− ·25	·10770	+ ·135	− ·29	·10541	+ ·158	− ·333
c d	·1	+ ·1	− ·224	·08	+ ·1	− ·215	·06667	+ ·1	− ·211
e f	·18028	+ ·180	− ·403	·15620	+ ·195	− ·421	·14142	+ ·212	− ·447
f g	·2	+ ·1	− ·224	·16	+ ·1	− ·215	·13333	+ ·1	− ·211
c e	·18028	− ·180	+ ·403	·15620	− ·195	+ ·421	·14142	− ·212	+ ·447
f h	·26926	− ·269	+ ·602	·22361	− ·280	+ ·602	·19436	− ·292	+ ·615
Reactions									
Va	—	+ ·5	− ·615	—	+ ·5	− ·659	—	+ ·5	− ·685
Vr	—	+ ·5	− ·280	—	+ ·5	− ·269	—	+ ·5	− ·264
Ha = Hr	—	0	+ ·224	—	0	+ ·186	—	0	+ ·158

Length coefficient multiplied by span = length of member between intersections.
Stress coefficient multiplied by the respective load = load in member.
Plus indicates compressive stress. Minus indicates tensile stress.
If either of the applied loads is reversed in direction from that indicated on the diagram, the corresponding loads in the members are reversed in sign.
Under dead load, W_1, stress coefficients are symmetrical about mid-span.
Under wind suction W_2, internal members on the right half of the truss carry no stress.
Equal horizontal reactions have been assumed for wind suction.

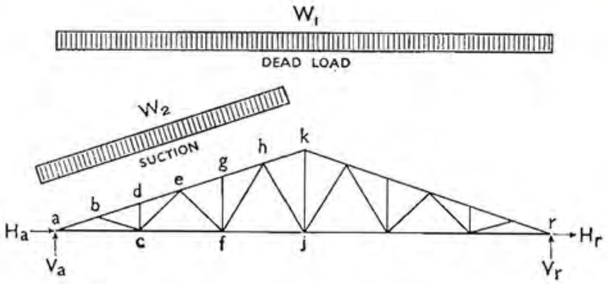
ROOF TRUSSES



SLOPE	1 : 2½		
Member of Truss	Length Coefficients	Stress Coefficients	
		Dead Load	Normal Wind Suction
a b	·08975	+ 1·234	− 1·567
b d	·08975	+ 1·122	− 1·392
d e	·08975	+ 1·122	− 1·458
e g	·08975	+ ·898	− 1·042
g h	·08975	+ ·954	− 1·229
h k	·08975	+ ·954	− 1·296
k r	·53852		− ·725
a c	·16667	− 1·146	+ 1·609
c f	·16667	− ·937	+ 1·161
f l	·16667	− ·625	+ ·487
l r	·5		+ ·487
b c	·08975	+ ·112	− ·242
c d	·06667	+ ·083	− ·180
e f	·13017	+ ·163	− ·350
f g	·13333	+ ·125	− ·269
h j	·06667	+ ·083	− ·180
c e	·13017	− ·163	+ ·350
g j	·08975	− ·056	+ ·121
f j	·13017	− ·325	+ ·701
j k	·13017	− ·407	+ ·876
k l	·2	0	0
Reactions			
Va	—	+ ·5	− ·659
Vr	—	+ ·5	− ·269
Ha = Hr	—	0	+ ·186

Length coefficient multiplied by span = length of member between intersections.
Stress coefficient multiplied by the respective load = load in member.
Plus indicates compressive stress. Minus indicates tensile stress.
If either of the applied loads is reversed in direction from that indicated on the diagram, the corresponding loads in the members are reversed in sign.
Under dead load, W_1, stress coefficients are symmetrical about mid-span.
Under wind suction W_2, internal members on the right half of the truss carry no stress.
Equal horizontal reactions have been assumed for wind suction.

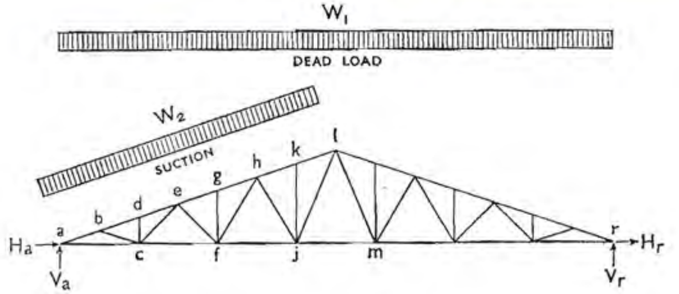
ROOF TRUSSES



SLOPE	1 : 3		
Member of Truss	Length Coefficients	Stress Coefficients	
		Dead Load	Normal Wind Suction
a b	·08784	+ 1·449	− 1·917
b d	·08784	+ 1·318	− 1·694
d e	·08784	+ 1·318	− 1·75
e g	·08784	+ 1·054	− 1·25
g h	·08784	+ 1·054	− 1·306
h k	·08784	+ ·791	− ·806
k r	·52705		− ·833
a c	·16667	− 1·375	+ 1·950
c f	·16667	− 1·125	+ 1·423
f j	·16667	− ·875	+ ·896
j r	·5		+ ·632
b c	·08784	+ ·132	− ·278
c d	·05556	+ ·083	− ·176
e f	·11785	+ ·177	− ·373
f g	·11111	+ ·083	− ·176
h j	·16197	+ ·243	− ·512
c e	·11785	− ·177	+ ·373
f h	·16197	− ·243	+ ·512
j k	·16667	− ·417	+ ·439
Reactions			
Va	—	+ ·5	− ·685
Vr	—	+ ·5	− ·264
Ha = Hr	—	0	+ ·158

Length coefficient multiplied by span = length of member between intersections.
Stress coefficient multiplied by the respective load = load in member.
Plus indicates compressive stress. Minus indicates tensile stress.
If either of the applied loads is reversed in direction from that indicated on the diagram, the corresponding loads in the members are reversed in sign.
Under dead load, W_1, stress coefficients are symmetrical about mid-span.
Under wind suction W_2, internal members on the right half of the truss carry no stress.
Equal horizontal reactions have been assumed for wind suction.

ROOF TRUSSES

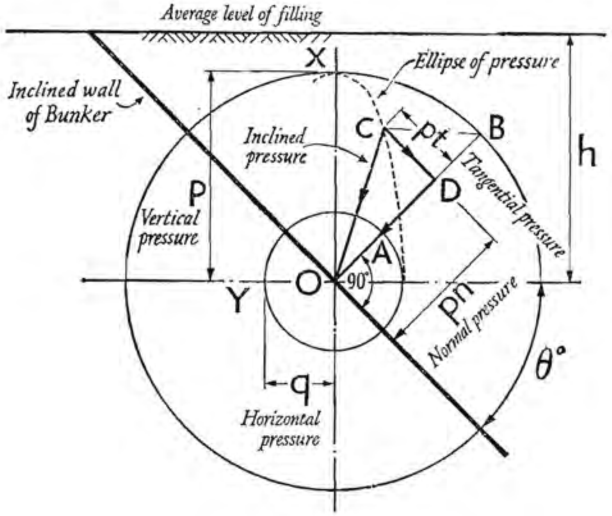


SLOPE	1 : 2½			1 : 3		
		Stress Coefficients			Stress Coefficients	
Member of Truss	Length Coefficients	Dead Load	Normal Wind Suction	Length Coefficients	Dead Load	Normal Wind Suction
a b	·07693	+ 1·250	− 1·596	·07529	+ 1·468	− 1·952
b d	·07693	+ 1·154	− 1·446	·07529	+ 1·355	− 1·762
d e	·07693	+ 1·154	− 1·504	·07529	+ 1·355	− 1·810
e g	·07693	+ ·962	− 1·146	·07529	+ ·994	− 1·381
g h	·07693	+ ·962	− 1·204	·07529	+ ·994	− 1·429
h k	·07693	+ ·769	− ·846	·07529	+ ·768	− 1·000
k l	·07693	+ ·769	− ·904	·07529	+ ·768	− 1·048
l r	·53852		− ·725	·52705		− ·833
a c	·14286	− 1·161	+ 1·641	·14286	− 1·393	+ 1·988
c f	·14286	− ·982	+ 1·257	·14286	− 1·179	+ 1·536
f j	·14286	− ·804	+ ·872	·14286	− ·964	+ 1·084
j m	·14286	− ·625	+ ·487	·14286	− ·75	+ ·632
m r	·42857		+ ·487	·42858		+ ·632
b c	·07693	+ ·096	− ·207	·07529	+ ·113	− ·238
d c	·05714	+ ·071	− ·154	·04762	+ ·071	− ·151
e f	·11157	+ ·139	− ·300	·10102	+ ·152	− ·319
f g	·11429	+ ·071	− ·154	·09524	+ ·071	− ·151
h j	·15972	+ ·200	− ·430	·13883	+ ·208	− ·439
j k	·17143	+ ·071	− ·154	·14286	+ ·071	− ·151
c e	·11157	− ·139	+ ·300	·10102	− ·152	+ ·319
f h	·15972	− ·200	+ ·430	·13883	− ·208	+ ·439
j l	·21237	− ·265	+ ·572	·18133	− ·272	+ ·573
Reactions						
Va	—	+ ·5	− ·659	—	+ ·5	− ·685
Vr	—	+ ·5	− ·269	—	+ ·5	− ·264
Ha = Hr	—	0	+ ·186	—	0	+ ·158

Length coefficient multiplied by span = length of member between intersections.
Stress coefficient multiplied by the respective load = load in member.
Plus indicates compressive stress. Minus indicates tensile stress.
If either of the applied loads is reversed in direction from that indicated on the diagram, the corresponding loads in the members are reversed in sign.
Under dead load, W_1, stress coefficients are symmetrical about mid-span.
Under wind suction W_2, internal members on the right half of the truss carry no stress.
Equal horizontal reactions have been assumed for wind suction.

COEFFICIENTS FOR PRESSURES ON BUNKER WALLS

(Based on Rankine's ellipse of pressure) For weights and angles of repose of materials see page 572



W = Wt/cu. ft. of filling.
h = depth of point under consideration.
φ = angle of repose of filling.
θ = angle of inclination of wall.

Vertical pressure $p = wh = OX = OB$
Horizontal pressure $q = wh\left(\frac{1-\sin\varphi}{1+\sin\varphi}\right) = OY = OA$
Normal pressure $pn = p\cos^2\theta + q\sin^2\theta = OD$
Tangential pressure $pt = (p-q)\cos\theta\sin\theta = DC$

Angle of repose		22°	25°	27°	30°	35°	37½°	40°	45°
Ratio $\left(\frac{1-\sin\varphi}{1+\sin\varphi}\right)$		·455	·407	·376	·333	·271	·244	·218	·172
ANGLE OF INCLINATION OF WALL = θ	30°	·864 ·236	·852 ·257	·844 ·270	·833 ·288	·818 ·316	·811 ·328	·805 ·339	·793 ·359
	40°	·777 ·268	·757 ·292	·744 ·308	·727 ·328	·701 ·329	·690 ·372	·680 ·386	·665 ·408
	50°	·678 ·268	·650 ·292	·652 ·308	·607 ·328	·570 ·359	·554 ·372	·539 ·386	·518 ·408
	60°	·591 ·236	·555 ·257	·532 ·270	·500 ·288	·455 ·316	·433 ·328	·413 ·339	·379 ·359
	70°	·519 ·175	·476 ·191	·449 ·201	·411 ·214	·356 ·234	·332 ·242	·309 ·251	·269 ·266
	80°	·471 ·093	·425 ·101	·395 ·107	·353 ·114	·293 ·125	·267 ·129	·242 ·134	·197 ·142
	90°	·455 0	·407 0	·376 0	·333 0	·271 0	·244 0	·218 0	·172 0

Coefficients shown thus .864 = pn
Coefficients shown thus .236 = pt
To be multiplied by w × h

PART IX

Design Stresses

DESIGN STRESSES

The design stresses for structural steel in building in Britain should conform to the provisions of British Standard 449 : 1959 (amended). The main provisions of this Specification in regard to bending, shear, compression and tension, rivets, bolts and welds are included on pages 167 to 191; the text on these pages constitute the notes on safe load tables in Parts IV and V.

References and additional extracts from B.S. 449 : 1959 (amended) are given below:

COMBINED STRESSES

Clause 14b *Bending and axial tension.* Members subject to both axial tension and bending stress shall be so proportioned that the quantity

$$\frac{f_t}{p_t} + \frac{f_{bt}}{p_{bt}}$$

does not exceed unity at any point, where

f_t = the calculated axial tensile stress

p_t = the permissible axial tensile stress (see pages 185 & 640)

f_{bt} = the resultant tensile stress due to bending about both principal axes

p_{bt} = the appropriate allowable tensile stress in bending (see pages 167, 173 & 637).

For *Bending and axial compression* see pages 179, 180 & 183.

Clause 14c *Bending and shear.* The equivalent stress f_e due to bending and shear shall not exceed the values given of p_e in Table 1 (page 637). The equivalent stress f_e is obtained from the following formulae:

$$f_e = \sqrt{(f_{bt}^2 + 3f_q^2)} \quad \text{or} \quad \sqrt{(f_{bc}^2 + 3f_q^2)}$$

in which f_{bc} or f_{bt} and f_q are the numerical values of the co-existent bending and shear stresses.

Clause 14d *Combined bearing, bending and shear stresses.* Where a bearing stress is combined with tensile bending and shear stresses under the most unfavourable conditions of loading, the equivalent stress f_e, obtained from the following formulae, shall not exceed the values of p_e given in Table 1:

$$f_e = \sqrt{(f_{bt}^2 + f_b^2 + f_{bt} \cdot f_b + 3f_q^2)}$$

$$\text{or } f_e = \sqrt{(f_{bc}^2 + f_b^2 - f_{bc} \cdot f_b + 3f_q^2)}$$

in which f_{bt}, f_{bc}, f_q and f_b are the numerical values of the co-existent bending, shear and bearing stresses.

TABLE 1. MAXIMUM ALLOWABLE EQUIVALENT STRESS p_e

Note. The increases permitted by Clauses 7 and 13 do not apply to these stresses.

Form	Steel to B.S. No.	Thickness or diameter inches	p_e tons/ins^2
Rolled I-beams and channels	B.S. 15 and B.S. 2762	All	14·5
Plates, bars, universal beams and columns and sections other than above.	B.S. 15 and B.S. 2762	Up to and including ¾ Over ¾	14·5 14·0
Plates, sections and bars	B.S. 968	Up to and including 2	20·0
Plates, sections and bars	B.S. 968	Over 2	$Y_s/1{\cdot}1$

where Y_s = yield stress agreed with manufacturer, with a maximum value of 22 tons/ins^2.

BENDING STRESSES

Permissible stresses in High Yield Stress (Welding Quality) Structural Steel to B.S. 968 : 1962 and Mild Steel to B.S. 15 : 1961 are tabulated on pages 167 to 173.

Permissible stresses in Notch Ductile Steel to B.S. 2762 : 1956 are identical with those for Mild Steel to B.S. 15 : 1961.

Permissible stresses for castellated beams with lateral support may be taken as for universal beams and columns, joists and channels.

Castellated beams without lateral support shall be treated as plate girders.

Permissible stresses in Slab Bases—all steels	12·0 Tons/sq. in.

BEARING STRESSES

Clause 22. The calculated bearing stress on the net projected area of contact shall not exceed the values of p_b below:

TABLE 9. ALLOWABLE BEARING STRESS p_b

Form	Steel to B.S. No.	p_b tons/ins^2
Plates, sections and bars	B.S. 15 and B.S. 2762	12
Plates, sections and bars	B.S. 968	17

SHEAR STRESSES

Clause 23a. *Maximum shear stress.* The maximum value f_q of the shear stress, having regard to the distribution of stresses in conformity with the elastic behaviour of the member in flexure, shall not exceed values of p_q given in Table 10 below.

TABLE 10. ALLOWABLE MAXIMUM SHEAR STRESS p_q

Form	Steel to B.S. No.	Thickness or diameter inches	p_q tons/ins^2
Plates, sections and bars	B.S. 15 and B.S. 2762	All	7·0
Plates, sections and bars	B.S. 968	Up to 2	10·0
Plates, sections and bars	B.S. 968	Over 2	$Y_s/2·2$

where Y_s = yield stress agreed with manufacturer with a maximum value of 22 tons/ins^2.

Clause 23b. *Average shear stress in webs of I beams, channels and plate girders.* The average shear stress f_q' on the gross section of the web shall not exceed the values of p_q' given in Table 11 for unstiffened webs or, for stiffened webs, the values given in Table 12 or Table 13 (see pages 174 & 175), as appropriate.

The gross section of the web shall be taken as:

For rolled I beams and channels: Depth of beam × web thickness

For plate girders: Depth of web plate × web thickness

Compliance with this sub-clause shall be deemed to satisfy the requirements of sub-clause *a*.

For webs which have tongue plates or which are reinforced by additional plates (see Clause 27*a*(iv) of B.S. 449), the maximum shear stress shall be calculated and the beam designed so as to satisfy both *a* and *b* above.

TABLE 11. ALLOWABLE AVERAGE SHEAR STRESS p_q' IN UNSTIFFENED WEBS

(For stiffened webs, see also *b* above and Tables 12 and 13 on pages 174 and 175.)

Steel to B.S. No.		p_q' for rolled I-beams tons/ins^2	p_q' for plate girders and single channels tons/ins^2
B.S. 15	Up to and including ¾ ins. thick	6·0	6·0
	Over ¾ ins. thick	6·0	5·5
B.S. 968	Up to 2 ins.	8·5	8·0
B.S. 968	Over 2 ins.	—	7·0

AXIAL COMPRESSION STRESSES

Permissible stresses for steels to B.S. 968 : 1962 and B.S. 15 ; 1961 and B.S. 2762 : 1956 are tabulated on pages 176 and 177.

Clause 30b *Cased struts*

Extracts and formulae based on the provisions of this sub-clause are given on pages 181 to 183.

Clause 30c *Angles as struts*

A digest of the provisions of this sub-clause is given on pages 178 and 179.

Clause 34 *Eccentricity for stanchions and solid columns*

a For the purposes of determining the stress in a stanchion or column section, the beam reactions or similar loads shall be assumed to be applied 4 in. from the face of the section or at the centre of the bearing, whichever dimension gives the greater eccentricity, and with the exception of the following two cases:

(i) In the case of cap connections, the load shall be assumed to be applied at the face of the column shaft or stanchion section, or edge of packing if used, towards the span of the beam.

(ii) In the case of a roof truss bearing on a cap, no eccentricity need be taken for simple bearings without connections capable of developing an appreciable moment.

b in effectively jointed and continuous stanchions the bending moments due to eccentricities of loading at any one floor or horizontal frame level may be taken as being:

(i) Ineffective at the floor or frame levels above and below that floor

(ii) Divided equally between the stanchion lengths above and below that floor or frame level, provided that the moment of inertia of either stanchion section, divided by its actual length, does not exceed 1·5 times the corresponding value for the other length. In cases exceeding this ratio the bending moment shall be divided in proportion to the moments of inertia of the stanchion sections, divided by their respective actual lengths.

For permissible combined stresses due to eccentricity and axial load refer to pages 179 and 183.

AXIAL TENSION STRESSES

Clause 41. The direct stress in axial tension on the net area of section shall not exceed p_t where p_t has the following values:

TABLE 19. ALLOWABLE STRESSES p_t IN AXIAL TENSION

Form	Steel to B.S. No.	Thickness or diameter inches	p_t tons/ins²
Rolled I-beams and channels	B.S. 15 and B.S. 2762	All	9·5
Universal Beams and Columns	B.S. 15 and B.S. 2762	Up to and including 1½	9·5
		Over 1½	9·0
Plates, bars, and sections other than above.	B.S. 15 and B.S. 2762	Up to and including ¾	9·5
		Over ¾	9·0
Plates, bars and sections	B.S. 968	Up to and including 2	13·5
Plates, bars and sections	B.S. 968	Over 2	Y_s/1·63

where Y_S = yield stress agreed with manufacturer, with a maximum value of 22 tons/ins².

For the calculation of net areas of members subject to concentric or eccentric tensile loading reference should be made to clauses 17*a* and 42.

STRESSES IN RIVETS AND BOLTS

Permissible shear and bearing stresses for rivets and bolts for steel to B.S. 15 : 1961 and steel to B.S. 968 : 1962 are tabulated on page 187. Permissible tensile stresses are given in the following table:

Description	Steel		Remarks
	B.S. 15 rivets and mild steel bolts	B.S. 968 rivets and bolts	
Axial tensile stress on gross area of rivets and on net area of bolts and tension rods:	tons/ins²	tons/ins²	For gross and net areas, see Clause 17*b* and *c*.
Rivets	6·0	9·0	
Bolts 1⅛ in. dia. and over	8·0	12·0	
Bolts ⅞ in. up to 1⅛ in. dia.	7·0	10·5	
Bolts less than ⅞ in. dia.	6·0	9·0	

Data for calculating the stress value of high strength friction grip bolts is given on pages 189 and 190.

STRESSES IN WELDS

Permissible stresses in fillet and butt welds for steel to B.S. 15 : 1961 and steel to B.S. 968 : 1962 with electrodes to B.S. 639 and B.S. 2549 are given on page 191. Reference should be made to Clause 54 of B.S. 449 for the design of welds.

CAST IRON AND WROUGHT IRON ALLOWABLE STRESSES

Cast iron and wrought iron are very rarely used in modern structures but are still found in older buildings. The following stresses taken from the London Building Act, 1930, may be used when assessing the strength of structural members in these materials.

CAST IRON PILLARS

Ratio of Length to Least Radius of Gyration	Working Stresses in Tons per Square Inch of Net Section		
	Hinged Ends	One End hinged and one End fixed	Both Ends fixed
20	3·5	4·0	4·5
30	3·0	3·5	4·0
40	2·5	3·0	3·5
50	2·0	2·5	3·0
60	1·5	2·0	2·5
70	1·0	1·5	2·0
80	0·5	1·0	1·5

WROUGHT IRON PILLARS

Reference should be made to the London Building Act, 1930, third schedule, paragraphs 20*a* and 20*b* for details of the safe stresses.

MEMBERS OTHER THAN PILLARS

	Working Stresses in Tons per Square Inch			
	Tension	Compression	Shear	Bearing
Cast iron	1·5	8·0	1·5	10·0
Wrought iron	5·0	5·0	4·0	7·0

Reference may also be made to the following British Standards for data on the strength and properties of cast iron

B.S. 309	Whiteheart malleable iron castings
B.S. 310	Blackheart malleable iron castings
B.S. 991	Data on cast iron
B.S. 1452	Grey iron castings
B.S. 2789	Iron castings with spheroidal or nodular graphite.

ALLOWABLE STRESSES ON BRICKWORK AND MASONRY

Based on London Building (Constructional) By-Laws 1952

The safe pressure on walls and piers of brickwork or masonry depends on the following factors:

(1) The crushing strength of the bricks or masonry blocks.

(2) The type of mortar used.

(3) The slenderness ratio of the wall or pier, that is the ratio of its effective height to its thickness or least dimension. If a wall has lateral support at the top the effective height equals 0·75 × the storey height; if it has no lateral support the effective height equals 1·5 × the storey height. The corresponding factors for piers are 1·0 and 2·0. The maximum slenderness ratio for walls and piers is 18, or 12 if lime mortar is used.

For walls and piers with a slenderness ratio of unity or less, the following uniform pressures in tons per sq. ft. are permitted for combined dead and superimposed loads:

Mix of Mortar			Designation of bricks and blocks and crushing strength					
			First	Second	Third	Fourth	Fifth	Sixth
Cement	Lime	Sand	**10000**	**7500**	**5000**	**4000**	**3000**	**1500**
1	0–¼	3	42	33	23	16	13	10
1	0–¼	4	28	24	20	15	12	9
1	1	6	22	22	17	15	12	9
1	2	9	22	22	16	13	11	8
1	3	12	13	13	13	11	8	6
—	1	3	6	6	6	6	6	5

If the slenderness ratio exceeds unity, the pressures must be multiplied by the following factors:

Slenderness ratio	1	2	6	14	18
Factor	1·00	·96	·80	·40	·30

Intermediate ratios may be interpolated.

When a wall or pier whose slenderness ratio exceeds unity is subject to a uniformly distributed load and loads of a purely local nature, as at girder bearings or stanchion bases, the reduced pressure obtained by using the factors given above may be increased by 50% provided they do not exceed the maximum values in the table above.

ALLOWABLE STRESSES ON CONCRETE WALLS

Based on London Building (Constructional) By-Laws 1952

For walls with a slenderness ratio of unity or less the following uniform pressures are permitted for combined dead and superimposed loads: (For definition of slenderness ratio see opposite page.)

Designation	Nominal Mix	Max. permissible pressure	
		tons/sq. ft.	lbs./sq. inch
Grade I	1 : 1 : 2	50	777
II	1 : 1½ : 3	44	684
III	1 : 2 : 4	39	606
IV	1 : — : 6	20	311
V	1 : — : 8	15	233

If the slenderness ratio exceeds unity the pressure must be multiplied by the following factor:

Slenderness ratio	1	2	6	14	18
Factor	1·00	·97	·85	·61	·49

Intermediate ratios may be interpolated.

Local pressures as at girder bearings may be increased as for masonry and brickwork. See opposite page.

CRUSHING STRENGTHS OF BRICK AND STONE

Type	Crushing Strength lbs/sq. in.
Staffordshire Blue, pressed	10000—16000
Engineering Bricks Grade A	10000 upwards
Leicester Red	4000— 6000
Flettons	3000— 3500
Burwell, Gault	2500— 3000
London Stocks	500— 1250
Granite	8000—18000
Marble	8000—18000
Sandstone	3000— 9000
Limestone	1500— 3000

ALLOWABLE STRESSES ON CONCRETE FOUNDATIONS

The following pressures are specified in The London Building (Constructional) By-Laws, 1952; may be used for concrete foundations.

Designation	Nominal Mix	Pressure in Tons/sq. foot
Grade I ordinary	1 : 1 : 2	50
II ordinary	1 : 1½ : 3	44
III ordinary	1 : 2 : 4	39
IV	1 : — : 6	20
V	1 : — : 8	15
IA (Quality A)	1 : 1 : 2	96
IIA (Quality A)	1 : 1½ : 3	80
IIIA (Quality A)	1 : 2 : 4	64
High Alumina Cement Concrete	1 : 2 : 4	96

Reference should be made to the By-Laws for information regarding minimum strength of concrete, intermediate mixes, etc.

ALLOWABLE GROUND PRESSURES

IN TONS PER SQUARE FOOT

The allowable pressure on the ground shall be determined by physical investigation and/or reference to the appropriate local authorities.

The following table may be used as a guide for preliminary design:

Alluvial:	Soil	¼ - ½
Artificial:	Filling	¼ - ½
Chalk:	Soft	1 - 1½
	Hard Solid	4 - 6
Clay:	Soft	¾ - 1
	Ordinary	1½ - 2
	Firm Dry	2 - 3
	London Blue, etc,	4 - 6
Gravel:	Loose	2 - 3
	Compact, Sandy	4 - 6
Rock:	Very soft	2 - 4
	Shale, Medium	5 - 10
	Hard	20 - 40
Sand:	Wet or Loose	½ - 1
	Fine, Sandy Clay	1½ - 2
	Compact	3 - 4
Silt		¼ - ½

ALLOWABLE STRESSES IN TIMBER

IN POUNDS PER SQUARE INCH

The London Building (Constructional) By-Laws, 1952, recognise two classes of structural timbers:

(A) Douglas fir (coast),
Longleaf pitch pine,
Shortleaf pitch pine.

(B) Canadian spruce,
European larch,
Red pine,
Western hemlock or whitewood.

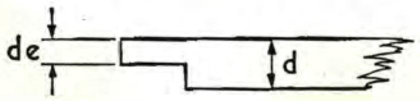
Reference should be made to the By-Laws for information regarding the required condition and moisture content, etc., of the timber.

The following are the maximum allowable stresses in lbs. per sq. inch in structural timber, other than posts and struts:

TYPE OF STRESS	CLASS OF TIMBER	
	A	**B**
Flexural stress in extreme fibres (other than floorboards) with adequate lateral restraint against winding or buckling	1,000	800
Flexural stress in extreme fibres of floorboards	800	800
Shear stress in direction of grain	100	100
Compressive stress perpendicular to grain	350	250
Tension in direction of grain	1,500	1,200
Modulus of elasticity (*mean*)	1,600,000	1,200,000
Modulus of elasticity (*minimum*)	1,000,000	750,000

MODIFICATION FOR SHEAR STRESS

The shear stress in flexural members notched at the ends, is the basic shear stress multiplied by factor K.



$$K = \frac{\text{effective depth de}}{\text{total depth d}}$$

PART X

Composite Construction

Notes on Composite Construction

BASIS OF DESIGN

The design of the concrete deck slab is independent of the composite action and is carried out in the normal manner for a slab continuous over supports. The thickness of the slab is thus governed by the beam spacing, the load to be carried and the stresses to be used in concrete and reinforcing steel.

Interaction between the steel beams and concrete deck requires some form of shear connector to transfer horizontal shear from the slab to the beam and to resist horizontal slip between them in order that composite action can be achieved.

The T-section formed by deck and steel beam can be designed by the method of transformed sections. It is necessary to make the calculations in units appropriate to one of the materials used and in the calculations which follow the area of the concrete has been divided by the Modular Ratio, *m*, and it has been treated as an equivalent steel area.

The notation used is given below:

A_c = Effective area of concrete in compression
A_s = Area of steel beam
m = Modular ratio
$\bar{y}$ = Depth from upper surface of slab to neutral axis
y_c = Depth from upper surface of slab to the centroid of the effective area of concrete in compression
y_s = Depth from upper surface of slab to the centroid of the steel beam
D = Overall depth of slab and beam
d = Thickness of slab
B = Width of slab in compression

All quantities are in inch units.

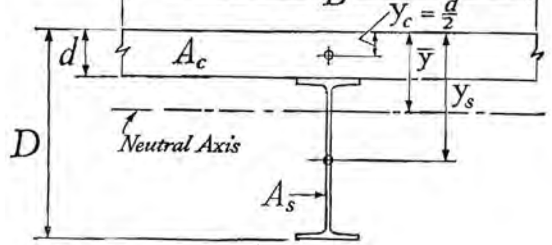
CALCULATION OF NEUTRAL AXIS DEPTH

Two cases require consideration:

(1) Neutral axis below the slab
(2) Neutral axis within the slab

In Case (1) the whole of the slab is in compression and the depth to the neutral axis is given by

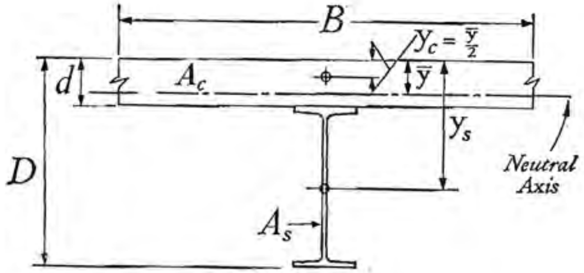
$$\bar{y} = \frac{A_c y_c/m + A_s y_s}{A_c/m + A_s}$$



In Case (2) only that portion of the slab above the neutral axis is in compression and the depth to the neutral axis is given by

$$\bar{y} = \frac{mA_s}{B}\left[\sqrt{\left(1 + \frac{2y_sB}{mA_s}\right)} - 1\right]$$

The tabulated values have been calculated accordingly.



CALCULATION OF MOMENT OF INERTIA (SECOND MOMENT OF AREA)

The position of the neutral axis having been determined the Moment of Inertia of the composite section can be found; the calculations fall into two cases as for the neutral axis.

In Case (1), where the neutral axis is below the slab, the gross moment of inertia, I_g, of the composite section is given by

$$I_g = \frac{I_c}{m} + \frac{A_c}{m}\left(\bar{y} - y_c\right)^2 + I_s + A_s\left(y_s - \bar{y}\right)^2$$

where

I_c = moment of inertia of concrete slab about its own centroid
I_s = moment of inertia of steel beam about its own centroid

For Case (2) where the neutral axis falls within the slab

$$I_g = \frac{B\bar{y}^3}{3m} + I_s + A_s\left(y_s - \bar{y}\right)^2$$

The tabulated values have been obtained in this way and are given in units of equivalent steel in (ins.)^4. Should this be required in equivalent concrete units the tabulated values must be multiplied by the Modular Ratio, m, which has been used.

SECTION MODULI (*a*) For concrete in compression.

The value of Z_c for the upper surface of the slab in equivalent concrete units (ins.)^3 is given by

$$Z_c = \frac{mI_g}{\bar{y}}$$

(*b*) For steel in tension.

The value of Z_s for the extreme fibre stress at the bottom of the steel beam in equivalent steel units (ins.)^3 is given by

$$Z_s = \frac{I_g}{D - \bar{y}}$$

The flexural stresses in concrete and steel respectively are given directly by dividing the bending moment by the appropriate tabulated section modulus.

If it is required to ascertain the stress at the uppermost fibre in the steel beam the required modulus is given by

$$Z_{sc} = \frac{I_g}{\bar{y} - d}$$

In this case it should be noted that when $\bar{y} - d$ is negative there will be tension in the top flange of the steel beam.

HORIZONTAL SHEAR COEFFICIENT The horizontal shear at the top surface of the steel beam is given by the formula

$$q = Qk$$

where

q = shear per lineal inch of girder

Q = vertical shear force at the section under consideration

$k = \dfrac{A_c(\bar{y} - y_c)}{mI_g}$

$\bar{y} - y_c$ = distance between the centroid of the effective concrete area in compression and the neutral axis of the composite section.

The tabulated values of k, the horizontal shear coefficient, are given in inch units.

COMPOSITE CONSTRUCTION

SHEAR CONNECTORS

Under flexural load, horizontal shear is induced between the steel beam and the concrete slab and it is the function of the shear connectors to transmit this shear and at the same time prevent the slab lifting off the beam; the spacing and shape of the connectors should be designed to fulfil these functions. Shear connectors may be spaced in accordance with their safe loads and the variation in horizontal shear: the maximum spacing should not exceed four times the depth of the concrete slab.

The safe loads on stud and channel connectors are the subject of current research. Pending the issue of a Code of Practice or Specification the following values may be used.

WELDED STUD CONNECTORS

SAFE LOAD IN TONS

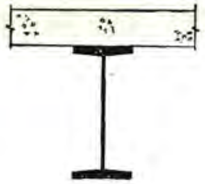
Diameter in inches	Length in inches					
	1	**1½**	**2**	**2½**	**3**	**3½**
½	·424	·635	·847	·873		
⅝	·529	·794	1·059	1·323	1·365	
¾	·635	·953	1·27	1·588	1·906	1·965

WELDED CHANNEL CONNECTORS

SAFE LOAD IN TONS

Size of Channel	Length in inches										
	3	**3½**	**4**	**4½**	**5**	**5½**	**6**	**7**	**8**	**9**	**10**
3×1½×4·5	2·42	2·83	3·23	3·64	4·04	4·44	4·85	5·66	6·46	7·27	8·08
4×2 ×7	2·84	3·31	3·79	4·26	4·74	5·21	5·68	6·63	7·58	8·52	9·47
5×2½×10	3·36	3·92	4·48	5·04	5·60	6·15	6·71	7·83	8·95	10·07	11·19
6×3 ×12	3·43	4·00	4·57	5·14	5·72	6·29	6·86	8·00	9·14	10·29	11·43
6×3½×16	4·20	4·90	5·60	6·30	7·00	7·70	8·39	9·79	11·19	12·59	13·99
7×3 ×14	3·74	4·37	4·99	5·62	6·24	6·86	7·49	8·74	9·98	11·23	12·48
7×3½×18	4·43	5·16	5·90	6·64	7·38	8·11	8·85	10·33	11·80	13·28	14·75

COMPOSITE CONSTRUCTION



SLAB THICKNESS 8 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
36″×16½″×260 lbs U.B.	3	24847	17187	1101·6	·0137	21·68
	4	26758	19505	1130·8	·0159	20·58
I_{xx} = 17234·0 ins^4	5	28447	21771	1154·5	·0175	19·60
Z_{xx} = 951·1 ins^3	6	29952	23985	1174·2	·0189	18·73
	7	31301	26151	1190·8	·0200	17·95
	8	32519	28269	1205·1	·0209	17·26
36″×16½″×230 lbs U.B.	3	22291	15851	978·3	·0147	21·09
	4	24067	18121	1004·6	·0169	19·92
I_{xx} = 14988·0 ins^4	5	25620	20333	1025·6	·0186	18·90
Z_{xx} = 835·5 ins^3	6	26989	22489	1042·9	·0199	18·00
	7	28207	24591	1057·4	·0210	17·21
	8	29297	26642	1069·8	·0218	16·49
36″×12″×194 lbs U.B.	3	19313	14032	810·2	·0165	20·64
	4	20983	16260	835·2	·0187	19·36
I_{xx} = 12103·0 ins^4	5	22418	18422	854·8	·0203	18·25
Z_{xx} = 663·6 ins^3	6	23665	20521	870·6	·0216	17·30
	7	24760	22559	883·7	·0226	16·46
	8	25729	24540	894·8	·0233	15·73
36″×12″×170 lbs U.B.	3	17335	13033	716·1	·0177	19·95
	4	18860	15209	737·9	·0198	18·60
I_{xx} = 10470·0 ins^4	5	20152	17311	754·8	·0214	17·46
Z_{xx} = 579·1 ins^3	6	21262	19345	768·3	·0226	16·49
	7	22226	21312	779·4	·0235	15·64
	8	23073	23217	788·7	·0242	14·91
36″×12″×150 lbs U.B.	3	15544	12095	632·8	·0189	19·28
	4	16935	14211	652·3	·0210	17·88
I_{xx} = 9012·1 ins^4	5	18098	16246	667·1	·0225	16·71
Z_{xx} = 502·9 ins^3	6	19086	18206	678·8	·0236	15·72
	7	19936	20096	688·4	·0245	14·88
	8	20678	21918	696·5	·0251	14·15
33″×11½″×152 lbs U.B.	3	14033	11368	610·6	·0199	18·52
	4	15293	13341	629·2	·0221	17·19
I_{xx} = 8147·6 ins^4	5	16349	15237	643·5	·0237	16·09
Z_{xx} = 486·4 ins^3	6	17247	17062	654·8	·0249	15·16
	7	18021	18819	664·1	·0258	14·36
	8	18697	20512	671·9	·0265	13·67

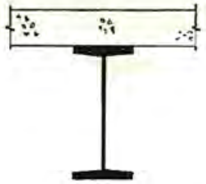
COMPOSITE CONSTRUCTION

SLAB THICKNESS 8 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
33″×11½″×130 lbs U.B.	3	12200	10349	521·0	·0215	17·68
	4	13313	12242	537·1	·0237	16·31
I_{xx} = 6699.0 ins^4	5	14229	14050	549·2	·0252	15·19
Z_{xx} = 404·8 ins^3	6	14997	15780	558·7	·0263	14·26
	7	15653	17436	566·4	·0271	13·47
	8	16219	19024	572·9	·0277	12·79
30″×10½″×132 lbs U.B.	3	10567	9427	491·8	·0233	16·81
	4	11548	11145	507·4	·0256	15·54
I_{xx} = 5753·1 ins^4	5	12357	12785	519·2	·0272	14·50
Z_{xx} = 379·7 ins^3	6	13038	14350	528·5	·0284	13·63
	7	13620	15848	536·0	·0292	12·89
	8	14124	17282	542·4	·0299	12·26
30″×10½″×116 lbs U.B.	3	9457	8779	433·0	·0247	16·16
	4	10336	10436	446·6	·0269	14·86
I_{xx} = 4919·1 ins^4	5	11052	12008	456·8	·0284	13·81
Z_{xx} = 327·9 ins^3	6	11647	13500	464·8	·0295	12·94
	7	12151	14921	471·3	·0303	12·22
	8	12585	16274	476·7	·0309	11·60
27″×10″×114 lbs U.B.	3	7982	7868	397·8	·0270	15·22
	4	8734	9356	410·5	·0293	14·00
I_{xx} = 4080·5 ins^4	5	9346	10763	420·0	·0309	13·03
Z_{xx} = 299·2 ins^3	6	9855	12094	427·4	·0320	12·22
	7	10287	13358	433·5	·0329	11·55
	8	10658	14560	438·6	·0335	10·98
27″×10″×102 lbs U.B.	3	7307	7459	358·6	·0281	14·69
	4	7988	8901	369·7	·0303	13·46
I_{xx} = 3604·1 ins^4	5	8537	10255	378·0	·0318	12·49
Z_{xx} = 266·3 ins^3	6	8988	11531	384·5	·0329	11·69
	7	9369	12736	389·8	·0336	11·03
	8	9695	13876	394·3	·0342	10·48
27″×10″×94 lbs U.B.	3	6822	7155	331·0	·0290	14·30
	4	7453	8558	341·2	·0311	13·06
I_{xx} = 3266·8 ins^4	5	7957	9871	348·7	·0325	12·09
Z_{xx} = 242·8 ins^3	6	8369	11103	354·6	·0335	11·31
	7	8715	12261	359·4	·0342	10·66
	8	9010	13354	363·5	·0348	10·12

COMPOSITE CONSTRUCTION



SLAB THICKNESS 7 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch *k*	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
36″ × 16½″ × 260 lbs U.B.	3	23742	16775	1078·7	·0125	21·23
	4	25426	18856	1104·8	·0147	20·23
I_{xx} = 17234·0 ins^4	5	26931	20898	1126·4	·0165	19·33
Z_{xx} = 951·1 ins^3	6	28286	22903	1144·5	·0178	18·53
	7	29512	24872	1160·0	·0190	17·80
	8	30627	26805	1173·4	·0200	17·14
36″ × 16½″ × 230 lbs U.B.	3	21244	15410	956·9	·0136	20·68
	4	22817	17452	980·6	·0158	19·61
I_{xx} = 14988·0 ins^4	5	24209	19451	999·9	·0175	18·67
Z_{xx} = 835·5 ins^3	6	25449	21409	1015·9	·0189	17·83
	7	26562	23327	1029·5	·0200	17·08
	8	27566	25206	1041·2	·0210	16·40
36″ × 12″ × 194 lbs U.B.	3	18307	13528	789·7	·0154	20·30
	4	19799	15536	812·6	·0177	19·12
I_{xx} = 12103·0 ins^4	5	21097	17496	830·9	·0194	18·09
Z_{xx} = 663·6 ins^3	6	22238	19408	845·8	·0207	17·19
	7	23249	21276	858·3	·0217	16·39
	8	24152	23100	868·9	·0226	15·68
36″ × 12″ × 170 lbs U.B.	3	16394	12514	697·4	·0166	19·65
	4	17765	14481	717·5	·0188	18·40
I_{xx} = 10470·0 ins^4	5	18942	16394	733·4	·0204	17·33
Z_{xx} = 579·1 ins^3	6	19964	18255	746·2	·0217	16·40
	7	20861	20066	756·8	·0227	15·59
	8	21655	21830	765·7	·0235	14·88
36″ × 12″ × 150 lbs U.B.	3	14665	11567	615·6	·0178	19·02
	4	15922	13485	633·6	·0200	17·71
I_{xx} = 9012·1 ins^4	5	16988	15343	647·6	·0216	16·61
Z_{xx} = 502·9 ins^3	6	17904	17145	658·8	·0228	15·66
	7	18700	18892	668·0	·0238	14·85
	8	19399	20589	675·7	·0246	14·13
33″ × 11½″ × 152 lbs U.B.	3	13224	10887	593·5	·0187	18·22
	4	14359	12676	610·8	·0210	16·99
I_{xx} = 8147·6 ins^4	5	15322	14408	624·2	·0228	15·95
Z_{xx} = 486·4 ins^3	6	16151	16085	634·9	·0241	15·06
	7	16873	17711	643·7	·0251	14·29
	8	17507	19288	651·2	·0259	13·61

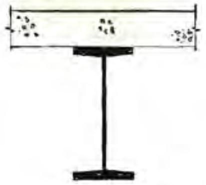
COMPOSITE CONSTRUCTION

SLAB THICKNESS 7 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch *k*	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
33″ × 11½″ × 130 lbs U.B.	3	11461	9861	505·6	·0204	17·43
	4	12470	11585	520·6	·0227	16·15
I_{xx} = 6699·0 ins^4	5	13313	13245	532·0	·0243	15·08
Z_{xx} = 404·8 ins^3	6	14028	14844	541·1	·0256	14·18
	7	14643	16387	548·5	·0265	13·40
	8	15178	17876	554·7	·0273	12·74
30″ × 10½″ × 132 lbs U.B.	3	9900	8991	476·4	·0221	16·52
	4	10785	10555	490·9	·0246	15·33
I_{xx} = 5753·1 ins^4	5	11526	12060	501·9	·0263	14·34
Z_{xx} = 379·7 ins^3	6	12156	13508	510·7	·0276	13·50
	7	12698	14903	517·9	·0287	12·78
	8	13171	16248	523·9	·0295	12·16
30″ × 10½″ × 116 lbs U.B.	3	8841	8342	418·9	·0236	15·90
	4	9639	9856	431·7	·0260	14·67
I_{xx} = 4919·1 ins^4	5	10298	11306	441·3	·0276	13·66
Z_{xx} = 327·9 ins^3	6	10851	12694	448·8	·0289	12·82
	7	11323	14025	454·9	·0298	12·11
	8	11732	15303	460·1	·0305	11·50
27″ × 10″ × 114 lbs U.B.	3	7437	7478	384·1	·0258	14·92
	4	8117	8839	395·9	·0284	13·78
I_{xx} = 4080·5 ins^4	5	8677	10137	404·7	·0301	12·84
Z_{xx} = 299·2 ins^3	6	9148	11377	411·7	·0314	12·06
	7	9550	12563	417·4	·0324	11·40
	8	9897	13699	422·2	·0332	10·84
27″ × 10″ × 102 lbs U.B.	3	6798	7071	346·0	·0270	14·42
	4	7418	8395	356·3	·0295	13·25
I_{xx} = 3604·1 ins^4	5	7922	9651	364·1	·0311	12·31
Z_{xx} = 266·3 ins^3	6	8341	10845	370·2	·0324	11·54
	7	8697	11983	375·1	·0333	10·89
	8	9002	13067	379·3	·0340	10·33
27″ × 10″ × 94 lbs U.B.	3	6340	6770	319·2	·0279	14·05
	4	6916	8062	328·6	·0303	12·87
I_{xx} = 3266·8 ins^4	5	7380	9284	335·7	·0320	11·92
Z_{xx} = 242·8 ins^3	6	7764	10442	341·2	·0331	11·15
	7	8088	11540	345·7	·0340	10·51
	8	8365	12584	349·4	·0347	9·97

COMPOSITE CONSTRUCTION



SLAB THICKNESS 6 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli Concrete in ins^3	Elastic Moduli Steel in ins^3	Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
36″ × 16½″ × 260 lbs U.B.	3	22684	16377	1056·8	·0113	20·78
	4	24139	18208	1079·8	·0134	19·89
I_{xx} = 17234·0 ins^4	5	25456	20013	1099·1	·0152	19·08
Z_{xx} = 951·1 ins^3	6	26655	21793	1115·6	·0166	18·35
	7	27751	23547	1129·8	·0178	17·68
	8	28756	25276	1142·3	·0188	17·07
36″ × 16½″ × 230 lbs U.B.	3	20238	14978	936·5	·0123	20·27
	4	21605	16778	957·5	·0145	19·32
I_{xx} = 14988.0 ins^4	5	22830	18550	974·9	·0163	18·46
Z_{xx} = 835·5 ins^3	6	23935	20293	989·6	·0177	17·69
	7	24937	22007	1002·1	·0189	17·00
	8	25849	23695	1013·0	·0199	16·36
36″ × 12″ × 194 lbs U.B.	3	17334	13025	769·8	·0141	19·96
	4	18643	14799	790·5	·0164	18·90
I_{xx} = 12103·0 ins^4	5	19799	16540	807·3	·0181	17·96
Z_{xx} = 663·6 ins^3	6	20827	18248	821·2	·0195	17·12
	7	21747	19924	833·0	·0207	16·37
	8	22577	21570	843·1	·0216	15·70
36″ × 12″ × 170 lbs U.B.	3	15481	11991	679·1	·0152	19·36
	4	16692	13734	697·5	·0175	18·23
I_{xx} = 10470·0 ins^4	5	17747	15440	712·2	·0193	17·24
Z_{xx} = 579·1 ins^3	6	18676	17109	724·2	·0206	16·37
	7	19499	18742	734·3	·0217	15·61
	8	20235	20342	742·9	·0226	14·92
36″ × 12″ × 150 lbs U.B.	3	13808	11031	598·7	·0165	18·78
	4	14926	12735	615·3	·0188	17·58
I_{xx} = 9012·1 ins^4	5	15889	14398	628·4	·0205	16·55
Z_{xx} = 502·9 ins^3	6	16727	16020	639·0	·0218	15·66
	7	17464	17604	647·8	·0229	14·88
	8	18116	19151	655·2	·0237	14·19
33″ × 11½″ × 152 lbs U.B.	3	12439	10402	576·9	·0173	17·94
	4	13444	11992	592·7	·0197	16·82
I_{xx} = 8147·6 ins^4	5	14311	13542	605·2	·0216	15·85
Z_{xx} = 486·4 ins^3	6	15067	15054	615·3	·0230	15·01
	7	15731	16529	623·7	·0241	14·28
	8	16321	17968	630·7	·0250	13·62

COMPOSITE CONSTRUCTION

SLAB THICKNESS 6 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli Concrete in ins^3	Elastic Moduli Steel in ins^3	Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
33″ × 11½″ × 130 lbs U.B.	3	10741	9365	490·5	·0190	17·20
	4	11643	10903	504·4	·0215	16·02
I_{xx} = 6699·0 ins^4	5	12408	12396	515·1	·0232	15·01
Z_{xx} = 404·8 ins^3	6	13066	13847	523·8	·0246	14·15
	7	13637	15255	530·8	·0256	13·41
	8	14139	16625	536·7	·0265	12·76
30″ × 10½″ × 132 lbs U.B.	3	9257	8550	461·5	·0206	16·24
	4	10043	9947	474·7	·0232	15·14
I_{xx} = 5753·1 ins^4	5	10711	11301	485·0	·0251	14·22
Z_{xx} = 379·7 ins^3	6	11287	12615	493·3	·0266	13·42
	7	11788	13889	500·1	·0277	12·73
	8	12228	15127	505·8	·0287	12·13
30″ × 10½″ × 116 lbs U.B.	3	8244	7897	405·3	·0221	15·66
	4	8958	9254	417·0	·0247	14·52
I_{xx} = 4919·1 ins^4	5	9557	10565	426·0	·0265	13·57
Z_{xx} = 327·9 ins^3	6	10066	11831	433·2	·0279	12·76
	7	10506	13055	439·0	·0290	12·07
	8	10889	14240	443·9	·0299	11·47
27″ × 10″ × 114 lbs U.B.	3	6913	7083	370·9	·0242	14·64
	4	7519	8304	381·7	·0270	13·58
I_{xx} = 4080·5 ins^4	5	8026	9480	389·9	·0290	12·70
Z_{xx} = 299·2 ins^3	6	8457	10614	396·5	·0305	11·95
	7	8828	11707	401·9	·0316	11·31
	8	9152	12762	406·3	·0325	10·76
27″ × 10″ × 102 lbs U.B.	3	6308	6676	333·8	·0255	14·17
	4	6863	7868	343·4	·0282	13·08
I_{xx} = 3604·1 ins^4	5	7322	9012	350·6	·0301	12·19
Z_{xx} = 266·3 ins^3	6	7709	10109	356·3	·0315	11·44
	7	8039	11164	361·0	·0326	10·80
	8	8325	12179	364·9	·0335	10·25
27″ × 10″ × 94 lbs U.B.	3	5874	6375	307·7	·0265	13·82
	4	6393	7544	316·5	·0292	12·71
I_{xx} = 3266·8 ins^4	5	6818	8660	323·1	·0310	11·81
Z_{xx} = 242·8 ins^3	6	7173	9728	328·3	·0324	11·06
	7	7475	10751	332·5	·0334	10·43
	8	7735	11733	336·0	·0342	9·89

COMPOSITE CONSTRUCTION

SLAB THICKNESS 5 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
24″×12″×160 lbs U.B.	2	6526	6404	446·0	·0157	15·29
	3	7114	7431	460·9	·0200	14·42
I_{xx} = 4979·2 ins^4	4	7685	8436	472·7	·0232	13·66
Z_{xx} = 399·6 ins^3	5	8162	9419	482·3	·0257	13·00
	6	8586	10381	490·3	·0277	12·41
	7	8966	11322	497·0	·0293	11·88
24″×12″×120 lbs U.B.	2	5053	5246	339·9	·0189	14·45
	3	5584	6233	351·7	·0235	13·44
I_{xx} = 3635·3 ins^4	4	6033	7192	360·7	·0267	12·58
Z_{xx} = 299·1 ins^3	5	6419	8122	367·7	·0291	11·85
	6	6753	9026	373·4	·0310	11·22
	7	7047	9905	378·1	·0325	10·67
24″×12″×100 lbs U.B.	2	4326	4669	286·5	·0211	13·90
	3	4805	5630	296·6	·0257	12·80
I_{xx} = 2987·3 ins^4	4	5200	6558	304·0	·0289	11·89
Z_{xx} = 248·9 ins^3	5	5533	7454	309·7	·0312	11·13
	6	5817	8320	314·2	·0330	10·49
	7	6062	9157	317·9	·0343	9·93
24″×9″×94 lbs U.B.	2	4030	4363	261·1	·0225	13·86
	3	4502	5313	271·6	·0272	12·71
I_{xx} = 2683·0 ins^4	4	4890	6229	279·2	·0303	11·77
Z_{xx} = 220·9 ins^3	5	5213	7112	284·9	·0326	11·00
	6	5488	7963	289·5	·0343	10·34
	7	5724	8785	293·3	·0356	9·77
24″×9″×84 lbs U.B.	2	3659	4070	234·5	·0240	13·49
	3	4098	5002	243·9	·0287	12·29
I_{xx} = 2364·3 ins^4	4	4452	5895	250·7	·0317	11·33
Z_{xx} = 196·3 ins^3	5	4744	6753	255·7	·0339	10·54
	6	4990	7577	259·7	·0355	9·88
	7	5200	8370	263·0	·0367	9·32
24″×9″×76 lbs U.B.	2	3344	3816	212·2	·0255	13·15
	3	3753	4728	220·8	·0301	11·91
I_{xx} = 2096·4 ins^4	4	4079	5599	226·8	·0331	10·93
Z_{xx} = 175·4 ins^3	5	4344	6432	231·4	·0351	10·13
	6	4566	7229	234·9	·0367	9·47
	7	4753	7993	237·8	·0378	8·92

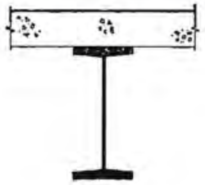
COMPOSITE CONSTRUCTION

SLAB THICKNESS 5 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
21″×13″×142 lbs U.B.	2	4596	5067	357·5	·0193	13·60
	3	5061	5941	369·9	·0244	12·78
I_{xx} = 3403·9 ins^4	4	5462	6790	379·5	·0280	12·07
Z_{xx} = 317·2 ins^3	5	5813	7617	387·2	·0308	11·45
	6	6122	8422	393·5	·0329	10·90
	7	6397	9207	398·8	·0347	10·42
21″×13″×127 lbs U.B.	2	4169	4699	322·4	·0207	13·31
	3	4607	5558	333·6	·0259	12·43
I_{xx} = 3018·0 ins^4	4	4980	6391	342·2	·0295	11·69
Z_{xx} = 284·2 ins^3	5	5302	7200	349·0	·0322	11·05
	6	5584	7985	354·5	·0343	10·49
	7	5832	8747	359·1	·0360	10·00
21″×13″×112 lbs U.B.	2	3726	4312	285·8	·0225	12·96
	3	4133	5153	295·9	·0277	12·03
I_{xx} = 2621·4 ins^4	4	4475	5966	303·5	·0313	11·25
Z_{xx} = 249·7 ins^3	5	4767	6751	309·4	·0339	10·59
	6	5019	7510	314·1	·0360	10·02
	7	5239	8246	318·1	·0376	9·53
21″×8¼″×82 lbs U.B.	2	2894	3494	206·6	·0274	12·43
	3	3253	4308	215·3	·0326	11·33
I_{xx} = 1827·8 ins^4	4	3542	5086	221·5	·0359	10·45
Z_{xx} = 170·5 ins^3	5	3780	5830	226·2	·0382	9·73
	6	3980	6542	229·9	·0400	9·13
	7	4151	7225	232·9	·0413	8·62
21″×8¼″×73 lbs U.B.	2	2620	3260	184·7	·0292	12·06
	3	2950	4054	192·5	·0342	10·91
I_{xx} = 1600·3 ins^4	4	3211	4809	197·9	·0374	10·02
Z_{xx} = 150·7 ins^3	5	3424	5528	202·0	·0397	9·29
	6	3601	6212	205·2	·0413	8·69
	7	3750	6866	207·8	·0425	8·19
21″×8¼″×68 lbs U.B.	2	2471	3131	172·8	·0302	11·83
	3	2784	3914	180·1	·0352	10·67
I_{xx} = 1478·3 ins^4	4	3030	4655	185·1	·0384	9·76
Z_{xx} = 139·9 ins^3	5	3228	5358	188·8	·0405	9·04
	6	3391	6026	191·7	·0420	8·44
	7	3529	6661	194·1	·0432	7·95

COMPOSITE CONSTRUCTION

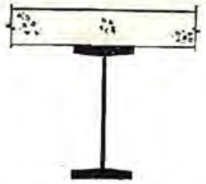


SLAB THICKNESS 5 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli Concrete in ins^3	Elastic Moduli Steel in ins^3	Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
21″×8¼″×62 lbs U.B.	2	2282	2969	157·9	·0317	11·53
	3	2574	3735	164·4	·0365	10·34
I_{xx} = 1326·8 ins^4	4	2799	4457	168·9	·0396	9·42
Z_{xx} = 126·4 ins^3	5	2979	5138	172·3	·0416	8·70
	6	3126	5783	174·8	·0431	8·11
	7	3250	6393	176·9	·0442	7·62
18″×7½″×66 lbs U.B.	2	1889	2627	149·7	·0351	10·78
	3	2137	3294	156·3	·0406	9·73
I_{xx} = 1096·8 ins^4	4	2330	3922	160·9	·0440	8·91
Z_{xx} = 119·2 ins^3	5	2487	4515	164·2	·0463	8·26
	6	2615	5075	166·9	·0480	7·73
	7	2724	5606	169·1	·0492	7·29
18″×7½″×60 lbs U.B.	2	1744	2493	136·8	·0367	10·50
	3	1974	3144	142·7	·0421	9·42
I_{xx} = 984·0 ins^4	4	2151	3754	146·8	·0453	8·60
Z_{xx} = 107·8 ins^3	5	2292	4326	149·8	·0475	7·95
	6	2408	4865	152·2	·0491	7·42
	7	2505	5373	154·1	·0502	6·99
18″×7½″×55 lbs U.B.	2	1622	2377	125·9	·0382	10·24
	3	1836	3013	131·3	·0434	9·14
I_{xx} = 889·9 ins^4	4	1999	3606	135·0	·0465	8·31
Z_{xx} = 98·2 ins^3	5	2127	4159	137·7	·0486	7·67
	6	2232	4678	139·8	·0501	7·16
	7	2319	5165	141·5	·0511	6·74
18″×7½″×50 lbs U.B.	2	1503	2265	115·1	·0397	9·95
	3	1700	2886	120·0	·0447	8·83
I_{xx} = 800·6 ins^4	4	1847	3460	123·2	·0477	8·01
Z_{xx} = 89·0 ins^3	5	1963	3994	125·6	·0496	7·37
	6	2057	4491	127·5	·0510	6·87
	7	2134	4955	129·0	·0520	6·46
18″×6″×55 lbs U.B.	2	1613	2349	123·9	·0387	10·30
	3	1830	2986	129·6	·0439	9·19
I_{xx} = 868·7 ins^4	4	1995	3579	133·4	·0470	8·36
Z_{xx} = 94·9 ins^3	5	2125	4134	136·3	·0490	7·71
	6	2232	4653	138·5	·0505	7·19
	7	2320	5142	140·3	·0515	6·77

COMPOSITE CONSTRUCTION

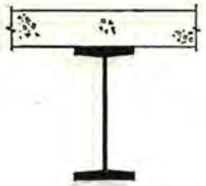


SLAB THICKNESS 5 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli Concrete in ins^3	Elastic Moduli Steel in ins^3	Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
18″×6″×50 lbs U.B.	2	1489	2234	113·2	·0403	10·00
	3	1689	2854	118·3	·0453	8·88
I_{xx} = 777·9 ins^4	4	1839	3428	121·7	·0483	8·05
Z_{xx} = 85·7 ins^3	5	1956	3961	124·2	·0502	7·41
	6	2051	4458	126·1	·0515	6·90
	7	2129	4923	127·7	·0524	6·49
18″×6″×45 lbs U.B.	2	1361	2112	102·1	·0421	9·66
	3	1542	2712	106·6	·0469	8·53
I_{xx} = 685·2 ins^4	4	1676	3263	109·6	·0497	7·70
Z_{xx} = 76·1 ins^3	5	1779	3772	111·7	·0514	7·08
	6	1863	4243	113·5	·0526	6·58
	7	1931	4681	114·9	·0535	6·19
16″×7″×50 lbs U.B.	2	1257	2010	105·9	·0438	9·38
	3	1426	2562	110·6	·0492	8·35
I_{xx} = 655·4 ins^4	4	1554	3071	113·7	·0524	7·59
Z_{xx} = 80·7 ins^3	5	1654	3543	116·0	·0544	7·00
	6	1735	3981	117·9	·0558	6·54
	7	1802	4389	119·4	·0568	6·16
16″×7″×45 lbs U.B.	2	1156	1909	96·0	·0456	9·08
	3	1310	2445	100·2	·0507	8·04
I_{xx} = 583·3 ins^4	4	1425	2935	102·9	·0537	7·28
Z_{xx} = 72·4 ins^3	5	1513	3385	105·0	·0556	6·71
	6	1585	3801	106·6	·0569	6·25
	7	1644	4187	108·0	·0577	5·89
16″×7″×40 lbs U.B.	2	1057	1812	86·3	·0473	8·75
	3	1196	2329	89·9	·0522	7·70
I_{xx} = 515·5 ins^4	4	1296	2798	92·3	·0549	6·95
Z_{xx} = 64·4 ins^3	5	1374	3226	94·0	·0566	6·39
	6	1436	3618	95·5	·0577	5·95
	7	1487	3979	96·6	·0585	5·61
16″×7″×36 lbs U.B.	2	958	1703	77·2	·0496	8·44
	3	1083	2198	80·4	·0542	7·39
I_{xx} = 446·3 ins^4	4	1172	2643	82·6	·0567	6·65
Z_{xx} = 56·3 ins^3	5	1240	3046	84·2	·0582	6·11
	6	1295	3413	85·4	·0592	5·69
	7	1340	3749	86·5	·0598	5·36

COMPOSITE CONSTRUCTION

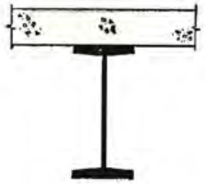


SLAB THICKNESS 5 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
16″×6″×50 lbs U.B.	2	1256	1999	105·0	·0441	9·43
	3	1428	2553	109·8	·0495	8·39
I_{xx} = 647·2 ins^4	4	1557	3064	113·1	·0526	7·62
Z_{xx} = 79·0 ins^3	5	1658	3537	115·5	·0547	7·03
	6	1740	3977	117·3	·0560	6·56
	7	1808	4387	118·9	·0570	6·18
16″×6″×45 lbs U.B.	2	1150	1893	94·9	·0460	9·12
	3	1306	2428	99·2	·0512	8·07
I_{xx} = 571·8 ins^4	4	1421	2918	102·1	·0541	7·30
Z_{xx} = 70·5 ins^3	5	1511	3369	104·2	·0560	6·73
	6	1583	3785	105·8	·0572	6·27
	7	1643	4172	107·2	·0581	5·91
16″×6″×40 lbs U.B.	2	1040	1779	84·6	·0482	8·77
	3	1179	2293	88·3	·0530	7·71
I_{xx} = 495·4 ins^4	4	1280	2759	90·8	·0557	6·96
Z_{xx} = 61·7 ins^3	5	1358	3184	92·6	·0574	6·40
	6	1421	3573	94·1	·0585	5·96
	7	1472	3933	95·3	·0592	5·61
15″×6″×45 lbs U.B.	2	1042	1770	90·8	·0486	8·83
	3	1185	2271	95·0	·0539	7·82
I_{xx} = 511·2 ins^4	4	1291	2729	97·8	·0570	7·10
Z_{xx} = 66·8 ins^3	5	1374	3149	99·8	·0589	6·54
	6	1440	3537	101·5	·0601	6·11
	7	1496	3896	102·9	·0610	5·76
15″×6″×40 lbs U.B.	2	948	1673	81·3	·0506	8·50
	3	1076	2155	85·0	·0557	7·49
I_{xx} = 447·6 ins^4	4	1169	2591	87·4	·0584	6·77
Z_{xx} = 59·1 ins^3	5	1241	2988	89·2	·0601	6·23
	6	1299	3351	90·6	·0612	5·82
	7	1347	3686	91·8	·0620	5·48
15″×6″×35 lbs U.B.	2	852	1573	71·8	·0528	8·13
	3	964	2033	74·9	·0574	7·12
I_{xx} = 385·5 ins^4	4	1045	2444	76·9	·0599	6·41
Z_{xx} = 51·4 ins^3	5	1107	2815	78·5	·0614	5·90
	6	1156	3151	79·7	·0623	5·50
	7	1196	3459	80·8	·0629	5·19

COMPOSITE CONSTRUCTION



SLAB THICKNESS 5 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{v}$
			Concrete in ins^3	Steel in ins^3		
14″×6¾″×45 lbs U.B.	2	950	1673	87·9	·0507	8·52
	3	1081	2142	91·9	·0563	7·57
I_{xx} = 468·1 ins^4	4	1178	2570	94·6	·0594	6·87
Z_{xx} = 65·3 ins^3	5	1254	2962	96·6	·0614	6·35
	6	1315	3323	98·2	·0627	5·93
	7	1366	3657	99·5	·0636	5·60
14″×6¾″×38 lbs U.B.	2	828	1539	74·9	·0538	8·07
	3	939	1981	78·2	·0589	7·11
I_{xx} = 385·3 ins^4	4	1020	2379	80·4	·0617	6·43
Z_{xx} = 54·6 ins^3	5	1082	2739	82·0	·0633	5·93
	6	1132	3067	83·3	·0644	5·54
	7	1173	3368	84·5	·0651	5·23
14″×6¾″×34 lbs U.B.	2	757	1460	67·5	·0558	7·78
	3	856	1884	70·3	·0605	6·82
I_{xx} = 339·2 ins^4	4	928	2262	72·2	·0630	6·15
Z_{xx} = 48·5 ins^3	5	983	2601	73·7	·0645	5·67
	6	1026	2908	74·9	·0653	5·29
	7	1063	3188	75·9	·0659	5·00
14″×6¾″×30 lbs U.B.	2	679	1369	59·5	·0582	7·44
	3	766	1771	62·0	·0625	6·49
I_{xx} = 289·6 ins^4	4	828	2124	63·6	·0647	5·85
Z_{xx} = 41·8 ins^3	5	875	2438	64·9	·0659	5·38
	6	913	2721	66·0	·0666	5·03
	7	944	2979	66·9	·0670	4·75
12″×6½″×36 lbs U.B.	2	636	1288	64·7	·0618	7·41
	3	724	1660	67·7	·0670	6·54
I_{xx} = 280·8 ins^4	4	788	1991	69·7	·0697	5·93
Z_{xx} = 45·9 ins^3	5	837	2289	71·2	·0713	5·48
	6	877	2559	72·5	·0722	5·14
	7	910	2806	73·5	·0728	4·86
12″×6½″×31 lbs U.B.	2	566	1204	56·4	·0643	7·05
	3	642	1555	58·9	·0690	6·19
I_{xx} = 238·4 ins^4	4	696	1863	60·6	·0713	5·60
Z_{xx} = 39·4 ins^3	5	737	2137	61·9	·0726	5·18
	6	771	2384	63·0	·0733	4·85
	7	799	2613	63·9	·0737	4·59

COMPOSITE CONSTRUCTION

SLAB THICKNESS 5 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch *k*	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
12″×6½″×27 lbs U.B.	2	508	1132	49·7	·0667	6·73
	3	574	1462	51·8	·0708	5·88
I_{xx} = 204·2 ins^4	4	620	1749	53·3	·0728	5·32
Z_{xx} = 34·1 ins^3	5	656	2001	54·4	·0737	4·92
	6	684	2231	55·4	·0743	4·60
	7	708	2444	56·1	·0747	4·35
12″×5″×32 lbs U.B.	2	565	1185	56·2	·0659	7·16
	3	644	1537	58·9	·0705	6·29
I_{xx} = 227·9 ins^4	4	701	1847	60·8	·0728	5·69
Z_{xx} = 37·3 ins^3	5	744	2124	62·2	·0741	5·26
	6	779	2373	63·4	·0747	4·93
	7	809	2604	64·4	·0751	4·66
12″×5″×28 lbs U.B.	2	507	1115	49·5	·0682	6·83
	3	576	1446	51·9	·0724	5·97
I_{xx} = 195·2 ins^4	4	624	1735	53·5	·0743	5·40
Z_{xx} = 32·3 ins^3	5	662	1990	54·8	·0752	4·99
	6	692	2221	55·8	·0757	4·67
	7	717	2436	56·6	·0761	4·41
12″×5″×25 lbs U.B.	2	464	1060	44·6	·0700	6·56
	3	524	1375	46·7	·0737	5·72
I_{xx} = 171·6 ins^4	4	567	1646	48·1	·0753	5·17
Z_{xx} = 28·7 ins^3	5	600	1884	49·2	·0760	4·78
	6	626	2102	50·1	·0765	4·47
	7	648	2306	50·8	·0768	4·21
10″×5¾″×29 lbs U.B.	2	413	964	47·0	·0761	6·43
	3	471	1248	49·3	·0806	5·66
I_{xx} = 157·3 ins^4	4	513	1495	50·9	·0826	5·15
Z_{xx} = 30·8 ins^3	5	545	1714	52·2	·0835	4·77
	6	572	1916	53·2	·0841	4·48
	7	594	2104	54·0	·0845	4·23
10″×5¾″×25 lbs U.B.	2	368	903	41·0	·0786	6·11
	3	417	1167	43·0	·0824	5·36
I_{xx} = 133·2 ins^4	4	453	1394	44·4	·0839	4·87
Z_{xx} = 26·4 ins^3	5	480	1598	45·4	·0846	4·51
	6	502	1785	46·3	·0851	4·22
	7	521	1960	46·9	·0854	3·99

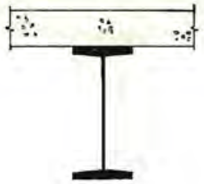
COMPOSITE CONSTRUCTION

SLAB THICKNESS 5 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch *k*	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
10″×5¾″×21 lbs U.B.	2	317	826	34·6	·0821	5·75
	3	358	1066	36·3	·0850	5·04
I_{xx} = 106·3 ins^4	4	387	1273	37·5	·0861	4·56
Z_{xx} = 21·5 ins^3	5	410	1459	38·3	·0867	4·21
	6	428	1629	39·0	·0870	3·94
	7	443	1788	39·6	·0872	3·71
8″×5¼″×20 lbs U.B.	2	232	659	29·5	·0959	5·28
	3	265	853	31·2	·0982	4·65
I_{xx} = 69·2 ins^4	4	288	1022	32·3	·0991	4·22
Z_{xx} = 17·0 ins^3	5	305	1175	33·1	·0995	3·90
	6	320	1316	33·7	·0998	3·65
	7	332	1446	34·2	·0999	3·44
8″×5¼″×17 lbs U.B.	2	203	609	25·4	·0985	5·00
	3	230	788	26·7	·1002	4·39
I_{xx} = 56·4 ins^4	4	250	944	27·6	·1008	3·97
Z_{xx} = 14·1 ins^3	5	264	1085	28·3	·1011	3·66
	6	276	1214	28·8	·1012	3·41
	7	286	1334	29·2	·1012	3·21
8″×4″×17 lbs I	2	202	605	25·2	·0991	5·00
	3	229	783	26·6	·1007	4·39
I_{xx} = 55·1 ins^4	4	248	939	27·5	·1013	3·97
Z_{xx} = 13·8 ins^3	5	263	1079	28·1	·1016	3·66
	6	275	1208	28·7	·1017	3·41
	7	284	1327	29·1	·1017	3·21
7″×4″×14·5 lbs I	2	153	503	20·6	·1091	4·57
	3	174	653	21·8	·1102	4·00
I_{xx} = 36·6 ins^4	4	189	784	22·5	·1105	3·61
Z_{xx} = 10·5 ins^3	5	200	902	23·0	·1105	3·32
	6	208	1010	23·4	·1104	3·10
	7	216	1110	23·7	·1103	2·91
6″×3½″×11·5 lbs I	2	109	403	15·8	·1214	4·07
	3	124	525	16·6	·1216	3·54
I_{xx} = 21·2 ins^4	4	134	631	17·2	·1213	3·19
Z_{xx} = 7·1 ins^3	5	142	726	17·5	·1211	2·93
	6	148	812	17·8	·1208	2·73
	7	153	893	18·1	·1205	2·56

COMPOSITE CONSTRUCTION

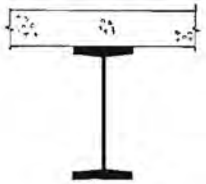


SLAB THICKNESS 4 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
24″×12″×160 lbs U.B. I_{xx} = 4979·2 ins^4 Z_{xx} = 399·6 ins^3	2	6166	6279	434·5	·0132	14·73
	3	6659	7130	446·6	·0173	14·01
	4	7100	7967	456·5	·0205	13·37
	5	7497	8792	464·8	·0230	12·79
	6	7856	9604	471·8	·0251	12·27
24″×12″×120 lbs U.B. I_{xx} = 3635·3 ins^4 Z_{xx} = 299·1 ins^3	2	4729	5074	330·1	·0162	13·98
	3	5160	5896	339·9	·0207	13·13
	4	5534	6702	347·6	·0240	12·39
	5	5862	7491	353·8	·0266	11·74
	6	6152	8264	358·9	·0286	11·17
24″×12″×100 lbs U.B. I_{xx} = 2987·3 ins^4 Z_{xx} = 248·9 ins^3	2	4026	4474	277·7	·0183	13·50
	3	4419	5279	286·1	·0229	12·56
	4	4753	6064	292·6	·0263	11·76
	5	5040	6830	297·7	·0288	11·07
	6	5290	7577	301·8	·0307	10·47
24″×9″×94 lbs U.B. I_{xx} = 2683·0 ins^4 Z_{xx} = 220·9 ins^3	2	3731	4150	252·0	·0197	13·48
	3	4121	4946	261·0	·0245	12·50
	4	4450	5722	267·7	·0278	11·67
	5	4732	6477	273·0	·0303	10·96
	6	4975	7213	277·3	·0322	10·35
24″×9″×84 lbs U.B. I_{xx} = 2364·3 ins^4 Z_{xx} = 196·3 ins^3	2	3376	3849	226·0	·0212	13·16
	3	3741	4632	234·2	·0260	12·12
	4	4045	5392	240·2	·0293	11·25
	5	4301	6130	244·9	·0317	10·52
	6	4521	6848	248·6	·0336	9·90
24″×9″×76 lbs U.B. I_{xx} = 2096·4 ins^4 Z_{xx} = 175·4 ins^3	2	3074	3588	204·1	·0226	12·85
	3	3417	4357	211·7	·0274	11·76
	4	3699	5101	217·2	·0307	10·88
	5	3934	5822	221·4	·0331	10·14
	6	4134	6521	224·7	·0349	9·51
21″×13″×142 lbs U.B. I_{xx} = 3403·9 ins^4 Z_{xx} = 317·2 ins^3	2	4312	4960	347·1	·0164	13·04
	3	4682	5686	357·2	·0212	12·35
	4	5009	6397	365·2	·0249	11·74
	5	5300	7095	371·8	·0278	11·20
	6	5561	7780	377·3	·0301	10·72

COMPOSITE CONSTRUCTION

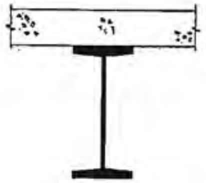


SLAB THICKNESS 4 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
21″×13″×127 lbs U.B. I_{xx} = 3018·0 ins^4 Z_{xx} = 284·2 ins^3	2	3897	4575	312·6	·0177	12·78
	3	4247	5291	321·8	·0227	12·04
	4	4554	5991	329·0	·0264	11·40
	5	4824	6677	334·9	·0293	10·84
	6	5064	7348	339·8	·0316	10·34
21″×13″×112 lbs U.B. I_{xx} = 2621·4 ins^4 Z_{xx} = 249·7 ins^3	2	3467	4172	276·7	·0193	12·47
	3	3796	4874	285·0	·0245	11·68
	4	4079	5560	291·5	·0283	11·00
	5	4326	6230	296·6	·0311	10·42
	6	4543	6883	300·8	·0334	9·90
21″×8¼″×82 lbs U.B. I_{xx} = 1827·8 ins^4 Z_{xx} = 170·5 ins^3	2	2655	3304	198·3	·0242	12·05
	3	2952	3989	205·8	·0296	11·10
	4	3198	4653	211·4	·0333	10·31
	5	3405	5295	215·6	·0359	9·65
	6	3583	5918	219·0	·0380	9·08
21″×8¼″×73 lbs U.B. I_{xx} = 1600·3 ins^4 Z_{xx} = 150·7 ins^3	2	2394	3064	177·1	·0260	11·72
	3	2669	3735	183·8	·0314	10·72
	4	2894	4383	188·7	·0350	9·90
	5	3081	5008	192·5	·0375	9·23
	6	3240	5611	195·4	·0395	8·66
21″×8¼″×68 lbs U.B. I_{xx} = 1478·3 ins^4 Z_{xx} = 139·9 ins^3	2	2252	2933	165·5	·0271	11·52
	3	2516	3596	171·9	·0324	10·49
	4	2728	4234	176·4	·0360	9·66
	5	2904	4848	179·8	·0385	8·98
	6	3051	5440	182·5	·0404	8·41
21″×8¼″×62 lbs U.B. I_{xx} = 1326·8 ins^4 Z_{xx} = 126·4 ins^3	2	2075	2767	151·0	·0285	11·25
	3	2321	3419	156·8	·0338	10·18
	4	2518	4043	160·9	·0373	9·34
	5	2679	4642	164·0	·0398	8·65
	6	2812	5217	166·4	·0415	8·09
18″×7½″×66 lbs U.B. I_{xx} = 1096·8 ins^4 Z_{xx} = 119·2 ins^3	2	1709	2460	142·7	·0315	10·42
	3	1915	3026	148·4	·0376	9·49
	4	2081	3569	152·4	·0415	8·75
	5	2218	4088	155·5	·0443	8·14
	6	2333	4587	157·9	·0463	7·63

COMPOSITE CONSTRUCTION



SLAB THICKNESS 4 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch *k*	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
18″×7½″×60 lbs U.B.	2	1574	2323	130·2	·0332	10·16
I_{xx} = 984·0 ins^4	3	1766	2878	135·4	·0392	9·20
Z_{xx} = 107·8 ins^3	4	1919	3408	139·0	·0430	8·45
	5	2044	3913	141·8	·0457	7·83
	6	2147	4396	143·9	·0476	7·33
18″×7½″×55 lbs U.B.	2	1460	2205	119·7	·0348	9·93
I_{xx} = 889·9 ins^4	3	1640	2751	124·5	·0406	8·94
Z_{xx} = 98·2 ins^3	4	1781	3268	127·8	·0444	8·18
	5	1896	3760	130·2	·0470	7·56
	6	1990	4228	132·1	·0488	7·06
18″×7½″×50 lbs U.B.	2	1349	2093	109·3	·0364	9·67
I_{xx} = 800·6 ins^4	3	1516	2628	113·6	·0421	8·66
Z_{xx} = 89·0 ins^3	4	1646	3132	116·6	·0457	7·88
	5	1749	3610	118·7	·0482	7·27
	6	1834	4062	120·4	·0500	6·77
18″×6″×55 lbs U.B.	2	1448	2173	117·6	·0353	9·99
I_{xx} = 868·7 ins^4	3	1631	2718	122·6	·0412	9·00
Z_{xx} = 94·9 ins^3	4	1775	3236	126·0	·0449	8·23
	5	1891	3728	128·6	·0475	7·61
	6	1987	4197	130·6	·0493	7·10
18″×6″×50 lbs U.B.	2	1334	2058	107·2	·0370	9·72
I_{xx} = 777·9 ins^4	3	1504	2591	111·8	·0428	8·70
Z_{xx} = 85·7 ins^3	4	1635	3095	114·9	·0464	7·92
	5	1740	3572	117·2	·0488	7·31
	6	1826	4024	118·9	·0505	6·81
18″×6″×45 lbs U.B.	2	1216	1937	96·6	·0390	9·41
I_{xx} = 685·2 ins^4	3	1371	2456	100·6	·0446	8·37
Z_{xx} = 76·1 ins^3	4	1489	2943	103·3	·0480	7·59
	5	1582	3402	105·3	·0503	6·98
	6	1658	3835	106·9	·0519	6·49

COMPOSITE CONSTRUCTION

SLAB THICKNESS 4 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch *k*	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
16″×7″×50 lbs U.B.	2	1121	1857	100·1	·0403	9·05
I_{xx} = 655·4 ins^4	3	1264	2333	104·2	·0465	8·12
Z_{xx} = 80·7 ins^3	4	1374	2780	107·0	·0504	7·41
	4	1462	3203	109·1	·0531	6·85
	6	1535	3602	110·7	·0549	6·39
16″×7″×45 lbs U.B.	2	1028	1757	90·7	·0422	8·78
I_{xx} = 583·3 ins^4	3	1159	2220	94·3	·0483	7·83
Z_{xx} = 72·4 ins^3	4	1259	2654	96·8	·0520	7·11
	5	1338	3061	98·6	·0545	6·56
	6	1402	3444	100·0	·0562	6·11
16″×7″×40 lbs U.B.	2	939	1661	81·5	·0442	8·48
I_{xx} = 515·5 ins^4	3	1057	2112	84·6	·0500	7·51
Z_{xx} = 64·4 ins^3	4	1146	2531	86·7	·0535	6·79
	5	1215	2921	88·3	·0558	6·24
	6	1271	3286	89·5	·0574	5·80
16″×7″×36 lbs U.B.	2	848	1553	72·7	·0467	8·19
I_{xx} = 446·3 ins^4	3	955	1988	75·5	·0523	7·21
Z_{xx} = 56·3 ins^3	4	1034	2389	77·4	·0556	6·49
	5	1095	2760	78·8	·0577	5·95
	6	1144	3105	79·9	·0592	5·53
16″×6″×50 lbs U.B.	2	1119	1844	99·2	·0406	9·10
I_{xx} = 647·2 ins^4	3	1264	2321	103·4	·0469	8·17
Z_{xx} = 79·0 ins^3	4	1375	2769	106·3	·0507	7·45
	5	1465	3193	108·4	·0533	6·88
	6	1538	3593	110·1	·0552	6·42
16″×6″×45 lbs U.B.	2	1022	1738	89·5	·0427	8·82
I_{xx} = 571·8 ins^4	3	1154	2201	93·3	·0488	7·86
Z_{xx} = 70·5 ins^3	4	1254	2635	95·8	·0525	7·14
	5	1334	3042	97·7	·0549	6·58
	6	1399	3425	99·2	·0566	6·13

COMPOSITE CONSTRUCTION

SLAB THICKNESS 4 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
16″×6″×40 lbs U.B. I_{xx} = 495·4 ins^4 Z_{xx} = 61·7 ins^3	2	921	1626	79·6	·0451	8·50
	3	1040	2074	82·9	·0510	7·52
	4	1129	2490	85·2	·0544	6·80
	5	1199	2877	86·8	·0567	6·25
	6	1255	3239	88·0	·0583	5·81
15″×6″×45 lbs U.B. I_{xx} = 511·2 ins^4 Z_{xx} = 66·8 ins^3	2	922	1625	85·4	·0452	8·51
	3	1042	2059	89·0	·0515	7·59
	4	1134	2464	91·5	·0554	6·91
	5	1207	2843	93·4	·0579	6·37
	6	1267	3199	94·8	·0597	5·94
15″×6″×40 lbs U.B. I_{xx} = 447·6 ins^4 Z_{xx} = 59·1 ins^3	2	836	1529	76·4	·0475	8·20
	3	945	1949	79·6	·0536	7·27
	4	1027	2338	81·7	·0572	6·59
	5	1091	2700	83·3	·0595	6·06
	6	1142	3038	84·5	·0612	5·64
15″×6″×35 lbs U.B. I_{xx} = 385·5 ins^4 Z_{xx} = 51·4 ins^3	2	750	1432	67·3	·0500	7·86
	3	847	1836	70·0	·0557	6·91
	4	917	2207	71·9	·0591	6·23
	5	972	2550	73·2	·0612	5·72
	6	1016	2867	74·2	·0627	5·31
14″×6¾″×45 lbs U.B. I_{xx} = 468·1 ins^4 Z_{xx} = 65·3 ins^3	2	839	1539	82·6	·0471	8·18
	3	948	1945	86·1	·0538	7·31
	4	1032	2324	88·4	·0578	6·66
	5	1093	2678	90·1	·0605	6·15
	6	1152	3010	91·5	·0623	5·74
14″×6¾″×38 lbs U.B. I_{xx} = 385·3 ins^4 Z_{xx} = 54·6 ins^3	2	728	1407	70·3	·0506	7·76
	3	822	1794	73·1	·0569	6·87
	4	892	2150	75·0	·0606	6·22
	5	947	2480	76·4	·0630	5·72
	6	991	2786	77·5	·0646	5·33

COMPOSITE CONSTRUCTION

SLAB THICKNESS 4 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
14″×6¾″×34 lbs U.B. I_{xx} = 339·2 ins^4 Z_{xx} = 48·5 ins^3	2	664	1330	63·1	·0529	7·49
	3	749	1704	65·6	·0589	6·59
	4	811	2045	67·3	·0623	5·95
	5	859	2359	68·5	·0645	5·46
	6	897	2649	69·5	·0659	5·08
14″×6¾″×30 lbs U.B. I_{xx} = 289·6 ins^4 Z_{xx} = 41·8 ins^3	2	594	1242	55·6	·0558	7·17
	3	669	1599	57·7	·0613	6·27
	4	723	1922	59·2	·0645	5·64
	5	764	2216	60·2	·0664	5·17
	6	797	2485	61·0	·0677	4·81
12″×6½″×36 lbs U.B. I_{xx} = 280·8 ins^4 Z_{xx} = 45·9 ins^3	2	552	1173	60·2	·0586	7·06
	3	626	1499	62·7	·0654	6·26
	4	680	1797	64·4	·0692	5·68
	5	722	2070	65·6	·0716	5·23
	6	756	2322	66·6	·0733	4·89
12″×6½″×31 lbs U.B. I_{xx} = 238·4 ins^4 Z_{xx} = 39·4 ins^3	2	490	1093	52·4	·0617	6·73
	3	554	1404	54·5	·0679	5·92
	4	600	1684	55·9	·0714	5·35
	5	636	1938	56·9	·0735	4·92
	6	664	2170	57·8	·0749	4·59
12″×6½″×27 lbs U.B. I_{xx} = 204·2 ins^4 Z_{xx} = 34·1 ins^3	2	439	1024	46·0	·0646	6·43
	3	494	1319	47·8	·0703	5·62
	4	534	1582	49·0	·0734	5·06
	5	564	1819	49·9	·0752	4·65
	6	588	2033	50·6	·0764	4·34
12″×5″×32 lbs U.B. I_{xx} = 227·9 ins^4 Z_{xx} = 37·3 ins^3	2	487	1070	51·9	·0635	6·83
	3	553	1380	54·2	·0697	6·02
	4	602	1660	55·8	·0731	5·44
	5	639	1916	57·0	·0752	5·01
	6	669	2150	57·9	·0766	4·67

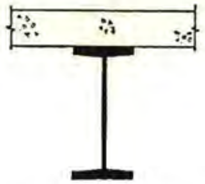
COMPOSITE CONSTRUCTION

SLAB THICKNESS 4 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch *k*	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
12″×5″×28 lbs U.B.	2	436	1003	45·7	·0663	6·52
I_{xx} = 195·2 ins^4	3	494	1298	47·7	·0721	5·71
Z_{xx} = 32·3 ins^3	4	536	1562	49·0	·0751	5·14
	5	567	1800	50·0	·0770	4·73
	6	593	2016	50·8	·0781	4·41
12″×5″×25 lbs U.B.	2	398	953	41·1	·0686	6·27
I_{xx} = 171·6 ins^4	3	449	1235	42·8	·0739	5·46
Z_{xx} = 28·7 ins^3	4	486	1484	44·0	·0767	4·91
	5	514	1708	44·9	·0782	4·51
	6	536	1909	45·6	·0792	4·21
10″×5¾″×29 lbs U.B.	2	351	868	43·0	·0741	6·06
I_{xx} = 157·3 ins^4	3	398	1118	44·9	·0806	5·35
Z_{xx} = 30·8 ins^3	4	433	1341	46·2	·0840	4·84
	5	460	1542	47·2	·0860	4·47
	6	481	1725	48·0	·0872	4·19
10″×5¾″×25 lbs U.B.	2	311	810	37·4	·0774	5·76
I_{xx} = 133·2 ins^4	3	352	1046	39·0	·0832	5·05
Z_{xx} = 26·4 ins^3	4	382	1253	40·1	·0861	4·57
	5	404	1438	41·0	·0877	4·22
	6	422	1604	41·7	·0886	3·95
10″×5¾″×21 lbs U.B.	2	267	739	31·5	·0820	5·42
I_{xx} = 106·3 ins^4	3	301	955	32·8	·0869	4·72
Z_{xx} = 21·5 ins^3	4	325	1143	33·7	·0893	4·27
	5	343	1307	34·5	·0904	3·94
	6	358	1457	35·0	·0910	3·69
8″×5¼″×20 lbs U.B.	2	191	583	26·4	·0976	4·91
I_{xx} = 69·2 ins^4	3	216	754	27·6	·1023	4·31
Z_{xx} = 17·0 ins^3	4	235	900	28·5	·1042	3·91
	5	249	1032	29·2	·1052	3·62
	6	260	1153	29·7	·1058	3·39

COMPOSITE CONSTRUCTION



SLAB THICKNESS 4 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch *k*	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
8″×5¼″×17 lbs U.B.	2	166	538	22·5	·1015	4·63
I_{xx} = 56·4 ins^4	3	188	694	23·6	·1052	4·05
Z_{xx} = 14·1 ins^3	4	203	828	24·4	·1066	3·68
	5	215	949	24·9	·1073	3·39
	6	224	1059	25·4	·1078	3·17
8″×4″×17 lbs I	2	165	533	22·4	·1023	4·63
I_{xx} = 55·1 ins^4	3	186	689	23·4	·1059	4·05
Z_{xx} = 13·8 ins^3	4	202	823	24·2	·1073	3·68
	5	213	943	24·8	·1080	3·39
	6	223	1053	25·2	·1084	3·17
7″×4″×14·5 lbs I	2	123	438	18·0	·1148	4·20
I_{xx} = 36·6 ins^4	3	139	565	18·9	·1173	3·68
Z_{xx} = 10·5 ins^3	4	150	676	19·6	·1183	3·33
	5	159	775	20·0	·1188	3·07
	6	166	867	20·4	·1191	2·87
6″×3½″×11·5 lbs I	2	85	343	13·5	·1303	3·72
I_{xx} = 21·2 ins^4	3	96	444	14·3	·1318	3·25
Z_{xx} = 7·1 ins^3	4	104	532	14·7	·1322	2·93
	5	110	612	15·1	·1323	2·70
	6	115	684	15·3	·1323	2·51
5″×3″×9 lbs I	2	58	265	10·1	·1480	3·27
I_{xx} = 11·5 ins^4	3	65	345	10·6	·1483	2·84
Z_{xx} = 4·6 ins^3	4	70	414	10·9	·1481	2·55
	5	74	476	11·2	·1478	2·34
	6	77	532	11·3	·1475	2·18
4″×2½″×6·5 lbs I	2	36	197	7·0	·1689	2·77
I_{xx} = 5·2 ins^4	3	41	257	7·3	·1679	2·40
Z_{xx} = 2·6 ins^3	4	44	308	7·5	·1669	2·15
	5	46	355	7·7	·1661	1·96
	6	48	397	7·8	·1655	1·82

COMPOSITE CONSTRUCTION

SLAB THICKNESS 3 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
24″×12″×160 lbs U.B.	2·0	5832	6174	424·0	·0104	14·17
I_{xx} = 4979·2 ins^4	2·5	6021	6506	428·9	·0123	13·88
Z_{xx} = 399·6 ins^3	3·0	6202	6836	433·3	·0141	13·61
	3·5	6375	7165	437·4	·0156	13·35
	4·0	6540	7492	441·1	·0170	13·09
24″×12″×120 lbs U.B.	2·0	4427	4911	321·0	·0130	13·52
I_{xx} = 3635·3 ins^4	2·5	4596	5234	325·1	·0152	13·17
Z_{xx} = 299·1 ins^3	3·0	4756	5555	328·7	·0172	12·84
	3·5	4907	5874	332·0	·0189	12·53
	4·0	5050	6191	335·0	·0204	12·23
24″×12″×100 lbs U.B.	2·0	3743	4284	269·4	·0149	13·11
I_{xx} = 2987·3 ins^4	2·5	3900	4601	273·0	·0173	12·71
Z_{xx} = 248·9 ins^3	3·0	4047	4917	276·2	·0193	12·35
	3·5	4185	5230	279·0	·0211	12·00
	4·0	4314	5540	281·6	·0227	11·68
24″×9″×94 lbs U.B.	2·0	3448	3940	243·4	·0162	13·13
I_{xx} = 2683·0 ins^4	2·5	3605	4255	247·3	·0187	12·71
Z_{xx} = 220·9 ins^3	3·0	3752	4566	250·7	·0208	12·32
	3·5	3889	4876	253·7	·0226	11·96
	4·0	4017	5182	256·4	·0242	11·63
24″×9″×84 lbs U.B.	2·0	3105	3627	217·9	·0175	12·84
I_{xx} = 2364·3 ins^4	2·5	3255	3937	221·5	·0201	12·40
Z_{xx} = 196·3 ins^3	3·0	3393	4245	224·7	·0223	11·99
	3·5	3521	4549	227·4	·0241	11·61
	4·0	3640	4851	229·9	·0257	11·26
24″×9″×76 lbs U.B.	2·0	2815	3358	196·4	·0189	12·58
I_{xx} = 2096·4 ins^4	2·5	2957	3663	199·8	·0215	12·11
Z_{xx} = 175·4 ins^3	3·0	3088	3966	202·7	·0237	11·68
	3·5	3208	4266	205·3	·0256	11·28
	4·0	3320	4562	207·5	·0272	10·91
21″×13″×142 lbs U.B.	2·0	4051	4874	337·9	·0130	12·47
I_{xx} = 3403·9 ins^4	2·5	4193	5158	341·9	·0153	12·19
Z_{xx} = 317·2 ins^3	3·0	4328	5441	345·5	·0174	11·93
	3·5	4456	5722	348·8	·0192	11·68
	4·0	4579	6001	351·8	·0209	11·44

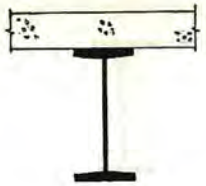
COMPOSITE CONSTRUCTION

SLAB THICKNESS 3 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
21″×13″×127 lbs U.B.	2·0	3646	4468	303·9	·0141	12·24
I_{xx} = 3018·0 ins^4	2·5	3782	4750	307·6	·0166	11·94
Z_{xx} = 284·2 ins^3	3·0	3910	5029	310·9	·0187	11·66
	3·5	4032	5307	313·9	·0206	11·40
	4·0	4147	5583	316·7	·0223	11·14
21″×13″×112 lbs U.B.	2·0	3228	4044	268·5	·0156	11·97
I_{xx} = 2621·4 ins^4	2·5	3357	4321	271·9	·0181	11·65
Z_{xx} = 249·7 ins^3	3·0	3478	4597	274·9	·0204	11·35
	3·5	3592	4870	277·6	·0224	11·06
	4·0	3699	5141	280·1	·0241	10·79
21″×8¼″×82 lbs U.B.	2·0	2429	3117	190·6	·0201	11·69
I_{xx} = 1827·8 ins^4	2·5	2550	3389	193·8	·0230	11·29
Z_{xx} = 170·5 ins^3	3·0	2661	3659	196·7	·0255	10·91
	3·5	2764	3925	199·2	·0275	10·56
	4·0	2860	4190	201·5	·0293	10·24
21″×8¼″×73 lbs U.B.	2·0	2180	2867	169·9	·0218	11·40
I_{xx} = 1600·3 ins^4	2·5	2294	3136	172·9	·0248	10·97
Z_{xx} = 150·7 ins^3	3·0	2398	3401	175·5	·0273	10·58
	3·5	2493	3663	177·7	·0293	10·21
	4·0	2582	3922	179·7	·0311	9·87
21″×8¼″×68 lbs U.B.	2·0	2045	2732	158·6	·0228	11·23
I_{xx} = 1478·3 ins^4	2·5	2155	2998	161·4	·0258	10·78
Z_{xx} = 139·9 ins^3	3·0	2255	3260	163·9	·0283	10·37
	3·5	2346	3519	166·0	·0304	10·00
	4·0	2430	3775	167·9	·0322	9·65
21″×8¼″×62 lbs U.B.	2·0	1877	2561	144·4	·0243	10·99
I_{xx} = 1326·8 ins^4	2·5	1981	2823	147·1	·0273	10·52
Z_{xx} = 126·4 ins^3	3·0	2075	3082	149·4	·0298	10·10
	3·5	2160	3337	151·3	·0319	9·71
	4·0	2239	3589	153·0	·0337	9·36
18″×7½″×66 lbs U.B.	2·0	1541	2294	136·1	·0267	10·08
I_{xx} = 1096·8 ins^4	2·5	1626	2522	138·6	·0302	9·67
Z_{xx} = 119·2 ins^3	3·0	1703	2746	140·8	·0330	9·30
	3·5	1774	2968	142·7	·0354	8·97
	4·0	1839	3187	144·3	·0374	8·66

COMPOSITE CONSTRUCTION

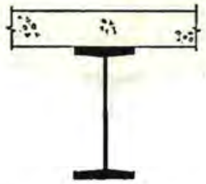


SLAB THICKNESS 3 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
18″×7½″×60 lbs U.B.	2·0	1414	2152	124·0	·0284	9·85
I_{xx} = 984·0 ins^4	2·5	1494	2377	126·4	·0318	9·43
Z_{xx} = 107·8 ins^3	3·0	1567	2598	128·4	·0347	9·05
	3·5	1633	2816	130·1	·0370	8·70
	4·0	1693	3030	131·6	·0390	8·38
18″×7½″×55 lbs U.B.	2·0	1306	2032	113·8	·0299	9·65
I_{xx} = 889·9 ins^4	2·5	1383	2253	116·0	·0334	9·20
Z_{xx} = 98·2 ins^3	3·0	1451	2471	117·9	·0363	8·81
	3·5	1513	2685	119·4	·0386	8·45
	4·0	1569	2895	120·8	·0406	8·13
18″×7½″×50 lbs U.B.	2·0	1203	1917	103·9	·0316	9·42
I_{xx} = 800·6 ins^4	2·5	1275	2135	105·9	·0351	8·96
Z_{xx} = 89·0 ins^3	3·0	1339	2349	107·5	·0379	8·55
	3·5	1396	2560	109·0	·0402	8·18
	4·0	1448	2766	110·2	·0421	7·85
18″×6″×55 lbs U.B.	2·0	1293	1995	111·5	·0305	9·72
I_{xx} = 868·7 ins^4	2·5	1370	2216	113·8	·0340	9·27
Z_{xx} = 94·9 ins^3	3·0	1440	2434	115·8	·0369	8·87
	3·5	1503	2648	117·4	·0392	8·51
	4·0	1560	2858	118·9	·0412	8·19
18″×6″×50 lbs U.B.	2·0	1187	1878	101·6	·0323	9·48
I_{xx} = 777·9 ins^4	2·5	1259	2096	103·7	·0358	9·01
Z_{xx} = 85·7 ins^3	3·0	1324	2309	105·5	·0386	8·60
	3·5	1383	2519	107·0	·0409	8·23
	4·0	1435	2725	108·3	·0428	7·90
18″×6″×45 lbs U.B.	2·0	1077	1755	91·3	·0343	9·20
I_{xx} = 685·2 ins^4	2·5	1145	1969	93·2	·0379	8·72
Z_{xx} = 76·1 ins^3	3·0	1205	2177	94·8	·0406	8·30
	3·5	1258	2382	96·2	·0429	7·92
	4·0	1306	2583	97·3	·0447	7·58
16″×7″×50 lbs U.B.	2·0	994	1703	94·7	·0350	8·76
I_{xx} = 655·4 ins^4	2·5	1055	1898	96·6	·0389	8·34
Z_{xx} = 80·7 ins^3	3·0	1109	2089	98·2	·0420	7·96
	3·5	1157	2276	99·5	·0445	7·62
	4·0	1201	2459	100·7	·0466	7·32

COMPOSITE CONSTRUCTION

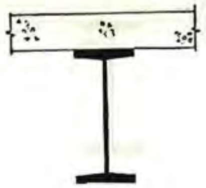


SLAB THICKNESS 3 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
16″×7″×45 lbs U.B.	2·0	909	1601	85·7	·0371	8·52
I_{xx} = 583·3 ins^4	2·5	965	1792	87·4	·0409	8·08
Z_{xx} = 72·4 ins^3	3·0	1015	1979	88·8	·0439	7·69
	3·5	1059	2162	90·0	·0464	7·35
	4·0	1099	2341	91·0	·0484	7·04
16″×7″×40 lbs U.B.	2·0	827	1504	76·9	·0392	8·25
	2·5	879	1691	78·4	·0430	7·79
	3·0	924	1875	79·6	·0459	7·39
I_{xx} = 515·5 ins^4	3·5	964	2053	80·6	·0483	7·04
Z_{xx} = 64·4 ins^3	4·0	1000	2228	81·5	·0502	6·73
16″×7″×36 lbs U.B.	2·0	743	1396	68·4	·0419	7·99
I_{xx} = 446·3 ins^4	2·5	791	1579	69·8	·0456	7·52
Z_{xx} = 56·3 ins^3	3·0	832	1756	70·9	·0485	7·11
	3·5	869	1929	71·8	·0508	6·76
	4·0	901	2097	72·6	·0527	6·44
16″×6″×50 lbs U.B.	2·0	991	1687	93·6	·0354	8·81
I_{xx} = 647·2 ins^4	2·5	1052	1882	95·6	·0393	8·38
Z_{xx} = 79·0 ins^3	3·0	1107	2073	97·2	·0423	8·01
	3·5	1156	2261	98·6	·0448	7·67
	4·0	1200	2445	99·8	·0469	7·36
16″×6″×45 lbs U.B.	2·0	901	1580	84·4	·0376	8·56
I_{xx} = 571·8 ins^4	2·5	958	1771	86·2	·0414	8·12
Z_{xx} = 70·5 ins^3	3·0	1008	1957	87·6	·0445	7·73
	3·5	1053	2140	88·9	·0469	7·38
	4·0	1093	2319	89·9	·0489	7·07
16″×6″×40 lbs U.B.	2·0	809	1467	74·9	·0402	8·27
I_{xx} = 495·4 ins^4	2·5	861	1653	76·5	·0440	7·81
Z_{xx} = 61·7 ins^3	3·0	906	1835	77·8	·0470	7·41
	3·5	947	2012	78·9	·0493	7·06
	4·0	983	2185	79·8	·0513	6·75

COMPOSITE CONSTRUCTION



SLAB THICKNESS 3 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch *k*	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
15″×6″×45 lbs U.B. I_{xx} = 511·2 ins^4 Z_{xx} = 66·8 ins^3	2·0	810	1478	80·3	·0398	8·22
	2·5	861	1657	82·0	·0439	7·80
	3·0	907	1832	83·4	·0470	7·43
	3·5	948	2003	84·6	·0496	7·10
	4·0	984	2170	85·6	·0517	6·80
15″×6″×40 lbs U.B. I_{xx} = 447·6 ins^4 Z_{xx} = 59·1 ins^3	2·0	732	1382	71·7	·0423	7·95
	2·5	779	1557	73·3	·0463	7·51
	3·0	821	1727	74·5	·0494	7·13
	3·5	858	1893	75·5	·0519	6·80
	4·0	890	2055	76·4	·0539	6·50
15″×6″×35 lbs U.B. I_{xx} = 385·5 ins^4 Z_{xx} = 51·4 ins^3	2·0	654	1285	63·1	·0450	7·64
	2·5	697	1455	64·4	·0489	7·19
	3·0	734	1620	65·5	·0519	6·80
	3·5	766	1781	66·4	·0543	6·46
	4·0	795	1937	67·1	·0562	6·16
14″×6¾″×45 lbs U.B. I_{xx} = 468·1 ins^4 Z_{xx} = 65·3 ins^3	2·0	736	1405	77·7	·0415	7·86
	2·5	783	1573	79·3	·0457	7·46
	3·0	824	1737	80·6	·0491	7·11
	3·5	860	1897	81·7	·0518	6·80
	4·0	893	2054	82·6	·0540	6·52
14″×6¾″×38 lbs U.B. I_{xx} = 385·3 ins^4 Z_{xx} = 54·6 ins^3	2·0	635	1272	65·9	·0453	7·49
	2·5	676	1434	67·2	·0494	7·07
	3·0	711	1592	68·3	·0527	6·70
	3·5	743	1745	69·2	·0552	6·39
	4·0	771	1894	70·0	·0573	6·10
14″×6¾″×34 lbs U.B. I_{xx} = 339·2 ins^4 Z_{xx} = 48·5 ins^3	2·0	577	1195	59·2	·0478	7·24
	2·5	615	1353	60·3	·0519	6·81
	3·0	647	1507	61·3	·0550	6·44
	3·5	675	1655	62·1	·0575	6·12
	4·0	700	1800	62·7	·0595	5·84

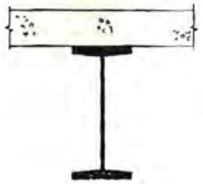
COMPOSITE CONSTRUCTION

SLAB THICKNESS 3 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch *k*	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
14″×6¾″×30 lbs U.B. I_{xx} = 289·6 ins^4 Z_{xx} = 41·8 ins^3	2·0	514	1108	51·9	·0510	6·96
	2·5	548	1261	52·9	·0549	6·51
	3·0	577	1409	53·8	·0579	6·14
	3·5	601	1551	54·5	·0603	5·82
	4·0	623	1689	55·0	·0621	5·53
12″×6½″×36 lbs U.B. I_{xx} = 280·8 ins^4 Z_{xx} = 45·9 ins^3	2·0	476	1059	56·0	·0529	6·74
	2·5	508	1197	57·2	·0575	6·36
	3·0	535	1330	58·1	·0610	6·04
	3·5	559	1459	58·9	·0638	5·75
	4·0	580	1584	59·6	·0661	5·50
12″×6½″×31 lbs U.B. I_{xx} = 238·4 ins^4 Z_{xx} = 39·4 ins^3	2·0	421	980	48·7	·0564	6·44
	2·5	449	1113	49·7	·0608	6·05
	3·0	473	1241	50·4	·0642	5·72
	3·5	494	1364	51·1	·0668	5·43
	4·0	512	1483	51·6	·0689	5·18
12″×6½″×27 lbs U.B. I_{xx} = 204·2 ins^4 Z_{xx} = 34·1 ins^3	2·0	375	913	42·7	·0597	6·17
	2·5	400	1041	43·5	·0640	5·77
	3·0	421	1164	44·2	·0672	5·43
	3·5	439	1282	44·7	·0696	5·14
	4·0	455	1395	45·2	·0716	4·89
12″×5″×32 lbs U.B. I_{xx} = 227·9 ins^4 Z_{xx} = 37·3 ins^3	2·0	416	953	47·9	·0582	6·54
	2·5	445	1085	49·0	·0627	6·15
	3·0	470	1212	49·9	·0661	5·81
	3·5	491	1335	50·7	·0688	5·52
	4·0	510	1453	51·3	·0709	5·27
12″×5″×28 lbs U.B. I_{xx} = 195·2 ins^4 Z_{xx} = 32·3 ins^3	2·0	371	889	42·1	·0616	6·26
	2·5	397	1016	43·1	·0659	5·86
	3·0	419	1138	43·8	·0691	5·52
	3·5	438	1255	44·5	·0716	5·23
	4·0	454	1368	45·0	·0735	4·98

COMPOSITE CONSTRUCTION

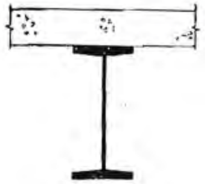


SLAB THICKNESS 3 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
12″×5″×25 lbs U.B.	2·0	338	841	37·8	·0643	6·02
I_{xx} = 171·6 ins^4	2·5	361	964	38·6	·0685	5·62
Z_{xx} = 28·7 ins^3	3·0	380	1081	39·3	·0715	5·28
	3·5	397	1194	39·8	·0738	4·99
	4·0	412	1302	40·3	·0756	4·74
10″×5¾″×29 lbs U.B.	2·0	295	773	39·4	·0688	5·73
I_{xx} = 157·3 ins^4	2·5	316	880	40·3	·0738	5·38
Z_{xx} = 30·8 ins^3	3·0	333	983	41·0	·0774	5·08
	3·5	349	1082	41·5	·0803	4·83
	4·0	362	1177	42·0	·0825	4·61
10″×5¾″×25 lbs U.B.	2·0	261	718	34·2	·0728	5·46
I_{xx} = 133·2 ins^4	2·5	279	820	35·0	·0774	5·10
Z_{xx} = 26·4 ins^3	3·0	294	919	35·5	·0809	4·80
	3·5	307	1012	36·0	·0835	4·55
	4·0	318	1102	36·4	·0855	4·34
10″×5¾″×21 lbs U.B.	2·0	222	650	28·6	·0784	5·13
I_{xx} = 106·3 ins^4	2·5	238	746	29·2	·0827	4·78
Z_{xx} = 21·5 ins^3	3·0	250	837	29·7	·0858	4·48
	3·5	261	924	30·1	·0881	4·24
	4·0	270	1006	30·4	·0899	4·03
8″×5¼″×20 lbs U.B.	2·0	155	508	23·5	·0951	4·57
I_{xx} = 69·2 ins^4	2·5	166	584	24·1	·0997	4·26
Z_{xx} = 17·0 ins^3	3·0	175	656	24·5	·1030	4·00
	3·5	183	723	24·9	·1054	3·79
	4·0	190	786	25·2	·1072	3·62
8″×5¼″×17 lbs U.B.	2·0	134	467	20·0	·1005	4·31
I_{xx} = 56·4 ins^4	2·5	143	538	20·5	·1046	4·00
Z_{xx} = 14·1 ins^3	3·0	151	604	20·8	·1074	3·75
	3·5	158	665	21·1	·1094	3·55
	4·0	163	723	21·4	·1109	3·38

COMPOSITE CONSTRUCTION



SLAB THICKNESS 3 *ins*

MODULAR RATIO 15

Size of Steel Beam	Width of Slab in feet	PROPERTIES OF COMPOSITE SECTION				
		Inertia in ins^4	Elastic Moduli		Shear Coefficient per inch k	Neutral Axis Depth $\bar{y}$
			Concrete in ins^3	Steel in ins^3		
8″×4″×17 lbs I	2·0	133	463	19·8	·1014	4·31
I_{xx} = 55·1 ins^4	2·5	142	533	20·3	·1056	4·00
Z_{xx} = 13·8 ins^3	3·0	150	598	20·7	·1084	3·75
	3·5	156	660	21·0	·1104	3·55
	4·0	162	717	21·2	·1118	3·38
7″×4″×14·5 lbs I	2·0	97	376	15·7	·1168	3·85
I_{xx} = 36·6 ins^4	2·5	103	434	16·1	·1205	3·58
Z_{xx} = 10·5 ins^3	3·0	109	486	16·4	·1229	3·36
	3·5	114	535	16·7	·1244	3·18
	4·0	118	581	16·9	·1255	3·04
6″×3½″×11·5 lbs I	2·0	65	290	11·5	·1374	3·36
I_{xx} = 21·2 ins^4	2·5	69	334	11·8	·1400	3·12
Z_{xx} = 7·1 ins^3	3·0	73	374	12·1	·1415	2·94
	3·5	76	411	12·3	·1424	2·79
	4·0	79	446	12·5	·1430	2·66
5″×3″×9 lbs I	2·0	42	218	8·3	·1609	2·92
I_{xx} = 11·5 ins^4	2·5	45	251	8·6	·1624	2·71
Z_{xx} = 4·6 ins^3	3·0	48	281	8·8	·1632	2·55
	3·5	50	309	8·9	·1638	2·41
	4·0	52	336	9·0	·1641	2·30
4″×2½″×6·5 lbs I	2·0	25	155	5·6	·1904	2·46
I_{xx} = 5·2 ins^4	2·5	27	179	5·8	·1908	2·28
Z_{xx} = 2·6 ins^3	3·0	29	201	5·9	·1909	2·14
	3·5	30	222	6·0	·1908	2·02
	4·0	31	241	6·1	·1907	1·92
3″×2″×4·5 lbs I	2·0	15	108	3·6	·2254	2·02
I_{xx} = 2·0 ins^4	2·5	15	125	3·7	·2246	1·86
Z_{xx} = 1·3 ins^3	3·0	16	140	3·8	·2238	1·74
	3·5	17	155	3·9	·2231	1·64
	4·0	17	168	3·9	·2224	1·56

PART XI

English - Metric Conversion Tables

METRIC EQUIVALENTS OF BRITISH UNITS

LINEAR MEASURE

BRITISH	METRIC	METRIC	BRITISH
1 *inch*	= 2·54 *centimetres*	1 *millimetre*	= ·0393701 *inch*
1 *inch*	= ·0254 *metre*	1 *centimetre*	= ·393701 *inch*
1 *foot*	= ·3048 *metre*	1 *metre*	= 39·3701 *inches*
1 *yard*	= ·9144 *metre*	1 *metre*	= 3·28084 *feet*
1 *fathom*	= 1·8288 *metres*	1 *metre*	= 1·09361 *yards*
1 *pole*	= 5·0292 *metres*	1 *kilometre*	= 1093·61 *yards*
1 *chain*	= 20·1168 *metres*	1 *kilometre*	= 49·7097 *chains*
1 *furlong*	= 201·168 *metres*	1 *kilometre*	= 3280·84 *feet*
1 *mile*	= 1609·344 *metres*	1 *kilometre*	= ·62137 *mile*

SQUARE MEASURE

BRITISH	METRIC	METRIC	BRITISH
1 *sq. inch*	= 6·4516 *sq. centimetres*	1 *sq. centimetre*	= ·15500 *sq. inch*
1 *sq. foot*	= ·092903 *sq. metre*	1 *sq. metre*	= 10·7639 *sq. feet*
1 *sq. yard*	= ·83613 *sq. metre*	1 *sq. metre*	= 1·19599 *sq. yards*
1 *sq. yard*	= ·0083613 *are*	1 *are*	= 119·599 *sq. yards*
1 *acre*	= ·404686 *hectare*	1 *hectare*	= 2·47105 *acres*
1 *sq. mile*	= 258·999 *hectares*	1 *hectare*	= ·00386 *sq. mile*

CUBIC MEASURE

BRITISH	METRIC	METRIC	BRITISH
1 *cubic inch*	= 16·3871 *cubic centimetres*	1 *cubic centimetre*	= ·061024 *cubic inch*
1 *cubic foot*	= ·028317 *cubic metre*	1 *cubic metre*	= 35·31466 *cubic feet*
1 *cubic yard*	= ·76455 *cubic metre*	1 *cubic metre*	= 1·30795 *cubic yards*

CAPACITY

BRITISH	METRIC	METRIC	BRITISH
1 *cubic inch*	= 16·3866 *millilitres*	1 *millilitre*	= ·061025 *cubic inch*
1 *cubic inch*	= 1·63866 *centilitres*	1 *centilitre*	= ·61025 *cubic inch*
1 *gill*	= 14·206 *centilitres*	1 *centilitre*	= ·07039 *gill*
1 *pint*	= ·56825 *litre*	1 *litre*	= 1·75980 *pints*
1 *quart*	= 1·1365 *litres*	1 *litre*	= ·87990 *quart*
1 *gallon*	= 4·54596 *litres*	1 *litre*	= ·219975 *gallon*
1 *gallon*	= ·454596 *dekalitre*	1 *dekalitre*	= 2·19975 *gallons*
1 *bushel*	= 3·6368 *dekalitres*	1 *dekalitre*	= ·27497 *bushel*
1 *bushel*	= ·36368 *hectolitre*	1 *hectolitre*	= 2·7497 *bushels*

METRIC EQUIVALENTS OF BRITISH UNITS

WEIGHT

BRITISH	METRIC	METRIC	BRITISH
Avoirdupois			*Avoirdupois*
1 *grain*	= 64·799 *milligrammes*	1 *milligramme*	= ·0154324 *grain*
1 *grain*	= 6·4799 *centigrammes*	1 *centigramme*	= ·154324 *grain*
1 *grain*	= ·064799 *gramme*	1 *gramme*	= 15·4324 *grains*
1 *ounce*	= 28·3495 *grammes*	1 *gramme*	= ·035274 *ounce*
1 *ounce*	= ·0283495 *kilogramme*	1 *kilogramme*	= 35·274 *ounces*
1 *pound*	= ·45359243 *kilogramme*	1 *kilogramme*	= 2·20462 *pounds*
1 *hundred-weight*	= ·50802 *quintal*	1 *quintal*	= 1·96841 *hundredweights*
1 *ton*	= 1·01605 *metric tonnes*	1 *metric tonne*	= ·98421 *ton*
		1 *metric tonne*	= 2204·62 *pounds*

MISCELLANEOUS COMPOUND MEASURES

BRITISH	METRIC	METRIC	BRITISH
1 *foot per second*	= ·3048 *metre per second*	1 *metre per second*	= 3·28084 *feet per [second*
1 *foot per minute*	= ·3048 *metre per minute*	1 *metre per minute*	= 3·28084 *feet per [minute*
1 *mile per hour*	= 1·60934 *kilometres [per hour*	1 *kilometre per hour*	= ·62137 *mile per hour*
1 *pound per foot*	= 1·48816 *kilogrammes [per metre*	1 *kilogramme [per metre*	= ·67197 *pound per foot*
1 *pound per yard*	= ·496055 *kilogramme [per metre*	1 *kilogramme [per metre*	= 2·01591 *pounds per [yard*
1 *pound per [square inch*	= ·070307 *kilogramme [per square centimetre*	1 *kilometre per [square centimetre*	= 14·2233 *pounds per [square inch*
1 *pound per [square foot*	= 4·8824 *kilogrammes [per square metre*	1 *kilogramme per [square metre*	= ·204816 *pound per [square foot*
1 *ton per [square inch*	= 1·57488 *kilogrammes [per square millimetre*	i *kilogramme per [square millimetre*	= ·63497 *ton per [square inch*
1 *ton per [square foot*	= 10·9366 *tonnes per [square metre*	1 *tonne per [square metre*	= ·091436 *ton per [square foot*
1 *pound per [cubic inch*	= ·0276799 *kilogramme [per cubic centimetre*	1 *kilogramme per [cubic centimetre*	= 36·1273 *pounds per [cubic inch*
1 *pound per [cubic foot*	= 16·0185 *kilogrammes [per cubic metre*	1 *kilogramme per [cubic metre*	= ·062428 *pound per [cubic foot*
1 *pound per [cubic yard*	= ·5933 *kilogramme [per cubic metre*	1 *kilogramme per [cubic metre*	= 1·6855 *pounds per [cubic yard*
1 *pound per [gallon*	= ·0998 *kilogramme [per litre*	1 *kilogramme per [litre*	= 10·0221 *pounds per [gallon*

EQUIVALENTS IN MILLIMETRES

of inches and fractions of an inch,
advancing by 32nds

12 inches = 304·8 *millimetres.*

Inches	0	1	2	3	4	5
0		25·400	50·800	76·200	101·600	127·000
$\frac{1}{32}$	·794	26·194	51·594	76·994	102·394	127·794
$\frac{1}{16}$	1·588	26·988	52·388	77·788	103·188	128·588
$\frac{3}{32}$	2·381	27·781	53·181	78·581	103·981	129·381
$\frac{1}{8}$	3·175	28·575	53·975	79·375	104·775	130·175
$\frac{5}{32}$	3·969	29·369	54·769	80·169	105·569	130·969
$\frac{3}{16}$	4·762	30·162	55·562	80·962	106·362	131·762
$\frac{7}{32}$	5·556	30·956	56·356	81·756	107·156	132·556
$\frac{1}{4}$	6·350	31·750	57·150	82·550	107·950	133·350
$\frac{9}{32}$	7·144	32·544	57·944	83·344	108·744	134·144
$\frac{5}{16}$	7·938	33·338	58·738	84·138	109·538	134·938
$\frac{11}{32}$	8·731	34·131	59·531	84·931	110·331	135·731
$\frac{3}{8}$	9·525	34·925	60·325	85·725	111·125	136·525
$\frac{13}{32}$	10·319	35·719	61·119	86·519	111·919	137·319
$\frac{7}{16}$	11·112	36·512	61·912	87·312	112·712	138·112
$\frac{15}{32}$	11·906	37·306	62·706	88·106	113·506	138·906
$\frac{1}{2}$	12·700	38·100	63·500	88·900	114·300	139·700
$\frac{17}{32}$	13·494	38·894	64·294	89·694	115·094	140·494
$\frac{9}{16}$	14·288	39·688	65·088	90·488	115·888	141·288
$\frac{19}{32}$	15·081	40·481	65·881	91·281	116·681	142·081
$\frac{5}{8}$	15·875	41·275	66·675	92·075	117·475	142·875
$\frac{21}{32}$	16·669	42·069	67·469	92·869	118·269	143·669
$\frac{11}{16}$	17·462	42·862	68·262	93·662	119·062	144·462
$\frac{23}{32}$	18·256	43·656	69·056	94·456	119·856	145·256
$\frac{3}{4}$	19·050	44·450	69·850	95·250	120·650	146·050
$\frac{25}{32}$	19·844	45·244	70·644	96·044	121·444	146·844
$\frac{13}{16}$	20·638	46·038	71·438	96·838	122·238	147·638
$\frac{27}{32}$	21·431	46·831	72·231	97·631	123·031	148·431
$\frac{7}{8}$	22·225	47·625	73·025	98·425	123·825	149·225
$\frac{29}{32}$	23·019	48·419	73·819	99·219	124·619	150·019
$\frac{15}{16}$	23·812	49·212	74·612	100·012	125·412	150·812
$\frac{31}{32}$	24·606	50·006	75·406	100·806	126·206	151·606

EQUIVALENTS IN MILLIMETRES

of inches and fractions of an inch,
advancing by 32nds

12 inches = 304·8 *millimetres.*

Inches	6	7	8	9	10	11
0	152·400	177·800	203·200	228·600	254·000	279·400
$\frac{1}{32}$	153·194	178·594	203·994	229·394	254·794	280·194
$\frac{1}{16}$	153·988	179·388	204·788	230·188	255·588	280·988
$\frac{3}{32}$	154·781	180·181	205·581	230·981	256·381	281·781
$\frac{1}{8}$	155·575	180·975	206·375	231·775	257·175	282·575
$\frac{5}{32}$	156·369	181·769	207·169	232·569	257·969	283·369
$\frac{3}{16}$	157·162	182·562	207·962	233·362	258·762	284·162
$\frac{7}{32}$	157·956	183·356	208·756	234·156	259·556	284·956
$\frac{1}{4}$	158·750	184·150	209·550	234·950	260·350	285·750
$\frac{9}{32}$	159·544	184·944	210·344	235·744	261·144	286·544
$\frac{5}{16}$	160·338	185·738	211·138	236·538	261·938	287·338
$\frac{11}{32}$	161·131	186·531	211·931	237·331	262·731	288·131
$\frac{3}{8}$	161·925	187·325	212·725	238·125	263·525	288·925
$\frac{13}{32}$	162·719	188·119	213·519	238·919	264·319	289·719
$\frac{7}{16}$	163·512	188·912	214·312	239·712	265·112	290·512
$\frac{15}{32}$	164·306	189·706	215·106	240·506	265·906	291·306
$\frac{1}{2}$	165·100	190·500	215·900	241·300	266·700	292·100
$\frac{17}{32}$	165·894	191·294	216·694	242·094	267·494	292·894
$\frac{9}{16}$	166·688	192·088	217·488	242·888	268·288	293·688
$\frac{19}{32}$	167·481	192·881	218·281	243·681	269·081	294·481
$\frac{5}{8}$	168·275	193·675	219·075	244·475	269·875	295·275
$\frac{21}{32}$	169·069	194·469	219·869	245·269	270·669	296·069
$\frac{11}{16}$	169·862	195·262	220·662	246·062	271·462	296·862
$\frac{23}{32}$	170·656	196·056	221·456	246·856	272·256	297·656
$\frac{3}{4}$	171·450	196·850	222·250	247·650	273·050	298·450
$\frac{25}{32}$	172·244	197·644	223·044	248·444	273·844	299·244
$\frac{13}{16}$	173·038	198·438	223·838	249·238	274·638	300·038
$\frac{27}{32}$	173·831	199·231	224·631	250·031	275·431	300·831
$\frac{7}{8}$	174·625	200·025	225·425	250·825	276·225	301·625
$\frac{29}{32}$	175·419	200·819	226·219	251·619	277·019	302·419
$\frac{15}{16}$	176·212	201·612	227·012	252·412	277·812	303·212
$\frac{31}{32}$	177·006	202·406	227·806	253·206	278·606	304·006

EQUIVALENTS OF MILLIMETRES IN INCHES

Millimetres	Inches	Millimetres	Inches	Millimetres	Inches	Millimetres	Inches	Millimetres	Inches
1	0·03937	51	2·00787	101	3·97638	151	5·9449	201	7·9134
2	0·07874	52	2·04724	102	4·01575	152	5·9843	202	7·9528
3	0·11811	53	2·08661	103	4·05512	153	6·0236	203	7·9921
4	0·15748	54	2·12598	104	4·09449	154	6·0630	204	8·0315
5	0·19685	55	2·16535	105	4·13386	155	6·1024	205	8·0709
6	0·23622	56	2·20472	106	4·17323	156	6·1417	206	8·1102
7	0·27559	57	2·24409	107	4·21260	157	6·1811	207	8·1496
8	0·31496	58	2·28346	108	4·25197	158	6·2205	208	8·1890
9	0·35433	59	2·32283	109	4·29134	159	6·2598	209	8·2283
10	0·39370	60	2·36220	110	4·33071	160	6·2992	210	8·2677
11	0·43307	61	2·40157	111	4·37008	161	6·3386	211	8·3071
12	0·47244	62	2·44094	112	4·40945	162	6·3780	212	8·3465
13	0·51181	63	2·48031	113	4·44882	163	6·4173	213	8·3858
14	0·55118	64	2·51969	114	4·48819	164	6·4567	214	8·4252
15	0·59055	65	2·55906	115	4·52756	165	6·4961	215	8·4646
16	0·62992	66	2·59843	116	4·56693	166	6·5354	216	8·5039
17	0·66929	67	2·63780	117	4·60630	167	6·5748	217	8·5433
18	0·70866	68	2·67717	118	4·64567	168	6·6142	218	8·5827
19	0·74803	69	2·71654	119	4·68504	169	6·6535	219	8·6220
20	0·78740	70	2·75591	120	4·72441	170	6·6929	220	8·6614
21	0·82677	71	2·79528	121	4·76378	171	6·7323	221	8·7008
22	0·86614	72	2·83465	122	4·80315	172	6·7717	222	8·7402
23	0·90551	73	2·87402	123	4·84252	173	6·8110	223	7·7795
24	0·94488	74	2·91339	124	4·88189	174	6·8504	224	8·8189
25	0·98425	75	2·95276	125	4·92126	175	6·8898	225	8·8583
26	1·02362	76	2·99213	126	4·96063	176	6·9291	226	8·8976
27	1·06299	77	3·03150	127	5·0000	177	6·9685	227	8·9370
28	1·10236	78	3·07087	128	5·0394	178	7·0079	228	8·9764
29	1·14173	79	3·11024	129	5·0787	179	7·0472	229	9·0157
30	1·18110	80	3·14961	130	5·1181	180	7·0866	230	9·0551
31	1·22047	81	3·18898	131	5·1575	181	7·1260	231	9·0945
32	1·25984	82	3·22835	132	5·1969	182	7·1654	232	9·1339
33	1·29921	83	3·26772	133	5·2362	183	7·2047	233	9·1732
34	1·33858	84	3·30709	134	5·2756	184	7·2441	234	9·2126
35	1·37795	85	3·34646	135	5·3150	185	7·2835	235	9·2520
36	1·41732	86	3·38583	136	5·3543	186	7·3228	236	9·2913
37	1·45669	87	3·42520	137	5·3937	187	7·3622	237	9·3307
38	1·49606	88	3·46457	138	5·4331	188	7·4016	238	9·3701
39	1·53543	89	3·50394	139	5·4724	189	7·4409	239	9·4094
40	1·57480	90	3·54331	140	5·5118	190	7·4803	240	9·4488
41	1·61417	91	3·58268	141	5·5512	191	7·5197	241	9·4882
42	1·65354	92	3·62205	142	5·5906	192	7·5591	242	9·5276
43	1·69291	93	3·66142	143	5·6299	193	7·5984	243	9·5669
44	1·73228	94	3·70079	144	5·6693	194	7·6378	244	9·6063
45	1·77165	95	3·74016	145	5·7087	195	7·6772	245	9·6457
46	1·81102	96	3·77953	146	5·7480	196	7·7165	246	9·6850
47	1·85039	97	3·81890	147	5·7874	197	7·7559	247	9·7244
48	1·88976	98	3·85827	148	5·8268	198	7·7953	248	9·7638
49	1·92913	99	3·89764	149	5·8661	199	7·8346	249	9·8031
50	1·96850	100	3·93701	150	5·9055	200	7·8740	250	9·8425

EQUIVALENTS OF MILLIMETRES IN INCHES

Millimetres	Inches	Millimetres	Inches	Millimetres	Inches	Millimetres	Inches	Millimetres	Inches
251	9·8819	301	11·8504	351	13·8189	401	15·7874	451	17·7559
252	9·9213	302	11·8898	352	13·8583	402	15·8268	452	17·7953
253	9·9606	303	11·9291	353	13·8976	403	15·8661	453	17·8346
254	10·0000	304	11·9685	354	13·9370	404	15·9055	454	17·8740
255	10·0394	305	12·0079	355	13·9764	405	15·9449	455	17·9134
256	10·0787	306	12·0472	356	14·0157	406	15·9843	456	17·9528
257	10·1181	307	12·0866	357	14·0551	407	16·0236	457	17·9921
258	10·1575	308	12·1260	358	14·0945	408	16·0630	458	18·0315
259	10·1969	309	12·1654	359	14·1339	409	16·1024	459	18·0709
260	10·2362	310	12·2047	360	14·1732	410	16·1417	460	18·1102
261	10·2756	311	12·2441	361	14·2126	411	16·1811	461	18·1496
262	10·3150	312	12·2835	362	14·2520	412	16·2205	462	18·1890
263	10·3543	313	12·3228	363	14·2913	413	16·2598	463	18·2283
264	10·3937	314	12·3622	364	14·3307	414	16·2992	464	18·2677
265	10·4331	315	12·4016	365	14·3701	415	16·3386	465	18·3071
266	10·4724	316	12·4409	366	14·4094	416	16·3780	466	18·3465
267	10·5118	317	12·4803	367	14·4488	417	16·4173	467	18·3858
268	10·5512	318	12·5197	368	14·4882	418	16·4567	468	18·4252
269	10·5906	319	12·5591	369	14·5276	419	16·4961	469	18·4646
270	10·6299	320	12·5984	370	14·5669	420	16·5354	470	18·5039
271	10·6693	321	12·6378	371	14·6063	421	16·5748	471	18·5433
272	10·7087	322	12·6772	372	14·6457	422	16·6142	472	18·5827
273	10·7480	323	12·7165	373	14·6850	423	16·6535	473	18·6220
274	10·7874	324	12·7559	374	14·7244	424	16·6929	474	18·6614
275	10·8268	325	12·7953	375	14·7638	425	16·7323	475	18·7008
276	10·8661	326	12·8346	376	14·8031	426	16·7717	476	18·7402
277	10·9055	327	12·8740	377	14·8425	427	16·8110	477	18·7795
278	10·9449	328	12·9134	378	14·8819	428	16·8504	478	18·8189
279	10·9843	329	12·9528	379	14·9213	429	16·8898	479	18·8583
280	11·0236	330	12·9921	380	14·9606	430	16·9291	480	18·8976
281	11·0630	331	13·0315	381	15·0000	431	16·9685	481	18·9370
282	11·1024	332	13·0709	382	15·0394	432	17·0079	482	18·9764
283	11·1417	333	13·1102	383	15·0787	433	17·0472	483	19·0157
284	11·1811	334	13·1496	384	15·1181	434	17·0866	484	19·0551
285	11·2205	335	13·1890	385	15·1575	435	17·1260	485	19·0945
286	11·2598	336	13·2283	386	15·1969	436	17·1654	486	19·1339
287	11·2992	337	13·2677	387	15·2362	437	17·2047	487	19·1732
288	11·3386	338	13·3071	388	15·2756	438	17·2441	488	19·2126
289	11·3780	339	13·3465	389	15·3150	439	17·2835	489	19·2520
290	11·4173	340	13·3858	390	15·3543	440	17·3228	490	19·2913
291	11·4567	341	13·4252	391	15·3937	441	17·3622	491	19·3307
292	11·4961	342	13·4646	392	15·4331	442	17·4016	492	19·3701
293	11·5354	343	13·5039	393	15·4724	443	17·4409	493	19·4094
294	11·5748	344	13·5433	394	15·5118	444	17·4803	494	19·4488
295	11·6142	345	13·5827	395	15·5512	445	17·5197	495	19·4882
296	11·6535	346	13·6220	396	15·5906	446	17·5591	496	19·5276
297	11·6929	347	13·6614	397	15·6299	447	17·5984	497	19·5669
298	11·7323	348	13·7008	398	15·6693	448	17·6378	498	19·6063
299	11·7717	349	13·7402	399	15·7087	449	17·6772	499	19·6457
300	11·8110	350	13·7795	400	15·7480	450	17·7165	500	19·6850

EQUIVALENTS OF MILLIMETRES IN INCHES

Milli-metres	Inches	Milli-metres	Inches	Milli-metres	Inches	Milli-metres	Inches	Milli-metres	Inches
501	19·7244	551	21·6929	601	23·6614	651	25·6299	701	27·5984
502	19·7638	552	21·7323	602	23·7008	652	25·6693	702	27·6378
503	19·8031	553	21·7717	603	23·7402	653	25·7087	703	27·6772
504	19·8425	554	21·8110	604	23·7795	654	25·7480	704	27·7165
505	19·8819	555	21·8504	605	23·8189	655	25·7874	705	27·7559
506	19·9213	556	21·8898	606	23·8583	656	25·8268	706	27·7953
507	19·9606	557	21·9291	607	23·8976	657	25·8661	707	27·8346
508	20·0000	558	21·9685	608	23·9370	658	25·9055	708	27·8740
509	20·0394	559	22·0079	609	23·9764	659	25·9449	709	27·9134
510	20·0787	560	22·0472	610	24·0157	660	25·9843	710	27·9528
511	20·1181	561	22·0866	611	24·0551	661	26·0236	711	27·9921
512	20·1575	562	22·1260	612	24·0945	662	26·0630	712	28·0315
513	20·1969	563	22·1654	613	24·1339	663	26·1024	713	28·0709
514	20·2362	564	22·2047	614	24·1732	664	26·1417	714	28·1102
515	20·2756	565	22·2441	615	24·2126	665	26·1811	715	28·1496
516	20·3150	566	22·2835	616	24·2520	666	26·2205	716	28·1890
517	20·3543	567	22·3228	617	24·2913	667	26·2598	717	28·2283
518	20·3937	568	22·3622	618	24·3307	668	26·2992	718	28·2677
519	20·4331	569	22·4016	619	24·3701	669	26·3386	719	28·3071
520	20·4724	570	22·4409	620	24·4094	670	26·3780	720	28·3465
521	20·5118	571	22·4803	621	24·4488	671	26·4173	721	28·3858
522	20·5512	572	22·5197	622	24·4882	672	26·4567	722	28·4252
523	20·5906	573	22·5591	623	24·5276	673	26·4961	723	28·4646
524	20·6299	574	22·5984	624	24·5669	674	26·5354	724	28·5039
525	20·6693	575	22·6378	625	24·6063	675	26·5748	725	28·5433
526	20·7087	576	22·6772	626	24·6457	676	26·6142	726	28·5827
527	20·7480	577	22·7165	627	24·6850	677	26·6535	727	28·6220
528	20·7874	578	22·7559	628	24·7244	678	26·6929	728	28·6614
529	20·8268	579	22·7953	629	24·7638	679	26·7323	729	28·7008
530	20·8661	580	22·8346	630	24·8031	680	26·7717	730	28·7402
531	20·9055	581	22·8740	631	24·8425	681	26·8110	731	28·7795
532	20·9449	582	22·9134	632	24·8819	682	26·8504	732	28·8189
533	20·9843	583	22·9528	633	24·9213	683	26·8898	733	28·8583
534	21·0236	584	22·9921	634	24·9606	684	26·9291	734	28·8976
535	21·0630	585	23·0315	635	25·0000	685	26·9685	735	28·9370
536	21·1024	586	23·0709	636	25·0394	686	27·0079	736	28·9764
537	21·1417	587	23·1102	637	25·0787	687	27·0472	737	29·0157
538	21·1811	588	23·1496	638	25·1181	688	27 0866	738	29·0551
539	21·2205	589	23·1890	639	25·1575	689	27·1260	739	29·0945
540	21·2598	590	23·2283	640	25·1969	690	27·1654	740	29·1339
541	21·2992	591	23·2677	641	25·2362	691	27·2047	741	29·1732
542	21·3386	592	23·3071	642	25·2756	692	27·2441	742	29·2126
543	21·3780	593	23·3465	643	25·3150	693	27·2835	743	29·2520
544	21·4173	594	23·3858	644	25·3543	694	27·3228	744	29·2913
545	21·4567	595	23·4252	645	25·3937	695	27·3622	745	29·3307
546	21·4961	596	23·4646	646	25·4331	696	27·4016	746	29·3701
547	21·5354	597	23·5039	647	25·4724	697	27·4409	747	29·4094
548	21·5748	598	23·5433	648	25·5118	698	27·4803	748	29·4488
549	21·6142	599	23·5827	649	25·5512	699	27·5197	749	29·4882
550	21·6535	600	23·6220	650	25·5906	700	27·5591	750	29·5276

EQUIVALENTS OF MILLIMETRES IN INCHES

Milli-metres	Inches	Milli-metres	Inches	Milli-metres	Inches	Milli-metres	Inches	Milli-metres	Inches
751	29·5669	801	31·5354	851	33·5039	901	35·4724	951	37·4409
752	29·6063	802	31·5748	852	33·5433	902	35·5118	952	37·4803
753	29·6457	803	31·6142	853	33·5827	903	35·5512	953	37·5197
754	29·6850	804	31·6535	854	33·6220	904	35·5906	954	37·5591
755	29·7244	805	31·6929	855	33·6614	905	35·6299	955	37·5984
756	29·7638	806	31·7323	856	33·7008	906	35·6693	956	37·6378
757	29·8031	807	31·7717	857	33·7402	907	35·7087	957	37·6772
758	29·8425	808	31·8110	858	33·7795	908	35·7480	958	37·7165
759	29·8819	809	31·8504	859	33·8189	909	35·7874	959	37·7559
760	29·9213	810	31·8898	860	33·8583	910	35·8268	960	37·7953
761	29·9606	811	31·9291	861	33·8976	911	35·8661	961	37·8346
762	30·0000	812	31·9685	862	33·9370	912	35·9055	962	37·8740
763	30·0394	813	32·0079	863	33·9764	913	35·9449	963	37·9134
764	30·0787	814	32·0472	864	34·0157	914	35·9843	964	57·9528
765	30·1181	815	32·0866	865	34·0551	915	36·0236	965	37·9921
766	30·1575	816	32·1260	866	34·0945	916	36·0630	966	38·0315
767	30·1969	817	32·1654	867	34·1339	917	36·1024	967	38·0709
768	30·2362	818	32·2047	868	34·1732	918	36·1417	968	38·1102
769	30·2756	819	32·2441	869	34·2126	919	36·1811	969	38·1496
770	30·3150	820	32·2835	870	34·2520	920	36·2205	970	38·1890
771	30·3543	821	32·3228	871	34·2913	921	36·2598	971	38·2283
772	30·3937	822	32·3622	872	34·3307	922	36·2992	972	38·2677
773	30·4331	823	32·4016	873	34·3701	923	36·3386	973	38·3071
774	30·4724	824	32·4409	874	34·4094	924	36·3780	974	38·3465
775	30·5118	825	32·4803	875	34·4488	925	36·4173	975	38·3858
776	30·5512	826	32·5197	876	34·4882	926	36·4567	976	38·4252
777	30·5906	827	32·5591	877	34·5276	927	36·4961	977	38·4646
778	30·6299	828	32·5984	878	34·5669	928	36·5354	978	38·5039
779	30·6693	829	32·6378	879	34·6063	929	36·5748	979	38·5433
780	30·7087	830	32·6772	880	34·6457	930	36·6142	980	38·5827
781	30·7480	831	32·7165	881	34·6850	931	36·6535	981	38·6220
782	30·7874	832	32·7559	882	34·7244	932	36·6929	982	38·6614
783	30·8268	833	32·7953	883	34·7638	933	36·7323	983	38·7008
784	30·8661	834	32·8346	884	34·8031	934	36·7717	984	38·7402
785	30·9055	835	32·8740	885	34·8425	935	36·8110	985	38·7795
786	30·9449	836	32·9134	886	34·8819	936	36·8504	986	38·8189
787	30·9843	837	32·9528	887	34·9213	937	36·8898	987	38·8583
788	31·0236	838	32·9921	888	34·9606	938	36·9291	988	38·8976
789	31·0630	839	33·0315	889	35·0000	939	36·9685	989	38·9370
790	31·1024	840	33·0709	890	35·0394	940	37·0079	990	38·9764
791	31·1417	841	33·1102	891	35·0787	941	37·0472	991	39·0157
792	31·1811	842	33·1496	892	35·1181	942	37·0866	992	39·0551
793	31·2205	843	33·1890	893	35·1575	943	37·1260	993	39·0945
794	31·2598	844	33·2283	894	35·1969	944	37·1654	994	39·1339
795	31·2992	845	33·2677	895	35·2362	945	37·2047	995	39·1732
796	31·3386	846	33·3071	896	35·2756	946	37·2441	996	39·2126
797	31·3780	847	33·3465	897	35·3150	947	37·2835	997	39·2520
798	31·4173	848	33·3858	898	35·3543	948	37·3228	998	39·2913
799	31·4567	849	33·4252	899	35·3937	949	37·3622	999	39·3307
800	31·4961	850	33·4646	900	35·4331	950	37·4016	1000	39·3701

EQUIVALENTS OF METRES IN FEET

1 metre = 3·28084 feet

Metres	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		·3281	·6562	·9843	1·3123	1·6404	1·9685	2·2966	2·6247	2·9528
1	3·2808	3·6089	3·9370	4·2651	4·5932	4·9213	5·2493	5·5774	5·9055	6·2336
2	6·5617	6·8898	7·2178	7·5459	7·8740	8·2021	8·5302	8·8583	9·1863	9·5144
3	9·8425	10·1706	10·4987	10·8268	11·1549	11·4829	11·8110	12·1391	12·4672	12·7953
4	13·1234	13·4514	13·7795	14·1076	14·4357	14·7638	15·0919	15·4199	15·7480	16·0761
5	16·4042	16·7323	17·0604	17·3884	17·7165	18·0446	18·3727	18·7008	19·0289	19·3570
6	19·6850	20·0131	20·3412	20·6693	20·9974	21·3255	21·6535	21·9816	22·3097	22·6378
7	22·9659	23·2940	23·6220	23·9501	24·2782	24·6063	24·9344	25·2625	25·5905	25·9186
8	26·2467	26·5748	26·9029	27·2310	27·5590	27·8871	28·2152	28·5433	28·8714	29·1995
9	29·5276	29·8556	30·1837	30·5118	30·8399	31·1680	31·4961	31·8241	32·1522	32·4803
10	32·8084	33·1365	33·4646	33·7926	34·1207	34·4488	34·7769	35·1050	35·4331	35·7611

EQUIVALENTS OF FEET IN METRES

1 foot = ·3048 of a metre

Feet	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		·03048	·06096	·09144	·12192	·15240	·18288	·21336	·24384	·27432
1	·30480	·33528	·36576	·39624	·42672	·45720	·48768	·51816	·54864	·57912
2	·60960	·64008	·67056	·70104	·73152	·76200	·79248	·82296	·85344	·88392
3	·91440	·94488	·97536	1·00584	1·03632	1·06680	1·09728	1·12776	1·15824	1·18872
4	1·21920	1·24968	1·28016	1·31064	1·34112	1·37160	1·40208	1·43256	1·46304	1·49352
5	1·52400	1·55448	1·58496	1·61544	1·64592	1·67640	1·70688	1·73736	1·76784	1·79832
6	1·82880	1·85928	1·88976	1·92024	1·95072	1·98120	2·01168	2·04216	2·07264	2·10312
7	2·13360	2·16408	2·19456	2·22504	2·25552	2·28600	2·31648	2·34696	2·37744	2·40792
8	2·43840	2·46888	2·49936	2·52984	2·56032	2·59080	2·62128	2·65176	2·68224	2·71272
9	2·74320	2·77368	2·80416	2·83464	2·86512	2·89560	2·92608	2·95656	2·98704	3·01752
10	3·04800	3·07848	3·10896	3·13944	3·16992	3·20040	3·23088	3·26136	3·29184	3·32232

EQUIVALENTS OF SQUARE CENTIMETRES IN SQUARE INCHES

1 square centimetre = ·15500 of a square inch

Square cent.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		·01550	·03100	·04650	·06200	·07750	·09300	·10850	·12400	·13950
1	·15500	·17050	·18600	·20150	·21700	·23250	·24800	·26350	·27900	·29450
2	·31000	·32550	·34100	·35650	·37200	·38750	·40300	·41850	·43400	·44950
3	·46500	·48050	·49600	·51150	·52700	·54250	·55800	·57350	·58900	·60450
4	·62000	·63550	·65100	·66650	·68200	·69750	·71300	·72850	·74400	·75950
5	·77500	·79050	·80600	·82150	·83700	·85250	·86800	·88350	·89900	·91450
6	·93000	·94550	·96100	·97650	·99200	1·00750	1·02300	1·03850	1·05400	1·06950
7	1·08500	1·10050	1·11600	1·13150	1·14700	1·16250	1·17800	1·19350	1·20900	1·22450
8	1·24000	1·25550	1·27100	1·28650	1·30200	1·31750	1·33300	1·34850	1·36400	1·37950
9	1·39500	1·41050	1·42600	1·44150	1·45700	1·47250	1·48800	1·50350	1·51900	1·53450
10	1·55000	1·56550	1·58100	1·59650	1·61200	1·62750	1·64300	1·65850	1·67400	1·68950

EQUIVALENTS OF SQUARE INCHES IN SQUARE CENTIMETRES

1 square inch = 6·4516 square centimetres

Square inches	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		·64516	1·29032	1·93548	2·58064	3·22580	3·87096	4·51612	5·16130	5·80640
1	6·4516	7·0968	7·7419	8·3871	9·0322	9·6774	10·3226	10·9677	11·6129	12·2580
2	12·9032	13·5484	14·1935	14·8387	15·4838	16·1290	16·7742	17·4193	18·0645	18·7096
3	19·3548	20·0000	20·6451	21·2903	21·9354	22·5806	23·2258	23·8709	24·5161	25·1612
4	25·8064	26·4516	27·0967	27·7419	28·3870	29·0322	29·6774	30·3225	30·9677	31·6128
5	32·2580	32·9032	33·5483	34·1935	34·8386	35·4838	36·1290	36·7741	37·4193	38·0644
6	38·7096	39·3548	39·9999	40·6451	41·2902	41·9354	42·5806	43·2257	43·8709	44·5160
7	45·1612	45·8064	46·4515	47·0967	47·7418	48·3870	49·0322	49·6773	50·3220	50·9680
8	51·613	52·258	52·903	53·548	54·193	54·839	55·484	56·129	56·774	57·419
9	58·064	58·710	59·355	60·000	60·645	61·290	61·935	62·581	63·226	63·871
10	64·516	65·161	65·806	66·451	67·097	67·742	68·387	69·032	69·677	70·322

EQUIVALENTS OF SQUARE METRES IN SQUARE FEET

1 square metre = 10·7639 square feet

Square metres	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		1·07639	2·15278	3·22917	4·30556	5·3820	6·4583	7·5347	8·6111	9·6875
1	10·7639	11·8403	12·9167	13·9931	15·0695	16·1459	17·2223	18·2986	19·3759	20·4514
2	21·5278	22·6042	23·6806	24·7570	25·8334	26·9098	27·9862	29·0626	30·1389	31·2153
3	32·2917	33·3681	34·4445	35·5209	36·5973	37·6737	38·7501	39·8265	40·9029	41·9792
4	43·0556	44·1320	45·2084	46·2848	47·3612	48·4376	49·5140	50·590	51·667	52·743
5	53·820	54·896	55·972	57·049	58·125	59·201	60·278	61·354	62·431	63·507
6	64·583	65·660	66·736	67·813	68·889	69·965	71·042	72·118	73·195	74·271
7	75·347	76·424	77·500	78·577	79·653	80·729	81·806	82·882	83·958	85·035
8	86·111	87·188	88·264	89·340	90·417	91·493	92·570	93·646	94·722	95·799
9	96·875	97·952	99·028	100·104	101·181	102·257	103·334	104·410	105·486	106·563
10	107·639	108·715	109·792	110·868	111·945	113·021	114·097	115·174	116·250	117·327

EQUIVALENTS OF SQUARE FEET IN SQUARE METRES

1 square foot = ·092903 of a square metre

Square feet	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		·00929	·01858	·02787	·03716	·04645	·05574	·06503	·07432	·08361
1	·09290	·10219	·11148	·12077	·13006	·13936	·14865	·15794	·16723	·17652
2	·18581	·19510	·20439	·21368	·22297	·23226	·24155	·25084	·26013	·26942
3	·27871	·28800	·29729	·30658	·31587	·32516	·33445	·34374	·35303	·36232
4	·37161	·38090	·39019	·39948	·40877	·41806	·42735	·43664	·44594	·45523
5	·46452	·47381	·48310	·49239	·50168	·51097	·52026	·52955	·53884	·54813
6	·55742	·56671	·57600	·58529	·59458	·60387	·61316	·62245	·63174	·64103
7	·65032	·65961	·66890	·67819	·68748	·69677	·70606	·71535	·72464	·73393
8	·74322	·75251	·76180	·77110	·78039	·78968	·79897	·80826	·81755	·82684
9	·83613	·84542	·85471	·86400	·87329	·88258	·89187	·90116	·91045	·91974
10	·92903	·93832	·94761	·95690	·96619	·97548	·98477	·99406	1·00335	1·01264

EQUIVALENTS OF CUBIC CENTIMETRES IN CUBIC INCHES

1 cubic centimetre = ·061024 of a cubic inch

Cubic cent.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		·006102	·012205	·018307	·024410	·030512	·036614	·042717	·048819	·054921
1	·061024	·067126	·073228	·079331	·085433	·091536	·097638	·103740	·109843	·115945
2	·122047	·128150	·134252	·140355	·146457	·152559	·158662	·164764	·170866	·176969
3	·183071	·189174	·195276	·201378	·207481	·213583	·219685	·225788	·231890	·237993
4	·244095	·250197	·256300	·262402	·268504	·274607	·280709	·286812	·292914	·299016
5	·305119	·311221	·317323	·323426	·329528	·335631	·341733	·347835	·353938	·360040
6	·366142	·372245	·378347	·384450	·390552	·396654	·402757	·408859	·414961	·421064
7	·427166	·433269	·439371	·445473	·451576	·457678	·463780	·469883	·475985	·482088
8	·488190	·494292	·50039	·50650	·51260	·51870	·52480	·53091	·53701	·54311
9	·54921	·55532	·56142	·56752	·57362	·57973	·58583	·59193	·59803	·60414
10	·61024	·61634	·62244	·62855	·63465	·64075	·64685	·65296	·65906	·66516

EQUIVALENTS OF CUBIC INCHES IN CUBIC CENTIMETRES

1 cubic inch = 16·3871 cubic centimetres

Cubic inches	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		1·6387	3·2774	4·9161	6·5548	8·1935	9·8322	11·4709	13·1097	14·7484
1	16·3871	18·0258	19·6645	21·3032	22·9419	24·5806	26·2193	27·8580	29·4967	31·1354
2	32·7741	34·4128	26·0515	37·6902	39·3290	40·9677	42·6064	44·2451	45·8838	47·5225
3	49·1612	50·800	52·439	54·077	55·716	57·355	58·993	60·632	62·271	63·910
4	65·548	67·187	68·826	70·464	72·103	73·742	75·380	77·019	78·658	80·297
5	81·935	83·574	85·213	86·851	88·490	90·129	91·768	93·406	95·045	96·684
6	98·322	99·961	101·600	103·239	104·877	106·516	108·155	109·793	111·432	113·071
7	114·709	116·348	117·987	119·626	121·264	122·903	124·542	126·180	127·819	129·458
8	131·097	132·735	134·374	136·013	137·651	139·290	140·929	142·567	144·206	145·845
9	147·484	149·122	150·761	152·400	154·038	155·677	157·316	158·955	160·593	162·232
10	163·871	165·510	167·148	168·787	170·426	172·065	173·703	175·342	176·981	178·619

EQUIVALENTS OF CUBIC METRES IN CUBIC FEET

1 cubic metre = 35·3147 cubic feet

Cubic metres	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		3·5315	7·0629	10·5944	14·1259	17·6573	21·1888	24·7203	28·2517	31·7832
1	35·3147	38·8461	42·3776	45·9091	49·4405	52·972	56·503	60·035	63·566	67·098
2	70·629	74·161	77·692	81·224	84·755	88·287	91·818	95·350	98·881	102·413
3	105·944	109·475	113·007	116·538	120·070	123·601	127·133	130·664	134·196	137·727
4	141·259	144·790	148·322	151·853	155·384	158·916	162·447	165·979	169·510	173·042
5	176·573	180·105	183·636	187·168	190·699	194·231	197·762	201·294	204·825	208·356
6	211·888	215·419	218·951	222·482	226·014	229·545	233·077	236·608	240·140	243·671
7	247·203	250·734	254·266	257·797	261·328	264·860	268·391	271·923	275·454	278·986
8	282·517	286·049	289·580	293·112	296·643	300·175	303·706	307·238	310·769	314·300
9	317·832	321·363	324·895	328·426	331·958	335·489	339·021	342·552	346·084	349·615
10	353·147	356·678	360·210	363·741	367·273	370·804	374·336	377·867	381·399	384·930

EQUIVALENTS OF CUBIC FEET IN CUBIC METRES

1 cubic foot = ·0283169 of a cubic metre

Cubic feet	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		·002832	·005663	·008495	·011327	·014158	·016990	·019822	·022654	·025485
1	·028317	·031149	·033980	·036812	·039644	·042475	·045307	·048139	·050970	·053802
2	·056634	·059465	·062297	·065129	·067960	·070792	·073624	·076456	·079287	·082119
3	·084951	·087782	·090614	·093446	·096277	·099109	·101941	·104772	·107604	·110436
4	·113267	·116099	·118931	·121762	·124594	·127426	·130258	·133089	·135921	·138753
5	·141584	·144416	·147248	·150079	·152911	·155743	·158574	·161406	·164238	·167069
6	·169901	·172733	·175565	·178396	·181228	·184060	·186891	·189723	·192555	·195386
7	·198218	·201050	·203881	·206713	·209545	·212376	·215208	·218040	·220872	·223703
8	·226535	·229367	·232198	·235030	·237862	·240693	·243525	·246357	·249188	·252020
9	·254852	·257683	·260515	·263347	·266178	·269010	·271842	·274674	·277505	·280337
10	·283169	·286001	·288832	·291664	·294496	·297327	·300159	·302991	·305823	·308654

EQUIVALENTS OF KILOGRAMMES IN POUNDS

1 kilogramme = 2·20462 pounds

Kilo-grammes	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		·2205	·4409	·6614	·8819	1·1023	1·3228	1·5432	1·7637	1·9842
1	2·2046	2·4251	2·6456	2·8660	3·0865	3·3069	3·5274	3·7479	3·9683	4·1888
2	4·4092	4·6297	4·8502	5·0706	5·2911	5·5116	5·7320	5·9525	6·1729	6·3934
3	6·6139	6·8343	7·0548	7·2753	7·4957	7·7162	7·9366	8·1571	8·3776	8·5980
4	8·8185	9·0390	9·2954	9·4799	9·7003	9·9208	10·1413	10·3617	10·5822	10·8026
5	11·0231	11·2436	11·4640	11·6845	11·9050	12·1254	12·3459	12·5663	12·7868	13·0073
6	13·2277	13·4482	13·6687	13·8891	14·1096	14·3300	14·5505	14·7710	14·9914	15·2119
7	15·4324	15·6528	15·8733	16·0937	16·3142	16·5347	16·7551	16·9756	17·1961	17·4165
8	17·6370	17·8574	18·0779	18·2984	18·5118	18·7393	18·9598	19·1802	19·4007	19·6211
9	19·8416	20·0621	20·2825	20·5030	20·7235	20·9439	21·1644	21·3848	21·6053	21·8258
10	22·0462	22·2667	22·4871	22·7076	22·9281	23·1485	23·3690	23·5895	23·8099	24·0304

EQUIVALENTS OF POUNDS IN KILOGRAMMES

1 pound = ·45359243 of a kilogramme

Pounds	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		·04536	·09072	·13608	·18144	·22680	·27216	·31752	·36287	·40823
1	·45359	·49895	·54431	·58967	·63503	·68039	·72575	·77111	·81647	·86183
2	·90718	·95254	·99790	1·04326	1·08862	1·13398	1·17934	1·22470	1·27006	1·31542
3	1·36078	1·40614	1·45150	1·49686	1·54221	1·58757	1·63293	1·67829	1·72365	1·76901
4	1·81437	1·85973	1·90509	1·95045	1·99581	2·04117	2·08653	2·13188	2·17724	2·22260
5	2·26796	2·31332	2·35868	2·40404	2·44940	2·49476	2·54012	2·58548	2·63084	2·67620
6	2·72155	2·76691	2·81227	2·85763	2·90299	2·94835	2·99371	3·03907	3·08443	3·12979
7	3·17515	3·22051	3·26587	3·31122	3·35658	3·40194	3·44730	3·49266	3·53802	3·58338
8	3·62874	3·67410	3·71946	3·76482	3·81018	3·85554	3·90089	3·94625	3·99161	4·03697
9	4·08233	4·12769	4·17305	4·21841	4·26377	4·30913	4·35449	4·39985	4·44521	4·49057
10	4·53592	4·58128	4·62664	4·67200	4·71736	4·76272	4·80808	4·85344	4·89880	4·94416

EQUIVALENTS OF KILOGRAMMES PER SQUARE CENTIMETRE IN POUNDS PER SQUARE INCH

1 kilogramme per square centimetre = 14·2233 pounds per square inch

Kilogrammes per square cent.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		1·4223	2·8447	4·2670	5·6893	7·1117	8·5340	9·9563	11·3787	12·8010
1	14·2233	15·6457	17·0680	18·4903	19·9127	21·3350	22·7573	24·1797	25·6020	27·0243
2	28·4467	29·8690	31·2914	32·7137	34·1360	35·5584	36·9807	38·4030	39·8254	41·2477
3	42·6700	44·0924	45·5147	46·9370	48·3594	49·7817	51·204	52·626	54·049	55·471
4	56·893	58·316	59·738	61·160	62·583	64·005	65·427	66·850	68·272	69·694
5	71·117	72·539	73·961	75·384	76·806	78·228	79·651	81·073	82·495	83·918
6	85·340	86·762	88·185	89·607	91·029	92·452	93·874	95·296	96·719	98·141
7	99·563	100·986	102·408	103·830	105·253	106·675	108·097	109·520	110·942	112·364
8	113·787	115·209	116·631	118·054	119·476	120·898	122·321	123·743	125·165	126·588
9	128·010	129·432	130·855	132·277	133·699	135·122	136·544	137·966	139·389	140·811
10	142·233	143·656	145·078	146·500	147·923	149·345	150·767	152·190	153·612	155·034

EQUIVALENTS OF POUNDS PER SQUARE INCH IN KILOGRAMMES PER SQUARE CENTIMETRE

1 pound per square inch = ·070307 of a kilogramme per square centimetre

Pounds	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		·00703	·01406	·02109	·02812	·03515	·04218	·04922	·05625	·06328
1	·07031	·07734	·08437	·09140	·09843	·10546	·11249	·11952	·12655	·13358
2	·14061	·14765	·15468	·16171	·16874	·17577	·18280	·18983	·19686	·20389
3	·21092	·21795	·22498	·23201	·23904	·24607	·25311	·26014	·26717	·27420
4	·28123	·28826	·29529	·30232	·30935	·31638	·32341	·33044	·33747	·34450
5	·35154	·35857	·36560	·37263	·37966	·38669	·39372	·40075	·40778	·41481
6	·42184	·42887	·43590	·44293	·44997	·45700	·46403	·47106	·47809	·48512
7	·49215	·49918	·50621	·51324	·52027	·52730	·53433	·54136	·54839	·55543
8	·56246	·56949	·57652	·58355	·59058	·59761	·60464	·61167	·61870	·62573
9	·63276	·63979	·64682	·65385	·66089	·66792	·67495	·68198	·68901	·69604
10	·70307	·71010	·71713	·72416	·73119	·73822	·74525	·75228	·75932	·76635

EQUIVALENTS OF KILOGRAMMES PER METRE IN POUNDS PER FOOT

1 kilogramme per metre = ·67197 pounds per foot

Kilogrammes per metre	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0		·06720	·13439	·20159	·26879	·33598	·40318	·47038	·53758	·60477
1	·67197	·73917	·80636	·87356	·94076	1·00795	1·07515	1·14235	1·20954	1·27674
2	1·34394	1·41113	1·47833	1·54553	1·61273	1·67992	1·74712	1·81432	1·88151	1·94871
3	2·01591	2·08310	2·15030	2·21750	2·28469	2·35189	2·41909	2·48629	2·55348	2·62068
4	2·68788	2·75507	2·82227	2·88947	2·95666	3·02386	3·09106	3·15825	3·22545	3·29265
5	3·35984	3·42704	3·49424	3·56144	3·62863	3·69583	3·76303	3·83022	3·89742	3·96462
6	4·03181	4·09901	4·16621	4·23340	4·30060	4·36780	4·43500	4·50219	4·56939	4·63659
7	4·70378	4·77098	4·83818	4·90537	4·97257	5·0398	5·1070	5·1742	5·2414	5·3086
8	5·3758	5·4429	5·5101	5·5772	5·6445	5·7117	5·7789	5·8461	5·9133	5·9805
9	6·0477	6·1149	6·1821	6·2493	6·3165	6·3837	6·4509	6·5181	6·5853	6·6525
10	6·7197	6·7869	6·8541	6·9213	6·9885	7·0557	7·1229	7·1901	7·2573	7·3245

EQUIVALENTS OF POUNDS PER FOOT IN KILOGRAMMES PER METRE

1 pound per foot = 1·48816 kilogrammes per metre

Pounds per foot	·0	·1	·2	·3	·4	·5	·6	·7	·8	.9
0		·14882	·29763	·44645	·59527	·74408	·89290	1·0417	1·1905	1·3393
1	1·4882	1·6370	1·7858	1·9346	2·0834	2·2322	2·3811	2·5299	2·6787	2·8275
2	2·9763	3·1251	3·2740	3·4228	3·5716	3·7204	3·8692	4·0180	4·1669	4·3157
3	4·4645	4·6133	4·7621	4·9109	5·0598	5·2086	5·3574	5·5062	5·6550	5·8038
4	5·9527	6·1015	6·2503	6·3991	6·5479	6·6967	6·8456	6·9944	7·1432	7·2920
5	7·4408	7·5896	7·7385	7·8873	8·0361	8·1849	8·3337	8·4825	8·6314	8·7802
6	8·9290	9·0778	9·2266	9·3754	9·5242	9·6731	9·8219	9·9707	10·1195	10·2683
7	10·4171	10·5660	10·7148	10·8636	11·0124	11·1612	11·3100	11·4589	11·6077	11·7565
8	11·9053	12·0541	12·2029	12·3518	12·5006	12·6494	12·7982	12·9470	13·0958	13·2447
9	13·3935	13·5423	13·6911	13·8399	13·9887	14·1376	14·2864	14·4352	14·5840	14·7328
10	14·8816	15·0304	15·1792	15·3280	15·4769	15·6257	15·7745	15·9233	16·0721	16·2209

EQUIVALENTS OF MOMENTS OF INERTIA AND SECTION MODULI

Moment of Inertia in centimetre units = Moment of Inertia in inch units × 41·6231

Moment of Inertia in inch units = Moment of Inertia in centimetre units × ·0240251

Section Modulus in centimetre units = Section Modulus in inch units × 16·3871

Section Modulus in inch units = Section Modulus in centimetre units × ·061024

CONTRACTIONS GENERALLY ADOPTED

LINEAR MEASURE

km = kilometre
m = metre
dm = decimetre
cm = centimetre
mm = millimetre

CUBIC MEASURE

km^3 = cub. kilometre
m^3 = cub. metre
dm^3 = cub. decimetre
cm^3 = cub. centimetre
mm^3 = cub. millimetre

WEIGHT

t = tonne=1000kg.
q = quintal=100kg.
kg = kilogramme
dkg = dekagramme
g = gramme
dg = decigramme
cg = centigramme
mg = milligramme

SQUARE MEASURE

km^2 = sq. kilometre
m^2 = sq. metre
dm^2 = sq. decimetre
cm^2 = sq. centimetre
mm^2 = sq. millimetre
ha = hectare
a = are

CAPACITY

hl = hectolitre
l = litre
dl = decilitre
cl = centilitre

Italic letters are used for these contractions, and no stop is used at the right of them. The contractions succeed the figures to which they refer, on the same line and after the last decimal place, when decimals are used.

EQUIVALENTS OF TONS PER SQUARE INCH IN KILOGRAMMES PER SQUARE MILLIMETRE

Tons per Square Inch	Kilogrammes per Square Millimetre	Tons per Square Inch	Kilogrammes per Square Millimetre	Tons per Square Inch	Kilogrammes per Square Millimetre	Tons per Square Inch	Kilogrammes per Square Millimetre
0		38	59·85	76	119·69	114	179·54
1	1·57	39	61·42	77	121·27	115	181·11
2	3·15	40	63·00	78	122·84	116	182·69
3	4·72	41	64·57	79	124·42	117	184·26
4	6·30	42	66·15	80	125·99	118	185·84
5	7·87	43	67·72	81	127·57	119	187·41
6	9·45	44	69·30	82	129·14	120	188·99
7	11·02	45	70·87	83	130·72	121	190·56
8	12·60	46	72·44	84	132·29	122	192·14
9	14·17	47	74·02	85	133·86	123	193·71
10	15·75	48	75·59	86	135·44	124	195·29
11	17·32	49	77·17	87	137·01	125	196·86
12	18·90	50	78·74	88	138·59	126	198·43
13	20·47	51	80·32	89	140·16	127	200·01
14	22·05	52	81·89	90	141·74	128	201·58
15	23·62	53	83·47	91	143·31	129	203·16
16	25·20	54	85·04	92	144·89	130	204·73
17	26·77	55	86·62	93	146·46	131	206·31
18	28·35	56	88·19	94	148·04	132	207·88
19	29·92	57	89·77	95	149·61	133	209·46
20	31·50	58	91·34	96	151·19	134	211·03
21	33·07	59	92·92	97	152·76	135	212·61
22	34·65	60	94·49	98	154·34	136	214·18
23	36·22	61	96·07	99	155·91	137	215·76
24	37·80	62	97·64	100	157·49	138	217·33
25	39·37	63	99·22	101	159·06	139	218·91
26	40·95	64	100·79	102	160·64	140	220·48
27	42·52	65	102·37	103	162·21	141	222·06
28	44·10	66	103·94	104	163·79	142	223·63
29	45·67	67	105·52	105	165·36	143	225·21
30	47·25	68	107·09	106	166·94	144	226·78
31	48·82	69	108·67	107	168·51	145	228·36
32	50·40	70	110·24	108	170·09	146	229·93
33	51·97	71	111·82	109	171·66	147	231·51
34	53·55	72	113·39	110	173·24	148	233·08
35	55·12	73	114·97	111	174·81	149	234·66
36	56·70	74	116·54	112	176·39	150	236·23
37	58·27	75	118·12	113	177·96		

EQUIVALENTS OF KILOGRAMMES PER SQUARE MILLIMETRE IN TONS PER SQUARE INCH

Kilogrammes per Square Millimetre	Tons per Square Inch	Kilogrammes per Square Millimetre	Tons per Square Inch	Kilogrammes per Square Millimetre	Tons per Square Inch	Kilogrammes per Square Millimetre	Tons per Square Inch	Kilogrammes per Square Millimetre	Tons per Square Inch
0		45	28·57	90	57·15	135	85·72	180	114·30
1	·63	46	29·21	91	57·78	136	86·36	181	114·93
2	1·27	47	29·84	92	58·42	137	86·99	182	115·57
3	1·90	48	30·48	93	59·05	138	87·63	183	116·20
4	2·54	49	31·11	94	59·69	139	88·26	184	116·84
5	3·17	50	31·75	95	60·32	140	88·90	185	117·47
6	3·81	51	32·38	96	60·96	141	89·53	186	118·11
7	4·44	52	33·02	97	61·59	142	90·17	187	118·74
8	5·08	53	33·65	98	62·23	143	90·80	188	119·37
9	5·71	54	34·29	99	62·86	144	91·44	189	120·01
10	6·35	55	34·92	100	63·50	145	92·07	190	120·64
11	6·98	56	35·56	101	64·13	146	92·71	191	121·28
12	7·62	57	36·19	102	64·77	147	93·34	192	121·91
13	8·25	58	36·83	103	65·40	148	93·98	193	122·55
14	8·89	59	37·46	104	66·04	149	94·61	194	123·18
15	9·52	60	38·10	105	66·67	150	95·25	195	123·82
16	10·16	61	38·73	106	67·31	151	95·88	196	124·45
17	10·79	62	39·37	107	67·94	152	96·52	197	125·09
18	11·43	63	40·00	108	68·58	153	97·15	198	125·72
19	12·06	64	40·64	109	69·21	154	97·79	199	126·36
20	12·70	65	41·27	110	69·85	155	98·42	200	126·99
21	13·33	66	41·91	111	70·48	156	99·06	201	127·63
22	13·97	67	42·54	112	71·12	157	99·69	202	128·26
23	14·60	68	43·18	113	71·75	158	100·33	203	128·90
24	15·24	69	43·81	114	72·39	159	100·96	204	129·53
25	15·87	70	44·45	115	73·02	160	101·60	205	130·17
26	16·51	71	45·08	116	73·66	161	102·23	206	130·80
27	17·14	72	45·72	117	74·29	162	102·87	207	131·44
28	17·78	73	46·35	118	74·93	163	103·50	208	132·07
29	18·41	74	46·99	119	75·56	164	104·14	209	132·71
30	19·05	75	47·62	120	76·20	165	104·77	210	133·34
31	19·68	76	48·26	121	76·83	166	105·41	211	133·98
32	20·32	77	48·89	122	77·47	167	106·04	212	134·61
33	20·95	78	49·53	123	78·10	168	106·68	213	135·25
34	21·59	79	50·16	124	78·74	169	107·31	214	135·88
35	22·22	80	50·80	125	79·37	170	107·95	215	136·52
36	22·86	81	51·43	126	80·01	171	108·58	216	137·15
37	23·49	82	52·07	127	80·64	172	109·22	217	137·79
38	24·13	83	52·70	128	81·28	173	109·85	218	138·42
39	24·76	84	53·34	129	81·91	174	110·49	219	139·06
40	25·40	85	53·97	130	82·55	175	111·12	220	139·69
41	26·03	86	54·61	131	83·18	176	111·76	221	140·33
42	26·67	87	55·24	132	83·82	177	112·39	222	140·96
43	27·30	88	55·88	133	84·45	178	113·03	223	141·60
44	27·94	89	56·51	134	85·09	179	113·66	224	142·23
								225	142·87

PART XII

Miscellaneous Tables

STRUCTURAL STEELS

COMPOSITION AND PROPERTIES

Structural engineers are concerned principally with High Yield Stress Steel and Mild Steel; other types, such as Notch Ductile Steel, are also used on occasion. These three steels are covered by British Specifications 968, 15 and 2762 respectively.

Reference should be made to these specifications for full particulars of the method of manufacture, chemical composition, mechanical properties, tests, rolling margins and tolerances, etc. For convenience the principal features in chemical composition and mechanical properties are summarized in the two tables below and particulars of the rolling margins and tolerances are given on succeeding pages.

TABLE 1. CHEMICAL COMPOSITION

Element	High Yield Stress Steel B.S. 968	Mild Steel	Notch Ductile Steel	
			ND I & II B.S. 2762	ND III & IV B.S. 2762
Carbon	0·20 (1) 0·22 (2)	0·250 (5) —	0·20 —	0·17 —
Silicon	0·35	—	—	—
Manganese	1·50 (3)	—	1·50	1·50
Chromium	0·50 (3)	—	—	—
Sulphur	0·05	0·06 (5)	0·06	0·05
Phosphorus	0·05	0·06 (5)	0·05	0·05
Copper	0·50 (4)	0·20–0·50 (6)	—	—

(1) For material up to and including $\frac{5}{8}''$ thick.
(2) For material over $\frac{5}{8}''$ thick.
(3) Manganese plus chromium not to exceed 1·60%.
(4) By arrangement between maker and purchaser.
(5) Mild Steel Grade 1.
(6) Mild Steel Grades 2 and 3.

Note. Grade refining elements not exceeding 0·10% total may be used in High Yield Stress Steel.

STRUCTURAL STEELS

COMPOSITION AND PROPERTIES

TABLE 2. MECHANICAL PROPERTIES. PLATES, FLATS, BARS AND SECTIONS*

	High Yield Stress Steel	Mild Steel	Notch Ductile Steel ND I, II, III & IV	
			Class a	Class b
Ultimate Tensile Strength (tons/sq. inch)	32–39	28–33	26–31	28–33
Minimum Yield Stress (tons/sq. inch)	23·0 (1) 22·5 (2) 22·0 (3) (4)	16·0 (5) 15·0 (6) 14·75 (7)	15·0 (8) 14·85	16·0 (8) 15·25 (9)
Minimum Elongation	15% (10) 18% (12) (4)	16% (11) 20% (13)	20%	20%

(1) Up to and including $\frac{5}{8}''$ thick
(2) Over $\frac{5}{8}''$ up to and including $1\frac{1}{4}''$
(3) Over $1\frac{1}{4}''$ up to and including 2″
(4) Over 2″ to be agreed
(5) $\frac{1}{4}''$ thick up to and including $\frac{3}{4}''$
(6) Over $\frac{3}{4}''$ up to and including $1\frac{1}{2}''$
(7) Over $1\frac{1}{2}''$
(8) Over 0·40 up to and including 0·75
(9) Over 0·75
(10) Less than $\frac{3}{8}''$ thick
(11) $\frac{1}{4}''$ thick up to and including $\frac{3}{8}''$
(12) $\frac{3}{8}''$ thick up to and including 2″
(13) Over $\frac{3}{8}''$ thick

* The requirements for round and square bars and rivet bars are slightly different.

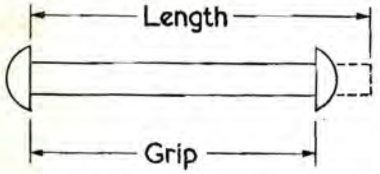
Notch Ductile Steel to B.S. 2762.

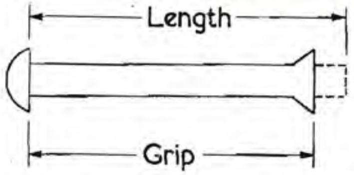
The essential difference between B.S. 2762 and B.S. 15 is that it provides for special impact tests at temperatures down to −50°C. This specification has arisen from the need for a mild steel whose 'notch ductility' or resistance to 'brittle fracture' is better than that of ordinary mild steel to B.S. 15.

MACHINE RIVETING

LENGTHS OF RIVETS FOR VARYING GRIPS

PNEUMATIC MACHINE RIVETING





Grip in inches	NOMINAL DIAMETERS IN INCHES			
	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$
	LENGTH IN INCHES			
$\frac{3}{4}$	$1\frac{3}{4}$	2	$2\frac{1}{8}$	$2\frac{1}{4}$
$\frac{7}{8}$	$1\frac{7}{8}$	$2\frac{1}{8}$	$2\frac{1}{4}$	$2\frac{3}{8}$
1	2	$2\frac{1}{4}$	$2\frac{3}{8}$	$2\frac{1}{2}$
$1\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{5}{8}$
$1\frac{1}{4}$	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{3}{4}$
$1\frac{3}{8}$	$2\frac{3}{8}$	$2\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{7}{8}$
$1\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{7}{8}$	3	$3\frac{1}{8}$
$1\frac{5}{8}$	$2\frac{3}{4}$	3	$3\frac{1}{8}$	$3\frac{1}{4}$
$1\frac{3}{4}$	$2\frac{7}{8}$	$3\frac{1}{8}$	$3\frac{1}{4}$	$3\frac{3}{8}$
$1\frac{7}{8}$	3	$3\frac{1}{4}$	$3\frac{3}{8}$	$3\frac{1}{2}$
2	$3\frac{1}{8}$	$3\frac{3}{8}$	$3\frac{1}{2}$	$3\frac{5}{8}$
$2\frac{1}{8}$	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{5}{8}$	$3\frac{3}{4}$
$2\frac{1}{4}$	$3\frac{3}{8}$	$3\frac{5}{8}$	$3\frac{3}{4}$	$3\frac{7}{8}$
$2\frac{3}{8}$	$3\frac{1}{2}$	$3\frac{3}{4}$	$3\frac{7}{8}$	4
$2\frac{1}{2}$	$3\frac{5}{8}$	$3\frac{7}{8}$	4	$4\frac{1}{8}$
$2\frac{5}{8}$	$3\frac{3}{4}$	4	$4\frac{1}{8}$	$4\frac{1}{4}$
$2\frac{3}{4}$	$3\frac{7}{8}$	$4\frac{1}{8}$	$4\frac{1}{4}$	$4\frac{1}{2}$
$2\frac{7}{8}$	4	$4\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{5}{8}$
3	$4\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{5}{8}$	$4\frac{3}{4}$
$3\frac{1}{8}$		$4\frac{5}{8}$	$4\frac{3}{4}$	$4\frac{7}{8}$
$3\frac{1}{4}$		$4\frac{3}{4}$	$4\frac{7}{8}$	5
$3\frac{3}{8}$		$4\frac{7}{8}$	5	$5\frac{1}{8}$
$3\frac{1}{2}$		5	$5\frac{1}{8}$	$5\frac{1}{4}$
$3\frac{5}{8}$		$5\frac{1}{8}$	$5\frac{1}{4}$	$5\frac{3}{8}$
$3\frac{3}{4}$		$5\frac{1}{4}$	$5\frac{3}{8}$	$5\frac{1}{2}$
$3\frac{7}{8}$		$5\frac{3}{8}$	$5\frac{1}{2}$	$5\frac{5}{8}$
4			$5\frac{5}{8}$	$5\frac{3}{4}$
$4\frac{1}{8}$			$5\frac{3}{4}$	$5\frac{7}{8}$
$4\frac{1}{4}$			$5\frac{7}{8}$	6
$4\frac{3}{8}$			6	$6\frac{1}{4}$
$4\frac{1}{2}$			$6\frac{1}{4}$	$6\frac{3}{8}$
$4\frac{5}{8}$			$6\frac{3}{8}$	$6\frac{1}{2}$
$4\frac{3}{4}$			$6\frac{1}{2}$	$6\frac{5}{8}$
$4\frac{7}{8}$			$6\frac{5}{8}$	$6\frac{3}{4}$
5			$6\frac{3}{4}$	$6\frac{7}{8}$

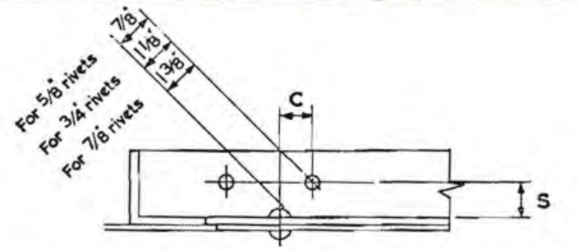
Grip in inches	NOMINAL DIAMETERS IN INCHES			
	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$
	LENGTH IN INCHES			
$\frac{3}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{5}{8}$
$\frac{7}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{5}{8}$	$1\frac{3}{4}$
1	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{7}{8}$
$1\frac{1}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	$1\frac{7}{8}$	2
$1\frac{1}{4}$	$1\frac{7}{8}$	2	2	$2\frac{1}{8}$
$1\frac{3}{8}$	2	$2\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{1}{4}$
$1\frac{1}{2}$	$2\frac{1}{8}$	$2\frac{1}{4}$	$2\frac{3}{8}$	$2\frac{3}{8}$
$1\frac{5}{8}$	$2\frac{1}{4}$	$2\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{1}{2}$
$1\frac{3}{4}$	$2\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{5}{8}$
$1\frac{7}{8}$	$2\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{3}{4}$
2	$2\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{7}{8}$	$2\frac{7}{8}$
$2\frac{1}{8}$	$2\frac{3}{4}$	$2\frac{7}{8}$	3	3
$2\frac{1}{4}$	$2\frac{7}{8}$	3	$3\frac{1}{8}$	$3\frac{1}{8}$
$2\frac{3}{8}$	3	$3\frac{1}{8}$	$3\frac{1}{4}$	$3\frac{1}{4}$
$2\frac{1}{2}$	$3\frac{1}{8}$	$3\frac{1}{4}$	$3\frac{3}{8}$	$3\frac{3}{8}$
$2\frac{5}{8}$	$3\frac{1}{4}$	$3\frac{3}{8}$	$3\frac{1}{2}$	$3\frac{1}{2}$
$2\frac{3}{4}$	$3\frac{3}{8}$	$3\frac{1}{2}$	$3\frac{5}{8}$	$3\frac{5}{8}$
$2\frac{7}{8}$	$3\frac{1}{2}$	$3\frac{5}{8}$	$3\frac{3}{4}$	$3\frac{3}{4}$
3	$3\frac{3}{4}$	$3\frac{7}{8}$	$3\frac{7}{8}$	4
$3\frac{1}{8}$		4	4	$4\frac{1}{8}$
$3\frac{1}{4}$		$4\frac{1}{8}$	$4\frac{1}{8}$	$4\frac{1}{4}$
$3\frac{3}{8}$		$4\frac{1}{4}$	$4\frac{1}{4}$	$4\frac{3}{8}$
$3\frac{1}{2}$		$4\frac{3}{8}$	$4\frac{3}{8}$	$4\frac{1}{2}$
$3\frac{5}{8}$		$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{5}{8}$
$3\frac{3}{4}$		$4\frac{5}{8}$	$4\frac{5}{8}$	$4\frac{3}{4}$
$3\frac{7}{8}$		$4\frac{3}{4}$	$4\frac{3}{4}$	$4\frac{7}{8}$
4			$4\frac{7}{8}$	5
$4\frac{1}{8}$			5	$5\frac{1}{8}$
$4\frac{1}{4}$			$5\frac{1}{8}$	$5\frac{1}{4}$
$4\frac{3}{8}$			$5\frac{1}{4}$	$5\frac{3}{8}$
$4\frac{1}{2}$			$5\frac{1}{2}$	$5\frac{1}{2}$
$4\frac{5}{8}$			$5\frac{5}{8}$	$5\frac{5}{8}$
$4\frac{3}{4}$			$5\frac{3}{4}$	$5\frac{3}{4}$
$4\frac{7}{8}$			$5\frac{7}{8}$	$5\frac{7}{8}$
5			6	6

For hand riveting deduct $\frac{1}{4}$ inch from above lengths.

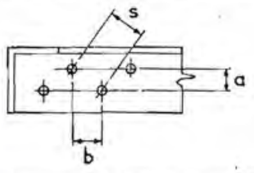
NOTE: All the above lengths are based on the rivet having $\frac{1}{16}''$ clearance in the hole.

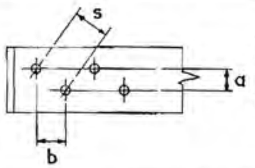
RIVET SPACING

MINIMUM STAGGER FOR RIVETS



Dia. of rivet inches	MINIMUM STAGGER, C INCHES, FOR S INCHES														
	$1\frac{1}{8}$	$1\frac{3}{16}$	$1\frac{1}{4}$	$1\frac{5}{16}$	$1\frac{3}{8}$	$1\frac{7}{16}$	$1\frac{1}{2}$	$1\frac{9}{16}$	$1\frac{5}{8}$	$1\frac{11}{16}$	$1\frac{3}{4}$	$1\frac{13}{16}$	$1\frac{7}{8}$	$1\frac{15}{16}$	2
$\frac{5}{8}$	$\frac{3}{4}$	$\frac{5}{8}$	$\frac{7}{16}$	0											
$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{3}{16}$	$1\frac{1}{8}$	$1\frac{1}{16}$	$\frac{15}{16}$	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{9}{16}$	$\frac{5}{16}$	0					
$\frac{7}{8}$			$1\frac{5}{8}$	$1\frac{9}{16}$	$1\frac{1}{2}$	$1\frac{7}{16}$	$1\frac{3}{8}$	$1\frac{5}{16}$	$1\frac{3}{16}$	$1\frac{1}{8}$	1	$\frac{7}{8}$	$\frac{11}{16}$	$\frac{1}{2}$	0



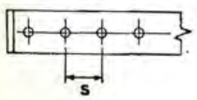


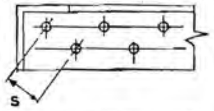
Distance centre to centre of staggered rivets

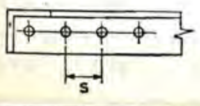
Values of **s** for varying values of **a** and **b**

b inches	STAGGER **s** INCHES FOR **a** INCHES													
	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2	$2\frac{1}{8}$	$2\frac{1}{4}$	$2\frac{3}{8}$	$2\frac{1}{2}$
$1\frac{1}{8}$	$1\frac{7}{16}$	$1\frac{1}{2}$	$1\frac{9}{16}$	$1\frac{11}{16}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2	$2\frac{1}{16}$	$2\frac{3}{16}$	$2\frac{5}{16}$	$2\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{3}{4}$
$1\frac{1}{4}$	$1\frac{9}{16}$	$1\frac{5}{8}$	$1\frac{11}{16}$	$1\frac{3}{4}$	$1\frac{7}{8}$	$1\frac{15}{16}$	$2\frac{1}{16}$	$2\frac{1}{8}$	$2\frac{1}{4}$	$2\frac{3}{8}$	$2\frac{7}{16}$	$2\frac{9}{16}$	$2\frac{11}{16}$	$2\frac{13}{16}$
$1\frac{3}{8}$	$1\frac{5}{8}$	$1\frac{11}{16}$	$1\frac{3}{4}$	$1\frac{7}{8}$	$1\frac{15}{16}$	2	$2\frac{1}{8}$	$2\frac{3}{16}$	$2\frac{5}{16}$	$2\frac{7}{16}$	$2\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{7}{8}$
$1\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{13}{16}$	$1\frac{7}{8}$	$1\frac{15}{16}$	2	$2\frac{1}{8}$	$2\frac{3}{16}$	$2\frac{5}{16}$	$2\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{11}{16}$	$2\frac{13}{16}$	$2\frac{15}{16}$
$1\frac{5}{8}$	$1\frac{7}{8}$	$1\frac{7}{8}$	2	$2\frac{1}{16}$	$2\frac{1}{8}$	$2\frac{3}{16}$	$2\frac{5}{16}$	$2\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{9}{16}$	$2\frac{11}{16}$	$2\frac{3}{4}$	$2\frac{7}{8}$	3
$1\frac{3}{4}$	$1\frac{15}{16}$	2	$2\frac{1}{16}$	$2\frac{1}{8}$	$2\frac{3}{16}$	$2\frac{5}{16}$	$2\frac{3}{8}$	$2\frac{7}{16}$	$2\frac{9}{16}$	$2\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{7}{8}$	$2\frac{15}{16}$	$3\frac{1}{16}$
$1\frac{7}{8}$	$2\frac{1}{16}$	$2\frac{1}{8}$	$2\frac{3}{16}$	$2\frac{1}{4}$	$2\frac{5}{16}$	$2\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{9}{16}$	$2\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{13}{16}$	$2\frac{15}{16}$	3	$3\frac{1}{8}$
2	$2\frac{3}{16}$	$2\frac{1}{4}$	$2\frac{5}{16}$	$2\frac{3}{8}$	$2\frac{7}{16}$	$2\frac{1}{2}$	$2\frac{9}{16}$	$2\frac{5}{8}$	$2\frac{3}{4}$	$2\frac{13}{16}$	$2\frac{15}{16}$	3	$3\frac{1}{8}$	$3\frac{3}{16}$
$2\frac{1}{8}$	$2\frac{5}{16}$	$2\frac{5}{16}$	$2\frac{3}{8}$	$2\frac{7}{16}$	$2\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{11}{16}$	$2\frac{3}{4}$	$2\frac{13}{16}$	$2\frac{15}{16}$	3	$3\frac{1}{16}$	$3\frac{3}{16}$	$3\frac{1}{4}$
$2\frac{1}{4}$	$2\frac{7}{16}$	$2\frac{7}{16}$	$2\frac{1}{2}$	$2\frac{9}{16}$	$2\frac{5}{8}$	$2\frac{11}{16}$	$2\frac{3}{4}$	$2\frac{7}{8}$	$2\frac{15}{16}$	3	$3\frac{1}{16}$	$3\frac{3}{16}$	$3\frac{1}{4}$	$3\frac{3}{8}$
$2\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{9}{16}$	$2\frac{5}{8}$	$2\frac{11}{16}$	$2\frac{3}{4}$	$2\frac{13}{16}$	$2\frac{7}{8}$	$2\frac{15}{16}$	3	$3\frac{1}{8}$	$3\frac{3}{16}$	$3\frac{1}{4}$	$3\frac{3}{8}$	$3\frac{7}{16}$
$2\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{11}{16}$	$2\frac{3}{4}$	$2\frac{13}{16}$	$2\frac{7}{8}$	$2\frac{15}{16}$	3	$3\frac{1}{16}$	$3\frac{1}{8}$	$3\frac{3}{16}$	$3\frac{1}{4}$	$3\frac{3}{8}$	$3\frac{7}{16}$	$3\frac{9}{16}$

Values below and to the right of dotted zig zag line are suitable for $\frac{5}{8}''$ rivets.
Values below and to the right of dashed zig zag line are suitable for $\frac{3}{4}''$ rivets.
Values below and to the right of full zig zag line are suitable for $\frac{7}{8}''$ rivets.



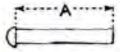




Minimum rivet spacing

Dia. of rivet, inches	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$
s, minimum, inches	$1\frac{9}{16}$	$1\frac{7}{8}$	$2\frac{3}{16}$

APPROXIMATE WEIGHT IN LBS. PER 100 OF STEEL CUP-HEADED RIVETS

 A Length A in inches	DIAMETER OF RIVET IN INCHES ⅜	½	⅝	¾	⅞	1	1⅛	1¼
1	4·58	9·0						
1⅛	4·98	9·7						
1¼	5·37	10·4						
1⅜	5·76	11·1						
1½	6·15	11·8	19·7	30·4				
1⅝	6·54	12·4	20·8	31·9				
1¾	6·93	13·1	21·9	33·5				
1⅞	7·33	13·8	23·0	35·1				
2	7·72	14·5	24·1	36·6	52·5	72·0		
2⅛	8·11	15·2	25·2	38·2	54·6	74·8		
2¼	8·50	15·9	26·3	39·8	56·7	77·6		
2⅜	8·89	16·6	27·3	41·3	58·9	80·3		
2½	9·28	17·3	28·4	42·9	61·0	83·1	110	141
2⅝	9·68	18·0	29·5	44·5	63·1	85·9	113	145
2¾	10·07	18·7	30·6	46·0	65·2	88·7	117	149
2⅞	10·46	19·4	31·7	47·6	67·4	91·5	120	154
3	10·85	20·1	32·8	49·2	69·5	94·3	124	158
3⅛	11·24	20·8	33·9	50·7	71·6	97·0	127	162
3¼	11·63	21·5	35·0	52·3	73·8	100	131	167
3⅜	12·03	22·2	36·0	53·8	75·9	103	134	171
3½	12·42	22·8	37·1	55·4	78·0	105	138	175
3⅝		23·6	38·2	57·0	80·1	108	141	180
3¾		24·3	39·3	58·5	82·3	111	145	184
3⅞		25·0	40·4	60·1	84·4	114	148	189
4			41·5	61·7	86·5	117	152	193
4¼			43·6	64·8	90·8	122	159	202
4½			45·8	67·9	95·1	128	166	210
4¾			48·0	71·1	99·0	133	173	219
5				74·2	104	139	180	228
5¼				77·3	108	144	187	236
5½				80·4	112	150	194	245
5¾				83·6	116	155	201	254
6					121	161	208	262
6¼					125	167	215	271
6½					129	172	222	280
6¾					133	178	229	288
7						183	236	297
7¼						189	243	306
7½						194	250	315
7¾						200	258	323
8						206	265	332
Approximate Weight in lbs of 100 Heads	1·45	3·4	6·7	11·6	18·4	27·5	39·2	53·8
Variation in Weight of 100 Rivets per inch of length	3·13	5·56	8·69	12·5	17·0	22·3	28·2	34·8

DIMENSIONS OF UNIFIED BLACK HEXAGON BOLTS AND NUTS

NORMAL SERIES TO B.S. 2708 : 1956

Nominal Diameter of Bolt	No. of Threads per inch UNC	Max. Width across flats Head and Nut	Max. Width across corners Head & Nut	Max. Thickness		Area at bottom of Thread	Minimum distance between centres
				Head	Nut		
ins		*ins*	*ins*	*ins*	*ins*	*ins 2*	*ins*
¼	20	·4375	·505	·183	·226	·026	⅝
$\frac{5}{16}$	18	·5000	·577	·231	·273	·043	$\frac{25}{32}$
⅜	16	·5625	·650	·263	·337	·065	$\frac{15}{16}$
$\frac{7}{16}$	14	·6250	·722	·311	·385	·090	$1\frac{3}{32}$
½	13	·7500	·866	·353	·448	·122	1¼
⅝	11	·9375	1·083	·433	·559	·195	$1\frac{9}{16}$
¾	10	1·1250	1·299	·513	·665	·295	1⅞
⅞	9	1·3125	1·516	·605	·776	·410	$2\frac{3}{16}$
1	8	1·5000	1·732	·667	·887	·539	2½
1⅛	7	1·6875	1·949	·758	·999	·679	$2\frac{13}{16}$
1¼	7	1·8750	2·165	·873	1·094	·874	3⅛
1½	6	2·2500	2·598	1·034	1·317	1·273	3¾
1¾	5	2·6250	3·031	1·234	1·540	1·717	4⅜
2	4½	3·0000	3·464	1·363	1·763	2·267	5

The above dimensions are for bolts and nuts as forged, i.e. not faced

DIMENSIONS OF BLACK HEXAGON BOLTS AND NUTS

TO B.S. 916 : 1953

Nominal Diameter of Bolt	No. of Threads per inch B.S.W.	Max. Width across flats Head and Nut	Max. Width across corners Head & Nut	Max. Thickness		Area at bottom of Thread	Minimum distance between centres
				Head	Nut		
ins		*ins*	*ins*	*ins*	*ins*	*ins 2*	*ins*
¼	20	·445	·51	·186	·220	·024	⅝
$\frac{5}{16}$	18	·525	·61	·228	·270	·041	$\frac{25}{32}$
⅜	16	·600	·69	·270	·332	·062	$\frac{15}{16}$
$\frac{7}{16}$	14	·710	·82	·312	·395	·087	$1\frac{3}{32}$
½	12	·820	·95	·363	·467	·112	1¼
⅝	11	1·010	1·17	·447	·602	·191	$1\frac{9}{16}$
¾	10	1·200	1·39	·530	·728	·287	1⅞
⅞	9	1·300	1·50	·623	·810	·403	$2\frac{3}{16}$
1	8	1·480	1·71	·706	·935	·532	2½
1⅛	7	1·670	1·93	·79	1·060	·670	$2\frac{13}{16}$
1¼	7	1·860	2·15	·89	1·205	·863	3⅛
1½	6	2·220	2·56	1·06	1·455	1·260	3¾
1¾	5	2·580	2·98	1·27	1·725	1·702	4⅜
2	4½	2·760	3·19	1·43	1·850	2·249	5

The above dimensions are for bolts and nuts as forged, i.e. not faced

The minimum distance between centres is 2½ times the nominal diameter of the bolt in accordance with clause 52a of B.S. 449 : 1959.

APPROXIMATE WEIGHTS IN LBS. PER 100 OF UNIFIED BLACK HEXAGON BOLTS WITH NUT

NORMAL SERIES TO B.S. 2708 : 1956

These weights may be used for Close Tolerance Bolts

Length under Head in ins.	DIAMETER OF BOLT IN INCHES											
	¼	5/16	⅜	7/16	½	⅝	¾	⅞	1	1⅛	1¼	1½
1	2·61	4·12	5·97	9·30	12·9	23·0						
1¼	2·94	4·65	6·73	10·1	14·1	24·8						
1½	3·28	5·03	7·41	11·2	15·4	27·7	43·8	65·5	93·6			
1¾	3·62	5·65	8·17	12·1	16·8	28·7	46·3	69·0	98·5			
2	3·95	6·11	8·86	12·9	17·9	30·7	49·3	72·6	104			
2¼	4·29	6·64	9·63	14·1	19·2	32·8	52·4	76·7	110			
2½	4·63	7·17	10·4	14·9	20·6	34·5	55·2	80·9	113	152	204	
2¾	4·97	7·69	11·1	16·0	21·9	36·7	53·2	85·0	119	159	213	342
3	5·26	8·22	11·9	17·0	23·3	38·8	60·7	88·6	128	166	221	355
3¼	5·60	8·75	12·6	18·0	24·6	40·9	63·8	92·5	130	172	229	367
3½	5·94	9·27	13·4	19·1	26·0	43·0	66·8	96·9	135	179	238	380
3¾	6·28	9·80	14·1	20·1	27·4	45·1	69·8	101	140	186	246	392
4	6·61	10·3	14·9	21·1	28·7	47·2	72·9	105	145	192	254	405
4¼	6·95	10·9	15·7	22·2	30·1	49·3	75·9	109	150	199	262	415
4½	7·29	11·4	16·4	23·2	31·4	51·4	78·9	113	155	206	270	425
4¾	7·63	12·0	17·2	24·3	32·8	53·5	82·0	117	160	213	278	438
5	7·97	12·5	17·8	25·3	34·1	55·6	85·0	121	165	218	285	450
5¼	8·31	12·9	18·6	26·4	35·6	57·8	88·0	125	171	224	294	463
5½	8·65	13·5	19·4	27·4	36·9	59·9	91·1	129	176	231	302	475
5¾	8·99	14·0	20·1	28·4	38·2	62·0	94·1	133	182	238	310	488
6	9·33	14·5	20·9	29·5	39·2	64·1	97·1	137	188	245	318	500
6¼	9·67	15·0	21·6	30·5	40·6	66·2	100	141	193	252	327	513
6½	10·0	15·6	22·4	31·5	41·9	68·3	103	146	198	259	334	525
6¾	10·3	16·1	23·1	32·6	43·3	70·4	106	150	203	266	343	538
7	10·7	16·6	23·9	33·6	44·6	72·5	109	154	209	273	351	550
7¼	11·0	17·1	24·6	34·6	46·0	74·6	112	158	214	280	360	563
7½	11·3	17·7	25·4	35·7	47·3	77·8	116	162	219	286	368	575
7¾	11·7	18·2	26·2	36·7	48·7	78·9	120	166	225	293	377	588
8	12·0	18·7	26·9	37·7	50·1	80·5	121	170	230	300	385	600
8½	12·7	19·8	28·4	39·5	52·8	84·7	127	179	241	314	401	620
9	13·3	20·8	30·0	41·6	55·5	88·9	133	187	252	328	418	645
9½	14·0	21·9	31·5	43·7	58·2	93·1	139	195	263	339	435	670
10	14·7	23·0	33·0	45·8	60·9	97·4	145	202	273	355	452	695
10½	15·4	24·0	34·5	47·8	63·6	102	151	210	283	369	469	720
11	16·1	25·1	36·0	49·9	66·3	106	157	219	294	383	486	745
11½	16·7	26·1	37·6	52·0	69·0	110	164	227	305	396	503	770
12	17·4	27·2	39·1	54·0	71·7	114	170	235	315	410	520	795
Weight in lbs of 100 Nuts	·72	1·06	1·53	2·78	3·60	6·92	12·7	19·9	29·4	41·9	59·3	101·5
Weight in lbs of Shank per inch of Length	·014	·022	·031	·043	·056	·087	·125	·170	·222	·282	·348	·501

APPROXIMATE WEIGHTS IN LBS. PER 100 OF BLACK HEXAGON BOLTS WITH NUT

TO B.S. 916 : 1953

Length under Head in ins.	DIAMETER OF BOLT IN INCHES											
	¼	5/16	⅜	7/16	½	⅝	¾	⅞	1	1⅛	1¼	1½
1	2·65	4·30	6·51	10·08	14·6							
1¼	3·00	4·84	7·29	11·14	15·98	28·9						
1½	3·34	5·38	8·07	12·20	17·37	31·0	49·7					
1¾	3·69	5·92	8·85	13·26	18·75	33·2	52·8					
2	4·03	6·46	9·63	14·32	20·14	35·4	55·9	73·7	104	142		
2¼	4·38	7·00	10·41	15·38	21·52	37·5	59·1	77·9	110	149		
2½	4·72	7·54	11·19	16·44	22·91	39·7	62·2	82·1	115	156		
2¾	5·07	8·08	11·97	17·50	24·29	41·8	65·3	86·4	121	163	214	342
3	5·41	8·62	12·75	18·56	25·68	44·0	68·4	90·6	127	170	223	355
3¼	5·76	9·16	13·53	19·62	27·06	46·2	71·5	94·8	132	177	231	367
3½	6·10	9·70	14·31	20·68	28·45	48·3	74·6	99·0	138	184	240	380
3¾	6·45	10·24	15·09	21·74	29·83	50·5	77·7	103·2	143	191	249	392
4	6·79	10·78	15·87	22·80	31·22	52·6	80·9	107·5	149	198	258	405
4¼	7·14	11·32	16·65	23·86	32·60	54·6	83·2	111·2	154	204	265	415
4½	7·48	11·86	17·43	24·92	33·99	56·5	86·3	114·8	158	210	272	425
4¾	7·83	12·40	18·21	25·98	35·37	58·7	89·4	119·1	164	217	280	438
5	8·17	12·94	18·99	27·04	36·76	60·8	92·5	123·3	170	224	289	450
5¼	8·52	13·48	19·77	28·10	38·14	63·0	95·6	127·5	176	231	298	463
5½	8·87	14·02	20·55	29·16	39·53	65·1	98·7	131·7	181	238	307	475
5¾	9·22	14·56	21·33	30·22	40·91	67·3	101·8	135·9	187	245	316	488
6	9·56	15·10	22·11	31·28	42·30	69·5	104·9	140·1	192	252	324	500
6¼	9·91	15·64	22·89	32·34	43·68	71·6	108·0	144·3	198	259	333	513
6½	10·26	16·18	23·67	33·39	45·06	73·8	111·2	148·6	203	266	341	525
6¾	10·61	16·72	24·45	34·45	46·44	75·9	114·3	152·8	209	273	350	538
7	10·95	17·26	25·23	35·51	47·83	78·1	117·4	157·0	214	280	359	550
7¼	11·30	17·80	26·01	36·57	49·21	80·2	120·5	161·2	220	287	368	563
7½	11·65	18·34	26·79	37·63	50·60	82·4	123·6	165·5	225	294	376	575
7¾	12·00	18·88	27·57	38·69	51·98	84·5	126·7	169·7	231	301	385	588
8	12·34	19·42	28·35	39·75	53·37	86·7	129·8	173·9	236	308	394	600
8½	12·99	20·43	29·83	41·69	55·84	90·6	135·2	181·3	246	320	408	620
9	13·68	21·51	31·39	43·80	58·61	94·9	141·5	189·7	257	334	425	645
9½	14·38	22·59	32·95	45·92	61·38	99·2	147·7	198·2	268	348	443	670
10	15·07	23·67	34·51	48·04	64·14	103·5	153·9	206·6	279	362	460	695
10½	15·77	24·75	36·07	50·15	66·91	107·9	160·1	215·1	290	376	477	720
11	16·46	25·83	37·63	52·27	69·68	112·2	166·4	223·5	302	390	495	745
11½	17·16	26·91	39·19	54·39	72·45	116·5	172·6	232·0	313	405	512	770
12	17·85	28·00	40·75	56·51	75·22	120·8	178·8	240·4	324	419	529	795
Weight in lbs of 100 Nuts	·69	1·11	1·73	3·04	4·77	9·41	15·97	19·50	29·26	42·13	57·22	99·38
Weight in lbs of Shank per inch of Length	·014	·022	·031	·043	·056	·087	·125	·170	·222	·282	·348	·501

DIMENSIONS OF CLOSE TOLERANCE HEXAGON BOLTS & NUTS

NORMAL SERIES TO B.S. 2708 : 1956

Nominal Diameter of Bolt	No. of Threads per inch		Maximum Width across flats Head&Nut	Maximum Width across corners Head&Nut	Maximum Thickness		Area at bottom of Thread		Minimum Distance between Centres
	UNC	UNF			Head	Nut	UNC	UNF	
ins			ins	ins	ins	ins	ins 2	ins 2	ins
¼	20	28	·4375	·505	·163	·226	·026	·031	⅝
5/16	18	24	·5000	·577	·211	·273	·043	·051	25/32
⅜	16	24	·5625	·650	·243	·337	·065	·078	15/16
7/16	14	20	·6250	·722	·291	·358	·090	·106	1 3/32
½	13	20	·7500	·866	·323	·448	·122	·145	1¼
⅝	11	18	·9375	1·083	·403	·559	·196	·235	1 9/16
¾	10	16	1·1250	1·299	·483	·644	·295	·345	1⅞
⅞	9	14	1·3125	1·516	·563	·754	·410	·472	2 3/16
1	8	12	1·5000	1·732	·627	·871	·539	·614	2½
1⅛	7	12	1·6875	1·949	·718	·979	·679	·800	2 13/16
1¼	7	12	1·8750	2·165	·813	1·080	·874	1·010	3⅛
1½	6	12	2·2500	2·598	·974	1·295	1·273	1·503	3¾
1¾	5	—	2·6250	3·031	1·134	1·510	1·717	—	4⅜
2	4½	—	3·0000	3·464	1·263	1·735	2·267	—	5

The above dimensions are for bolts 'faced under the head and turned on shank,' and nuts faced one side.

DIMENSIONS OF HIGH STRENGTH FRICTION GRIP BOLTS & NUTS

TO B.S. 3139 : 1959 and Amendment No. 2 : 1961

Nominal Dia. of Bolt	No. of Threads per inch UNC	Max. Width across Flats		Max. Width across Corners		Max. Diameter of Washer Face		Max. Thickness		Area at bottom of Thread	Min. distance between Centres
		Head	Nut	Head	Nut	Head	Nut	Head	Nut		
ins		ins	ins	ins	ins	ins	ins	ins	ins	ins 2	ins
½	13	·8750	·8750	1·010	1·010	·841	·841	·323	·504	·122	1¼
⅝	11	1·0625	1·0625	1·227	1·227	1·019	1·019	·403	·631	·196	1 9/16
¾	10	1·2500	1·2500	1·443	1·443	1·203	1·203	·483	·758	·295	1⅞
⅞	9	1·4375	1·4375	1·660	1·660	1·380	1·380	·563	·885	·410	2 3/16
1	8	1·6250	1·6250	1·876	1·876	1·559	1·559	·627	1·012	·539	2½
1⅛	7	1·8125	1·8125	2·093	2·093	1·736	1·736	·718	1·139	·679	2 13/16
1¼	7	2·0000	2·0000	2·309	2·309	1·915	1·915	·813	1·251	·874	3⅛
1½	6	2·3750	2·3750	2·742	2·742	2·271	2·271	·974	1·505	1·273	3¾

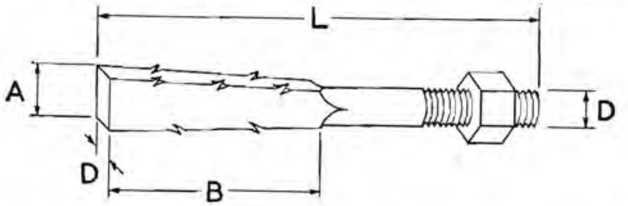
The minimum distance between centres is 2½ times the nominal diameter of the bolt in accordance with clause 52a of B.S. 449 : 1959. This dimension should be checked when torque spanners are necessary, to ensure sufficient working clearance, and also with the size of washers.

APPROXIMATE WEIGHTS IN LBS PER 100 OF HIGH STRENGTH FRICTION GRIP BOLTS WITH NUT

TO B.S. 3139 : 1959 and Amendment No. 2 : 1961

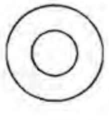
Length under Head in inches	DIAMETER OF BOLT IN INCHES							
	½	⅝	¾	⅞	1	1⅛	1¼	1½
1	16·39	28·12						
1¼	17·78	30·29	43·81					
1½	19·17	32·46	51·94	76·73	106·94			
1¾	20·56	34·63	55·07	80·99	112·50			
2	21·95	36·80	58·20	85·25	118·06			
2¼	23·34	38·97	61·33	89·51	123·62			
2½	24·73	41·14	64·46	93·77	129·18	174·54		
2¾	26·12	43·31	67·59	98·03	134·74	181·58	237·46	
3	27·51	45·48	70·72	102·29	140·30	188·62	246·15	391·30
3¼	28·90	47·65	73·85	106·55	145·86	195·66	254·84	403·82
3½	30·29	49·82	76·98	110·81	151·42	202·70	263·53	416·34
3¾	31·68	51·99	80·11	115·07	156·98	209·74	272·22	428·86
4	33·07	54·16	83·24	119·33	162·54	216·78	280·91	441·38
4½	35·85	58·50	89·50	127·85	173·66	230·86	298·29	466·42
5	38·63	62·84	95·76	136·37	184·78	244·94	315·67	491·46
5½	41·41	67·18	102·02	144·89	195·90	259·02	333·05	516·50
6	44·19	71·52	108·28	153·41	207·02	273·10	350·43	541·54
6½	46·97	75·86	114·54	161·93	218·14	287·18	367·81	566·58
7	49·75	80·20	120·80	170·45	229·26	301·26	385·19	591·62
7½	52·53	84·54	127·06	178·97	240·38	315·34	402·57	616·66
8	55·31	88·88	133·32	187·49	251·50	329·42	419·95	641·70
8½	58·09	93·22	139·58	196·01	262·62	343·50	437·33	666·74
9	60·87	97·56	145·84	204·53	273·74	357·58	454·71	691·78
9½	63·65	101·90	152·10	213·05	284·86	371·66	472·09	716·82
10	66·43	106·24	158·36	221·57	295·98	385·74	489·47	741·86
10½	69·21	110·58	164·62	230·09	307·10	399·82	506·85	766·90
11	71·99	114·92	170·88	238·61	318·22	413·90	524·23	791·94
11½	74·77	119·26	177·14	247·13	329·34	427·98	541·61	816·98
12	77·55	123·60	183·40	255·65	340·46	442·06	558·99	842·02
Weight in lbs of 100 Nuts	6·65	11·53	19·71	30·01	42·53	60·98	80·78	136·14

RAGGED LEWIS BOLTS AND NUTS



Diameter D inches	End Breadth A inches	Length in inches			Weight per Bolt in lbs.	Diameter D inches	End Breadth A inches	Length in inches			Weight per Bolt in lbs.
		Overall L	Taper B	Straight				Overall L	Taper B	Straight	
⅝	1⅛	4	2½	1½	64	1	1¾	6	3½	2½	3·40
		6	4	2	92			9	6	3	2·51
¾	1¼	6	4	2	1·31			12	8	4	4·53
		9	6	3	1·86			15	10	5	5·54
		12	8	4	2·41						
⅞	1½	6	3¾	2¼	1·80	1¼	2½	6	3	3	3·86
		9	6	3	2·59			9	6	3	5·85
		12	8	4	3·35			12	8	4	7 53
								15	10	5	9·21

ORDINARY WASHERS



Diameter of Bolt inches	Outside Diameter of Washer inches	Thickness of Washer inches	Weight per 100 in lbs.	Diameter of Bolt inches	Outside Diameter of Washer inches	Thickness of Washer inches	Weight per 100 in lbs.
¼	⅝	⅛	1	1	2⅛	3/16	14¼
⅜	⅞	⅛	1¾	1⅛	2⅜	3/16	17¾
½	1⅛	⅛	2¾	1¼	2⅝	3/16	21¾
⅝	1⅜	⅛	4	1½	3⅛	3/16	30¾
¾	1⅝	⅛	5¾	1¾	3⅝	¼	55
⅞	1⅞	⅛	7½	2	4⅛	¼	71

BEVELLED WASHERS

Diameter of Bolt in ins.	⅜	½	⅝	¾	⅞
Mean Thickness in ins.	⅛	⅛	⅛	3/16	3/16
Weight per 100 in lbs.	1½	5½	6½	8½	10½

COMPARISON OF WEIGHTS OF STEEL PLATES

UP TO ONE INCH THICK

Divided into 32nds and 40ths of an inch and millimeters

Millimetres	Weight in. lbs. per sq. foot	32nds	16ths
25	40·80	32	16
	39·525	31	
24	38·25	30	15
23	36·975	29	
22	35·70	28	14
21	34·425	27	
	33·15	26	13
20	31·875	25	
19	30·60	24	12
18	29·325	23	
17	28·05	22	11
	26·775	21	
16	25·50	20	10
15	24·225	19	
14	22·95	18	9
13	21·675	17	
	20·40	16	8
12	19·125	15	
11	17·85	14	7
10	16·575	13	
9	15·30	12	6
	14·025	11	
8	12·75	10	5
7	11·475	9	
6	10·20	8	4
	8·925	7	
5	7·65	6	3
4	6·375	5	
3	5·10	4	2
2	3·825	3	
	2·55	2	1
1	1·275	1	

20ths	40ths	Weight in lbs. per sq. foot	Millimetres
20	40	40·80	25
	39	39·78	
19	38	38·76	24
	37	37·74	
18	36	36·72	23
	35	35·70	22
17	34	34·68	
	33	33·66	21
16	32	32·64	20
	31	31·62	
15	30	30·60	19
	29	29·58	18
14	28	28·56	
	27	27·54	17
13	26	26·52	16
	25	25·50	
12	24	24·48	15
	23	23·46	
11	22	22·44	14
	21	21·42	13
10	20	20·40	
	19	19·38	12
9	18	18·36	11
	17	17·34	
8	16	16·32	10
	15	15·30	9
7	14	14·28	
	13	13·26	8
6	12	12·24	
	11	11·22	7
5	10	10·20	6
	9	9·18	
4	8	8·16	5
	7	7·14	4
3	6	6·12	
	5	5·10	3
2	4	4·08	
	3	3·06	2
1	2	2·04	1
	1	1·02	

WEIGHT OF FLAT ROLLED STEEL

IN LBS. PER LINEAR FOOT

Width in inches	THICKNESS IN INCHES															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
¼	·05	·11	·16	·21	·27	·32	·37	·43	·48	·53	·58	·64	·69	·74	·80	·85
½	·11	·21	·32	·43	·53	·64	·74	·85	·96	1·06	1·17	1·28	1·38	1·49	1·59	1·70
¾	·16	·32	·48	·64	·80	·96	1·12	1·28	1·43	1·59	1·75	1·91	2·07	2·23	2·39	2·55
1	·21	·43	·64	·85	1·06	1·28	1·49	1·70	1·91	2·13	2·34	2·55	2·76	2·98	3·19	3·40
1¼	·27	·53	·80	1·06	1·33	1·59	1·86	2·13	2·39	2·66	2·92	3·19	3·45	3·72	3·98	4·25
1½	·32	·64	·96	1·28	1·59	1·91	2·23	2·55	2·87	3·19	3·51	3·83	4·14	4·46	4·78	5·10
1¾	·37	·74	1·12	1·49	1·86	2·23	2·60	2·98	3·35	3·72	4·09	4·46	4·83	5·21	5·58	5·95
2	·43	·85	1·28	1·70	2·13	2·55	2·98	3·40	3·83	4·25	4·68	5·10	5·53	5·95	6·38	6·80
2¼	·48	·96	1·43	1·91	2·39	2·87	3·35	3·83	4·30	4·78	5·26	5·74	6·22	6·69	7·17	7·65
2½	·53	1·06	1·59	2·13	2·66	3·19	3·72	4·25	4·78	5·31	5·84	6·38	6·91	7·44	7·97	8·50
2¾	·58	1·17	1·75	2·34	2·92	3·51	4·09	4·68	5·26	5·84	6·43	7·01	7·60	8·18	8·77	9·35
3	·64	1·28	1·91	2·55	3·19	3·83	4·46	5·10	5·74	6·38	7·01	7·65	8·29	8·93	9·56	10·2
3¼	·69	1·38	2·07	2·76	3·45	4·14	4·83	5·53	6·22	6·91	7·60	8·29	8·98	9·67	10·4	11·1
3½	·74	1·49	2·23	2·98	3·72	4·46	5·21	5·95	6·69	7·44	8·18	8·93	9·67	10·4	11·2	11·9
3¾	·80	1·59	2·39	3·19	3·98	4·78	5·58	6·38	7·17	7·97	8·77	9·56	10·4	11·2	12·0	12·8
4	·85	1·70	2·55	3·40	4·25	5·10	5·95	6·80	7·65	8·50	9·35	10·2	11·1	11·9	12·8	13·6
4¼	·90	1·81	2·71	3·61	4·52	5·42	6·32	7·23	8·13	9·03	9·93	10·8	11·7	12·6	13·6	14·5
4½	·96	1·91	2·87	3·83	4·78	5·74	6·69	7·65	8·61	9·56	10·5	11·5	12·4	13·4	14·3	15·3
4¾	1·01	2·02	3·03	4·04	5·05	6·06	7·07	8·08	9·08	10·1	11·1	12·1	13·1	14·1	15·1	16·2
5	1·06	2·13	3·19	4·25	5·31	6·38	7·44	8·50	9·56	10·6	11·7	12·8	13·8	14·9	15·9	17·0
5¼	1·12	2·23	3·35	4·46	5·58	6·69	7·81	8·93	10·0	11·2	12·3	13·4	14·5	15·6	16·7	17·9
5½	1·17	2·34	3·51	4·68	5·84	7·01	8·18	9·35	10·5	11·7	12·9	14·0	15·2	16·4	17·5	18·7
5¾	1·22	2·44	3·67	4·89	6·11	7·33	8·55	9·78	11·0	12·2	13·4	14·7	15·9	17·1	18·3	19·6
6	1·28	2·55	3·83	5·10	6·38	7·65	8·93	10·2	11·5	12·8	14·0	15·3	16·6	17·9	19·1	20·4
6¼	1·33	2·66	3·98	5·31	6·64	7·97	9·30	10·6	12·0	13·3	14·6	15·9	17·3	18·6	19·9	21·3
6½	1·38	2·76	4·14	5·53	6·91	8·29	9·67	11·1	12·4	13·8	15·2	16·6	18·0	19·3	20·7	22·1
6¾	1·43	2·87	4·30	5·74	7·17	8·61	10·0	11·5	12·9	14·3	15·8	17·2	18·7	20·1	21·5	23·0
7	1·49	2·98	4·46	5·95	7·44	8·93	10·4	11·9	13·4	14·9	16·4	17·9	19·3	20·8	22·3	23·8
7¼	1·54	3·08	4·62	6·16	7·70	9·24	10·8	12·3	13·9	15·4	17·0	18·5	20·0	21·6	23·1	24·7
7½	1·59	3·19	4·78	6·38	7·97	9·56	11·2	12·8	14·3	15·9	17·5	19·1	20·7	22·3	23·9	25·5
7¾	1·65	3·29	4·94	6·59	8·23	9·88	11·5	13·2	14·8	16·5	18·1	19·8	21·4	23·1	24·7	26·4
8	1·70	3·40	5·10	6·80	8·50	10·2	11·9	13·6	15·3	17·0	18·7	20·4	22·1	23·8	25·5	27·2

For actual widths and thicknesses of Flats and Plates available, application should be made to manufacturers.

Weights of Plates or Slabs having greater widths and/or thicknesses than those tabulated may be obtained by appropriate summation from the range of weights given.

WEIGHT OF FLAT ROLLED STEEL

IN LBS. PER LINEAR FOOT

Width in inches	THICKNESS IN INCHES															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
8¼	1·75	3·51	5·26	7·01	8·77	10·5	12·3	14·0	15·8	17·5	19·3	21·0	22·8	24·5	26·3	28·1
8½	1·81	3·61	5·42	7·23	9·03	10·8	12·6	14·5	16·3	18·1	19·9	21·7	23·5	25·3	27·1	28·9
8¾	1·86	3·72	5·58	7·44	9·30	11·2	13·0	14·9	16·7	18·6	20·5	22·3	24·2	26·0	27·9	29·8
9	1·91	3·83	5·74	7·65	9·56	11·5	13·4	15·3	17·2	19·1	21·0	23·0	24·9	26·8	28·7	30·6
9¼	1·97	3·93	5·90	7·86	9·83	11·8	13·8	15·7	17·7	19·7	21·6	23·6	25·6	27·5	29·5	31·5
9½	2·02	4·04	6·06	8·08	10·1	12·1	14·1	16·2	18·2	20·2	22·2	24·2	26·2	28·3	30·3	32·3
9¾	2·07	4·14	6·22	8·29	10·4	12·4	14·5	16·6	18·7	20·7	22·8	24·9	26·9	29·0	31·1	33·2
10	2·13	4·25	6·38	8·50	10·6	12·8	14·9	17·0	19·1	21·3	23·4	25·5	27·6	29·8	31·9	34·0
10¼	2·18	4·36	6·53	8·71	10·9	13·1	15·3	17·4	19·6	21·8	24·0	26·1	28·3	30·5	32·7	34·9
10½	2·23	4·46	6·69	8·93	11·2	13·4	15·6	17·9	20·1	22·3	24·5	26·8	29·0	31·2	33·5	35·7
10¾	2·28	4·57	6·85	9·14	11·4	13·7	16·0	18·3	20·6	22·8	25·1	27·4	29·7	32·0	34·3	36·6
11	2·34	4·68	7·01	9·35	11·7	14·0	16·4	18·7	21·0	23·4	25·7	28·1	30·4	32·7	35·1	37·4
11¼	2·39	4·78	7·17	9·56	12·0	14·3	16·7	19·1	21·5	23·9	26·3	28·7	31·1	33·5	35·9	38·3
11½	2·44	4·89	7·33	9·78	12·2	14·7	17·1	19·6	22·0	24·4	26·9	29·3	31·8	34·2	36·7	39·1
11¾	2·50	5·00	7·49	9·99	12·5	15·0	17·5	20·0	22·5	25·0	27·5	30·0	32·5	35·0	37·5	40·0
12	2·55	5·10	7·65	10·2	12·8	15·3	17·9	20·4	23·0	25·5	28·1	30·6	33·2	35·7	38·3	40·8
12½	2·66	5·31	7·97	10·6	13·3	15·9	18·6	21·3	23·9	26·6	29·2	31·9	34·5	37·2	39·8	42·5
13	2·76	5·53	8·29	11·1	13·8	16·6	19·3	22·1	24·9	27·6	30·4	33·2	35·9	38·7	41·4	44·2
13½	2·87	5·74	8·61	11·5	14·3	17·2	20·1	23·0	25·8	28·7	31·6	34·4	37·3	40·2	43·0	45·9
14	2·98	5·95	8·93	11·9	14·9	17·9	20·8	23·8	26·8	29·8	32·7	35·7	38·7	41·7	44·6	47·6
14½	3·08	6·16	9·24	12·3	15·4	18·5	21·6	24·7	27·7	30·8	33·9	37·0	40·1	43·1	46·2	49·3
15	3·19	6·38	9·56	12·8	15·9	19·1	22·3	25·5	28·7	31·9	35·1	38·3	41·4	44·6	47·8	51·0
15½	3·29	6·59	9·88	13·2	16·5	19·8	23·1	26·4	29·6	32·9	36·2	39·5	42·8	46·1	49·4	52·7
16	3·40	6·80	10·2	13·6	17·0	20·4	23·8	27·2	30·6	34·0	37·4	40·8	44·2	47·6	51·0	54·4
16½	3·51	7·01	10·5	14·0	17·5	21·0	24·5	28·1	31·6	35·1	38·6	42·1	45·6	49·1	52·6	56·1
17	3·61	7·23	10·8	14·5	18·1	21·7	25·3	28·9	32·5	36·1	39·7	43·4	47·0	50·6	54·2	57·8
17½	3·72	7·44	11·2	14·9	18·6	22·3	26·0	29·8	33·5	37·2	40·9	44·6	48·3	52·1	55·8	59·5
18	3·83	7·65	11·5	15·3	19·1	23·0	26·8	30·6	34·4	38·3	42·1	45·9	49·7	53·6	57·4	61·2
18½	3·93	7·86	11·8	15·7	19·7	23·6	27·5	31·5	35·4	39·3	43·2	47·2	51·1	55·0	59·0	62·9
19	4·04	8·08	12·1	16·2	20·2	24·2	28·3	32·3	36·3	40·4	44·4	48·5	52·5	56·5	60·6	64·6
19½	4·14	8·29	12·4	16·6	20·7	24·9	29·0	33·2	37·3	41·4	45·6	49·7	53·9	58·0	62·2	66·3
20	4·25	8·50	12·8	17·0	21·3	25·5	29·8	34·0	38·3	42·5	46·8	51·0	55·3	59·5	63·8	68·0

For actual widths and thicknesses of Flats and Plates available, application should be made to manufacturers.

Weights of Plates or Slabs having greater widths and/or thicknesses than those tabulated may be obtained by appropriate summation from the range of weights given.

WEIGHT OF FLAT ROLLED STEEL

IN LBS. PER LINEAR FOOT

Width in inches	THICKNESS IN INCHES															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
20½	4·36	8·71	13·1	17·4	21·8	26·1	30·5	34·9	39·2	43·6	47·9	52·3	56·6	61·0	65·3	69·7
21	4·46	8·93	13·4	17·9	22·3	26·8	31·2	35·7	40·2	44·6	49·1	53·6	58·0	62·5	66·9	71·4
21½	4·57	9·14	13·7	18·3	22·8	27·4	32·0	36·6	41·1	45·7	50·3	54·8	59·4	64·0	68·5	73·1
22	4·68	9·35	14·0	18·7	23·4	28·1	32·7	37·4	42·1	46·8	51·4	56·1	60·8	65·5	70·1	74·8
22½	4·78	9·56	14·3	19·1	23·9	28·7	33·5	38·3	43·0	47·8	52·6	57·4	62·2	66·9	71·7	76·5
23	4·89	9·78	14·7	19·6	24·4	29·3	34·2	39·1	44·0	48·9	53·8	58·7	63·5	68·4	73·3	78·2
23½	4·99	9·99	15·0	20·0	25·0	30·0	35·0	40·0	44·9	49·9	54·9	59·9	64·9	69·9	74·9	79·9
24	5·10	10·2	15·3	20·4	25·5	30·6	35·7	40·8	45·9	51·0	56·1	61·2	66·3	71.4	76·5	81·6
25	5·31	10·6	15·9	21·3	26·6	31·9	37·2	42·5	47·8	53·1	58·4	63·8	69·1	74·4	79·7	85·0
26	5·53	11·1	16·6	22·1	27·6	33·2	38·7	44·2	49·7	55·3	60·8	66·3	71·8	77·4	82·9	88·4
27	5·74	11·5	17·2	23·0	28·7	34·4	40·2	45·9	51·6	57·4	63·1	68·9	74·6	80·3	86·1	91·8
28	5·95	11·9	17·9	23·8	29·8	35·7	41·7	47·6	53·6	59·5	65·5	71·4	77·4	83·3	89·3	95·2
29	6·16	12·3	18·5	24·7	30·8	37·0	43·1	49·3	55·5	61·6	67·8	74·0	80·1	86·3	92·4	98·6
30	6·38	12·8	19·1	25·5	31·9	38·3	44·6	51·0	57·4	63·8	70·1	76·5	82·9	89·3	95·6	102
31	6·59	13·2	19·8	26·4	32·9	39·5	46·1	52·7	59·3	65·9	72·5	79·1	85·6	92·2	98·8	105
32	6·80	13·6	20·4	27·2	34·0	40·8	47·6	54·4	61·2	68·0	74·8	81·6	88·4	95·2	102	109
33	7·01	14·0	21·0	28·1	35·1	42·1	49·1	56·1	63·1	70·1	77·1	84·2	91·2	98·2	105	112
34	7·23	14·5	21·7	28·9	36·1	43·4	50·6	57·8	65·0	72·3	79·5	86·7	93·9	101	108	116
35	7·44	14·9	22·3	29·8	37·2	44·6	52·1	59·5	66·9	74·4	81·8	89·3	96·1	104	112	119
36	7·65	15·3	23·0	30·6	38·3	45·9	53·6	61·2	68·9	76·5	84·2	91·8	99·5	107	115	122
37	7·86	15·7	23·6	31·5	39·3	47·2	55·0	62·9	70·8	78·6	86·5	94·4	102	110	118	126
38	8·08	16·2	24·2	32·3	40·4	48·5	56·5	64·6	72·7	80·8	88·8	96·9	105	113	121	129
39	8·29	16·6	24·9	33·2	41·4	49·7	58·0	66·3	74·6	82·9	91·2	99·5	108	116	124	133
40	8·50	17·0	25·5	34·0	42·5	51·0	59·5	68·0	76·5	85·0	93·5	102	111	119	128	136
41	8·71	17·4	26·1	34·9	43·6	52·3	61·0	69·7	78·4	87·1	95·8	105	113	122	131	139
42	8·93	17·9	26·8	35·7	44·6	53·6	62·5	71·4	80·3	89·3	98·2	107	116	125	134	143
43	9·14	18·3	27·4	36·6	45·7	54·8	64·0	73·1	82·2	91·4	101	110	119	128	137	146
44	9·35	18·7	28·1	37·4	46·8	56·1	65·5	74·8	84·2	93·5	103	112	122	131	140	150
45	9·56	19·1	28·7	38·3	47·8	57·4	66·9	76·5	86·1	95·6	105	115	124	134	143	153
46	9·78	19·6	29·3	39·1	48·9	58·7	68·4	78·2	88·0	97·8	108	117	127	137	147	156
47	9·99	20·0	30·0	40·0	49·9	59·9	69·9	79·9	89·9	99·9	110	120	130	140	150	160
48	10·2	20·4	30·6	40·8	51·0	61·2	71·4	81·6	91·8	102	112	122	133	143	153	163

For actual widths and thicknesses of Flats and Plates available, application should be made to manufacturers.
Weights of Plates or Slabs having greater widths and/or thicknesses than those tabulated may be obtained by appropriate summation from the range of weights given.

WEIGHT OF FLAT ROLLED STEEL

IN LBS. PER LINEAR FOOT

Width in inches	THICKNESS IN INCHES															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
49	10·4	20·8	31·2	41·7	52·1	62·5	72·9	83·3	93·7	104	115	125	135	146	156	167
50	10·6	21·3	31·9	42·5	53·1	63·8	74·4	85·0	95·6	106	117	128	138	149	159	170
51	10·8	21·7	32·5	43·4	54·2	65·0	75·9	86·7	97·5	108	119	130	141	152	163	173
52	11·1	22·1	33·2	44·2	55·3	66·3	77·4	88·4	99·5	111	122	133	144	155	166	177
53	11·3	22·5	33·8	45·1	56·3	67·6	78·8	90·1	101	113	124	135	146	158	169	180
54	11·5	23·0	34·4	45·9	57·4	68·9	80·3	91·8	103	115	126	138	149	161	172	184
55	11·7	23·4	35·1	46·8	58·4	70·1	81·8	93·5	105	117	129	140	152	164	175	187
56	11·9	23·8	35·7	47·6	59·5	71·4	83·3	95·2	107	119	131	143	155	167	179	190
57	12·1	24·2	36·3	48·5	60·6	72·7	84·8	96·9	109	121	133	145	158	170	182	194
58	12·3	24·6	37·0	49·3	61·6	74·0	86·3	98·6	111	123	136	148	160	173	185	197
59	12·5	25·0	37·6	50·2	62·7	75·2	87·8	100	113	125	138	151	163	176	188	201
60	12·8	25·4	38·3	51·0	63·8	76·5	89·3	102	115	128	140	153	166	179	191	204
61	13·0	25·9	38·9	51·9	64·8	77·8	90·7	104	117	130	143	156	169	182	194	207
62	13·2	26·4	39·5	52·7	65·9	79·1	92·2	105	119	132	145	158	171	185	198	211
63	13·4	26·8	40·2	53·6	66·9	80·3	93·7	107	121	134	147	161	174	187	201	214
64	13·6	27·2	40·8	54·4	68·0	81·6	95·2	109	122	136	150	163	177	190	204	218
65	13·8	27·6	41·4	55·3	69·1	82·9	96·7	111	124	138	152	166	180	193	207	221
66	14·0	28·1	42·1	56·1	70·1	84·2	98·2	112	126	140	154	168	182	196	210	224
67	14·2	28·5	42·7	57·0	71·2	85·4	99·7	114	128	142	157	171	185	199	214	228
68	14·5	28·9	43·4	57·8	72·3	86·7	101	116	130	145	159	173	188	202	217	231
69	14·7	29·3	44·0	58·7	73·3	88·0	103	117	132	147	161	176	191	205	220	235
70	14·9	29·8	44·6	59·5	74·4	89·3	104	119	134	149	164	179	193	208	223	238
71	15·1	30·2	45·3	60·4	75·4	90·5	106	121	136	151	166	181	196	211	226	241
72	15·3	30·6	45·9	61·2	76·5	91·8	107	122	138	153	168	184	199	214	230	245
73	15·5	31·0	46·5	62·1	77·6	93·1	109	124	140	155	171	186	202	217	233	248
74	15·7	31·5	47·2	62·9	78·6	94·4	110	126	142	157	173	189	204	220	236	252
75	15·9	31·9	47·8	63·8	79·7	95·6	112	128	143	159	175	191	207	223	239	255
76	16·2	32·3	48·5	64·6	80·8	96·9	113	129	145	162	178	194	210	226	242	258
77	16·4	32·7	49·1	65·5	81·8	98·2	115	131	147	164	180	196	213	229	245	262
78	16·6	33·2	49·7	66·3	82·9	99·5	116	133	149	166	182	199	216	232	249	265
79	16·8	33·6	50·4	67·2	83·9	101	118	134	151	168	185	202	218	235	252	269
80	17·0	34·0	51·0	68·0	85·0	102	119	136	153	170	187	204	221	238	255	272

For actual widths and thicknesses of Flats and Plates available, application should be made to manufacturers.
Weights of Plates or Slabs having greater widths and/or thicknesses than those tabulated may be obtained by appropriate summation from the range of weights given.

WEIGHTS OF ANGLES

IN LBS. PER LINEAR FOOT

Sum of flanges in inches	THICKNESS IN INCHES														
	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
2	·80	1·15	1·50												
2½	1·00	1·45	1·90												
3		1·80	2·35	2·85											
3½		2·1	2·7	3·4											
4		2·4	3·2	3·9	4·6										
4½		2·7	3·6	4·4	5·2										
5		3·1	4·0	5·0	5·9	6·8	7·6								
5½			4·4	5·5	6·5	7·5									
6			4·8	6·0	7·1	8·2	9·3	10·4							
6½			5·3	6·5	7·8	9·0	10·2	11·3							
7			5·7	7·1	8·4	9·7	11·0	12·3	13·5						
7½				7·6	9·1	10·5	11·9	13·2	14·6						
8				8·1	9·7	11·2	12·7	14·2	15·7	17·1	18·5				
8½				8·7	10·3	12·0	13·6	15·2	16·7						
9				9·2	11·0	12·7	14·4	16·1	17·8						
9½				9·7	11·6	13·5	15·3	17·1	18·8						
10					12·3	14·2	16·1	18·0	19·9	21·8	23·6				
10½					12·9	15·0	17·0	19·0	21·0						
12					14·8	17·2	19·5	21·9	24·2	26·4	28·7	30·9	33·1		
13							21·2	23·8	26·3	28·8	31·2	33·7	36·1		
14							22·9	25·7	28·4	31·1	33·8	36·4	39·0		
16									32·7	35·8	38·9	42·0	45·0	48·0	51·0

WEIGHTS OF ROUND AND SQUARE BARS

IN LBS. PER LINEAR FOOT

Dia. or Side in inches	ROUND ●	SQUARE ■	Dia. or Side in inches	ROUND ●	SQUARE ■	Dia. or Side in inches	ROUND ●	SQUARE ■
			2½	16·69	21·25	5	66·76	85·00
1/16	*·010*	*·013*	2 9/16	*17·53*	*22·33*	5 1/16	*68·44*	*87·14*
⅛	*·042*	*·053*	2⅝	*18·40*	*23·43*	5⅛	*70·14*	*89·30*
3/16	*·094*	*·120*	2 11/16	*19·29*	*24·56*	5 3/16	*71·86*	*91·49*
¼	*·167*	*·213*	2¾	20·19	25·71	5¼	73·60	93·71
5/16	*·261*	*·332*	2 13/16	*21·12*	*26·89*	5 5/16	*75·36*	*95·96*
⅜	*·376*	*·478*	2⅞	*22·07*	*28·10*	5⅜	*77·15*	*98·23*
7/16	*·511*	*·651*	2 15/16	*23·04*	*29·34*	5 7/16	*78·95*	*100·53*
½	·668	·850	3	24·03	30·60	5½	80·78	102·85
9/16	·845	1·076	3 1/16	*25·05*	*31·89*	5 9/16	*82·62*	*105·20*
⅝	1·043	1·328	3⅛	*26·08*	*33·20*	5⅝	*84·49*	*107·58*
11/16	1·262	1·607	3 3/16	*27·13*	*34·54*	5 11/16	*86·38*	*109·98*
¾	1·502	1·913	3¼	28·21	35·91	5¾	88·29	112·41
13/16	1·763	2·245	3 5/16	*29·30*	*37·31*	5 13/16	*90·22*	*114·87*
⅞	2·044	2·603	3⅜	*30·42*	*38·73*	5⅞	*92·17*	*117·35*
15/16	2·347	2·988	3 7/16	*31·55*	*40·18*	5 15/16	*94·14*	*119·86*
1	2·670	3·400	3½	32·71	41·65	6	96·13	122·40
1 1/16	3·015	*3·838*	3 9/16	*33·89*	*43·15*	6 1/16	*98·15*	*124·96*
1⅛	3·380	4·303	3⅝	*35·09*	*44·68*	6⅛	*100·18*	*127·55*
1 3/16	3·766	*4·795*	3 11/16	*36·31*	*46·23*	6 3/16	*102·23*	*130·17*
1¼	4·172	5·313	3¾	37·55	47·81	6¼	104·31	*132·81*
1 5/16	*4·600*	*5·857*	3 13/16	*38·81*	*49·42*	6⅜	*108·52*	*138·18*
1⅜	5·049	6·428	3⅞	*40·10*	*51·05*	6½	112·82	*143·65*
1 7/16	*5·518*	*7·026*	3 15/16	*41·40*	*52·71*	6¾	121·67	*154·91*
1½	6·008	7·650	4	42·73	54·40	7	130·85	*166·60*
1 9/16	*6·519*	*8·301*	4 1/16	*44·07*	*56·11*	7¼	140·36	*178·71*
1⅝	7·051	*8·978*	4⅛	*45·44*	*57·85*	7½	150·21	*191·25*
1 11/16	*7·604*	*9·682*	4 3/16	*46·83*	*59·62*	7¾	160·39	*204·21*
1¾	8·178	10·413	4¼	48·23	61·41	8	170·90	*217·60*
1 13/16	*8·773*	*11·170*	4 5/16	*49·66*	*63·23*	8¼	181·75	*231·41*
1⅞	9·388	*11·953*	4⅜	*51·11*	*65·08*	8½	192·93	*245·65*
1 15/16	*10·024*	*12·763*	4 7/16	*52·58*	*66·95*	8¾	204·45	*260·31*
						9	216·30	*275·40*
2	10·681	13·600	4½	54·07	68·85	9¼	228·48	*290·91*
2 1/16	*11·359*	*14·463*	4 9/16	*55·59*	*70·78*	9½	241·00	*306·85*
2⅛	*12·058*	*15·353*	4⅝	*57·12*	*72·73*	9¾	253·85	*323·21*
2 3/16	*12·778*	*16·270*	4 11/16	*58·67*	*74·71*	10	267·04	*340·00*
2¼	13·519	17·213	4¾	60·25	76·71	10¼	280·55	*357·21*
2 5/16	*14·280*	*18·182*	4 13/16	*61·85*	*78·74*	10½	294·41	*374·85*
2⅜	*15·062*	*19·178*	4⅞	*63·46*	*80·80*	11	323·11	*411·40*
2 7/16	*15·866*	*20·201*	4 15/16	*65·10*	*82·89*	11½	353·16	*449·65*
						12	384·53	*489·60*
						12½	417·24	*531·25*
						13	451·29	*574·60*

Weights printed in italics are for sections which are not rolled, and are included for reference only.

FLOOR PLATES

SUPPORTED ON FOUR SIDES

Early analysis of problem by Grashof who considered two various strips of plate at right angles. By considering each of these as a simple beam and equating the deflections at the centre he showed that the load carried by the shorter (and stiffer) strip was equal to

$$\frac{l^4}{l^4 + b^4}$$

where l and b are the long and short sides.

This method underestimates the stiffening effect of the other strips in each direction and underestimates the load on the shorter strips. The matter has been investigated by several writers, notably C. C. Pounder, who has given two formulæ for rectangular plates, simply supported at the edges and fixed at the edges, viz.:

$$f = \frac{3kpb^2}{4t^2}\left[1 + \frac{14}{75}(1 - k) + \frac{20}{57}(1 - k)^2\right] \text{ simply supported}$$

and

$$f = \frac{kpb^2}{2t^2}\left[1 + \frac{11}{35}(1 - k) + \frac{79}{141}(1 - k)^2\right] \text{ fixed edges}$$

where

f = maximum stress in lbs./sq. in.

b = breadth of plate in inches

l = length of plate in inches

p = pressure on plate in lbs./sq. in.

t = thickness of plate in inches

$$k = \frac{l^4}{l^4 + b^4} = \frac{1}{1 + \frac{b^4}{l^4}}$$

SAFE LOADS ON FLOOR PLATES

HIGH YIELD STRESS STEEL

Plates simply supported on four sides

Thickness in inches	Width ft. ins.	SAFE LOADS IN LBS./SQ. FT. FOR VARIOUS SPANS								
		2′ 0″	2′ 6″	3′ 0″	3′ 6″	4′ 0″	5′ 0″	6′ 0″	7′ 0″	8′ 0″
$\frac{3}{16}$	2 0	645	495	438	412	400	388	384	383	382
	2 6		413	329	291	272	256	250	247	245
	3 0			286	235	209	186	178	174	172
$\frac{1}{4}$	2 0	1146	880	779	733	710	691	683	680	679
	2 6		733	585	518	484	455	444	439	436
	3 0			509	418	371	331	316	309	306
	3 6				374	314	261	241	232	227
	4 0					286	220	195	183	178
$\frac{5}{16}$	2 6		1146	913	809	757	710	693	685	681
	3 0			796	653	581	517	493	483	477
	3 6				584	490	408	376	362	355
	4 0					448	344	304	286	277
	5 0						286	228	202	189
$\frac{3}{8}$	2 6		1650	1316	1166	1089	1023	998	987	982
	3 0			1146	940	836	745	710	695	687
	4 0					645	495	438	412	400
	5 0						412	328	291	272
	6 0							286	235	209
$\frac{1}{2}$	2 6		2933	2339	2072	1937	1818	1774	1755	1746
	3 0			2037	1671	1487	1324	1263	1236	1222
	4 0					1146	880	779	733	710
	5 0						733	585	518	485
	6 0							509	418	318
$\frac{5}{8}$	2 6		4584	3654	3238	3027	2841	2772	2742	2728
	3 0			3183	2611	2323	2069	1973	1931	1910
	4 0					1790	1375	1217	1146	1110
	5 0						1145	914	810	758
	6 0							796	653	581

SAFE LOADS ON FLOOR PLATES

HIGH YIELD STRESS STEEL

Plates fixed at edges

Thickness in inches	Width ft. ins.	SAFE LOADS IN LBS./SQ. FT. FOR VARIOUS SPANS								
		2′ 0″	2′ 6″	3′ 0″	3′ 6″	4′ 0″	5′ 0″	6′ 0″	7′ 0″	8′ 0″
3/16	2 0	880	702	641	610	594	581	576	574	572
	2 6		563	466	423	401	380	372	369	368
	3 0			391	331	302	275	264	260	257
1/4	2 0	1564	1256	1139	1084	1056	1033	1024	1020	1018
	2 6		1002	829	752	712	676	663	656	654
	3 0			695	589	536	488	470	[illegible]	457
	3 6				511	[illegible]	[illegible]	[illegible]	[illegible]	340
	4 0					391	314	285	[illegible]	264
5/16	2 6		1565	1295	1180	1113	1057	1036	1026	1022
	3 0			1087	921	837	763	734	721	714
	3 6				798	689	594	556	539	531
	4 0					611	490	445	423	413
	5 0						391	324	294	278
3/8	2 6		2253	1865	1692	1602	1512	1491	1478	1471
	3 0			1565	1326	1206	1098	1056	1038	1029
	4 0					880	707	641	610	594
	5 0						563	466	423	401
	6 0							391	331	302
1/2	2 6		4006	3316	3008	2849	2706	2651	2627	2615
	3 0			2782	2357	2144	1953	1879	1845	1829
	4 0					1565	1257	1139	1085	1057
	5 0						1002	829	752	712
	6 0							696	589	536
5/8	2 6		6260	5181	4700	4452	4228	4142	4105	4086
	3 0			4347	3682	3350	3052	2936	2883	2857
	4 0					2445	1963	1780	1695	1651
	5 0						1565	1295	1175	1113
	6 0							1087	921	838

SAFE LOADS ON FLOOR PLATES

MILD STEEL

Plates simply supported on four sides

Thickness in inches	Width ft. ins.	SAFE LOADS IN LBS./SQ. FT. FOR VARIOUS SPANS								
		2′ 0″	2′ 6″	3′ 0″	3′ 6″	4′ 0″	5′ 0″	6′ 0″	7′ 0″	8′ 0″
3/16	2 0	467	358	317	299	289	281	278	277	276
	2 6		298	238	211	197	185	180	178	178
	3 0			207	170	151	135	129	126	124
1/4	2 0	829	637	564	530	514	500	495	493	492
	2 6		531	423	375	351	329	321	318	316
	3 0			369	302	269	239	228	223	221
	3 6				271	227	189	174	168	165
	4 0					207	159	141	133	129
5/16	2 6		830	661	586	548	514	501	496	494
	3 0			576	472	420	375	357	350	346
	3 6				423	355	295	272	262	257
	4 0					324	249	220	207	201
	5 0						207	165	147	137
3/8	2 6		1195	952	844	789	741	723	715	711
	3 0			829	681	606	539	514	503	497
	4 0					467	385	317	299	289
	5 0						299	238	211	198
	6 0							207	170	151
1/2	2 6		2124	1694	1500	1403	1317	1285	1271	1264
	3 0			1475	1210	1077	959	914	895	885
	4 0					830	637	564	531	514
	5 0						531	423	375	351
	6 0							369	302	269
5/8	2 6		3319	2646	2345	2192	2058	2008	1986	1975
	3 0			2304	1891	1682	1498	1429	1398	1383
	4 0					1297	996	881	830	804
	5 0						829	662	586	549
	6 0							576	472	421

SAFE LOADS ON FLOOR PLATES

MILD STEEL

Plates fixed at edges

Thickness in inches	Width		SAFE LOADS IN LBS./SQ. FT. FOR VARIOUS SPANS								
	ft.	ins.	2′ 0″	2′ 6″	3′ 0″	3′ 6″	4′ 0″	5′ 0″	6′ 0″	7′ 0″	8′ 0″
$\frac{3}{16}$	2	0	637	512	464	442	430	421	417	415	414
	2	6		408	338	306	290	276	270	267	266
	3	0			283	239	218	199	191	188	186
$\frac{1}{4}$	2	0	1133	910	825	785	765	748	741	738	737
	2	6		725	600	544	516	490	480	476	473
	3	0			504	427	388	354	340	334	331
	3	6				370	319	275	257	250	246
	4	0					283	227	206	196	191
$\frac{5}{16}$	2	6		1133	937	851	806	765	749	743	740
	3	0			786	667	606	553	531	522	517
	3	6				578	499	429	403	390	384
	4	0					443	355	322	306	299
	5	0						283	234	213	201
$\frac{3}{8}$	2	6		1632	1351	1225	1160	1102	1080	1070	1065
	3	0			1133	960	873	796	765	752	745
	4	0					637	512	464	442	430
	5	0						408	338	306	290
	6	0							283	240	218
$\frac{1}{2}$	2	6		2901	2401	2178	2063	1959	1920	1902	1893
	3	0			2015	1707	1553	1415	1361	1336	1324
	4	0					1133	910	825	785	765
	5	0						725	600	545	516
	6	0							504	427	388
$\frac{5}{8}$	2	6		4532	3752	3403	3223	3061	3000	2972	2959
	3	0			3148	2667	2426	2210	2126	2088	2069
	4	0					1771	1422	1289	1227	1196
	5	0						1133	938	851	806
	6	0							787	667	606

RAINWATER GUTTERS AND PIPES

The function of gutters and pipes is to collect the rainwater falling on roofs and to discharge this to the surface water or other drains. To proportion the gutters and pipes correctly it is necessary to know the rate of rainfall and the rate of flow through the pipes, etc.

For short storms, of five minutes duration, the maximum rainfall in this country is at a rate of approximately 2 inches per hour. For longer periods the rate decreases but for very short periods higher rates have been recorded, e.g. ⅛-inch in three minutes, equivalent to 2½ inches per hour. In certain countries abroad much heavier rainfalls may occur and these require special consideration.

To ensure self cleansing the minimum rate of flow through a drain should be not less than 2½ feet per second and drains are usually laid to falls to ensure this. On the basis of 2½ inches of rain per hour and 2½ feet per second flow 1 square inch of cross section of drain will drain 300 square feet of roof.

The rate of flow through a vertical pipe is much greater than through a nearly horizontal drain even when allowance is made for bends, offsets and other obstructions but it is advisable to provide ample capacity in the pipes and the ratio of 300 square feet of roof to 1 square inch of pipe should not be exceeded. It is customary to provide rather larger pipes at a rate of 1 square inch to 200 square feet or less. The effectiveness of the pipes is considerably increased if a conical tapered outlet is used in the gutter.

Pipes to eaves gutters are usually placed at 30 feet–60 feet centres. The spacing of pipes to valley gutters depends on internal conditions and may be very much greater. If one large pipe does not provide sufficient cross sectional area twin pipes may be used.

Half-round eaves gutters should be at least twice the diameter of the largest pipe connected to them and are usually laid to a slight fall, 1 inch in 40 feet.

Valley gutters and similar gutters should have at least 2 square inches of cross sectional area for each 'foot of span drained measured on plan'. For example, a valley gutter between a 70 feet normal span roof and an 80 feet normal span roof drains 35 feet on one side and 40 feet on the other, a total of 75 feet. Cross sectional areas should be not less than 150 square inches and this will be provided by a valley gutter 28 inches wide at the top, 16 inches wide on the sole and 7 inches deep. Valley gutters may be laid with a slight fall or flat but in every case care should be taken to counter any deflection in the supporting valley beams. The sole of valley gutters should be not less than 12 inches wide to give easy access.

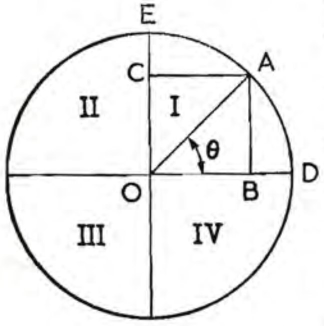
For details of gutters and pipes reference may be made to the following British Specifications:

No. 460 & 1205	Cast Iron Gutters and Pipes
No. 569	Asbestos Cement Rainwater goods
No. 1091	Pressed Steel Gutters and Pipes

PART XIII

Mathematical Tables

TRIGONOMETRICAL FORMULAE



$$\mathrm{Sin}\,\theta = \frac{AB}{OA} = \frac{1}{\mathrm{cosec}\,\theta} = \mathrm{Cos}\,(90^\circ - \theta)$$

$$\mathrm{Cos}\,\theta = \frac{OB}{OA} = \frac{1}{\mathrm{sec}\,\theta} = \mathrm{Sin}\,(90^\circ - \theta)$$

$$\mathrm{Tan}\,\theta = \frac{AB}{OB} = \frac{\sin\theta}{\cos\theta} = \mathrm{Cotan}\,(90^\circ - \theta)$$

$$\mathrm{Cosec}\,\theta = \frac{OA}{AB} = \frac{1}{\sin\theta} = \mathrm{Sec}\,(90^\circ - \theta)$$

$$\mathrm{Sec}\,\theta = \frac{OA}{OB} = \frac{1}{\cos\theta} = \mathrm{Cosec}\,(90^\circ - \theta)$$

$$\mathrm{Cotan}\,\theta = \frac{OB}{AB} = \frac{1}{\tan\theta} = \mathrm{Tan}\,(90^\circ - \theta)$$

$$\mathrm{Versine}\,\theta = 1 - \cos\theta = \frac{BD}{OA}$$

$$\mathrm{Coversine}\,\theta = 1 - \sin\theta = \frac{EC}{OA}$$

In quadrant **I** All ratios are positive
II Sin, Cosec, Versine, Coversine are positive
Cos, Tan, Sec, Cotan are negative
III Tan, Cotan, Versine, Coversine are positive
Sin, Cosec, Cos, Sec are negative
IV Cos, Sec, Versine, Coversine are positive
Sin, Tan, Cosec, Cotan are negative

$$\mathrm{Sin}^2\theta + \mathrm{Cos}^2\theta = 1$$

$$\mathrm{Sin}\,(\theta \pm \varphi) = \mathrm{Sin}\,\theta\,\mathrm{Cos}\,\varphi \pm \mathrm{Cos}\,\theta\,\mathrm{Sin}\,\varphi$$

$$\mathrm{Cos}\,(\theta \pm \varphi) = \mathrm{Cos}\,\theta\,\mathrm{Cos}\,\varphi \mp \mathrm{Sin}\,\theta\,\mathrm{Sin}\,\varphi$$

$$\mathrm{Tan}\,(\theta + \varphi) = \frac{\mathrm{Tan}\,\theta + \mathrm{Tan}\,\varphi}{1 - \mathrm{Tan}\,\theta\,\mathrm{Tan}\,\varphi}$$

$$\mathrm{Tan}\,(\theta - \varphi) = \frac{\mathrm{Tan}\,\theta - \mathrm{Tan}\,\varphi}{1 + \mathrm{Tan}\,\theta\,\mathrm{Tan}\,\varphi}$$

$$\mathrm{Sin}\,2\theta = 2\,\mathrm{Sin}\,\theta\,\mathrm{Cos}\,\theta$$

$$\mathrm{Cos}\,2\theta = \mathrm{Cos}^2\theta - \mathrm{Sin}^2\theta$$

$$\mathrm{Tan}\,2\theta = \frac{2\,\mathrm{Tan}\,\theta}{1 - \mathrm{Tan}^2\theta}$$

$$\mathrm{Sin}\,\tfrac{1}{2}\theta = \sqrt{\frac{1 - \mathrm{Cos}\,\theta}{2}}$$

$$\mathrm{Cos}\,\tfrac{1}{2}\theta = \sqrt{\frac{1 + \mathrm{Cos}\,\theta}{2}}$$

$$\mathrm{Tan}\,\tfrac{1}{2}\theta = \frac{1 - \mathrm{Cos}\,\theta}{\mathrm{Sin}\,\theta}$$

$$\mathrm{Sin}\,\theta + \mathrm{Sin}\,\varphi = 2\sin\left(\frac{\theta + \varphi}{2}\right)\mathrm{Cos}\left(\frac{\theta - \varphi}{2}\right)$$

$$\mathrm{Sin}\,\theta - \mathrm{Sin}\,\varphi = 2\cos\left(\frac{\theta + \varphi}{2}\right)\mathrm{Sin}\left(\frac{\theta - \varphi}{2}\right)$$

$$\mathrm{Cos}\,\theta + \mathrm{Cos}\,\varphi = 2\cos\left(\frac{\theta + \varphi}{2}\right)\mathrm{Cos}\left(\frac{\theta - \varphi}{2}\right)$$

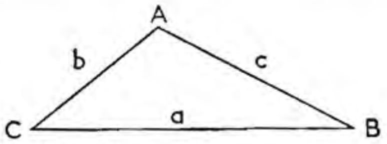
$$\mathrm{Cos}\,\theta - \mathrm{Cos}\,\varphi = -2\,\mathrm{Sin}\left(\frac{\theta + \varphi}{2}\right)\mathrm{Sin}\left(\frac{\theta - \varphi}{2}\right)$$

$$\mathrm{Tan}\,\theta + \mathrm{Tan}\,\varphi = \mathrm{Sin}\,(\theta + \varphi) \div \mathrm{Cos}\,\theta\,\cos\varphi$$

$$\mathrm{Tan}\,\theta - \mathrm{Tan}\,\varphi = \mathrm{Sin}\,(\theta - \varphi) \div \mathrm{Cos}\,\theta\,\cos\varphi$$

SOLUTION OF TRIANGLES

GENERAL



A, B, C are the angles of the triangle
a, b, c are the sides opposite the angles A, B & C

$$A + B + C = 180^\circ = \pi \text{ radians}$$

$$\frac{a}{\mathrm{Sin}\,A} = \frac{b}{\mathrm{Sin}\,B} = \frac{c}{\mathrm{Sin}\,C}$$

$$\mathrm{Cos}\,A = \frac{b^2 + c^2 - a^2}{2bc}$$

$$\mathrm{Cos}\,B = \frac{c^2 + a^2 - b^2}{2ca}$$

$$\mathrm{Cos}\,C = \frac{a^2 + b^2 - c^2}{2ab}$$

$$s = \frac{a + b + c}{2}$$

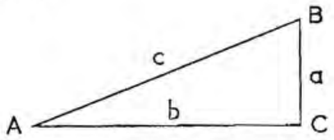
$$\text{Area} = \sqrt{s\,(s - a)\,(s - b)\,(s - c)}$$

OBLIQUE ANGLED TRIANGLES

Known	Required					
	A	B	C	b	c	Area
a, b, c	$\mathrm{Cos}\,A = \frac{b^2+c^2-a^2}{2bc}$	$\mathrm{Cos}\,B = \frac{c^2+a^2-b^2}{2ca}$	$\mathrm{Cos}\,C = \frac{a^2+b^2-c^2}{2ab}$	—	—	$\sqrt{s\,(s-a)\,(s-b)\,(s-c)}$
a, A, B	—	—	$180^\circ-(A+B)$	$\frac{a\,\mathrm{Sin}\,B}{\mathrm{Sin}\,A}$	$\frac{a\,\mathrm{Sin}\,C}{\mathrm{Sin}\,A}$	—
a, b, A	—	$\mathrm{Sin}\,B = \frac{b\,\mathrm{Sin}\,A}{a}$	—	—	$\frac{b\,\mathrm{Sin}\,C}{\mathrm{Sin}\,B}$	—
a, b, C	$\tan A = \frac{a\sin C}{b - a\cos C}$	—	—	—	$\sqrt{a^2+b^2-2ab\cos C}$	$\frac{1}{2}ab\sin C$

RIGHT ANGLED TRIANGLES

$a^2 = c^2 - b^2$
$b^2 = c^2 - a^2$
$c^2 = a^2 + b^2$



Known	Required					
	A	B	a	b	c	Area
a, b	$\tan A = \frac{a}{b}$	$\tan B = \frac{b}{a}$	—	—	$\sqrt{a^2+b^2}$	$\frac{ab}{2}$
a, c	$\mathrm{Sin}\,A = \frac{a}{c}$	$\mathrm{Cos}\,B = \frac{a}{c}$	—	$\sqrt{c^2-a^2}$	—	$\frac{a\sqrt{c^2-a^2}}{2}$
A, a	—	$90^\circ-A$	—	$a\cot A$	$\frac{a}{\mathrm{Sin}\,A}$	$\frac{a^2\cot A}{2}$
A, b	—	$90^\circ-A$	$b\tan A$	—	$\frac{b}{\mathrm{Cos}\,A}$	$\frac{b^2\tan A}{2}$
A, c	—	$90^\circ-A$	$c\sin A$	$c\cos A$	—	$\frac{c^2\sin 2A}{4}$

TRIGONOMETRICAL FUNCTIONS

NATURAL SINES

Angle	0′	10′	20′	30′	40′	50′	60′	
0°	0·00000	0·00291	0·00582	0·00873	0·01164	0·01454	0·01745	89°
1	0·01745	0·02036	0·02327	0·02618	0·02908	0·03199	0·03490	88
2	0·03490	0·03781	0·04071	0·04362	0·04653	0·04943	0·05234	87
3	0·05234	0·05524	0·05814	0·06105	0·06395	0·06685	0·06976	86
4	0·06976	0·07266	0·07556	0·07846	0·08136	0·08426	0·08716	85
5	0·08716	0·09005	0·09295	0·09585	0·09874	0·10164	0·10453	84
6	0·10453	0·10742	0·11031	0·11320	0·11609	0·11898	0·12187	83
7	0·12187	0·12476	0·12764	0·13053	0·13341	0·13629	0·13917	82
8	0·13917	0·14205	0·14493	0·14781	0·15069	0·15356	0·15643	81
9	0·15643	0·15931	0·16218	0·16505	0·16792	0·17078	0·17365	80
10	0·17365	0·17651	0·17937	0·18224	0·18509	0·18795	0·19081	79
11	0·19081	0·19366	0·19652	0·19937	0·20222	0·20507	0·20791	78
12	0·20791	0·21076	0·21360	0·21644	0·21928	0·22212	0·22495	77
13	0·22495	0·22778	0·23062	0·23345	0·23627	0·23910	0·24192	76
14	0·24192	0·24474	0·24756	0·25038	0·25320	0·25601	0·25882	75
15	0·25882	0·26163	0·26443	0·26724	0·27004	0·27284	0·27564	74
16	0·27564	0·27843	0·28123	0·28402	0·28680	0·28959	0·29237	73
17	0·29237	0·29515	0·29793	0·30071	0·30348	0·30625	0·30902	72
18	0·30902	0·31178	0·31454	0·31730	0·32006	0·32282	0·32557	71
19	0·32557	0·32832	0·33106	0·33381	0·33655	0·33929	0·34202	70
20	0·34202	0·34475	0·34748	0·35021	0·35293	0·35565	0·35837	69
21	0·35837	0·36108	0·36379	0·36650	0·36921	0·37191	0·37461	68
22	0·37461	0·37730	0·37999	0·38268	0·38537	0·38805	0·39073	67
23	0·39073	0·39341	0·39608	0·39875	0·40141	0·40408	0·40674	66
24	0·40674	0·40939	0·41204	0·41469	0·41734	0·41998	0·42262	65
25	0·42262	0·42525	0·42788	0·43051	0·43313	0·43575	0·43837	64
26	0·43837	0·44098	0·44359	0·44620	0·44880	0·45140	0·45399	63
27	0·45399	0·45658	0·45917	0·46175	0·46433	0·46690	0·46947	62
28	0·46947	0·47204	0·47460	0·47716	0·47971	0·48226	0·48481	61
29	0·48481	0·48735	0·48989	0·49242	0·49495	0·49748	0·50000	60
30	0·50000	0·50252	0·50503	0·50754	0·51004	0·51254	0·51504	59
31	0·51504	0·51753	0·52002	0·52250	0·52498	0·52745	0·52992	58
32	0·52992	0·53238	0·53484	0·53730	0·53975	0·54220	0·54464	57
33	0·54464	0·54708	0·54951	0·55194	0·55436	0·55678	0·55919	56
34	0·55919	0·56160	0·56401	0·56641	0·56880	0·57119	0·57358	55
35	0·57358	0·57596	0·57833	0·58070	0·58307	0·58543	0·58779	54
36	0·58779	0·59014	0·59248	0·59482	0·59716	0·59949	0·60182	53
37	0·60182	0·60414	0·60645	0·60876	0·61107	0·61337	0·61566	52
38	0·61566	0·61795	0·62024	0·62251	0·62479	0·62706	0·62932	51
39	0·62932	0·63158	0·63383	0·63608	0·63832	0·64056	0·64279	50
40	0·64279	0·64501	0·64723	0·64945	0·65166	0·65386	0·65606	49
41	0·65606	0·65825	0·66044	0·66262	0·66480	0·66697	0·66913	48
42	0·66913	0·67129	0·67344	0·67559	0·67773	0·67987	0·68200	47
43	0·68200	0·68412	0·68624	0·68835	0·69046	0·69256	0·69466	46
44°	0·69466	0·69675	0·69883	0·70091	0·70298	0·70505	0·70711	45°
	60′	50′	40′	30′	20′	10′	0′	Angle

NATURAL COSINES

TRIGONOMETRICAL FUNCTIONS

NATURAL SINES

Angle	0′	10′	20′	30′	40′	50′	60′	
45°	0·70711	0·70916	0·71121	0·71325	0·71529	0·71732	0·71934	44°
46	0·71934	0·72136	0·72337	0·72537	0·72737	0·72937	0·73135	43
47	0·73135	0·73333	0·73531	0·73728	0·73924	0·74120	0·74314	42
48	0·74314	0·74509	0·74703	0·74896	0·75088	0·75280	0·75471	41
49	0·75471	0·75661	0·75851	0·76041	0·76229	0·76417	0·76604	40
50	0·76604	0·76791	0·76977	0·77162	0·77347	0·77531	0·77715	39
51	0·77715	0·77897	0·78079	0·78261	0·78442	0·78622	0·78801	38
52	0·78801	0·78980	0·79158	0·79335	0·79512	0·79688	0·79864	37
53	0·79864	0·80038	0·80212	0·80386	0·80558	0·80730	0·80902	36
54	0·80902	0·81072	0·81242	0·81412	0·81580	0·81748	0·81915	35
55	0·81915	0·82082	0·82248	0·82413	0·82577	0·82741	0·82904	34
56	0·82904	0·83066	0·83228	0·83389	0·83549	0·83708	0·83867	33
57	0·83867	0·84025	0·84182	0·84339	0·84495	0·84650	0·84805	32
58	0·84805	0·84959	0·85112	0·85264	0·85416	0·85567	0·85717	31
59	0·85717	0·85866	0·86015	0·86163	0·86310	0·86457	0·86603	30
60	0·86603	0·86748	0·86892	0·87036	0·87178	0·87321	0·87462	29
61	0·87462	0·87603	0·87743	0·87882	0·88020	0·88158	0·88295	28
62	0·88295	0·88431	0·88566	0·88701	0·88835	0·88968	0·89101	27
63	0·89101	0·89232	0·89363	0·89493	0·89623	0·89752	0·89879	26
64	0·89879	0·90007	0·90133	0·90259	0·90383	0·90507	0·90631	25
65	0·90631	0·90753	0·90875	0·90996	0·91116	0·91236	0·91355	24
66	0·91355	0·91472	0·91590	0·91706	0·91822	0·91936	0·92050	23
67	0·92050	0·92164	0·92276	0·92388	0·92499	0·92609	0·92718	22
68	0·92718	0·92827	0·92935	0·93042	0·93148	0·93253	0·93358	21
69	0·93358	0·93462	0·93565	0·93667	0·93769	0·93869	0·93969	20
70	0·93969	0·94068	0·94167	0·94264	0·94361	0·94457	0·94552	19
71	0·94552	0·94646	0·94740	0·94832	0·94924	0·95015	0·95106	18
72	0·95106	0·95195	0·95284	0·95372	0·95459	0·95545	0·95630	17
73	0·95630	0·95715	0·95799	0·95882	0·95964	0·96046	0·96126	16
74	0·96126	0·96206	0·96285	0·96363	0·96440	0·96517	0·96593	15
75	0·96593	0·96667	0·96742	0·96815	0·96887	0·96959	0·97030	14
76	0·97030	0·97100	0·97169	0·97237	0·97304	0·97371	0·97437	13
77	0·97437	0·97502	0·97566	0·97630	0·97692	0·97754	0·97815	12
78	0·97815	0·97875	0·97934	0·97992	0·98050	0·98107	0·98163	11
79	0·98163	0·98218	0·98272	0·98325	0·98378	0·98430	0·98481	10
80	0·98481	0·98531	0·98580	0·98629	0·98676	0·98723	0·98769	9
81	0·98769	0·98814	0·98858	0·98902	0·98944	0·98986	0·99027	8
82	0·99027	0·99067	0·99106	0·99144	0·99182	0·99219	0·99255	7
83	0·99255	0·99290	0·99324	0·99357	0·99390	0·99421	0·99452	6
84	0·99452	0·99482	0·99511	0·99540	0·99567	0·99594	0·99619	5
85	0·99619	0·99644	0·99668	0·99692	0·99714	0·99736	0·99756	4
86	0·99756	0·99776	0·99795	0·99813	0·99831	0·99847	0·99863	3
87	0·99863	0·99878	0·99892	0·99905	0·99917	0·99929	0·99939	2
88	0·99939	0·99949	0·99958	0·99966	0·99973	0·99979	0·99985	1
89°	0·99985	0·99989	0·99993	0·99996	0·99998	1·00000	1·00000	0°
	60′	50′	40′	30′	20′	10′	0′	Angle

NATURAL COSINES

TRIGONOMETRICAL FUNCTIONS

NATURAL TANGENTS

Angle	0′	10′	20′	30′	40′	50′	60′	
0°	0·00000	0·00291	0·00582	0·00873	0·01164	0·01455	0·01746	**89°**
1	0·01746	0·02036	0·02328	0·02619	0·02910	0·03201	0·03492	**88**
2	0·03492	0·03783	0·04075	0·04366	0·04658	0·04949	0·05241	**87**
3	0·05241	0·05533	0·05824	0·06116	0·06408	0·06700	0·06993	**86**
4	0·06993	0·07285	0·07578	0·07870	0·08163	0·08456	0·08749	**85**
5	0·08749	0·09042	0·09335	0·09629	0·09923	0·10216	0·10510	**84**
6	0·10510	0·10805	0·11099	0·11394	0·11688	0·11983	0·12278	**83**
7	0·12278	0·12574	0·12869	0·13165	0·13461	0·13758	0·14054	**82**
8	0·14054	0·14351	0·14648	0·14945	0·15243	0·15540	0·15838	**81**
9	0·15838	0·16137	0·16435	0·16734	0·17033	0·17333	0·17633	**80**
10	0·17633	0·17933	0·18233	0·18534	0·18835	0·19136	0·19438	**79**
11	0·19438	0·19240	0·20042	0·20345	0·20648	0·20952	0·21256	**78**
12	0·21256	0·21560	0·21864	0·22169	0·22475	0·22781	0·23087	**77**
13	0·23087	0·23393	0·23700	0·24008	0·24316	0·24624	0·24933	**76**
14	0·24933	0·25242	0·25552	0·25862	0·26172	0·26483	0·26795	**75**
15	0·26795	0·27107	0·27419	0·27732	0·28046	0·28360	0·28675	**74**
16	0·28675	0·28990	0·29305	0·29621	0·29938	0·30255	0·30573	**73**
17	0·30573	0·30891	0·31210	0·31530	0·31850	0·32171	0·32492	**72**
18	0·32492	0·32814	0·33136	0·33460	0·33783	0·34108	0·34433	**71**
19	0·34433	0·34758	0·35085	0·35412	0·35740	0·36068	0·36397	**70**
20	0·36397	0·36727	0·37057	0·37388	0·37720	0·38053	0·38386	**69**
21	0·38386	0·38721	0·39055	0·39391	0·39727	0·40065	0·40403	**68**
22	0·40403	0·40741	0·41081	0·41421	0·41763	0·42105	0·42447	**67**
23	0·42447	0·42791	0·43136	0·43481	0·43828	0·44175	0·44523	**66**
24	0·44523	0·44872	0·45222	0·45573	0·45924	0·46277	0·46631	**65**
25	0·46631	0·46985	0·47341	0·47698	0·48055	0·48414	0·48773	**64**
26	0·48773	0·49134	0·49495	0·49858	0·50222	0·50587	0·50953	**63**
27	0·50953	0·51320	0·51688	0·52057	0·52427	0·52798	0·53171	**62**
28	0·53171	0·53545	0·53920	0·54296	0·54673	0·55051	0·55431	**61**
29	0·55431	0·55812	0·56194	0·56577	0·56962	0·57348	0·57735	**60**
30	0·57735	0·58124	0·58513	0·58905	0·59297	0·59691	0·60086	**59**
31	0·60086	0·60483	0·60881	0·61280	0·61681	0·62083	0·62487	**58**
32	0·62487	0·62892	0·63299	0·63707	0·64117	0·64528	0·64941	**57**
33	0·64941	0·65355	0·65771	0·66189	0·66608	0·67028	0·67451	**56**
34	0·67451	0·67875	0·68301	0·68728	0·69157	0·69588	0·70021	**55**
35	0·70021	0·70455	0·70891	0·71329	0·71769	0·72211	0·72654	**54**
36	0·72654	0·73100	0·73547	0·73996	0·74447	0·74900	0·75355	**53**
37	0·75355	0·75812	0·76272	0·76733	0·77196	0·77661	0·78129	**52**
38	0·78129	0·78598	0·79070	0·79544	0·80020	0·80498	0·80978	**51**
39	0·80978	0·81461	0·81946	0·82434	0·82923	0·83415	0·83910	**50**
40	0·83910	0·84407	0·84906	0·85408	0·85912	0·86419	0·86929	**49**
41	0·86929	0·87441	0·87955	0·88473	0·88992	0·89515	0·90040	**48**
42	0·90040	0·90569	0·91099	0·91633	0·92170	0·92709	0·93252	**47**
43	0·93252	0·93797	0·94345	0·94896	0·95451	0·96008	0·96569	**46**
44°	0·96569	0·97133	0·97700	0·98270	0·98843	0·99420	1·00000	**45°**
	60′	**50′**	**40′**	**30′**	**20′**	**10′**	**0′**	Angle

NATURAL COTANGENTS

TRIGONOMETRICAL FUNCTIONS

NATURAL TANGENTS

Angle	0′	10′	20′	30′	40′	50′	60′	
45°	1·00000	1·00583	1·01170	1·01761	1·02355	1·02952	1·03553	**44°**
46	1·03553	1·04158	1·04766	1·05378	1·05994	1·06613	1·07237	**43**
47	1·07237	1·07864	1·08496	1·09131	1·09770	1·10414	1·11061	**42**
48	1·11061	1·11713	1·12369	1·13029	1·13694	1·14363	1·15037	**41**
49	1·15037	1·15715	1·16398	1·17085	1·17777	1·18474	1·19175	**40**
50	1·19175	1·19882	1·20593	1·21310	1·22031	1·22758	1·23490	**39**
51	1·23490	1·24227	1·24969	1·25717	1·26471	1·27230	1·27994	**38**
52	1·27994	1·28764	1·29541	1·30323	1·31110	1·31904	1·32704	**37**
53	1·32704	1·33511	1·34323	1·35142	1·35968	1·36800	1·37638	**36**
54	1·37638	1·38484	1·39336	1·40195	1·41061	1·41934	1·42815	**35**
55	1·42815	1·43703	1·44598	1·45501	1·46411	1·47330	1·48256	**34**
56	1·48256	1·49190	1·50133	1·51084	1·52043	1·53010	1·53987	**33**
57	1·53987	1·54972	1·55966	1·56969	1·57981	1·59002	1·60033	**32**
58	1·60033	1·61074	1·62125	1·63185	1·64256	1·65337	1·66428	**31**
59	1·66428	1·67530	1·68643	1·69766	1·70901	1·72047	1·73205	**30**
60	1·73205	1·74375	1·75556	1·76749	1·77955	1·79174	1·80405	**29**
61	1·80405	1·81649	1·82906	1·84177	1·85462	1·86760	1·88073	**28**
62	1·88073	1·89400	1·90741	1·92098	1·93470	1·94858	1·96261	**27**
63	1·96261	1·97681	1·99116	2·00569	2·02039	2·03526	2·05030	**26**
64	2·05030	2·06553	2·08094	2·09654	2·11233	2·12832	2·14451	**25**
65	2·14451	2·16090	2·17749	2·19430	2·21132	2·22857	2·24604	**24**
66	2·24604	2·26374	2·28167	2·29984	2·31826	2·33693	2·35585	**23**
67	2·35585	2·37504	2·39449	2·41421	2·43422	2·45451	2·47509	**22**
68	2·47509	2·49597	2·51715	2·53865	2·56046	2·58261	2·60509	**21**
69	2·60509	2·62791	2·65109	2·67462	2·69853	2·72281	2·74748	**20**
70	2·74748	2·77254	2·79802	2·82391	2·85023	2·87700	2·90421	**19**
71	2·90421	2·93189	2·96004	2·98869	3·01783	3·04749	3·07768	**18**
72	3·07768	3·10842	3·13972	3·17159	3·20406	3·23714	3·27085	**17**
73	3·27085	3·30521	3·34023	3·37594	3·41236	3·44951	3·48741	**16**
74	3·48741	3·52609	3·56557	3·60588	3·64705	3·68909	3·73205	**15**
75	3·73205	3·77595	3·82083	3·86671	3·91364	3·96165	4·01078	**14**
76	4·01078	4·06107	4·11256	4·16530	4·21933	4·27471	4·33148	**13**
77	4·33148	4·38969	4·44942	4·51071	4·57363	4·63825	4·70463	**12**
78	4·70463	4·77286	4·84300	4·91516	4·98940	5·06584	5·14455	**11**
79	5·14455	5·22566	5·30928	5·39552	5·48451	5·57638	5·67128	**10**
80	5·67128	5·76937	5·87080	5·97576	6·08444	6·19703	6·31375	**9**
81	6·31375	6·43484	6·56055	6·69116	6·82694	6·96823	7·11537	**8**
82	7·11537	7·26873	7·42871	7·59575	7·77035	7·95302	8·14435	**7**
83	8·14435	8·34496	8·55555	8·77689	9·00983	9·25530	9·51436	**6**
84	9·51436	9·78817	10·07803	10·38540	10·71191	11·05943	11·43005	**5**
85	11·43005	11·82617	12·25051	12·70621	13·19688	13·72674	14·30067	**4**
86	14·30067	14·92442	15·60478	16·34986	17·16934	18·07498	19·08114	**3**
87	19·08114	20·20555	21·47040	22·90377	24·54176	26·43160	28·63625	**2**
88	28·63625	31·24158	34·36777	38·18846	42·96408	49·10388	57·28996	**1**
89°	57·28996	68·75009	85·93979	114·58865	171·88540	343·77371	Infinite	**0°**
	60′	**50′**	**40′**	**30′**	**20′**	**10′**	**0′**	Angle

NATURAL COTANGENTS

TRIGONOMETRICAL FUNCTIONS

NATURAL SECANTS

Angle	0′	10′	20′	30′	40′	50′	60′	
0°	1·00000	1·00001	1·00002	1·00004	1·00007	1·00011	1·00015	**89°**
1	1·00015	1·00021	1·00027	1·00034	1·00042	1·00051	1·00061	**88**
2	1·00061	1·00072	1·00083	1·00095	1·00108	1·00122	1·00137	**87**
3	1·00137	1·00153	1·00169	1·00187	1·00205	1·00224	1·00244	**86**
4	1·00244	1·00265	1·00287	1·00309	1·00333	1·00357	1·00382	**85**
5	1·00382	1·00408	1·00435	1·00463	1·00491	1·00521	1·00551	**84**
6	1·00551	1·00582	1·00614	1·00647	1·00681	1·00715	1·00751	**83**
7	1·00751	1·00787	1·00825	1·00863	1·00902	1·00942	1·00983	**82**
8	1·00983	1·01024	1·01067	1·01111	1·01155	1·01200	1·01247	**81**
9	1·01247	1·01294	1·01342	1·01391	1·01440	1·01491	1·01543	**80**
10	1·01543	1·01595	1·01649	1·01703	1·01758	1·01815	1·01872	**79**
11	1·01872	1·01930	1·01989	1·02049	1·02110	1·02171	1·02234	**78**
12	1·02234	1·02298	1·02362	1·02428	1·02494	1·02562	1·02630	**77**
13	1·02630	1·02700	1·02770	1·02842	1·02914	1·02987	1·03061	**76**
14	1·03061	1·03137	1·03213	1·03290	1·03368	1·03447	1·03528	**75**
15	1·03528	1·03609	1·03691	1·03774	1·03858	1·03944	1·04030	**74**
16	1·04030	1·04117	1·04206	1·04295	1·04385	1·04477	1·04569	**73**
17	1·04569	1·04663	1·04757	1·04853	1·04950	1·05047	1·05146	**72**
18	1·05146	1·05246	1·05347	1·05449	1·05552	1·05657	1·05762	**71**
19	1·05762	1·05869	1·05976	1·06085	1·06195	1·06306	1·06418	**70**
20	1·06418	1·06531	1·06645	1·06761	1·06878	1·06995	1·07115	**69**
21	1·07115	1·07235	1·07356	1·07479	1·07602	1·07727	1·07853	**68**
22	1·07853	1·07981	1·08109	1·08239	1·08370	1·08503	1·08636	**67**
23	1·08636	1·08771	1·08907	1·09044	1·09183	1·09323	1·09464	**66**
24	1·09464	1·09606	1·09750	1·09895	1·10041	1·10189	1·10338	**65**
25	1·10338	1·10488	1·10640	1·10793	1·10947	1·11103	1·11260	**64**
26	1·11260	1·11419	1·11579	1·11740	1·11903	1·12067	1·12233	**63**
27	1·12233	1·12400	1·12568	1·12738	1·12910	1·13083	1·13257	**62**
28	1·13257	1·13433	1·13610	1·13789	1·13970	1·14152	1·14335	**61**
29	1·14335	1·14521	1·14707	1·14896	1·15085	1·15277	1·15470	**60**
30	1·15470	1·15665	1·15861	1·16059	1·16259	1·16460	1·16663	**59**
31	1·16663	1·16868	1·17075	1·17283	1·17493	1·17704	1·17918	**58**
32	1·17918	1·18133	1·18350	1·18569	1·18790	1·19012	1·19236	**57**
33	1·19236	1·19463	1·19691	1·19920	1·20152	1·20386	1·20622	**56**
34	1·20622	1·20859	1·21099	1·21341	1·21584	1·21830	1·22077	**55**
35	1·22077	1·22327	1·22579	1·22833	1·23089	1·23347	1·23607	**54**
36	1·23607	1·23869	1·24134	1·24400	1·24669	1·24940	1·25214	**53**
37	1·25214	1·25489	1·25767	1·26047	1·26330	1·26615	1·26902	**52**
38	1·26902	1·27191	1·27483	1·27778	1·28075	1·28374	1·28676	**51**
39	1·28676	1·28980	1·29287	1·29597	1·29909	1·30223	1·30541	**50**
40	1·30541	1·30861	1·31183	1·31509	1·31837	1·32168	1·32501	**49**
41	1·32501	1·32838	1·33177	1·33519	1·33864	1·34212	1·34563	**48**
42	1·34563	1·34917	1·35274	1·35634	1·35997	1·36363	1·36733	**47**
43	1·36733	1·37105	1·37481	1·37860	1·38242	1·38628	1·39016	**46**
44°	1·39016	1·39409	1·39804	1·40203	1·40606	1·41012	1·41421	**45°**
	60′	50′	40′	30′	20′	10′	0′	Angle

NATURAL COSECANTS

TRIGONOMETRICAL FUNCTIONS

NATURAL SECANTS

Angle	0′	10′	20′	30′	40′	50′	60′	
45°	1·41421	1·41835	1·42251	1·42672	1·43096	1·43524	1·43956	**44°**
46	1·43956	1·44391	1·44831	1·45274	1·45721	1·46173	1·46628	**43**
47	1·46628	1·47087	1·47551	1·48019	1·48491	1·48967	1·49448	**42**
48	1·49448	1·49933	1·50422	1·50916	1·51415	1·51918	1·52425	**41**
49	1·52425	1·52938	1·53455	1·53977	1·54504	1·55036	1·55572	**40**
50	1·55572	1·56114	1·56661	1·57213	1·57771	1·58333	1·58902	**39**
51	1·58902	1·59475	1·60054	1·60639	1·61229	1·61825	1·62427	**38**
52	1·62427	1·63035	1·63648	1·64268	1·64894	1·65526	1·66164	**37**
53	1·66164	1·66809	1·67460	1·68117	1·68782	1·69452	1·70130	**36**
54	1·70130	1·70815	1·71506	1·72205	1·72911	1·73624	1·74345	**35**
55	1·74345	1·75073	1·75808	1·76552	1·77303	1·78062	1·78829	**34**
56	1·78829	1·79604	1·80388	1·81180	1·81981	1·82790	1·83608	**33**
57	1·83608	1·84435	1·85271	1·86116	1·86970	1·87834	1·88708	**32**
58	1·88708	1·89591	1·90485	1·91388	1·92302	1·93226	1·94160	**31**
59	1·94160	1·95106	1·96062	1·97029	1·98008	1·98998	2·00000	**30**
60	2·00000	2·01014	2·02039	2·03077	2·04128	2·05191	2·06267	**29**
61	2·06267	2·07356	2·08458	2·09574	2·10704	2·11847	2·13005	**28**
62	2·13005	2·14178	2·15366	2·16568	2·17786	2·19019	2·20269	**27**
63	2·20269	2·21535	2·22817	2·24116	2·25432	2·26766	2·28117	**26**
64	2·28117	2·29487	2·30875	2·32282	2·33708	2·35154	2·36620	**25**
65	2·36620	2·38107	2·39614	2·41142	2·42692	2·44264	2·45859	**24**
66	2·45859	2·47477	2·49119	2·50784	2·52474	2·54190	2·55930	**23**
67	2·55930	2·57698	2·59491	2·61313	2·63162	2·65040	2·66947	**22**
68	2·66947	2·68884	2·70851	2·72850	2·74881	2·76945	2·79043	**21**
69	2·79043	2·81175	2·83342	2·85545	2·87785	2·90063	2·92380	**20**
70	2·92380	2·94737	2·97135	2·99574	3·02057	3·04584	3·07155	**19**
71	3·07155	3·09774	3·12440	3·15155	3·17920	3·20737	3·23607	**18**
72	3·23607	3·26531	3·29512	3·32551	3·35649	3·38808	3·42030	**17**
73	3·42030	3·45317	3·48671	3·52094	3·55587	3·59154	3·62796	**16**
74	3·62796	3·66515	3·70315	3·74198	3·78166	3·82223	3·86370	**15**
75	3·86370	3·90613	3·94952	3·99393	4·03938	4·08591	4·13357	**14**
76	4·13357	4·18238	4·23239	4·28366	4·33622	4·39012	4·44541	**13**
77	4·44541	4·50216	4·56041	4·62023	4·68167	4·74482	4·80973	**12**
78	4·80973	4·87649	4·94517	5·01585	5·08863	5·16359	5·24084	**11**
79	5·24084	5·32049	5·40263	5·48740	5·57493	5·66533	5·75877	**10**
80	5·75877	5·85539	5·95536	6·05886	6·16607	6·27719	6·39245	**9**
81	6·39245	6·51208	6·63633	6·76547	6·89979	7·03962	7·18530	**8**
82	7·18530	7·33719	7·49571	7·66130	7·83443	8·01565	8·20551	**7**
83	8·20551	8·40466	8·61379	8·83367	9·06515	9·30917	9·56677	**6**
84	9·56677	9·83912	10·12752	10·43343	10·75849	11·10455	11·47371	**5**
85	11·47371	11·86837	12·29125	12·74550	13·23472	13·76312	14·33559	**4**
86	14·33559	14·95788	15·63679	16·38041	17·19843	18·10262	19·10732	**3**
87	19·10732	20·23028	21·49368	22·92559	24·56212	26·45051	28·65371	**2**
88	28·65371	31·25758	34·38232	38·20155	42·97571	49·11406	57·29869	**1**
89°	57·29869	68·75736	85·94561	114·59301	171·88831	343·77516	Infinite	**0°**
	60′	50′	40′	30′	20′	10′	0′	Angle

NATURAL COSECANTS

EXPONENTIAL AND HYPERBOLIC FUNCTIONS

Radians		e^{-x}	cosh x	sinh x	tanh x	log cosh x	log sinh x
x	e^{x}						
·1	1·1052	·9048	1·0050	·1002	·0997	·0022	$\bar{1}$·0007
·2	1·2214	·8187	1·0201	·2013	·1974	·0086	$\bar{1}$·3039
·3	1·3499	·7408	1·0453	·3045	·2913	·0193	$\bar{1}$·4836
·4	1·4918	·6703	1·0811	·4108	·3799	·0339	$\bar{1}$·6136
·5	1·6487	·6065	1·1276	·5211	·4621	·0522	$\bar{1}$·7169
·6	1·8221	·5488	1·1855	·6367	·5370	·0739	$\bar{1}$·8039
·7	2·0138	·4966	1·2552	·7586	·6044	·0987	$\bar{1}$·8800
·8	2·2255	·4493	1·3374	·8881	·6640	·1263	$\bar{1}$·9485
·9	2·4596	·4066	1·4331	1·0265	·7163	·1563	·0114
1·0	2·7183	·3679	1·5431	1·1752	·7616	·1884	·0701
1·1	3·0042	·3329	1·6685	1·3357	·8005	·2223	·1257
1·2	3·3201	·3012	1·8107	1·5095	·8337	·2578	·1788
1·3	3·6693	·2725	1·9709	1·6984	·8617	·2947	·2300
1·4	4·0552	·2466	2·1509	1·9043	·8854	·3326	·2797
1·5	4·4817	·2231	2·3524	2·1293	·9051	·3715	·3282
1·6	4·9530	·2019	2·5775	2·3756	·9217	·4112	·3758
1·7	5·4739	·1827	2·8283	2·6456	·9354	·4515	·4225
1·8	6·0496	·1653	3·1075	2·9422	·9468	·4924	·4687
1·9	6·6859	·1496	3·4177	3·2682	·9563	·5337	·5143
2·0	7·3891	·1353	3·7622	3·6269	·9640	·5754	·5595
2·1	8·1662	·1225	4·1443	4·0219	·9704	·6175	·6044
2·2	9·0251	·1108	4·5679	4·4571	·9758	·6597	·6491
2·3	9·9742	·1003	5·0372	4·9370	·9801	·7022	·6935
2·4	11·0232	·0907	5·5570	5·4662	·9837	·7448	·7377
2·5	12·1825	·0821	6·1323	6·0502	·9866	·7876	·7818
2·6	13·4638	·0743	6·7690	6·6947	·9890	·8305	·8257
2·7	14·8797	·0672	7·4735	7·4063	·9910	·8735	·8696
2·8	16·4446	·0608	8·2527	8·1919	·9926	·9166	·9134
2·9	18·1741	·0550	9·1146	9·0596	·9940	·9597	·9571
3·0	20·0855	·0498	10·068	10·018	·9951	1·0029	1·0008
3·1	22·1980	·0450	11·122	11·076	·9959	1·0462	1·0444
3·2	24·5325	·0408	12·287	12·246	·9967	1·0894	1·0880
3·3	27·1126	·0369	13·575	13·538	·9973	1·1327	1·1316
3·4	29·9641	·0334	14·999	14·965	·9978	1·1761	1·1751
3·5	33·1155	·0302	16·573	16·543	·9982	1·2194	1·2186
3·6	36·5982	·0273	18·313	18·285	·9985	1·2628	1·2621
3·7	40·4473	·0247	20·236	20·211	·9988	1·3061	1·3056
3·8	44·7012	·0224	22·362	22·339	·9990	1·3495	1·3491
3·9	49·4024	·0202	24·711	24·691	·9992	1·3929	1·3925
4·0	54·5982	·0183	27·308	27·290	·9993	1·4363	1·4360
4·1	60·3403	·0166	30·178	30·162	·9995	1·4797	1·4795
4·2	66·6863	·0150	33·351	33·336	·9996	1·5231	1·5229
4·3	73·6998	·0136	36·857	36·843	·9996	1·5665	1·5664
4·4	81·4509	·0123	40·732	40·719	·9997	1·6099	1·6098
4·5	90·0171	·0111	45·014	45·003	·9997	1·6533	1·6532
4·6	99·4843	·0101	49·747	49·737	·9998	1·6968	1·6967
4·7	109·9472	·0091	54·978	54·969	·9998	1·7402	1·7401
4·8	121·5104	·0082	60·759	60·751	·9999	1·7836	1·7836
4·9	134·2898	·0074	67·149	67·141	·9999	1·8270	1·8270
5·0	148·4132	·0067	74·210	74·203	·9999	1·8705	1·8704

AREAS AND VOLUMES

GEOMETRIC AND IRREGULAR FIGURES

The areas of a number of common geometrical shapes are given on the following pages. The areas of many other figures can be found by breaking them down into the component rectangles, triangles, etc., and computing the area of each item separately. When this cannot be done one of the following methods may be used to find the area of an irregular figure.

(*a*) SQUARED PAPER. Place a sheet of squared transparent paper over the figure and count the number of squares. Areas less than a half square are ignored and those over a half square are taken as equal to one square.

(*b*) SIMPSON'S RULE. Draw a line through the figure, as long as possible, and divide into an even number of equal strips. Set up ordinates and measure them. If $h_1; h_2; h_3 \ldots\ldots h_n$ are the ordinates and b is the breadth of each strip, the area of the figure is approximately: $b/3$ $[h_1 + h_n +$ (four times the sum of the even ordinates) + (twice the sum of the odd ordinates)].

(*c*) SUM OF MID-ORDINATES. Draw a line as before and divide into any number of equal spaces. At the centre of each space set up an ordinate at right angles and measure this. The area of the figure equals the sum of the mid-ordinates multiplied by the width of the strips.

(*d*) WEDDLE'S RULE. If necessary divide the main figure into several sub-figures and divide each of these into six strips of equal width b. Measure the seven ordinates thus formed: h_1, h_2, h_3, h_4, h_5, h_6, h_7, then the area of this figure is equal to $3b/10\ [h_1 + h_3 + h_5 + h_7 + 5\,(h_2 + h_6) + 6h_4]$.

SPHERE

Surface area $= 4\pi r^2$

Volume $= \dfrac{4\pi r^3}{3}$

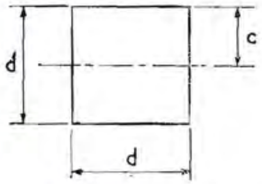
CONE OR RIGHT PYRAMID

Volume $= \frac{1}{3}$ (*Area of base*) × *height*

PROPERTIES OF GEOMETRICAL FIGURES

SQUARE

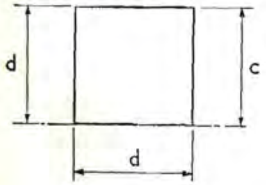
Axis of moments through centre



$$A = d^2$$
$$c = \frac{d}{2}$$
$$I = \frac{d^4}{12}$$
$$z = \frac{d^3}{6}$$
$$r = \frac{d}{\sqrt{12}} = \cdot 288675\ d$$

SQUARE

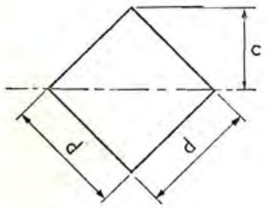
Axis of moments on base



$$A = d^2$$
$$c = d$$
$$I = \frac{d^4}{3}$$
$$z = \frac{d^3}{3}$$
$$r = \frac{d}{\sqrt{3}} = \cdot 577350\ d$$

SQUARE

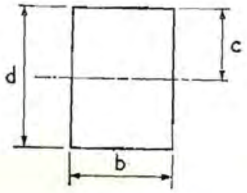
Axis of moments on diagonal



$$A = d^2$$
$$c = \frac{d}{\sqrt{2}} = \cdot 707107\ d$$
$$I = \frac{d^4}{12}$$
$$z = \frac{d^3}{6\sqrt{2}} = \cdot 117851\ d^3$$
$$r = \frac{d}{\sqrt{12}} = \cdot 288675\ d$$

RECTANGLE

Axis of moments through centre

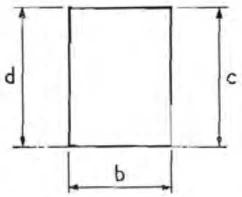


$$A = bd$$
$$c = \frac{d}{2}$$
$$I = \frac{bd^3}{12}$$
$$z = \frac{bd^2}{6}$$
$$r = \frac{d}{\sqrt{12}} = \cdot 288675\ d$$

PROPERTIES OF GEOMETRICAL FIGURES

RECTANGLE

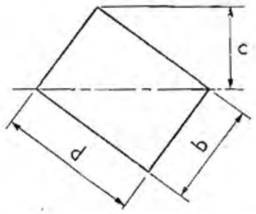
Axis of moments on base



$$A = bd$$
$$c = d$$
$$I = \frac{bd^3}{3}$$
$$z = \frac{bd^2}{3}$$
$$r = \frac{d}{\sqrt{3}} = \cdot 577350\ d$$

RECTANGLE

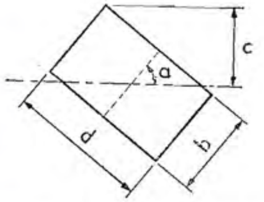
Axis of moments on diagonal



$$A = bd$$
$$c = \frac{bd}{\sqrt{b^2 + d^2}}$$
$$I = \frac{b^3d^3}{6\ (b^2 + d^2)}$$
$$z = \frac{b^2d^2}{6\ \sqrt{b^2 + d^2}}$$
$$r = \frac{bd}{\sqrt{6\ (b^2 + d^2)}}$$

RECTANGLE

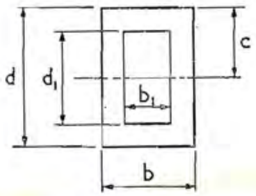
Axis of moments any line through centre of gravity



$$A = bd$$
$$c = \frac{b \sin a + d \cos a}{2}$$
$$I = \frac{bd\ (b^2 \sin^2 a + d^2 \cos^2 a)}{12}$$
$$z = \frac{bd\ (b^2 \sin^2 a + d^2 \cos^2 a)}{6\ (b \sin a + d \cos a)}$$
$$r = \sqrt{\frac{b^2 \sin^2 a + d^2 \cos^2 a}{12}}$$

HOLLOW RECTANGLE

Axis of moments through centre

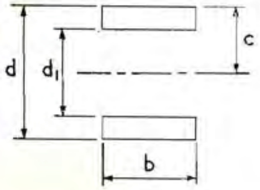


$$A = bd - b_1d_1$$
$$c = \frac{d}{2}$$
$$I = \frac{bd^3 - b_1d_1^3}{12}$$
$$z = \frac{bd^3 - b_1d_1^3}{6d}$$
$$r = \sqrt{\frac{bd^3 - b_1d_1^3}{12A}}$$

PROPERTIES OF GEOMETRICAL FIGURES

EQUAL RECTANGLES

Axis of moments through centre of gravity



$A = b\,(d - d_1)$

$c = \dfrac{d}{2}$

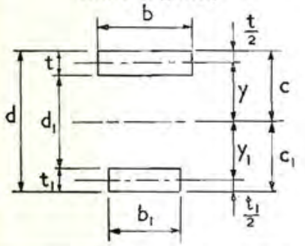
$I = \dfrac{b\,(d^3 - d_1{}^3)}{12}$

$z = \dfrac{b\,(d^3 - d_1{}^3)}{6d}$

$r = \sqrt{\dfrac{d^3 - d_1{}^3}{12(d - d_1)}}$

UNEQUAL RECTANGLES

Axis of moments through centre of gravity



$A = bt + b_1t_1$

$c = \dfrac{\frac{1}{2}\,bt^2 + b_1t_1\,(d - \frac{1}{2}\,t_1)}{A}$

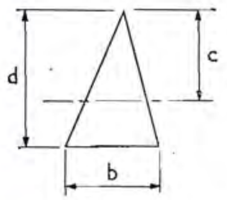
$I = \dfrac{bt^3}{12} + bty^2 + \dfrac{b_1t_1{}^3}{12} + b_1t_1y_1{}^2$

$z = \dfrac{I}{c} \qquad z_1 = \dfrac{I}{c_1}$

$r = \sqrt{\dfrac{I}{A}}$

TRIANGLE

Axis of moments through centre of gravity



$A = \dfrac{bd}{2}$

$c = \dfrac{2d}{3}$

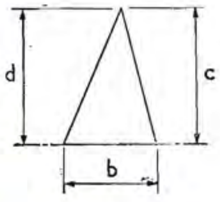
$I = \dfrac{bd^3}{36}$

$z = \dfrac{bd^2}{24}$

$r = \dfrac{d}{\sqrt{18}} = \cdot 235702\ d$

TRIANGLE

Axis of moments on base



$A = \dfrac{bd}{2}$

$c = d$

$I = \dfrac{bd^3}{12}$

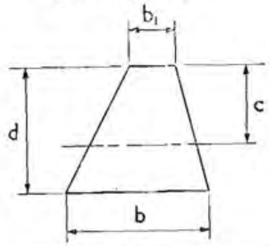
$z = \dfrac{bd^2}{12}$

$r = \dfrac{d}{\sqrt{6}} = \cdot 408248\ d$

PROPERTIES OF GEOMETRICAL FIGURES

TRAPEZOID

Axis of moments through centre of gravity



$A = \dfrac{d(b + b_1)}{2}$

$c = \dfrac{d(2b + b_1)}{3(b + b_1)}$

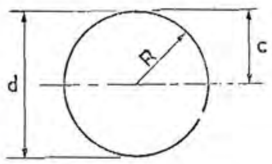
$I = \dfrac{d^3\,(b^2 + 4\,bb_1 + b_1{}^2)}{36\,(b + b_1)}$

$z = \dfrac{d^2\,(b^2 + 4\,bb_1 + b_1{}^2)}{12\,(2b + b_1)}$

$r = \dfrac{d}{6(b + b_1)}\sqrt{2\,(b^2 + 4\,bb_1 + b_1{}^2)}$

CIRCLE

Axis of moments through centre



$A = \dfrac{\pi d^2}{4} = \pi R^2 = \cdot 785398\ d^2 = 3\cdot 141593\ R^2$

$c = \dfrac{d}{2} = R$

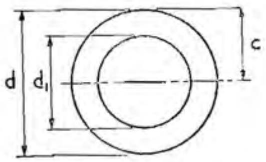
$I = \dfrac{\pi d^4}{64} = \dfrac{\pi R^4}{4} = \cdot 049087\ d^4 = \cdot 785398\ R^4$

$z = \dfrac{\pi d^3}{32} = \dfrac{\pi R^3}{4} = \cdot 098175\ d^3 = \cdot 785398\ R^3$

$r = \dfrac{d}{4} = \dfrac{R}{2}$

HOLLOW CIRCLE

Axis of moments through centre



$A = \dfrac{\pi(d^2 - d_1{}^2)}{4} = \cdot 785398\ (d^2 - d_1\ )$

$c = \dfrac{d}{2}$

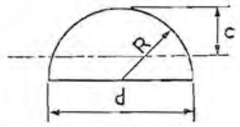
$I = \dfrac{\pi(d^4 - d_1{}^4)}{64} = \cdot 049087\ (d^4 - d_1{}^4)$

$z = \dfrac{\pi(d^4 - d_1{}^4)}{32d} = \cdot 098175\ \dfrac{d^4 - d_1{}^4}{d}$

$r = \dfrac{\sqrt{d^2 + d_1{}^2}}{4}$

HALF CIRCLE

Axis of moments through centre of gravity



$A = \dfrac{\pi R^2}{2} = 1\cdot 570796\ R^2$

$c = R\left(1 - \dfrac{4}{3\pi}\right) = \cdot 575587\ R$

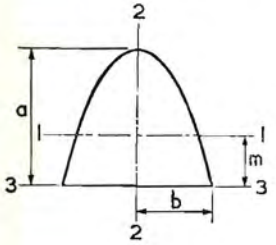
$I = R^4\left(\dfrac{\pi}{8} - \dfrac{8}{9\pi}\right) = \cdot 109757\ R^4$

$z = \dfrac{R^3}{24}\dfrac{(9\pi^2 - 64)}{(3\pi - 4)} = \cdot 190687\ R^3$

$r = R\,\dfrac{\sqrt{9\pi^2 - 64}}{6\pi} = \cdot 264336\ R$

PROPERTIES OF GEOMETRICAL FIGURES

PARABOLA



$A = \frac{4}{3} ab$

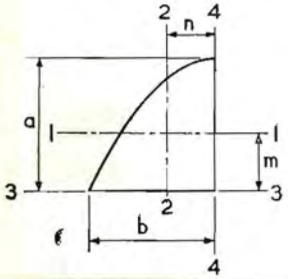
$m = \frac{2}{5} a$

$I_1 = \frac{16}{175} a^3b$

$I_2 = \frac{4}{15} ab^3$

$I_3 = \frac{32}{105} a^3b$

HALF PARABOLA



$A = \frac{2}{3} ab$

$m = \frac{2}{5} a$

$n = \frac{3}{8} b$

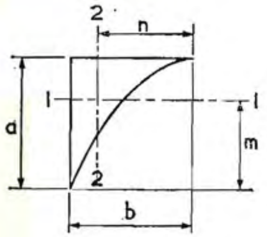
$I_1 = \frac{8}{175} a^3b$

$I_2 = \frac{19}{480} ab^3$

$I_3 = \frac{16}{105} a^3b$

$I_4 = \frac{2}{15} ab^3$

COMPLEMENT OF HALF PARABOLA



$A = \frac{1}{3} ab$

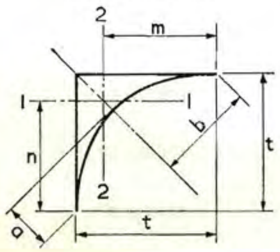
$m = \frac{7}{10} a$

$n = \frac{3}{4} b$

$I_1 = \frac{37}{2100} a^3b$

$I_2 = \frac{1}{80} ab^3$

PARABOLIC FILLET IN RIGHT ANGLE



$a = \frac{t}{2\sqrt{2}}$

$b = \frac{t}{\sqrt{2}}$

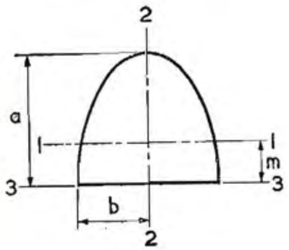
$A = \frac{1}{6} t^2$

$m = n = \frac{4}{5} t$

$I_1 = I_2 = \frac{11}{2100} t^4$

PROPERTIES OF GEOMETRICAL FIGURES

* HALF ELLIPSE



$A = \frac{1}{2} \pi ab$

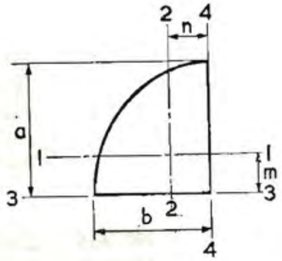
$m = \frac{4a}{3\pi}$

$I_1 = a^3b \left(\frac{\pi}{8} - \frac{8}{9\pi}\right)$

$I_2 = \frac{1}{8} \pi ab^3$

$I_3 = \frac{1}{8} \pi a^3b$

* QUARTER ELLIPSE



$A = \frac{1}{4} \pi ab$

$m = \frac{4a}{3\pi}$

$n = \frac{4b}{3\pi}$

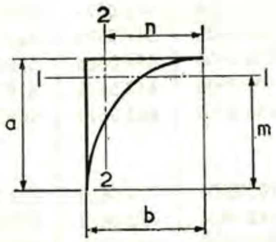
$I_1 = a^3b \left(\frac{\pi}{16} - \frac{4}{9\pi}\right)$

$I_2 = ab^3 \left(\frac{\pi}{16} - \frac{4}{9\pi}\right)$

$I_3 = \frac{1}{16} \pi a^3b$

$I_4 = \frac{1}{16} \pi ab^3$

* ELLIPTIC COMPLEMENT



$A = ab \left(1 - \frac{\pi}{4}\right)$

$m = \frac{a}{6\left(1 - \frac{\pi}{4}\right)}$

$n = \frac{b}{6\left(1 - \frac{\pi}{4}\right)}$

$I_1 = a^3b\left(\frac{1}{3} - \frac{\pi}{16} - \frac{1}{36\left(1 - \frac{\pi}{4}\right)}\right)$

$I_2 = ab^3\left(\frac{1}{3} - \frac{\pi}{16} - \frac{1}{36\left(1 - \frac{\pi}{4}\right)}\right)$

* To obtain properties of half circle, quarter circle and circular complement substitute $a = b = R$.

SQUARES OF NUMBERS

and fractional parts

No.	0	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$
0		·0156	·0625	·1406	·2500	·3906	·5625	·7656
1	1	1·2656	1·5625	1·8906	2·2500	2·6406	3·0625	3·5156
2	4	4·5156	5·0625	5·6406	6·2500	6·8906	7·5625	8·2656
3	9	9·7656	10·5625	11·3906	12·2500	13·1406	14·0625	15·0156
4	16	17·0156	18·0625	19·1406	20·2500	21·3906	22·5625	23·7656
5	25	26·2656	27·5625	28·8906	30·2500	31·6406	33·0625	34·5156
6	36	37·5156	39·0625	40·6406	42·2500	43·8906	45·5625	47·2656
7	49	50·7656	52·5625	54·3906	56·2500	58·1406	60·0625	62·0156
8	64	66·0156	68·0625	70·1406	72·2500	74·3906	76·5625	78·7656
9	81	83·2656	85·5625	87·8906	90·2500	92·6406	95·0625	97·5156
10	100	102·5156	105·0625	107·6406	110·2500	112·8906	115·5625	118·2656
11	121	123·7656	126·5625	129·3906	132·2500	135·1406	138·0625	141·0156
12	144	147·0156	150·0625	153·1406	156·2500	159·3906	162·5625	165·7656
13	169	172·2656	175·5625	178·8906	182·2500	185·6406	189·0625	192·5156
14	196	199·5156	203·0625	206·6406	210·2500	213·8906	217·5625	221·2656
15	225	228·7656	232·5625	236·3906	240·2500	244·1406	248·0625	252·0156
16	256	260·0156	264·0625	268·1406	272·2500	276·3906	280·5625	284·7656
17	289	293·2656	297·5625	301·8906	306·2500	310·6406	315·0625	319·5156
18	324	328·5156	333·0625	337·6406	342·2500	346·8906	351·5625	356·2656
19	361	365·7656	370·5625	375·3906	380·2500	385·1406	390·0625	395·0156
20	400	405·0156	410·0625	415·1406	420·2500	425·3906	430·5625	435·7656
21	441	446·2656	451·5625	456·8906	462·2500	467·6406	473·0625	478·5156
22	484	489·5156	495·0625	500·6406	506·2500	511·8906	517·5625	523·2656
23	529	534·7656	540·5625	546·3906	552·2500	558·1406	564·0625	570·0156
24	576	582·0156	588·0625	594·1406	600·2500	606·3906	612·5625	618·7656
25	625	631·2656	637·5625	643·8906	650·2500	656·6406	663·0625	669·5156
26	676	682·5156	689·0625	695·6406	702·2500	708·8906	715·5625	722·2656
27	729	735·7656	742·5625	749·3906	756·2500	763·1406	770·0625	777·0156
28	784	791·0156	798·0625	805·1406	812·2500	819·3906	826·5625	833·7656
29	841	848·2656	855·5625	862·8906	870·2500	877·6406	885·0625	892·5156
30	900	907·5156	915·0625	922·6406	930·2500	937·8906	945·5625	953·2656

SQUARES OF NUMBERS

and fractional parts

No.	0	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$
31	961	968·7656	976·5625	984·3906	992·2500	1000·1406	1008·0625	1016·0156
32	1024	1032·0156	1040·0625	1048·1406	1056·2500	1064·3906	1072·5625	1080·7656
33	1089	1097·2656	1105·5625	1113·8906	1122·2500	1130·6406	1139·0625	1147·5156
34	1156	1164·5156	1173·0625	1181·6406	1190·2500	1198·8906	1207·5625	1216·2656
35	1225	1233·7656	1242·5625	1251·3906	1260·2500	1269·1406	1278·0625	1287·0156
36	1296	1305·0156	1314·0625	1323·1406	1332·2500	1341·3906	1350·5625	1359·7656
37	1369	1378·2656	1387·5625	1396·8906	1406·2500	1415·6406	1425·0625	1434·5156
38	1444	1453·5156	1463·0625	1472·6406	1482·2500	1491·8906	1501·5625	1511·2656
39	1521	1530·7656	1540·5625	1550·3906	1560·2500	1570·1406	1580·0625	1590·0156
40	1600	1610·0156	1620·0625	1630·1406	1640·2500	1650·3906	1660·5625	1670·7656
41	1681	1691·2656	1701·5625	1711·8906	1722·2500	1732·6406	1743·0625	1753·5156
42	1764	1774·5156	1785·0625	1795·6406	1806·2500	1816·8906	1827·5625	1838·2656
43	1849	1859·7656	1870·5625	1881·3906	1892·2500	1903·1406	1914·0625	1925·0156
44	1936	1947·0156	1958·0625	1969·1406	1980·2500	1991·3906	2002·5625	2013·7656
45	2025	2036·2656	2047·5625	2058·8906	2070·2500	2081·6406	2093·0625	2104·5156
46	2116	2127·5156	2139·0625	2150·6406	2162·2500	2173·8906	2185·5625	2197·2656
47	2209	2220·7656	2232·5625	2244·3906	2256·2500	2268·1406	2280·0625	2292·0156
48	2304	2316·0156	2328·0625	2340·1406	2352·2500	2364·3906	2376·5625	2388·7656
49	2401	2413·2656	2425·5625	2437·8906	2450·2500	2462·6406	2475·0625	2487·5156
50	2500	2512·5156	2525·0625	2537·6406	2550·2500	2562·8906	2575·5625	2588·2656
51	2601	2613·7656	2626·5625	2639·3906	2652·2500	2665·1406	2678·0625	2691·0156
52	2704	2717·0156	2730·0625	2743·1406	2756·2500	2769·3906	2782·5625	2795·7656
53	2809	2822·2656	2835·5625	2848·8906	2862·2500	2875·6406	2889·0625	2902·5156
54	2916	2929·5156	2943·0625	2956·6406	2970·2500	2983·8906	2997·5625	3011·2656
55	3025	3038·7656	3052·5625	3066·3906	3080·2500	3094·1406	3108·0625	3122·0156
56	3136	3150·0156	3164·0625	3178·1406	3192·2500	3206·3906	3220·5625	3234·7656
57	3249	3263·2656	3277·5625	3291·8906	3306·2500	3320·6406	3335·0625	3349·5156
58	3364	3378·5156	3393·0625	3407·6406	3422·2500	3436·8906	3451·5625	3466·2656
59	3481	3495·7656	3510·5625	3525·3906	3540·2500	3555·1406	3570·0625	3585·0156
60	3600	3615·0156	3630·0625	3645·1406	3660·2500	3675·3906	3690·5625	3705·7656

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS

1 to 99

No.	Square	Cube	Square Root √	Cube Root ∛	No.	Square	Cube	Square Root √	Cube Root ∛
					50	2500	125000	7·0711	3·6840
1	1	1	1·0000	1·0000	**51**	2601	132651	7·1414	3·7084
2	4	8	1·4142	1·2599	**52**	2704	140608	7·2111	3·7325
3	9	27	1·7321	1·4422	**53**	2809	148877	7·2801	3·7563
4	16	64	2·0000	1·5874	**54**	2916	157464	7·3485	3·7798
5	25	125	2·2361	1·7100	**55**	3025	166375	7·4162	3·8030
6	36	216	2·4495	1·8171	**56**	3136	175616	7·4833	3·8259
7	49	343	2·6458	1·9129	**57**	3249	185193	7·5498	3·8485
8	64	512	2·8284	2·0000	**58**	3364	195112	7·6158	3·8709
9	81	729	3·0000	2·0801	**59**	3481	205379	7·6811	3·8930
10	100	1000	3·1623	2·1544	**60**	3600	216000	7·7460	3·9149
11	121	1331	3·3166	2·2240	**61**	3721	226981	7·8102	3·9365
12	144	1728	3·4641	2·2894	**62**	3844	238328	7·8740	3·9579
13	169	2197	3·6056	2·3513	**63**	3969	250047	7·9373	3·9791
14	196	2744	3·7417	2·4101	**64**	4096	262144	8·0000	4·0000
15	225	3375	3·8730	2·4662	**65**	4225	274625	8·0623	4·0207
16	256	4096	4·0000	2·5198	**66**	4356	287496	8·1240	4·0412
17	289	4913	4·1231	2·5713	**67**	4489	300763	8·1854	4·0615
18	324	5832	4·2426	2·6207	**68**	4624	314432	8·2462	4·0817
19	361	6859	4·3589	2·6684	**69**	4761	328509	8·3066	4·1016
20	400	8000	4·4721	2·7144	**70**	4900	343000	8·3666	4·1213
21	441	9261	4·5826	2·7589	**71**	5041	357911	8·4261	4·1408
22	484	10648	4·6904	2·8020	**72**	5184	373248	8·4853	4·1602
23	529	12167	4·7958	2·8439	**73**	5329	389017	8·5440	4·1793
24	576	13824	4·8990	2·8845	**74**	5476	405224	8·6023	4·1983
25	625	15625	5·0000	2·9240	**75**	5625	421875	8·6603	4·2172
26	676	17576	5·0990	2·9625	**76**	5776	438976	8·7178	4·2358
27	729	19683	5·1962	3·0000	**77**	5929	456533	8·7750	4·2543
28	784	21952	5·2915	3·0366	**78**	6084	474552	8·8318	4·2727
29	841	24389	5·3852	3·0723	**79**	6241	493039	8·8882	4·2908
30	900	27000	5·4772	3·1072	**80**	6400	512000	8·9443	4·3089
31	961	29791	5·5678	3·1414	**81**	6561	531441	9·0000	4·3267
32	1024	32768	5·6569	3·1748	**82**	6724	551368	9·0554	4·3445
33	1089	35937	5·7446	3·2075	**83**	6889	571787	9·1104	4·3621
34	1156	39304	5·8310	3·2396	**84**	7056	592704	9·1652	4·3795
35	1225	42875	5·9161	3·2711	**85**	7225	614125	9·2195	4·3968
36	1296	46656	6·0000	3·3019	**86**	7396	636056	9·2736	4·4140
37	1369	50653	6·0828	3·3322	**87**	7569	658503	9·3274	4·4310
38	1444	54872	6·1644	3·3620	**88**	7744	681472	9·3808	4·4480
39	1521	59319	6·2450	3·3912	**89**	7921	704969	9·4340	4·4647
40	1600	64000	6·3246	3·4200	**90**	8100	729000	9·4868	4·4814
41	1681	68921	6·4031	3·4482	**91**	8281	753571	9·5394	4·4979
42	1764	74088	6·4807	3·4760	**92**	8464	778688	9·5917	4·5144
43	1849	79507	6·5574	3·5034	**93**	8649	804357	9·6437	4·5307
44	1936	85184	6·6332	3·5303	**94**	8836	830584	9·6954	4·5468
45	2025	91125	6·7082	3·5569	**95**	9025	857375	9·7468	4·5629
46	2116	97336	6·7823	3·5830	**96**	9216	884736	9·7980	4·5789
47	2209	103823	6·8557	3·6088	**97**	9409	912673	9·8489	4·5947
48	2304	110592	6·9282	3·6342	**98**	9604	941192	9·8995	4·6104
49	2401	117649	7·0000	3·6593	**99**	9801	970299	9·9499	4·6261

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS

100 to 199

No.	Square	Cube	Square Root √	Cube Root ∛	No.	Square	Cube	Square Root √	Cube Root ∛
100	10000	1000000	10·0000	4·6416	**150**	22500	3375000	12·2474	5·3133
101	10201	1030301	10·0499	4·6570	**151**	22801	3442951	12·2882	5·3251
102	10404	1061208	10·0995	4·6723	**152**	23104	3511808	12·3288	5·3368
103	10609	1092727	10·1489	4·6875	**153**	23409	3581577	12·3693	5·3485
104	10816	1124864	10·1980	4·7027	**154**	23716	3652264	12·4097	5·3601
105	11025	1157625	10·2470	4·7177	**155**	24025	3723875	12·4499	5·3717
106	11236	1191016	10·2956	4·7326	**156**	24336	3796416	12·4900	5·3832
107	11449	1225043	10·3441	4·7475	**157**	24649	3869893	12·5300	5·3947
108	11664	1259712	10·3923	4·7622	**158**	24964	3944312	12·5698	5·4061
109	11881	1295029	10·4403	4·7769	**159**	25281	4019679	12·6095	5·4175
110	12100	1331000	10·4881	4·7914	**160**	25600	4096000	12·6491	5·4288
111	12321	1367631	10·5357	4·8059	**161**	25921	4173281	12·6886	5·4401
112	12544	1404928	10·5830	4·8203	**162**	26244	4251528	12·7279	5·4514
113	12769	1442897	10·6301	4·8346	**163**	26569	4330747	12·7671	5·4626
114	12996	1481544	10·6771	4·8488	**164**	26896	4410944	12·8062	5·4737
115	13225	1520875	10·7238	4·8629	**165**	27225	4492125	12·8452	5·4848
116	13456	1560896	10·7703	4·8770	**166**	27556	4574296	12·8841	5·4959
117	13689	1601613	10·8167	4·8910	**167**	27889	4657463	12·9228	5·5069
118	13924	1643032	10·8628	4·9049	**168**	28224	4741632	12·9615	5·5178
119	14161	1685159	10·9087	4·9187	**169**	28561	4826809	13·0000	5·5288
120	14400	1728000	10·9545	4·9324	**170**	28900	4913000	13·0384	5·5397
121	14641	1771561	11·0000	4·9461	**171**	29241	5000211	13·0767	5·5505
122	14884	1815848	11·0454	4·9597	**172**	29584	5088448	13·1149	5·5613
123	15129	1860867	11·0905	4·9732	**173**	29929	5177717	13·1529	5·5721
124	15376	1906624	11·1355	4·9866	**174**	30276	5268024	13·1909	5·5828
125	15625	1953125	11·1803	5·0000	**175**	30625	5359375	13·2288	5·5934
126	15876	2000376	11·2250	5·0133	**176**	30976	5451776	13·2665	5·6041
127	16129	2048383	11·2694	5·0265	**177**	31329	5545233	13·3041	5·6147
128	16384	2097152	11·3137	5·0397	**178**	31684	5639752	13·3417	5·6252
129	16641	2146689	11·3578	5·0528	**179**	32041	5735339	13·3791	5·6357
130	16900	2197000	11·4018	5·0658	**180**	32400	5832000	13·4164	5·6462
131	17161	2248091	11·4455	5·0788	**181**	32761	5929741	13·4536	5·6567
132	17424	2299968	11·4891	5·0916	**182**	33124	6028568	13·4907	5·6671
133	17689	2352637	11·5326	5·1045	**183**	33489	6128487	13·5277	5·6774
134	17956	2406104	11·5758	5·1172	**184**	33856	6229504	13·5647	5·6877
135	18225	2460375	11·6190	5·1299	**185**	34225	6331625	13·6015	5·6980
136	18496	2515456	11·6619	5·1426	**186**	34596	6434856	13·6382	5·7083
137	18769	2571353	11·7047	5·1551	**187**	34969	6539203	13·6748	5·7185
138	19044	2628072	11·7473	5·1676	**188**	35344	6644672	13·7113	5·7287
139	19321	2685619	11·7898	5·1801	**189**	35721	6751269	13·7477	5·7388
140	19600	2744000	11·8322	5·1925	**190**	36100	6859000	13·7840	5·7489
141	19881	2803221	11·8743	5·2048	**191**	36481	6967871	13·8203	5·7590
142	20164	2863288	11·9164	5·2171	**192**	36864	7077888	13·8564	5·7690
143	20449	2924207	11·9583	5·2293	**193**	37249	7189057	13·8924	5·7790
144	20736	2985984	12·0000	5·2415	**194**	37636	7301384	13·9284	5·7890
145	21025	3048625	12·0416	5·2536	**195**	38025	7414875	13·9642	5·7989
146	21316	3112136	12·0830	5·2656	**196**	38416	7529536	14·0000	5·8088
147	21609	3176523	12·1244	5·2776	**197**	38809	7645373	14·0357	5·8186
148	21904	3241792	12·1655	5·2896	**198**	39204	7762392	14·0712	5·8285
149	22201	3307949	12·2066	5·3015	**199**	39601	7880599	14·1067	5·8383

SQUARES, CUBES,
SQUARE ROOTS, CUBE ROOTS

200 to 299

No.	Square	Cube	Square Root √	Cube Root ∛	No.	Square	Cube	Square Root √	Cube Root ∛
200	40000	8000000	14·1421	5·8480	**250**	62500	15625000	15·8114	6·2996
201	40401	8120601	14·1774	5·8578	**251**	63001	15813251	15·8430	6·3080
202	40804	8242408	14·2127	5·8675	**252**	63504	16003008	15·8745	6·3164
203	41209	8365427	14·2478	5·8771	**253**	64009	16194277	15·9060	6·3247
204	41616	8489664	14·2829	5·8868	**254**	64516	16387064	15·9374	6·3330
205	42025	8615125	14·3178	5·8964	**255**	65025	16581375	15·9687	6·3413
206	42436	8741816	14·3527	5·9059	**256**	65536	16777216	16·0000	6·3496
207	42849	8869743	14·3875	5·9155	**257**	66049	16974593	16·0312	6·3579
208	43264	8998912	14·4222	5·9250	**258**	66564	17173512	16·0624	6·3661
209	43681	9129329	14·4568	5·9345	**259**	67081	17373979	16·0935	6·3743
210	44100	9261000	14·4914	5·9439	**260**	67600	17576000	16·1245	6·3825
211	44521	9393931	14·5258	5·9533	**261**	68121	17779581	16·1555	6·3907
212	44944	9528128	14·5602	5·9627	**262**	68644	17984728	16·1864	6·3988
213	45369	9663597	14·5945	5·9721	**263**	69169	18191447	16·2173	6·4070
214	45796	9800344	14·6287	5·9814	**264**	69696	18399744	16·2481	6·4151
215	46225	9938375	14·6629	5·9907	**265**	70225	18609625	16·2788	6·4232
216	46656	10077696	14·6969	6·0000	**266**	70756	18821096	16·3095	6·4312
217	47089	10218313	14·7309	6·0092	**267**	71289	19034163	16·3401	6·4393
218	47524	10360232	14·7648	6·0185	**268**	71824	19248832	16·3707	6·4473
219	47961	10503459	14·7986	6·0277	**269**	72361	19465109	16·4012	6·4553
220	48400	10648000	14·8324	6·0368	**270**	72900	19683000	16·4317	6·4633
221	48841	10793861	14·8661	6·0459	**271**	73441	19902511	16·4621	6·4713
222	49284	10941048	14·8997	6·0550	**272**	73984	20123648	16·4924	6·4792
223	49729	11089567	14·9332	6·0641	**273**	74529	20346417	16·5227	6·4872
224	50176	11239424	14·9666	6·0732	**274**	75076	20570824	16·5529	6·4951
225	50625	11390625	15·0000	6·0822	**275**	75625	20796875	16·5831	6·5030
226	51076	11543176	15·0333	6·0912	**276**	76176	21024576	16·6132	6·5108
227	51529	11697083	15·0665	6·1002	**277**	76729	21253933	16·6433	6·5187
228	51984	11852352	15·0997	6·1091	**278**	77284	21484952	16·6733	6·5265
229	52441	12008989	15·1327	6·1180	**279**	77841	21717639	16·7033	6·5343
230	52900	12167000	15·1658	6·1269	**280**	78400	21952000	16·7332	6·5421
231	53361	12326391	15·1987	6·1358	**281**	78961	22188041	16·7631	6·5499
232	53824	12487168	15·2315	6·1446	**282**	79524	22425768	16·7929	6·5577
233	54289	12649337	15·2643	6·1534	**283**	80089	22665187	16·8226	6·5654
234	54756	12812904	15·2971	6·1622	**284**	80656	22906304	16·8523	6·5731
235	55225	12977875	15·3297	6·1710	**285**	81225	23149125	16·8819	6·5808
236	55696	13144256	15·3623	6·1797	**286**	81796	23393656	16·9115	6·5885
237	56169	13312053	15·3948	6·1885	**287**	82369	23639903	16·9411	6·5962
238	56644	13481272	15·4272	6·1972	**288**	82944	23887872	16·9706	6·6039
239	57121	13651919	15·4596	6·2058	**289**	83521	24137569	17·0000	6·6115
240	57600	13824000	15·4919	6·2145	**290**	84100	24389000	17·0294	6·6191
241	58081	13997521	15·5242	6·2231	**291**	84681	24642171	17·0587	6·6267
242	58564	14172488	15·5563	6·2317	**292**	85264	24897088	17·0880	6·6343
243	59049	14348907	15·5885	6·2403	**293**	85849	25153757	17·1172	6·6419
244	59536	14526784	15·6205	6·2488	**294**	86436	25412184	17·1464	6·6494
245	60025	14706125	15·6525	6·2573	**295**	87025	25672375	17·1756	6·6569
246	60516	14886936	15·6844	6·2658	**296**	87616	25934336	17·2047	6·6644
247	61009	15069223	15·7162	6·2743	**297**	88209	26198073	17·2337	6·6719
248	61504	15252992	15·7480	6·2828	**298**	88804	26463592	17·2627	6·6794
249	62001	15438249	15·7797	6·2912	**299**	89401	26730899	17·2916	6·6869

SQUARES, CUBES,
SQUARE ROOTS, CUBE ROOTS

300 to 399

No.	Square	Cube	Square Root √	Cube Root ∛	No.	Square	Cube	Square Root √	Cube Root ∛
300	90000	27000000	17·3205	6·6943	**350**	122500	42875000	18·7083	7·0473
301	90601	27270901	17·3494	6·7018	**351**	123201	43243551	18·7350	7·0540
302	91204	27543608	17·3781	6·7092	**352**	123904	43614208	18·7617	7·0607
303	91809	27818127	17·4069	6·7166	**353**	124609	43986977	18·7883	7·0674
304	92416	28094464	17·4356	6·7240	**354**	125316	44361864	18·8149	7·0740
305	93025	28372625	17·4642	6·7313	**355**	126025	44738875	18·8414	7·0807
306	93636	28652616	17·4929	6·7387	**356**	126736	45118016	18·8680	7·0873
307	94249	28934443	17·5214	6·7460	**357**	127449	45499293	18·8944	7·0940
308	94864	29218112	17·5499	6·7533	**358**	128164	45882712	18·9209	7·1006
309	95481	29503629	17·5784	6·7606	**359**	128881	46268279	18·9473	7·1072
310	96100	29791000	17·6068	6·7679	**360**	129600	46656000	18·9737	7·1138
311	96721	30080231	17·6352	6·7752	**361**	130321	47045881	19·0000	7·1204
312	97344	30371328	17·6635	6·7824	**362**	131044	47437928	19·0263	7·1269
313	97969	30664297	17·6918	6·7897	**363**	131769	47832147	19·0526	7·1335
314	98596	30959144	17·7200	6·7969	**364**	132496	48228544	19·0788	7·1400
315	99225	31255875	17·7482	6·8041	**365**	133225	48627125	19·1050	7·1466
316	99856	31554496	17·7764	6·8113	**366**	133956	49027896	19·1311	7·1531
317	100489	31855013	17·8045	6·8185	**367**	134689	49430863	19·1572	7·1596
318	101124	32157432	17·8326	6·8256	**368**	135424	49836032	19·1833	7·1661
319	101761	32461759	17·8606	6·8328	**369**	136161	50243409	19·2094	7·1726
320	102400	32768000	17·8885	6·8399	**370**	136900	50653000	19·2354	7·1791
321	103041	33076161	17·9165	6·8470	**371**	137641	51064811	19·2614	7·1855
322	103684	33386248	17·9444	6·8541	**372**	138384	51478848	19·2873	7·1920
323	104329	33698267	17·9722	6·8612	**373**	139129	51895117	19·3132	7·1984
324	104976	34012224	18·0000	6·8683	**374**	139876	52313624	19·3391	7·2048
325	105625	34328125	18·0278	6·8753	**375**	140625	52734375	19·3649	7·2112
326	106276	34645976	18·0555	6·8824	**376**	141376	53157376	19·3907	7·2177
327	106929	34965783	18·0831	6·8894	**377**	142129	53582633	19·4165	7·2240
328	107584	35287552	18·1108	6·8964	**378**	142884	54010152	19·4422	7·2304
329	108241	35611289	18·1384	6·9034	**379**	143641	54439939	19·4679	7·2368
330	108900	35937000	18·1659	6·9104	**380**	144400	54872000	19·4936	7·2432
331	109561	36264691	18·1934	6·9174	**381**	145161	55306341	19·5192	7·2495
332	110224	36594368	18·2209	6·9244	**382**	145924	55742968	19·5448	7·2558
333	110889	36926037	18·2483	6·9313	**383**	146689	56181887	19·5704	7·2622
334	111556	37259704	18·2757	6·9382	**384**	147456	56623104	19·5959	7·2685
335	112225	37595375	18·3030	6·9451	**385**	148225	57066625	19·6214	7·2748
336	112896	37933056	18·3303	6·9521	**386**	148996	57512456	19·6469	7·2811
337	113569	38272753	18·3576	6·9589	**387**	149769	57960603	19·6723	7·2874
338	114244	38614472	18·3848	6·9658	**388**	150544	58411072	19·6977	7·2936
339	114921	38958219	18·4120	6·9727	**389**	151321	58863869	19·7231	7·2999
340	115600	39304000	18·4391	6·9795	**390**	152100	59319000	19·7484	7·3061
341	116281	39651821	18·4662	6·9864	**391**	152881	59776471	19·7737	7·3124
342	116964	40001688	18·4932	6·9932	**392**	153664	60236288	19·7990	7·3186
343	117649	40353607	18·5203	7·0000	**393**	154449	60698457	19·8242	7·3248
344	118336	40707584	18·5472	7·0068	**394**	155236	61162984	19·8494	7·3310
345	119025	41063625	18·5742	7·0136	**395**	156025	61629875	19·8746	7·3372
346	119716	41421736	18·6011	7·0203	**396**	156816	62099136	19·8997	7·3434
347	120409	41781923	18·6279	7·0271	**397**	157609	62570773	19·9249	7·3496
348	121104	42144192	18·6548	7·0338	**398**	159404	63044792	19·9499	7·3558
349	121801	42508549	18·6815	7·0406	**399**	159201	63521199	19·9750	7·3619

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS

400 to 499

No.	Square	Cube	Square Root √	Cube Root ∛	No.	Square	Cube	Square Root √	Cube Root ∛
400	160000	64000000	20·0000	7·3681	**450**	202500	91125000	21·2132	7·6631
401	160801	64481201	20·0250	7·3742	**451**	203401	91733851	21·2368	7·6688
402	161604	64964808	20·0499	7·3803	**452**	204304	92345408	21·2603	7·6744
403	162409	65450827	20·0749	7·3864	**453**	205209	92959677	21·2838	7·6801
404	163216	65939264	20·0998	7·3925	**454**	206116	93576664	21·3073	7·6857
405	164025	66430125	20·1246	7·3986	**455**	207025	94196375	21·3307	7·6914
406	164836	66923416	20·1494	7·4047	**456**	207936	94818816	21·3542	7·6970
407	165649	67419143	20·1742	7·4108	**457**	208849	95443993	21·3776	7·7026
408	166464	67917312	20·1990	7·4169	**458**	209764	96071912	21·4009	7·7082
409	167281	68417929	20·2237	7·4229	**459**	210681	96702579	21·4243	7·7138
410	168100	68921000	20·2485	7·4290	**460**	211600	97336000	21·4476	7·7194
411	168921	69426531	20·2731	7·4350	**461**	212521	97972181	21·4709	7·7250
412	169744	69934528	20·2978	7·4410	**462**	213444	98611128	21·4942	7·7306
413	170569	70444997	20·3224	7·4470	**463**	214369	99252847	21·5174	7·7362
414	171396	70957944	20·3470	7·4530	**464**	215296	99897344	21·5407	7·7418
415	172225	71473375	20·3715	7·4590	**465**	216225	100544625	21·5639	7·7473
416	173056	71991296	20·3961	7·4650	**466**	217156	101194696	21·5870	7·7529
417	173889	72511713	20·4206	7·4710	**467**	218089	101847563	21·6102	7·7584
418	174724	73034632	20·4450	7·4770	**468**	219024	102503232	21·6333	7·7639
419	175561	73560059	20·4695	7·4829	**469**	219961	103161709	21·6564	7·7695
420	176400	74088000	20·4939	7·4889	**470**	220900	103823000	21·6795	7·7750
421	177241	74618461	20·5183	7·4948	**471**	221841	104487111	21·7025	7·7805
422	178084	75151448	20·5426	7·5007	**472**	222784	105154048	21·7256	7·7860
423	178929	75686967	20·5670	7·5067	**473**	223729	105823817	21·7486	7·7915
424	179776	76225024	20·5913	7·5126	**474**	224676	106496424	21·7715	7·7970
425	180625	76765625	20·6155	7·5185	**475**	225625	107171875	21·7945	7·8025
426	181476	77308776	20·6398	7·5244	**476**	226576	107850176	21·8174	7·8079
427	182329	77854483	20·6640	7·5302	**477**	227529	108531333	21·8403	7·8134
428	183184	78402752	20·6882	7·5361	**478**	228484	109215352	21·8632	7·8188
429	184041	78953589	20·7123	7·5420	**479**	229441	109902239	21·8861	7·8243
430	184900	79507000	20·7364	7·5478	**480**	230400	110592000	21·9089	7·8297
431	185761	80062991	20·7605	7·5537	**481**	231361	111284641	21·9317	7·8352
432	186624	80621568	20·7846	7·5595	**482**	232324	111980168	21·9545	7·8406
433	187489	81182737	20·8087	7·5654	**483**	233289	112678587	21·9773	7·8460
434	188356	81746504	20·8327	7·5712	**484**	234256	113379904	22·0000	7·8514
435	189225	82312875	20·8567	7·5770	**485**	235225	114084125	22·0227	7·8568
436	190096	82881856	20·8806	7·5828	**486**	236196	114791256	22·0454	7·8622
437	190969	83453453	20·9045	7·5886	**487**	237169	115501303	22·0681	7·8676
438	191844	84027672	20·9284	7·5944	**488**	238144	116214272	22·0907	7·8730
439	192721	84604519	20·9523	7·6001	**489**	239121	116930169	22·1133	7·8784
440	193600	85184000	20·9762	7·6059	**490**	240100	117649000	22·1359	7·8837
441	194481	85766121	21·0000	7·6117	**491**	241081	118370771	22·1585	7·8891
442	195364	86350888	21·0238	7·6174	**492**	242064	119095488	22·1811	7·8944
443	196249	86938307	21·0476	7·6232	**493**	243049	119823157	22·2036	7·8998
444	197136	87528384	21·0713	7·6289	**494**	244036	120553784	22·2261	7·9051
445	198025	88121125	21·0950	7·6346	**495**	245025	121287375	22·2486	7·9105
446	198916	88716536	21·1187	7·6403	**496**	246016	122023936	22·2711	7·9158
447	199809	89314623	21·1424	7·6460	**497**	247009	122763473	22·2935	7·9211
448	200704	89915392	21·1660	7·6517	**498**	248004	123505992	22·3159	7·9264
449	201601	90518849	21·1896	7·6574	**499**	249001	124251499	22·3383	7·9317

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS

500 to 599

No.	Square	Cube	Square Root √	Cube Root ∛	No.	Square	Cube	Square Root √	Cube Root ∛
500	250000	125000000	22·3607	7·9370	**550**	302500	166375000	23·4521	8·1932
501	251001	125751501	22·3830	7·9423	**551**	303601	167284151	23·4734	8·1982
502	252004	126506008	22·4054	7·9476	**552**	304704	168196608	23·4947	8·2031
503	253009	127263527	22·4277	7·9528	**553**	305809	169112377	23·5160	8·2081
504	254016	128024064	22·4499	7·9581	**554**	306916	170031464	23·5372	8·2130
505	255025	128787625	22·4722	7·9634	**555**	308025	170953875	23·5584	8·2180
506	256036	129554216	22·4944	7·9686	**556**	309136	171879616	23·5797	8·2229
507	257049	130323843	22·5167	7·9739	**557**	310249	172808693	23·6008	8·2278
508	258064	131096512	22·5389	7·9791	**558**	311364	173741112	23·6220	8·2327
509	259081	131872229	22·5610	7·9843	**559**	312481	174676879	23·6432	8·2377
510	260100	132651000	22·5832	7·9896	**560**	313600	175616000	23·6643	8·2426
511	261121	133432831	22·6053	7·9948	**561**	314721	176558481	23·6854	8·2475
512	262144	134217728	22·6274	8·0000	**562**	315844	177504328	23·7065	8·2524
513	263169	135005697	22·6495	8·0052	**563**	316969	178453547	23·7276	8·2573
514	264196	135796744	22·6716	8·0104	**564**	318096	179406144	23·7487	8·2621
515	265225	136590875	22·6936	8·0156	**565**	319225	180362125	23·7697	8·2670
516	266256	137388096	22·7156	8·0208	**566**	320356	181321496	23·7908	8·2719
517	267289	138188143	22·7376	8·0260	**567**	321489	182284263	23·8118	8·2768
518	268324	138991832	22·7596	8·0311	**568**	322624	183250432	23·8328	8·2816
519	269361	139798359	22·7816	8·0363	**569**	323761	184220009	23·8537	8·2865
520	270400	140608000	22·8035	8·0415	**570**	324900	185193000	23·8747	8·2913
521	271441	141420761	22·8254	8·0466	**571**	326041	186169411	23·8956	8·2962
522	272484	142236648	22·8473	8·0517	**572**	327184	187149248	23·9165	8·3010
523	273529	143055667	22·8692	8·0569	**573**	328329	188132517	23·9374	8·3059
524	274576	143877824	22·8910	8·0620	**574**	329476	189119224	23·9583	8·3107
525	275625	144703125	22·9129	8·0671	**575**	330625	190109375	23·9792	8·3155
526	276676	145531576	22·9347	8·0723	**576**	331776	191102976	24·0000	8·3203
527	277729	146363183	22·9565	8·0774	**577**	332929	192100033	24·0208	8·3251
528	278784	147197952	22·9783	8·0825	**578**	334084	193100552	24·0416	8·3300
529	279841	148035889	23·0000	8·0876	**579**	335241	194104539	24·0624	8·3348
530	280900	148877000	23·0217	8·0927	**580**	336400	195112000	24·0832	8·3396
531	281961	149721291	23·0434	8·0978	**581**	337561	196122941	24·1039	8·3443
532	283024	150568768	23·0651	8·1028	**582**	338724	197137368	24·1247	8·3491
533	284089	151419437	23·0868	8·1079	**583**	339889	198155287	24·1454	8·3539
534	285156	152273304	23·1084	8·1130	**584**	341056	199176704	24·1661	8·3587
535	286225	153130375	23·1301	8·1180	**585**	342225	200201625	24·1868	8·3634
536	287296	153990656	23·1517	8·1231	**586**	343396	201230056	24·2074	8·3682
537	288369	154854153	23·1733	8·1281	**587**	344569	202262003	24·2281	8·3730
538	289444	155720872	23·1948	8·1332	**588**	345744	203297472	24·2487	8·3777
539	290521	156590819	23·2164	8·1382	**589**	346921	204336469	24·2693	8·3825
540	291600	157464000	23·2379	8·1433	**590**	348100	205379000	24·2899	8·3872
541	292681	158340421	23·2594	8·1483	**591**	349281	206425071	24·3105	8·3919
542	293764	159220088	23·2809	8·1533	**592**	350464	207474688	24·3311	8·3967
543	294849	160103007	23·3024	8·1583	**593**	351649	208527857	24·3516	8·4014
544	295936	160989184	23·3238	8·1633	**594**	352836	209584584	24·3721	8·4061
545	297025	161878625	23·3452	8·1683	**595**	354025	210644875	24·3926	8·4108
546	298116	162771336	23·3666	8·1733	**596**	355216	211708736	24·4131	8·4155
547	299209	163667323	23·3880	8·1783	**597**	356409	212776173	24·4336	8·4202
548	300304	164566592	23·4094	8·1833	**598**	357604	213847192	24·4540	8·4249
549	301401	165469149	23·4307	8·1882	**599**	358801	214921799	24·4745	8·4296

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS

600 to 699

No.	Square	Cube	Square Root √	Cube Root ∛	No.	Square	Cube	Square Root √	Cube Root ∛
600	360000	216000000	24·4949	8·4343	**650**	422500	274625000	25·4951	8·6624
601	361201	217081801	24·5153	8·4390	**651**	423801	275894451	25·5147	8·6668
602	362404	218167208	24·5357	8·4437	**652**	425104	277167808	25·5343	8·6713
603	363609	219256227	24·5561	8·4484	**653**	426409	278445077	25·5539	8·6757
604	364816	220348864	24·5764	8·4530	**654**	427716	279726264	25·5734	8·6801
605	366025	221445125	24·5967	8·4577	**655**	429025	281011375	25·5930	8·6845
606	367236	222545016	24·6171	8·4623	**656**	430336	282300416	25·6125	8·6890
607	368449	223648543	24·6374	8·4670	**657**	431649	283593393	25·6320	8·6934
608	369664	224755712	24·6577	8·4716	**658**	432964	284890312	25·6515	8·6978
609	370881	225866529	24·6779	8·4763	**659**	434281	286191179	25·6710	8·7022
610	372100	226981000	24·6982	8·4809	**660**	435600	287496000	25·6905	8·7066
611	373321	228099131	24·7184	8·4856	**661**	436921	288804781	25·7099	8·7110
612	374544	229220928	24·7386	8·4902	**662**	438244	290117528	25·7294	8·7154
613	375769	230346397	24·7588	8·4948	**663**	439569	291434247	25·7488	8·7198
614	376996	231475544	24·7790	8·4994	**664**	440896	292754944	25·7682	8·7241
615	378225	232608375	24·7992	8·5040	**665**	442225	294079625	25·7876	8·7285
616	379456	233744896	24·8193	8·5086	**666**	443556	295408296	25·8070	8·7329
617	380689	234885113	24·8395	8·5132	**667**	444889	296740963	25·8263	8·7373
618	381924	236029032	24·8596	8·5178	**668**	446224	298077632	25·8457	8·7416
619	383161	237176659	24·8797	8·5224	**669**	447561	299418309	25·8650	8·7460
620	384400	238328000	24·8998	8·5270	**670**	448900	300763000	25·8844	8·7503
621	385641	239483061	24·9199	8·5316	**671**	450241	302111711	25·9037	8·7547
622	386884	240641848	24·9399	8·5362	**672**	451584	303464448	25·9230	8·7590
623	388129	241804367	24·9600	8·5408	**673**	452929	304821217	25·9422	8·7634
624	389376	242970624	24·9800	8·5453	**674**	454276	306182024	25·9615	8·7677
625	390625	244140625	25·0000	8·5499	**675**	455625	307546875	25·9808	8·7721
626	391876	245314376	25·0200	8·5544	**676**	456976	308915776	26·0000	8·7764
627	393129	246491883	25·0400	8·5590	**677**	458329	310288733	26·0192	8·7807
628	394384	247673152	25·0599	8·5635	**678**	459684	311665752	26·0384	8·7850
629	395641	248858189	25·0799	8·5681	**679**	461041	313046839	26·0576	8·7893
630	396900	250047000	25·0998	8·5726	**680**	462400	314432000	26·0768	8·7937
631	398161	251239591	25·1197	8·5772	**681**	463761	315821241	26·0960	8·7980
632	399424	252435968	25·1396	8·5817	**682**	465124	317214568	26·1151	8·8023
633	400689	253636137	25·1595	8·5862	**683**	466489	318611987	26·1343	8·8066
634	401956	254840104	25·1794	8·5907	**684**	467856	320013504	26·1534	8·8109
635	403225	256047875	25·1992	8·5952	**685**	469225	321419125	26·1725	8·8152
636	404496	257259456	25·2190	8·5997	**686**	470596	322828856	26·1916	8·8194
637	405769	258474853	25·2389	8·6043	**687**	471969	324242703	26·2107	8·8237
638	407044	259694072	25·2587	8·6088	**688**	473344	325660672	26·2298	8·8280
639	408321	260917119	25·2784	8·6132	**689**	474721	327082769	26·2488	8·8323
640	409600	262144000	25·2982	8·6177	**690**	476100	328509000	26·2679	8·8366
641	410881	263374721	25·3180	8·6222	**691**	477481	329939371	26·2869	8·8408
642	412164	264609288	25·3377	8·6267	**692**	478864	331373888	26·3059	8·8451
643	413449	265847707	25·3574	8·6312	**693**	480249	332812557	26·3249	8·8493
644	414736	267089984	25·3772	8·6357	**694**	481636	334255384	26·3439	8·8536
645	416025	268336125	25·3969	8·6401	**695**	483025	335702375	26·3629	8·8578
646	417316	269586136	25·4165	8·6446	**696**	484416	337153536	26·3818	8·8621
647	418609	270840023	25·4362	8·6490	**697**	485809	338608873	26·4008	8·8663
648	419904	272097792	25·4558	8·6535	**698**	487204	340068392	26·4197	8·8706
649	421201	273359449	25·4755	8·6579	**699**	488601	341532099	26·4386	8·8748

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS

700 to 799

No.	Square	Cube	Square Root √	Cube Root ∛	No.	Square	Cube	Square Root √	Cube Root ∛
700	490000	343000000	26·4575	8·8790	**750**	562500	421875000	27·3861	9·0856
701	491401	344472101	26·4764	8·8833	**751**	564001	423564751	27·4044	9·0896
702	492804	345948408	26·4953	8·8875	**752**	565504	425259008	27·4226	9·0937
703	494209	347428927	26·5141	8·8917	**753**	567009	426957777	27·4408	9·0977
704	495616	348913664	26·5330	8·8959	**754**	568516	428661064	27·4591	9·1017
705	497025	350402625	26·5518	8·9001	**755**	570025	430368875	27·4773	9·1057
706	498436	351895816	26·5707	8·9043	**756**	571536	432081216	27·4955	9·1098
707	499849	353393243	26·5895	8·9085	**757**	573049	433798093	27·5136	9·1138
708	501264	354894912	26·6083	8·9127	**758**	574564	435519512	27·5318	9·1178
709	502681	356400829	26·6271	8·9169	**759**	576081	437245479	27·5500	9·1218
710	504100	357911000	26·6458	8·9211	**760**	577600	438976000	27·5681	9·1258
711	505521	359425431	26·6646	8·9253	**761**	579121	440711081	27·5862	9·1298
712	506944	360944128	26·6833	8·9295	**762**	580644	442450728	27·6043	9·1338
713	508369	362467097	26·7021	8·9337	**763**	582169	444194947	27·6225	9·1378
714	509796	363994344	26·7208	8·9378	**764**	583696	445943744	27·6405	9·1418
715	511225	365525875	26·7395	8·9420	**765**	585225	447697125	27·6586	9·1458
716	512656	367061696	26·7582	8·9462	**766**	586756	449455096	27·6767	9·1498
717	514089	368601813	26·7769	8·9503	**767**	588289	451217663	27·6948	9·1537
718	515524	370146232	26·7955	8·9545	**768**	589824	452984832	27·7128	9·1577
719	516961	371694959	26·8142	8·9587	**769**	591361	454756609	27·7308	9·1617
720	518400	373248000	26·8328	8·9628	**770**	592900	456533000	27·7489	9·1657
721	519841	374805361	26·8514	8·9670	**771**	594441	458314011	27·7669	9·1696
722	521284	376367048	26·8701	8·9711	**772**	595984	460099648	27·7849	9·1736
723	522729	377933067	26·8887	8·9752	**773**	597529	461889917	27·8029	9·1775
724	524176	379503424	26·9072	8·9794	**774**	599076	463684824	27·8209	9·1815
725	525625	381078125	26·9258	8·9835	**775**	600625	465484375	27·8388	9·1855
726	527076	382657176	26·9444	8·9876	**776**	602176	467288576	27·8568	9·1894
727	528529	384240583	26·9629	8·9918	**777**	603729	469097433	27·8747	9·1933
728	529984	385828352	26·9815	8·9959	**778**	605284	470910952	27·8927	9·1973
729	531441	387420489	27·0000	9·0000	**779**	606841	472729139	27·9106	9·2012
730	532900	389017000	27·0185	9·0041	**780**	608400	474552000	27·9285	9·2052
731	534361	390617891	27·0370	9·0082	**781**	609961	476379541	27·9464	9·2091
732	535824	392223168	27·0555	9·0123	**782**	611524	478211768	27·9643	9·2130
733	537289	393832837	27·0740	9·0164	**783**	613089	480048687	27·9821	9·2170
734	538756	395446904	27·0924	9·0205	**784**	614656	481890304	28·0000	9·2209
735	540225	397065375	27·1109	9·0246	**785**	616225	483736625	28·0179	9·2248
736	541696	398688256	27·1293	9·0287	**786**	617796	485587656	28·0357	9·2287
737	543169	400315553	27·1477	9·0328	**787**	619369	487443403	28·0535	9·2326
738	544644	401947272	27·1662	9·0369	**788**	620944	489303872	28·0713	9·2365
739	546121	403583419	27·1846	9·0410	**789**	622521	491169069	28·0891	9·2404
740	547600	405224000	27·2029	9·0450	**790**	624100	493039000	28·1069	9·2443
741	549081	406869021	27·2213	9·0491	**791**	625681	494913671	28·1247	9·2482
742	550564	408518488	27·2397	9·0532	**792**	627264	496793088	28·1425	9·2521
743	552049	410172407	27·2580	9·0572	**793**	628849	498677257	28·1603	9·2560
744	553536	411830784	27·2764	9·0613	**794**	630436	500566184	28·1780	9·2599
745	555025	413493625	27·2947	9·0654	**795**	632025	502459875	28·1957	9·2638
746	556516	415160936	27·3130	9·0694	**796**	633616	504358336	28·2135	9·2677
747	558009	416832723	27·3313	9·0735	**797**	635209	506261573	28·2312	9·2716
748	559504	418508992	27·3496	9·0775	**798**	636804	508169592	28·2489	9·2754
749	561001	420189749	27·3679	9·0816	**799**	638401	510082399	28·2666	9·2793

SQUARES, CUBES SQUARE ROOTS, CUBE ROOTS

800 to 899

No.	Square	Cube	Square Root √	Cube Root ∛	No.	Square	Cube	Square Root √	Cube Root ∛
800	640000	512000000	28·2843	9·2832	**850**	722500	614125000	29·1548	9·4727
801	641601	513922401	28·3019	9·2870	**851**	724201	616295051	29·1719	9·4764
802	643204	515849608	28·3196	9·2909	**852**	725904	618470208	29·1890	9·4801
803	644809	517781627	28·3373	9·2948	**853**	727609	620650477	29·2062	9·4838
804	646416	519718464	28·3549	9·2986	**854**	729316	622835864	29·2233	9·4875
805	648025	521660125	28·3725	9·3025	**855**	731025	625026375	29·2404	9·4912
806	649636	523606616	28·3901	9·3063	**856**	732736	627222016	29·2575	9·4949
807	651249	525557943	28·4077	9·3102	**857**	734449	629422793	29·2746	9·4986
808	652864	527514112	28·4253	9·3140	**858**	736164	631628712	29·2916	9·5023
809	654481	529475129	28·4429	9·3179	**859**	737881	633839779	29·3087	9·5060
810	656100	531441000	28·4605	9·3217	**860**	739600	636056000	29·3258	9·5097
811	657721	533411731	28·4781	9·3255	**861**	741321	638277381	29·3428	9·5134
812	659344	535387328	28·4956	9·3294	**862**	743044	640503928	29·3598	9·5171
813	660969	537367797	28·5132	9·3332	**863**	744769	642735647	29·3769	9·5207
814	662596	539353144	28·5307	9·3370	**864**	746496	644972544	29·3939	9·5244
815	664225	541343375	28·5482	9·3408	**865**	748225	647214625	29·4109	9·5281
816	665856	543338496	28·5657	9·3447	**866**	749956	649461896	29·4279	9·5317
817	667489	545338513	28·5832	9·3485	**867**	751689	651714363	29·4449	9·5354
818	669124	547343432	28·6007	9·3523	**868**	753424	653972032	29·4618	9·5391
819	670761	549353259	28·6182	9·3561	**869**	755161	656234909	29·4788	9·5427
820	672400	551368000	28·6356	9·3599	**870**	756900	658503000	29·4958	9·5464
821	674041	553387661	28·6531	9·3637	**871**	758641	660776311	29·5127	9·5501
822	675684	555412248	28·6705	9·3675	**872**	760384	663054848	29·5296	9·5537
823	677329	557441767	28·6880	9·3713	**873**	762129	665338617	29·5466	9·5574
824	678976	559476224	28·7054	9·3751	**874**	763876	667627624	29·5635	9·5610
825	680625	561515625	28·7228	9·3789	**875**	765625	669921875	29·5804	9·5647
826	682276	563559976	28·7402	9·3827	**876**	767376	672221376	29·5973	9·5683
827	683929	565609283	28·7576	9·3865	**877**	769129	674526133	29·6142	9·5719
828	685584	567663552	28·7750	9·3902	**878**	770884	676836152	29·6311	9·5756
829	687241	569722789	28·7924	9·3940	**879**	772641	679151439	29·6479	9·5792
830	688900	571787000	28·8097	9·3978	**880**	774400	681472000	29·6648	9·5828
831	690561	573856191	28·8271	9·4016	**881**	776161	683797841	29·6816	9·5865
832	692224	575930368	28·8444	9·4053	**882**	777924	686128968	29·6985	9·5901
833	693889	578009537	28·8617	9·4091	**883**	779689	688465387	29·7153	9·5937
834	695556	580093704	28·8791	9·4129	**884**	781456	690807104	29·7321	9·5973
835	697225	582182875	28·8964	9·4166	**885**	783225	693154125	29·7489	9·6010
836	698896	584277056	28·9137	9·4204	**886**	784996	695506456	29·7658	9·6046
837	700569	586376253	28·9310	9·4241	**887**	786769	697864103	29·7825	9·6082
838	702244	588480472	28·9482	9·4279	**888**	788544	700227072	29·7993	9·6118
839	703921	590589719	28·9655	9·4316	**889**	790321	702595369	29·8161	9·6154
840	705600	592704000	28·9828	9·4354	**890**	792100	704969000	29·8329	9·6190
841	707281	594823321	29·0000	9·4391	**891**	793881	707347971	29·8496	9·6226
842	708964	596947688	29·0172	9·4429	**892**	795664	709732288	29·8664	9·6262
843	710649	599077107	29·0345	9·4466	**893**	797449	712121957	29·8831	9·6298
844	712336	601211584	29·0517	9·4503	**894**	799236	714516984	29·8998	9·6334
845	714025	603351125	29·0689	9·4541	**895**	801025	716917375	29·9166	9·6370
846	715716	605495736	29·0861	9·4578	**896**	802816	719323136	29·9333	9·6406
847	717409	607645423	29·1033	9·4615	**897**	804609	721734273	29·9500	9·6442
848	719104	609800192	29·1204	9·4652	**898**	806404	724150792	29·9666	9·6477
849	720801	611960049	29·1376	9·4690	**899**	808201	726572699	29·9833	9·6513

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS

900 to 999

No.	Square	Cube	Square Root √	Cube Root ∛	No.	Square	Cube	Square Root √	Cube Root ∛
900	810000	729000000	30·0000	9·6549	**950**	902500	857375000	30·8221	9·8305
901	811801	731432701	30·0167	9·6585	**951**	904401	860085351	30·8383	9·8339
902	813604	733870808	30·0333	9·6620	**952**	906304	862801408	30·8545	9·8374
903	815409	736314327	30·0500	9·6656	**953**	908209	865523177	30·8707	9·8408
904	817216	738763264	30·0666	9·6692	**954**	910116	868250664	30·8869	9·8443
905	819025	741217625	30·0832	9·6727	**955**	912025	870983875	30·9031	9·8477
906	820836	743677416	30·0998	9·6763	**956**	913936	873722816	30·9192	9·8511
907	822649	746142643	30·1164	9·6799	**957**	915849	876467493	30·9354	9·8546
908	824464	748613312	30·1330	9·6834	**958**	917764	879217912	30·9516	9·8580
909	826281	751089429	30·1496	9·6870	**959**	919681	881974079	30·9677	9·8614
910	828100	753571000	30·1662	9·6905	**960**	921600	884736000	30·9839	9·8648
911	829921	756058031	30·1828	9·6941	**961**	923521	887503681	31·0000	9·8683
912	831744	758550528	30·1993	9·6976	**962**	925444	890277128	31·0161	9·8717
913	833569	761048497	30·2159	9·7012	**963**	927369	893056347	31·0322	9·8751
914	835396	763551944	30·2324	9·7047	**964**	929296	895841344	31·0483	9·8785
915	837225	766060875	30·2490	9·7082	**965**	931225	898632125	31·0644	9·8819
916	839056	768575296	30·2655	9·7118	**966**	933156	901428696	31·0805	9·8854
917	840889	771095213	30·2820	9·7153	**967**	935089	904231063	31·0966	9·8888
918	842724	773620632	30·2985	9·7188	**968**	937024	907039232	31·1127	9·8922
919	844561	776151559	30·3150	9·7224	**969**	938961	909853209	31·1288	9·8956
920	846400	778688000	30·3315	9·7259	**970**	940900	912673000	31·1448	9·8990
921	848241	781229961	30·3480	9·7294	**971**	942841	915498611	31·1609	9·9024
922	850084	783777448	30·3645	9·7329	**972**	944784	918330048	31·1769	9·9058
923	851929	786330467	30·3809	9·7364	**973**	946729	921167317	31·1929	9·9092
924	853776	788889024	30·3974	9·7400	**974**	948676	924010424	31·2090	9·9126
925	855625	791453125	30·4138	9·7435	**975**	950625	926859375	31·2250	9·9160
926	857476	794022776	30·4302	9·7470	**976**	952576	929714176	31·2410	9·9194
927	859329	796597983	30·4467	9·7505	**977**	954529	932574833	31·2570	9·9227
928	861184	799178752	30·4631	9·7540	**978**	956484	935441352	31·2730	9·9261
929	863041	801765089	30·4795	9·7575	**979**	958441	938313739	31·2890	9·9295
930	864900	804357000	30·4959	9·7610	**980**	960400	941192000	31·3050	9·9329
931	866761	806954491	30·5123	9·7645	**981**	962361	944076141	31·3209	9·9363
932	868624	809557568	30·5287	9·7680	**982**	964324	946966168	31·3369	9·9396
933	870489	812166237	30·5450	9·7715	**983**	966289	949862087	31·3528	9·9430
934	872356	814780504	30·5614	9·7750	**984**	968256	952763904	31·3688	9·9464
935	874225	817400375	30·5778	9·7785	**985**	970225	955671625	31·3847	9·9497
936	876096	820025856	30·5941	9·7819	**986**	972196	958585256	31·4006	9·9531
937	877969	822656953	30·6105	9·7854	**987**	974169	961504803	31·4166	9·9565
938	879844	825293672	30·6268	9·7889	**988**	976144	964430272	31·4325	9·9598
939	881721	827936019	30·6431	9·7924	**989**	978121	967361669	31·4484	9·9632
940	883600	830584000	30·6594	9·7959	**990**	980100	970299000	31·4643	9·9666
941	885481	833237621	30·6757	9·7993	**991**	982081	973242271	31·4802	9·9699
942	887364	835896888	30·6920	9·8028	**992**	984064	976191488	31·4960	9·9733
943	889249	838561807	30·7083	9·8063	**993**	986049	979146657	31·5119	9·9766
944	891136	841232384	30·7246	9·8097	**994**	988036	982107784	31·5278	9·9800
945	893025	843908625	30·7409	9·8132	**995**	990025	985074875	31·5436	9·9833
946	894916	846590536	30·7571	9·8167	**996**	992016	988047936	31·5595	9·9866
947	896809	849278123	30·7734	9·8201	**997**	994009	991026973	31·5753	9·9900
948	898704	851971392	30·7896	9·8236	**998**	996004	994011992	31·5911	9·9933
949	900601	854670349	30·8058	9·8270	**999**	998001	997002999	31·6070	9·9967

CIRCUMFERENCES OF CIRCLES

advancing by eighths

Diameter	0	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$
0		·393	·785	1·178	1·571	1·963	2·356	2·749
1	3·142	3·534	3·927	4·320	4·712	5·105	5·498	5·890
2	6·283	6·676	7·069	7·461	7·854	8·247	8·639	9·032
3	9·425	9·817	10·210	10·603	10·996	11·388	11·781	12·174
4	12·566	12·959	13·352	13·744	14·137	14·530	14·923	15·315
5	15·708	16·101	16·493	16·886	17·279	17·671	18·064	18·457
6	18·850	19·242	19·635	20·028	20·420	20·813	21·206	21·598
7	21·991	22·384	22·777	23·169	23·562	23·955	24·347	24·740
8	25·133	25·525	25·918	26·311	26·704	27·096	27·489	27·882
9	28·274	28·667	29·060	29·452	29·845	30·238	30·631	31·023
10	31·416	31·809	32·201	32·594	32·987	33·379	33·772	34·165
11	34·558	34·950	35·343	35·736	36·128	36·521	36·914	37·306
12	37·699	38·092	38·485	38·877	39·270	39·663	40·055	40·448
13	40·841	41·233	41·626	42·019	42·412	42·804	43·197	43·590
14	43·982	44·375	44·768	45·160	45·553	45·946	46·338	46·731
15	47·124	47·517	47·909	48·302	48·695	49·087	49·480	49·873
16	50·265	50·658	51·051	51·444	51·836	52·229	52·622	53·014
17	53·407	53·800	54·192	54·585	54·978	55·371	55·763	56·156
18	56·549	56·941	57·334	57·727	58·119	58·512	58·905	59·298
19	59·690	60·083	60·476	60·868	61·261	61·654	62·046	62·439
20	62·832	63·225	63·617	64·010	64·403	64·795	65·188	65·581
21	65·973	66·366	66·759	67·152	67·544	67·937	68·330	68·722
22	69·115	69·508	69·900	70·293	70·686	71·079	71·471	71·864
23	72·257	72·649	73·042	73·435	73·827	74·220	74·613	75·006
24	75·398	75·791	76·184	76·576	76·969	77·362	77·754	78·147
25	78·540	78·933	79·325	79·718	80·111	80·503	80·896	81·289
26	81·681	82·074	82·467	82·860	83·252	83·645	84·038	84·430
27	84·823	85·216	85·608	86·001	86·394	86·786	87·179	87·572
28	87·965	88·357	88·750	89·143	89·535	89·928	90·321	90·713
29	91·106	91·499	91·892	92·284	92·677	93·070	93·462	93·855
30	94·248	94·640	95·033	95·426	95·819	96·211	96·604	96·997
31	97·389	97·782	98·175	98·567	98·960	99·353	99·746	100·14
32	100·53	100·92	101·32	101·71	102·10	102·49	102·89	103·28
33	103·67	104·07	104·46	104·85	105·24	105·64	106·03	106·42
34	106·81	107·21	107·60	107·99	108·38	108·78	109·17	109·56
35	109·96	110·35	110·74	111·13	111·53	111·92	112·31	112·70
36	113·10	113·49	113·88	114·28	114·67	115·06	115·45	115·85
37	116·24	116·63	117·02	117·42	117·81	118·20	118·60	118·99
38	119·38	119·77	120·17	120·56	120·95	121·34	121·74	122·13
39	122·52	122·91	123·31	123·70	124·09	124·49	124·88	125·27
40	125·66	126·06	126·45	126·84	127·23	127·63	128·02	128·41
41	128·81	129·20	129·59	129·98	130·38	130·77	131·16	131·55
42	131·95	132·34	132·73	133·12	133·52	133·91	134·30	134·70
43	135·09	135·48	135·87	136·27	136·66	137·05	137·44	137·84
44	138·23	138·62	139·02	139·41	139·80	140·19	140·59	140·98
45	141·37	141·76	142·16	142·55	142·94	143·34	143·73	144·12
46	144·51	144·91	145·30	145·69	146·08	146·48	146·87	147·26
47	147·65	148·05	148·44	148·83	149·23	149·62	150·01	150·40
48	150·80	151·19	151·58	151·97	152·37	152·76	153·15	153·55
49	153·94	154·33	154·72	155·12	155·51	155·90	156·29	156·69
50	157·08	157·47	157·86	158·26	158·65	159·04	159·44	159·83

CIRCUMFERENCES OF CIRCLES

advancing by eighths

Diameter	0	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$
51	160·22	160·61	161·01	161·40	161·79	162·18	162·58	162·97
52	163·36	163·76	164·15	164·54	164·93	165·33	165·72	166·11
53	166·50	166·90	167·29	167·68	168·08	168·47	168·86	169·25
54	169·65	170·04	170·43	170·82	171·22	171·61	172·00	172·39
55	172·79	173·18	173·57	173·97	174·36	174·75	175·14	175·54
56	175·93	176·32	176·71	177·11	177·50	177·89	178·29	178·68
57	179·07	179·46	179·86	180·25	180·64	181·03	181·43	181·82
58	182·21	182·61	183·00	183·39	183·78	184·18	184·57	184·96
59	185·35	185·75	186·14	186·53	186·92	187·32	187·71	188·10
60	188·50	188·89	189·28	189·67	190·07	190·46	190·85	191·24
61	191·64	192·03	192·42	192·82	193·21	193·60	193·99	194·39
62	194·78	195·17	195·56	195·96	196·35	196·74	197·13	197·53
63	197·92	198·31	198·71	199·10	199·49	199·88	200·28	200·67
64	201·06	201·45	201·85	202·24	202·63	203·03	203·42	203·81
65	204·20	204·60	204·99	205·38	205·77	206·17	206·56	206·95
66	207·35	207·74	208·13	208·52	208·92	209·31	209·70	210·09
67	210·49	210·88	211·27	211·66	212·06	212·45	212·84	213·24
68	213·63	214·02	214·41	214·81	215·20	215·59	215·98	216·38
69	216·77	217·16	217·56	217·95	218·34	218·73	219·13	219·52
70	219·91	220·30	220·70	221·09	221·48	221·87	222·27	222·66
71	223·05	223·45	223·84	224·23	224·62	225·02	225·41	225·80
72	226·19	226·59	226·98	227·37	227·77	228·16	228·55	228·94
73	229·34	229·73	230·12	230·51	230·91	231·30	231·69	232·09
74	232·48	232·87	233·26	233·66	234·05	234·44	234·83	235·23
75	235·62	236·01	236·40	236·80	237·19	237·58	237·98	238·37
76	238·76	239·15	239·55	239·94	240·33	240·72	241·12	241·51
77	241·90	242·30	242·69	243·08	243·47	243·87	244·26	244·65
78	245·04	245·44	245·83	246·22	246·62	247·01	247·40	247·79
79	248·19	248·58	248·97	249·36	249·76	250·15	250·54	250·93
80	251·33	251·72	252·11	252·51	252·90	253·29	253·68	254·08
81	254·47	254·86	255·25	255·65	256·04	256·43	256·83	257·22
82	257·61	258·00	258·40	258·79	259·18	259·57	259·97	260·36
83	260·75	261·14	261·54	261·93	262·32	262·72	263·11	263·50
84	263·89	264·29	264·68	265·07	265·46	265·86	266·25	266·64
85	267·04	267·43	267·82	268·21	268·61	269·00	269·39	269·78
86	270·18	270·57	270·96	271·36	271·75	272·14	272·53	272·93
87	273·32	273·71	274·10	274·50	274·89	275·28	275·67	276·07
88	276·46	276·85	277·25	277·64	278·03	278·42	278·82	279·21
89	279·60	279·99	280·39	280·78	281·17	281·57	281·96	282·35
90	282·74	283·14	283·53	283·92	284·31	284·71	285·10	285·49
91	285·88	286·28	286·67	287·06	287·46	287·85	288·24	288·63
92	289·03	289·42	289·81	290·20	290·60	290·99	291·38	291·78
93	292·17	292·56	292·95	293·35	293·74	294·13	294·52	294·92
94	295·31	295·70	296·10	296·49	296·88	297·27	297·67	298·06
95	298·45	298·84	299·24	299·63	300·02	300·41	300·81	301·20
96	301·59	301·99	302·38	302·77	303·16	303·56	303·95	304·34
97	304·73	305·13	305·52	305·91	306·31	306·70	307·09	307·48
98	307·88	308·27	308·66	309·05	309·45	309·84	310·23	310·62
99	311·02	311·41	311·80	312·20	312·59	312·98	313·37	313·77
100	314·16	314·55	314·94	315·34	315·73	316·12	316·52	316·91

AREAS OF CIRCLES

advancing by eighths

Diameter	0	1/8	1/4	3/8	1/2	5/8	3/4	7/8
0		·012	·049	·110	·196	·307	·442	·601
1	·785	·994	1·227	1·485	1·767	2·074	2·405	2·761
2	3·142	3·547	3·976	4·430	4·909	5·412	5·940	6·492
3	7·069	7·670	8·296	8·946	9·621	10·321	11·045	11·793
4	12·566	13·364	14·186	15·033	15·904	16·800	17·721	18·665
5	19·635	20·629	21·648	22·691	23·758	24·850	25·967	27·109
6	28·274	29·465	30·680	31·919	33·183	34·472	35·785	37·122
7	38·485	39·871	41·282	42·718	44·179	45·664	47·173	48·707
8	50·265	51·849	53·456	55·088	56·745	58·426	60·132	61·862
9	63·617	65·397	67·201	69·029	70·882	72·760	74·662	76·589
10	78·540	80·516	82·516	84·541	86·590	88·664	90·763	92·886
11	95·033	97·205	99·402	101·62	103·87	106·14	108·43	110·75
12	113·10	115·47	117·86	120·28	122·72	125·19	127·68	130·19
13	132·73	135·30	137·89	140·50	143·14	145·80	148·49	151·20
14	153·94	156·70	159·48	162·30	165·13	167·99	170·87	173·78
15	176·71	179·67	182·65	185·66	188·69	191·75	194·83	197·93
16	201·06	204·22	207·39	210·60	213·82	217·08	220·35	223·65
17	226·98	230·33	233·71	237·10	240·53	243·98	247·45	250·95
18	254·47	258·02	261·59	265·18	268·80	272·45	276·12	279·81
19	283·53	287·27	291·04	294·83	298·65	302·49	306·35	310·24
20	314·16	318·10	322·06	326·05	330·06	334·10	338·16	342·25
21	346·36	350·50	354·66	358·84	363·05	367·28	371·54	375·83
22	380·13	384·46	388·82	393·20	397·61	402·04	406·49	410·97
23	415·48	420·00	424·56	429·13	433·74	438·36	443·01	447·69
24	452·39	457·11	461·86	466·64	471·44	476·26	481·11	485·98
25	490·87	495·79	500·74	505·71	510·71	515·72	520·77	525·84
26	530·93	536·05	541·19	546·35	551·55	556·76	562·00	567·27
27	572·56	577·87	583·21	588·57	593·96	599·37	604·81	610·27
28	615·75	621·26	626·80	632·36	637·94	643·55	649·18	654·84
29	660·52	666·23	671·96	677·71	683·49	689·30	695·13	700·98
30	706·86	712·76	718·69	724·64	730·62	736·62	742·64	748·69
31	754·77	760·87	766·99	773·14	779·31	785·51	791·73	797·98
32	804·25	810·54	816·86	823·21	829·58	835·97	842·39	848·83
33	855·30	861·79	868·31	874·85	881·41	888·00	894·62	901·26
34	907·92	914·61	921·32	928·06	934·82	941·61	948·42	955·25
35	962·11	969·00	975·91	982·84	989·80	996·78	1003·8	1010·8
36	1017·9	1025·0	1032·1	1039·2	1046·3	1053·5	1060·7	1068·0
37	1075·2	1082·5	1089·8	1097·1	1104·5	1111·8	1119·2	1126·7
38	1134·1	1141·6	1149·1	1156·6	1164·2	1171·7	1179·3	1186·9
39	1194·6	1202·3	1210·0	1217·7	1225·4	1233·2	1241·0	1248·8
40	1256·6	1264·5	1272·4	1280·3	1288·2	1296·2	1304·2	1312·2
41	1320·3	1328·3	1336·4	1344·5	1352·7	1360·8	1369·0	1377·2
42	1385·4	1393·7	1402·0	1410·3	1418·6	1427·0	1435·4	1443·8
43	1452·2	1460·7	1469·1	1477·6	1486·2	1494·7	1503·3	1511·9
44	1520·5	1529·2	1537·9	1546·6	1555·3	1564·0	1572·8	1581·6
45	1590·4	1599·3	1608·2	1617·0	1626·0	1634·9	1643·9	1652·9
46	1661·9	1670·9	1680·0	1689·1	1698·2	1707·4	1716·5	1725·7
47	1734·9	1744·2	1753·5	1762·7	1772·1	1781·4	1790·8	1800·1
48	1809·6	1819·0	1828·5	1837·9	1847·5	1857·0	1866·5	1876·1
49	1885·7	1895·4	1905·0	1914·7	1924·4	1934·2	1943·9	1953·7
50	1963·5	1973·3	1983·2	1993·1	2003·0	2012·9	2022·8	2032·8

AREAS OF CIRCLES

advancing by eighths

Diameter	0	1/8	1/4	3/8	1/2	5/8	3/4	7/8
51	2042·8	2052·8	2062·9	2073·0	2083·1	2093·2	2103·3	2113·5
52	2123·7	2133·9	2144·2	2154·5	2164·8	2175·1	2185·4	2195·8
53	2206·2	2216·6	2227·0	2237·5	2248·0	2258·5	2269·1	2279·6
54	2290·2	2300·8	2311·5	2322·1	2332·8	2343·5	2354·3	2365·0
55	2375·8	2386·6	2397·5	2408·3	2419·2	2430·1	2441·1	2452·0
56	2463·0	2474·0	2485·0	2496·1	2507·2	2518·3	2529·4	2540·6
57	2551·8	2563·0	2574·2	2585·4	2596·7	2608·0	2619·4	2630·7
58	2642·1	2653·5	2664·9	2676·4	2687·8	2699·3	2710·9	2722·4
59	2734·0	2745·6	2757·2	2768·8	2780·5	2792·2	2803·9	2815·7
60	2827·4	2839·2	2851·0	2862·9	2874·8	2886·6	2898·6	2910·5
61	2922·5	2934·5	2946·5	2958·5	2970·6	2982·7	2994·8	3006·9
62	3019·1	3031·3	3043·5	3055·7	3068·0	3080·3	3092·6	3104·9
63	3117·2	3129·6	3142·0	3154·5	3166·9	3179·4	3191·9	3204·4
64	3217·0	3229·6	3242·2	3254·8	3267·5	3280·1	3292·8	3305·6
65	3318·3	3331·1	3343·9	3356·7	3369·6	3382·4	3395·3	3408·2
66	3421·2	3434·2	3447·2	3460·2	3473·2	3486·3	3499·4	3512·5
67	3525·7	3538·8	3552·0	3565·2	3578·5	3591·7	3605·0	3618·3
68	3631·7	3645·0	3658·4	3671·8	3685·3	3698·7	3712·2	3725·7
69	3739·3	3752·8	3766·4	3780·0	3793·7	3807·3	3821·0	3834·7
70	3848·5	3862·2	3876·0	3889·8	3903·6	3917·5	3931·4	3945·3
71	3959·2	3973·1	3987·1	4001·1	4015·2	4029·2	4043·3	4057·4
72	4071·5	4085·7	4099·8	4114·0	4128·2	4142·5	4156·8	4171·1
73	4185·4	4199·7	4214·1	4228·5	4242·9	4257·4	4271·8	4286·3
74	4300·8	4315·4	4329·9	4344·5	4359·2	4373·8	4388·5	4403·2
75	4417·9	4432·6	4447·4	4462·2	4477·0	4491·8	4506·7	4521·5
76	4536·5	4551·4	4566·4	4581·3	4596·3	4611·4	4626·4	4641·5
77	4656·6	4671·8	4686·9	4702·1	4717·3	4732·5	4747·8	4763·1
78	4778·4	4793·7	4809·0	4824·4	4839·8	4855·2	4870·7	4886·2
79	4901·7	4917·2	4932·7	4948·3	4963·9	4979·5	4995·2	5010·9
80	5026·5	5042·3	5058·0	5073·8	5089·6	5105·4	5121·2	5137·1
81	5153·0	5168·9	5184·9	5200·8	5216·8	5232·8	5248·9	5264·9
82	5281·0	5297·1	5313·3	5329·4	5345·6	5361·8	5378·1	5394·3
83	5410·6	5426·9	5443·3	5459·6	5476·0	5492·4	5508·8	5525·3
84	5541·8	5558·3	5574·8	5591·4	5607·9	5624·5	5641·2	5657·8
85	5674·5	5691·2	5707·9	5724·7	5741·5	5758·3	5775·1	5791·9
86	5808·8	5825·7	5842·6	5859·6	5876·5	5893·5	5910·6	5927·6
87	5944·7	5961·8	5978·9	5996·0	6013·2	6030·4	6047·6	6064·9
88	6082·1	6099·4	6116·7	6134·1	6151·4	6168·8	6186·2	6203·7
89	6221·1	6238·6	6256·1	6273·7	6291·2	6308·8	6326·4	6344·1
90	6361·7	6379·4	6397·1	6414·9	6432·6	6450·4	6468·2	6486·0
91	6503·9	6521·8	6539·7	6557·6	6575·5	6593·5	6611·5	6629·6
92	6647·6	6665·7	6683·8	6701·9	6720·1	6738·2	6756·4	6774·7
93	6792·9	6811·2	6829·5	6847·8	6866·1	6884·5	6902·9	6921·3
94	6939·8	6958·2	6976·7	6995·3	7013·8	7032·4	7051·0	7069·6
95	7088·2	7106·9	7125·6	7144·3	7163·0	7181·8	7200·6	7219·4
96	7238·2	7257·1	7276·0	7294·9	7313·8	7332·8	7351·8	7370·8
97	7389·8	7408·9	7428·0	7447·1	7466·2	7485·3	7504·5	7523·7
98	7543·0	7562·2	7581·5	7600·8	7620·1	7639·5	7658·9	7678·3
99	7697·7	7717·1	7736·6	7756·1	7775·6	7795·2	7814·8	7834·4
100	7854·0	7873·6	7893·3	7913·0	7932·7	7952·5	7972·2	7992·0

AREA OF SMALL CIRCLES

Advancing by 32nds of an inch

1/32″ to 1″ dia.		1 1/32″ to 2″ dia.		2 1/32″ to 3″ dia.		3 1/32″ to 4″ dia.	
Diameter in Inches	Area in Square Inches	Diameter in Inches	Area in Square Inches	Diameter in Inches	Area in Square Inches	Diameter in Inches	Area in Square Inches
1/32	·0008	1 1/32	·8353	2 1/32	3·2405	3 1/32	7·2166
1/16	·0031	1 1/16	·8866	2 1/16	3·3410	3 1/16	7·3662
3/32	·0069	1 3/32	·9396	2 3/32	3·4430	3 3/32	7·5173
1/8	·0123	1 1/8	·9940	2 1/8	3·5466	3 1/8	7·6699
5/32	·0192	1 5/32	1·0500	2 5/32	3·6516	3 5/32	7·8241
3/16	·0276	1 3/16	1·1075	2 3/16	3·7582	3 3/16	7·9798
7/32	·0376	1 7/32	1·1666	2 7/32	3·8664	3 7/32	8·1370
1/4	·0491	1 1/4	1·2272	2 1/4	3·9761	3 1/4	8·2958
9/32	·0621	1 9/32	1·2893	2 9/32	4·0873	3 9/32	8·4561
5/16	·0767	1 5/16	1·3530	2 5/16	4·2000	3 5/16	8·6179
11/32	·0928	1 11/32	1·4182	2 11/32	4·3143	3 11/32	8·7813
3/8	·1104	1 3/8	1·4849	2 3/8	4·4301	3 3/8	8·9462
13/32	·1296	1 13/32	1·5532	2 13/32	4·5475	3 13/32	9·1126
7/16	·1503	1 7/16	1·6230	2 7/16	4·6664	3 7/16	9·2806
15/32	·1726	1 15/32	1·6943	2 15/32	4·7868	3 15/32	9·4501
1/2	·1963	1 1/2	1·7671	2 1/2	4·9087	3 1/2	9·6211
17/32	·2217	1 17/32	1·8415	2 17/32	5·0322	3 17/32	9·7937
9/16	·2485	1 9/16	1·9175	2 9/16	5·1572	3 9/16	9·9678
19/32	·2769	1 19/32	1·9949	2 19/32	5·2838	3 19/32	10·1434
5/8	·3068	1 5/8	2·0739	2 5/8	5·4119	3 5/8	10·3206
21/32	·3382	1 21/32	2·1545	2 21/32	5·5415	3 21/32	10·4993
11/16	·3712	1 11/16	2·2365	2 11/16	5·6727	3 11/16	10·6796
23/32	·4057	1 23/32	2·3201	2 23/32	5·8053	3 23/32	10·8613
3/4	·4418	1 3/4	2·4053	2 3/4	5·9396	3 3/4	11 0447
25/32	·4794	1 25/32	2·4920	2 25/32	6·0753	3 25/32	11·2295
13/16	·5185	1 13/16	2·5802	2 13/16	6·2126	3 13/16	11·4159
27/32	·5591	1 27/32	2·6699	2 27/32	6·3514	3 27/32	11·6038
7/8	·6013	1 7/8	2·7612	2 7/8	6·4918	3 7/8	11·7932
29/32	·6450	1 29/32	2·8540	2 29/32	6·6337	3 29/32	11·9842
15/16	·6903	1 15/16	2·9483	2 15/16	6·7771	3 15/16	12·1767
31/32	·7371	1 31/32	3·0442	2 31/32	6·9221	3 31/32	12·3708
1	·7854	2	3·1416	3	7·0686	4	12·5664

DECIMAL EQUIVALENTS

Exact Decimal Equivalents of Fractions of an Inch

Fractions				Decimals	Fractions				Decimals
1/64				·015625	33/64				·515625
	1/32			·03125		17/32			·53125
3/64				·046875	35/64				·546875
		1/16		·0625			9/16		·5625
5/64				·078125	37/64				·578125
	3/32			·09375		19/32			·59375
7/64				·109375	39/64				·609375
			1/8	·125				5/8	·625
9/64				·140625	41/64				·640625
	5/32			·15625		21/32			·65625
11/64				·171875	43/64				·671875
		3/16		·1875			11/16		·6875
13/64				·203125	45/64				·703125
	7/32			·21875		23/32			·71875
15/64				·234375	47/64				·734375
			1/4	·25				3/4	·75
17/64				·265625	49/64				·765625
	9/32			·28125		25/32			·78125
19/64				·296875	51/64				·796875
		5/16		·3125			13/16		·8125
21/64				·328125	53/64				·828125
	11/32			·34375		27/32			·84375
23/64				·359375	55/64				·859375
			3/8	·375				7/8	·875
25/64				·390625	57/64				·890625
	13/32			·40625		29/32			·90625
27/64				·421875	59/64				·921875
		7/16		·4375			15/16		·9375
29/64				·453125	61/64				·953125
	15/32			·46875		31/32			·96875
31/64				·484375	63/64				·984375
			1/2	·5				1	1·00

DECIMALS OF A FOOT
FOR EACH 64th OF AN INCH

Inch	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″
0	0	·0833	·1667	·2500	·3333	·4167	·5000	·5833	·6667	·7500	·8333	·9167
1/64	·0013	·0846	·1680	·2513	·3346	·4180	·5013	·5846	·6680	·7513	·8346	·9180
1/32	·0026	·0859	·1693	·2526	·3359	·4193	·5026	·5859	·6693	·7526	·8359	·9193
3/64	·0039	·0872	·1706	·2539	·3372	·4206	·5039	·5872	·6706	·7539	·8372	·9206
1/16	·0052	·0885	·1719	·2552	·3385	·4219	·5052	·5885	·6719	·7552	·8385	·9219
5/64	·0065	·0898	·1732	·2565	·3398	·4232	·5065	·5898	·6732	·7565	·8398	·9232
3/32	·0078	·0911	·1745	·2578	·3411	·4245	·5078	·5911	·6745	·7578	·8411	·9245
7/64	·0091	·0924	·1758	·2591	·3424	·4258	·5091	·5924	·6758	·7591	·8424	·9258
1/8	·0104	·0937	·1771	·2604	·3437	·4271	·5104	·5937	·6771	·7604	·8437	·9271
9/64	·0117	·0951	·1784	·2617	·3451	·4284	·5117	·5951	·6784	·7617	·8451	·9284
5/32	·0130	·0964	·1797	·2630	·3464	·4297	·5130	·5964	·6797	·7630	·8464	·9297
11/64	·0143	·0977	·1810	·2643	·3477	·4310	·5143	·5977	·6810	·7643	·8477	·9310
3/16	·0156	·0990	·1823	·2656	·3490	·4323	·5156	·5990	·6823	·7656	·8490	·9323
13/64	·0169	·1003	·1836	·2669	·3503	·4336	·5169	·6003	·6836	·7669	·8503	·9336
7/32	·0182	·1016	·1849	·2682	·3516	·4349	·5182	·6016	·6849	·7682	·8516	·9349
15/64	·0195	·1029	·1862	·2695	·3529	·4362	·5195	·6029	·6862	·7695	·8529	·9362
1/4	·0208	·1042	·1875	·2708	·3542	·4375	·5208	·6042	·6875	·7708	·8542	·9375
17/64	·0221	·1055	·1888	·2721	·3555	·4388	·5221	·6055	·6888	·7721	·8555	·9388
9/32	·0234	·1068	·1901	·2734	·3568	·4401	·5234	·6068	·6901	·7734	·8568	·9401
19/64	·0247	·1081	·1914	·2747	·3581	·4414	·5247	·6081	·6914	·7747	·8581	·9414
5/16	·0260	·1094	·1927	·2760	·3594	·4427	·5260	·6094	·6927	·7760	·8594	·9427
21/64	·0273	·1107	·1940	·2773	·3607	·4440	·5273	·6107	·6940	·7773	·8607	·9440
11/32	·0286	·1120	·1953	·2786	·3620	·4453	·5286	·6120	·6953	·7786	·8620	·9453
23/64	·0299	·1133	·1966	·2799	·3633	·4466	·5299	·6133	·6966	·7799	·8633	·9466
3/8	·0312	·1146	·1979	·2812	·3646	·4479	·5312	·6146	·6979	·7812	·8646	·9479
25/64	·0326	·1159	·1992	·2826	·3659	·4492	·5326	·6159	·6992	·7826	·8659	·9492
13/32	·0339	·1172	·2005	·2839	·3672	·4505	·5339	·6172	·7005	·7839	·8672	·9505
27/64	·0352	·1185	·2018	·2852	·3685	·4518	·5352	·6185	·7018	·7852	·8685	·9518
7/16	·0365	·1198	·2031	·2865	·3698	·4531	·5365	·6198	·7031	·7865	·8698	·9531
29/64	·0378	·1211	·2044	·2878	·3711	·4544	·5378	·6211	·7044	·7878	·8711	·9544
15/32	·0391	·1224	·2057	·2891	·3724	·4557	·5391	·6224	·7057	·7891	·8724	·9557
31/64	·0404	·1237	·2070	·2904	·3737	·4570	·5404	·6237	·7070	·7904	·8737	·9570
1/2	·0417	·1250	·2083	·2917	·3750	·4583	·5417	·6250	·7083	·7917	·8750	·9583

DECIMALS OF A FOOT
FOR EACH 64th OF AN INCH

Inch	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″
33/64	·0430	·1263	·2096	·2930	·3763	·4596	·5430	·6263	·7096	·7930	·8763	·9596
17/32	·0443	·1276	·2109	·2943	·3776	·4609	·5443	·6276	·7109	·7943	·8776	·9609
35/64	·0456	·1289	·2122	·2956	·3789	·4622	·5456	·6289	·7122	·7956	·8789	·9622
9/16	·0469	·1302	·2135	·2969	·3802	·4635	·5469	·6302	·7135	·7969	·8802	·9635
37/64	·0482	·1315	·2148	·2982	·3815	·4648	·5482	·6315	·7148	·7982	·8815	·9648
19/32	·0495	·1328	·2161	·2995	·3828	·4661	·5495	·6328	·7161	·7995	·8828	·9661
39/64	·0508	·1341	·2174	·3008	·3841	·4674	·5508	·6341	·7174	·8008	·8841	·9674
5/8	·0521	·1354	·2188	·3021	·3854	·4688	·5521	·6354	·7188	·8021	·8854	·9688
41/64	·0534	·1367	·2201	·3034	·3867	·4701	·5534	·6367	·7201	·8034	·8867	·9701
21/32	·0547	·1380	·2214	·3047	·3880	·4714	·5547	·6380	·7214	·8047	·8880	·9714
43/64	·0560	·1393	·2227	·3060	·3893	·4727	·5560	·6393	·7227	·8060	·8893	·9727
11/16	·0573	·1406	·2240	·3073	·3906	·4740	·5573	·6406	·7240	·8073	·8906	·9740
45/64	·0586	·1419	·2253	·3086	·3919	·4753	·5586	·6419	·7253	·8086	·8919	·9753
23/32	·0599	·1432	·2266	·3099	·3932	·4766	·5599	·6432	·7266	·8099	·8932	·9766
47/64	·0612	·1445	·2279	·3112	·3945	·4779	·5612	·6445	·7279	·8112	·8945	·9779
3/4	·0625	·1458	·2292	·3125	·3958	·4792	·5625	·6458	·7292	·8125	·8958	·9792
49/64	·0638	·1471	·2305	·3138	·3971	·4805	·5638	·6471	·7305	·8138	·8971	·9805
25/32	·0651	·1484	·2318	·3151	·3984	·4818	·5651	·6484	·7318	·8151	·8984	·9818
51/64	·0664	·1497	·2331	·3164	·3997	·4831	·5664	·6497	·7331	·8164	·8997	·9831
13/16	·0677	·1510	·2344	·3177	·4010	·4844	·5677	·6510	·7344	·8177	·9010	·9844
53/64	·0690	·1523	·2357	·3190	·4023	·4857	·5690	·6523	·7357	·8190	·9023	·9857
27/32	·0703	·1536	·2370	·3203	·4036	·4870	·5703	·6536	·7370	·8203	·9036	·9870
55/64	·0716	·1549	·2383	·3216	·4049	·4883	·5716	·6549	·7383	·8216	·9049	·9883
7/8	·0729	·1562	·2396	·3229	·4062	·4896	·5729	·6562	·7396	·8229	·9062	·9896
57/64	·0724	·1576	·2409	·3242	·4076	·4909	·5742	·6576	·7409	·8242	·9076	·9909
29/32	·0755	·1589	·2422	·3255	·4089	·4922	·5755	·6589	·7422	·8255	·9089	·9922
59/64	·0768	·1602	·2435	·3268	·4102	·4935	·5768	·6602	·7435	·8268	·9102	·9935
15/16	·0781	·1615	·2448	·3281	·4115	·4948	·5781	·6615	·7448	·8281	·9115	·9948
61/64	·0794	·1628	·2461	·3294	·4128	·4961	·5794	·6628	·7461	·8294	·9128	·9961
31/32	·0807	·1641	·2474	·3307	·4141	·4974	·5807	·6641	·7474	·8307	·9141	·9974
63/64	·0820	·1654	·2487	·3320	·4154	·4987	·5820	·6654	·7487	·8320	·9154	·9987
1												1·0000

LBS. RISING BY 7
EXPRESSED IN CWTS., QRS. AND LBS.
AND IN DECIMALS OF A TON

Lbs.	c.	q.	lbs.	Ton	Lbs.	c.	q.	lbs.	Ton	Lbs.	c.	q.	lbs.	Ton
					336	3	0	0	·15	672	6	0	0	·3
7			7	·003125	343	3	0	7	·153125	679	6	0	7	·303125
14			14	·00625	350	3	0	14	·15625	686	6	0	14	·30625
21			21	·009375	357	3	0	21	·159375	693	6	0	21	·309375
28		1	0	·0125	364	3	1	0	·1625	700	6	1	0	·3125
35		1	7	·015625	371	3	1	7	·165625	707	6	1	7	·315625
42		1	14	·01875	378	3	1	14	·16875	714	6	1	14	·31875
49		1	21	·021875	385	3	1	21	·171875	721	6	1	21	·321875
56		2	0	·025	392	3	2	0	·175	728	6	2	0	·325
63		2	7	·028125	399	3	2	7	·178125	735	6	2	7	·328125
70		2	14	·03125	406	3	2	14	·18125	742	6	2	14	·33125
77		2	21	·034375	413	3	2	21	·184375	749	6	2	21	·334375
84		3	0	·0375	420	3	3	0	·1875	756	6	3	0	·3375
91		3	7	·040625	427	3	3	7	·190625	763	6	3	7	·340625
98		3	14	·04375	434	3	3	14	·19375	770	6	3	14	·34375
105		3	21	·046875	441	3	3	21	·196875	777	6	3	21	·346875
112	1	0	0	·05	448	4	0	0	·2	784	7	0	0	·35
119	1	0	7	·053125	455	4	0	7	·203125	791	7	0	7	·353125
126	1	0	14	·05625	462	4	0	14	·20625	798	7	0	14	·35625
133	1	0	21	·059375	469	4	0	21	·209375	805	7	0	21	·359375
140	1	1	0	·0625	476	4	1	0	·2125	812	7	1	0	·3625
147	1	1	7	·065625	483	4	1	7	·215625	819	7	1	7	·365625
154	1	1	14	·06875	490	4	1	14	·21875	826	7	1	14	·36875
161	1	1	21	·071875	497	4	1	21	·221875	833	7	1	21	·371875
168	1	2	0	·075	504	4	2	0	·225	840	7	2	0	·375
175	1	2	7	·078125	511	4	2	7	·228125	847	7	2	7	·378125
182	1	2	14	·08125	518	4	2	14	·23125	854	7	2	14	·38125
189	1	2	21	·084375	525	4	2	21	·234375	861	7	2	21	·384375
196	1	3	0	·0875	532	4	3	0	·2375	868	7	3	0	·3875
203	1	3	7	·090625	539	4	3	7	·240625	875	7	3	7	·390625
210	1	3	14	·09375	546	4	3	14	·24375	882	7	3	14	·39375
217	1	3	21	·096875	553	4	3	21	·246875	889	7	3	21	·396875
224	2	0	0	·1	560	5	0	0	·25	896	8	0	0	·4
231	2	0	7	·103125	567	5	0	7	·253125	903	8	0	7	·403125
238	2	0	14	·10625	574	5	0	14	·25625	910	8	0	14	·40625
245	2	0	21	·109375	581	5	0	21	·259375	917	8	0	21	·409375
252	2	1	0	·1125	588	5	1	0	·2625	924	8	1	0	·4125
259	2	1	7	·115625	595	5	1	7	·265625	931	8	1	7	·415625
266	2	1	14	·11875	602	5	1	14	·26875	938	8	1	14	·41875
273	2	1	21	·121875	609	5	1	21	·271875	945	8	1	21	·421875
280	2	2	0	·125	616	5	2	0	·275	952	8	2	0	·425
287	2	2	7	·128125	623	5	2	7	·278125	959	8	2	7	·428125
294	2	2	14	·13125	630	5	2	14	·28125	966	8	2	14	·43125
301	2	2	21	·134375	637	5	2	21	·284375	973	8	2	21	·434375
308	2	3	0	·1375	644	5	3	0	·2875	980	8	3	0	·4375
315	2	3	7	·140625	651	5	3	7	·290625	987	8	3	7	·440625
322	2	3	14	·14375	658	5	3	14	·29375	994	8	3	14	·44375
329	2	3	21	·146875	665	5	3	21	·296875	1001	8	3	21	·446875

LBS. RISING BY 7
EXPRESSED IN CWTS., QRS. AND LBS.
AND IN DECIMALS OF A TON

Lbs.	c.	q.	lbs.	Ton	Lbs.	c.	q.	lbs.	Ton	Lbs.	c.	q.	lbs.	Ton
1008	9	0	0	·45	1344	12	0	0	·6	1680	15	0	0	·75
1015	9	0	7	·453125	1351	12	0	7	·603125	1687	15	0	7	·753125
1022	9	0	14	·45625	1358	12	0	14	·60625	1694	15	0	14	·75625
1029	9	0	21	·459375	1365	12	0	21	·609375	1701	15	0	21	·759375
1036	9	1	0	·4625	1372	12	1	0	·6125	1708	15	1	0	·7625
1043	9	1	7	·465625	1379	12	1	7	·615625	1715	15	1	7	·765625
1050	9	1	14	·46875	1386	12	1	14	·61875	1722	15	1	14	·76875
1057	9	1	21	·471875	1393	12	1	21	·621875	1729	15	1	21	·771875
1064	9	2	0	·475	1400	12	2	0	·625	1736	15	2	0	·775
1071	9	2	7	·478125	1407	12	2	7	·628125	1743	15	2	7	·778125
1078	9	2	14	·48125	1414	12	2	14	·63125	1750	15	2	14	·78125
1085	9	2	21	·484375	1421	12	2	21	·634375	1757	15	2	21	·784375
1092	9	3	0	·4875	1428	12	3	0	·6375	1764	15	3	0	·7875
1099	9	3	7	·490625	1435	12	3	7	·640625	1771	15	3	7	·790625
1106	9	3	14	·49375	1442	12	3	14	·64375	1778	15	3	14	·79375
1113	9	3	21	·496875	1449	12	3	21	·646875	1785	15	3	21	·796875
1120	10	0	0	·5	1456	13	0	0	·65	1792	16	0	0	·8
1127	10	0	7	·503125	1463	13	0	7	·653125	1799	16	0	7	·803125
1134	10	0	14	·50625	1470	13	0	14	·65625	1806	16	0	14	·80625
1141	10	0	21	·509375	1477	13	0	21	·659375	1813	16	0	21	·809375
1148	10	1	0	·5125	1484	13	1	0	·6625	1820	16	1	0	·8125
1155	10	1	7	·515625	1491	13	1	7	·665625	1827	16	1	7	·815625
1162	10	1	14	·51875	1498	13	1	14	·66875	1834	16	1	14	·81875
1169	10	1	21	·521875	1505	13	1	21	·671875	1841	16	1	21	·821875
1176	10	2	0	·525	1512	13	2	0	·675	1848	16	2	0	·825
1183	10	2	7	·528125	1519	13	2	7	·678125	1855	16	2	7	·828125
1190	10	2	14	·53125	1526	13	2	14	·68125	1862	16	2	14	·83125
1197	10	2	21	·534375	1533	13	2	21	·684375	1869	16	2	21	·834375
1204	10	3	0	·5375	1540	13	3	0	·6875	1876	16	3	0	·8375
1211	10	3	7	·540625	1547	13	3	7	·690625	1883	16	3	7	·840625
1218	10	3	14	·54375	1554	13	3	14	·69375	1890	16	3	14	·84375
1225	10	3	21	·546875	1561	13	3	21	·696875	1897	16	3	21	·846875
1232	11	0	0	·55	1568	14	0	0	·7	1904	17	0	0	·85
1239	11	0	7	·553125	1575	14	0	7	·703125	1911	17	0	7	·853125
1246	11	0	14	·55625	1582	14	0	14	·70625	1918	17	0	14	·85625
1253	11	0	21	·559375	1589	14	0	21	·709375	1925	17	0	21	·859375
1260	11	1	0	·5625	1596	14	1	0	·7125	1932	17	1	0	·8625
1267	11	1	7	·565625	1603	14	1	7	·715625	1939	17	1	7	·865625
1274	11	1	14	·56875	1610	14	1	14	·71875	1946	17	1	14	·86875
1281	11	1	21	·571875	1617	14	1	21	·721875	1953	17	1	21	·871875
1288	11	2	0	·575	1624	14	2	0	·725	1960	17	2	0	·875
1295	11	2	7	·578125	1631	14	2	7	·728125	1967	17	2	7	·878125
1302	11	2	14	·58125	1638	14	2	14	·73125	1974	17	2	14	·88125
1309	11	2	21	·584375	1645	14	2	21	·734375	1981	17	2	21	·884375
1316	11	3	0	·5875	1652	14	3	0	·7375	1988	17	3	0	·8875
1323	11	3	7	·590625	1659	14	3	7	·740625	1995	17	3	7	·890625
1330	11	3	14	·59375	1666	14	3	14	·74375	2002	17	3	14	·89375
1337	11	3	21	·596875	1673	14	3	21	·746875	2009	17	3	21	·896875

LBS. RISING BY 7
EXPRESSED IN CWTS., QRS. AND LBS.
AND IN DECIMALS OF A TON

Lbs.	c. q. lbs.	Ton	Lbs.	c. q. lbs.	Ton	Lbs.	c. q. lbs.	Ton
2016	18 0 0	·9	2100	18 3 0	·9375	2184	19 2 0	·975
2023	18 0 7	·903125	2107	18 3 7	·940625	2191	19 2 7	·978125
2030	18 0 14	·90625	2114	18 3 14	·94375	2198	19 2 14	·98125
2037	18 0 21	·909375	2121	18 3 21	·946875	2205	19 2 21	·984375
2044	18 1 0	·9125	2128	19 0 0	·95	2212	19 3 0	·9875
2051	18 1 7	·915625	2135	19 0 7	·953125	2219	19 3 7	·990625
2058	18 1 14	·91875	2142	19 0 14	·95625	2226	19 3 14	·99375
2065	18 1 21	·921875	2149	19 0 21	·959375	2233	19 3 21	·996875
2072	18 2 0	·925	2156	19 1 0	·9625	2240	20 0 0	1·
2079	18 2 7	·928125	2163	19 1 7	·965625			
2086	18 2 14	·93125	2170	19 1 14	·96875			
2093	18 2 21	·934375	2177	19 1 21	·971875			

CONVERSION TABLE — TONS INTO POUNDS

Tons	Pounds	Tons	Pounds	Tons	Pounds	Tons	Pounds
1	2,240	26	58,240	51	114,240	76	170,240
2	4,480	27	60,480	52	116,480	77	172,480
3	6,720	28	62,720	53	118,720	78	174,720
4	8,960	29	64,960	54	120,960	79	176,960
5	11,200	30	67,200	55	123,200	80	179,200
6	13,440	31	69,440	56	125,440	81	181,440
7	15,680	32	71,680	57	127,680	82	183,680
8	17,920	33	73,920	58	129,920	83	185,920
9	20,160	34	76,160	59	132,160	84	188,160
10	22,400	35	78,400	60	134,400	85	190,400
11	24,640	36	80,640	61	136,640	86	192,640
12	26,880	37	82,880	62	138,880	87	194,880
13	29,120	38	85,120	63	141,120	88	197,120
14	31,360	39	87,360	64	143,360	89	199,360
15	33,600	40	89,600	65	145,600	90	201,600
16	35,840	41	91,840	66	147,840	91	203,840
17	38,080	42	94,080	67	150,080	92	206,080
18	40,320	43	96,320	68	152,320	93	208,320
19	42,560	44	98,560	69	154,560	94	210,560
20	44,800	45	100,800	70	156,800	95	212,800
21	47,040	46	103,040	71	159,040	96	215,040
22	49,280	47	105,280	72	161,280	97	217,280
23	51,520	48	107,520	73	163,520	98	219,520
24	53,760	49	109,760	74	165,760	99	221,760
25	56,000	50	112,000	75	168,000	100	224,000

PART XIV

Logarithms and Antilogarithms

pages
776–779

LOGARITHMS

	0	1	2	3	4	5	6	7	8	9	Mean Differences								
											1	2	3	4	5	6	7	8	9
10	0000	0043	0086	0128	0170	0212	0253	0294	0334	0374	4	8	12	17	21	25	29	33	37
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4	8	11	15	19	23	26	30	34
12	0792	0828	0864	0899	0934	0969	1004	1038	1072	1106	3	7	10	14	17	21	24	28	31
13	1139	1173	1206	1239	1271	1303	1335	1367	1399	1430	3	6	10	13	16	19	23	26	29
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3	6	9	12	15	18	21	24	27
15	1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	3	6	8	11	14	17	20	22	25
16	2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	3	5	8	11	13	16	18	21	24
17	2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	2	5	7	10	12	15	17	20	22
18	2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	2	5	7	9	12	14	16	19	21
19	2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	2	4	7	9	11	13	16	18	20
20	3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	2	4	6	8	11	13	15	17	19
21	3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	2	4	6	8	10	12	14	16	18
22	3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	2	4	6	8	10	12	14	15	17
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2	4	6	7	9	11	13	15	17
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2	4	5	7	9	11	12	14	16
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2	3	5	7	9	10	12	14	15
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2	3	5	7	8	10	11	13	15
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2	3	5	6	8	9	11	13	14
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2	3	5	6	8	9	11	12	14
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1	3	4	6	7	9	10	12	13
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1	3	4	6	7	9	10	11	13
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1	3	4	6	7	8	10	11	12
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1	3	4	5	7	8	9	11	12
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1	3	4	5	6	8	9	10	12
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1	3	4	5	6	8	9	10	11
35	5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	1	2	4	5	6	7	9	10	11
36	5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	1	2	4	5	6	7	8	10	11
37	5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	1	2	3	5	6	7	8	9	10
38	5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	1	2	3	5	6	7	8	9	10
39	5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	1	2	3	4	5	7	8	9	10
40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1	2	3	4	5	6	8	9	10
41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1	2	3	4	5	6	7	8	9
42	6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1	2	3	4	5	6	7	8	9
43	6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1	2	3	4	5	6	7	8	9
44	6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	1	2	3	4	5	6	7	8	9
45	6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	1	2	3	4	5	6	7	8	9
46	6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	1	2	3	4	5	6	7	7	8
47	6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	1	2	3	4	5	5	6	7	8
48	6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	1	2	3	4	4	5	6	7	8
49	6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	1	2	3	4	4	5	6	7	8
50	6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	1	2	3	3	4	5	6	7	8
51	7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	1	2	3	3	4	5	6	7	8
52	7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	1	2	2	3	4	5	6	7	7
53	7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	1	2	2	3	4	5	6	6	7
54	7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	1	2	2	3	4	5	6	6	7

LOGARITHMS

	0	1	2	3	4	5	6	7	8	9	Mean Differences								
											1	2	3	4	5	6	7	8	9
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	1	2	2	3	4	5	5	6	7
56	7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	1	2	2	3	4	5	5	6	7
57	7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	1	2	2	3	4	5	5	6	7
58	7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	1	1	2	3	4	4	5	6	7
59	7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	1	1	2	3	4	4	5	6	7
60	7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	1	1	2	3	4	4	5	6	6
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	1	1	2	3	4	4	5	6	6
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	1	1	2	3	3	4	5	6	6
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	1	1	2	3	3	4	5	5	6
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	1	1	2	3	3	4	5	5	6
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	1	1	2	3	3	4	5	5	6
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	1	1	2	3	3	4	5	5	6
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	1	1	2	3	3	4	5	5	6
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	1	1	2	3	3	4	4	5	6
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	1	1	2	2	3	4	4	5	6
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	1	1	2	2	3	4	4	5	6
71	8513	8519	8525	8531	8537	8543	8549	8555	9561	8567	1	1	2	2	3	4	4	5	5
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	1	1	2	2	3	4	4	5	5
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	1	1	2	2	3	4	4	5	5
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	1	1	2	2	3	4	4	5	5
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	1	1	2	2	3	3	4	5	5
76	8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	1	1	2	2	3	3	4	5	5
77	8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	1	1	2	2	3	3	4	4	5
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	1	1	2	2	3	3	4	4	5
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	1	1	2	2	3	3	4	4	5
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	1	1	2	2	3	3	4	4	5
81	9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	1	1	2	2	3	3	4	4	5
82	9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	1	1	2	2	3	3	4	4	5
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	1	1	2	2	3	3	4	4	5
84	9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	1	1	2	2	3	3	4	4	5
85	9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	1	1	2	2	3	3	4	4	5
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	1	1	2	2	3	3	4	4	5
87	9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	0	1	1	2	2	3	3	4	4
88	9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	0	1	1	2	2	3	3	4	4
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	0	1	1	2	2	3	3	4	4
90	9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	0	1	1	2	2	3	3	4	4
91	9590	9595	9600	9605	9609	9614	9619	9624	9628	9633	0	1	1	2	2	3	3	4	4
92	9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	0	1	1	2	2	3	3	4	4
93	9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	0	1	1	2	2	3	3	4	4
94	9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	0	1	1	2	2	3	3	4	4
95	9777	9782	9786	9791	9795	9800	9805	9809	9814	9818	0	1	1	2	2	3	3	4	4
96	9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	0	1	1	2	2	3	3	4	4
97	9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	0	1	1	2	2	3	3	4	4
98	9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	0	1	1	2	2	3	3	4	4
99	9956	9961	9965	9969	9974	9978	9983	9987	9991	9996	0	1	1	2	2	3	3	3	4

ANTILOGARITHMS

	0	1	2	3	4	5	6	7	8	9	Mean Differences								
											1	2	3	4	5	6	7	8	9
·00	1000	1002	1005	1007	1009	1012	1014	1016	1019	1021	0	0	1	1	1	1	2	2	2
·01	1023	1026	1028	1030	1033	1035	1038	1040	1042	1045	0	0	1	1	1	1	2	2	2
·02	1047	1050	1052	1054	1057	1059	1062	1064	1067	1069	0	0	1	1	1	1	2	2	2
·03	1072	1074	1076	1079	1081	1084	1086	1089	1091	1094	0	0	1	1	1	1	2	2	2
·04	1096	1099	1102	1104	1107	1109	1112	1114	1117	1119	0	1	1	1	1	2	2	2	2
·05	1122	1125	1127	1130	1132	1135	1138	1140	1143	1146	0	1	1	1	1	2	2	2	2
·06	1148	1151	1153	1156	1159	1161	1164	1167	1169	1172	0	1	1	1	1	2	2	2	2
·07	1175	1178	1180	1183	1186	1189	1191	1194	1197	1199	0	1	1	1	1	2	2	2	2
·08	1202	1205	1208	1211	1213	1216	1219	1222	1225	1227	0	1	1	1	1	2	2	2	3
·09	1230	1233	1236	1239	1242	1245	1247	1250	1253	1256	0	1	1	1	1	2	2	2	3
·10	1259	1262	1265	1268	1271	1274	1276	1279	1282	1285	0	1	1	1	1	2	2	2	3
·11	1288	1291	1294	1297	1300	1303	1306	1309	1312	1315	0	1	1	1	2	2	2	2	3
·12	1318	1321	1324	1327	1330	1334	1337	1340	1343	1346	0	1	1	1	2	2	2	2	3
·13	1349	1352	1355	1358	1361	1365	1368	1371	1374	1377	0	1	1	1	2	2	2	3	3
·14	1380	1384	1387	1390	1393	1396	1400	1403	1406	1409	0	1	1	1	2	2	2	3	3
·15	1413	1416	1419	1422	1426	1429	1432	1435	1439	1442	0	1	1	1	2	2	2	3	3
·16	1445	1449	1452	1455	1459	1462	1466	1469	1472	1476	0	1	1	1	2	2	2	3	3
·17	1479	1483	1486	1489	1493	1496	1500	1503	1507	1510	0	1	1	1	2	2	2	3	3
·18	1514	1517	1521	1524	1528	1531	1535	1538	1542	1545	0	1	1	1	2	2	2	3	3
·19	1549	1552	1556	1560	1563	1567	1570	1574	1578	1581	0	1	1	1	2	2	3	3	3
·20	1585	1589	1592	1596	1600	1603	1607	1611	1614	1618	0	1	1	1	2	2	3	3	3
·21	1622	1626	1629	1633	1637	1641	1644	1648	1652	1656	0	1	1	2	2	2	3	3	3
·22	1660	1663	1667	1671	1675	1679	1683	1687	1690	1694	0	1	1	2	2	2	3	3	3
·23	1698	1702	1706	1710	1714	1718	1722	1726	1730	1734	0	1	1	2	2	2	3	3	4
·24	1738	1742	1746	1750	1754	1758	1762	1766	1770	1774	0	1	1	2	2	2	3	3	4
·25	1778	1782	1786	1791	1795	1799	1803	1807	1811	1816	0	1	1	2	2	2	3	3	4
·26	1820	1824	1828	1832	1837	1841	1845	1849	1854	1858	0	1	1	2	2	3	3	3	4
·27	1862	1866	1871	1875	1879	1884	1888	1892	1897	1901	0	1	1	2	2	3	3	3	4
·28	1905	1910	1914	1919	1923	1928	1932	1936	1941	1945	0	1	1	2	2	3	3	4	4
·29	1950	1954	1959	1963	1968	1972	1977	1982	1986	1991	0	1	1	2	2	3	3	4	4
·30	1995	2000	2004	2009	2014	2018	2023	2028	2032	2037	0	1	1	2	2	3	3	4	4
·31	2042	2046	2051	2056	2061	2065	2070	2075	2080	2084	0	1	1	2	2	3	3	4	4
·32	2089	2094	2099	2104	2109	2113	2118	2123	2128	2133	0	1	1	2	2	3	3	4	4
·33	2138	2143	2148	2153	2158	2163	2168	2173	2178	2183	0	1	1	2	2	3	3	4	4
·34	2188	2193	2198	2203	2208	2213	2218	2223	2228	2234	1	1	2	2	3	3	4	4	5
·35	2239	2244	2249	2254	2259	2265	2270	2275	2280	2286	1	1	2	2	3	3	4	4	5
·36	2291	2296	2301	2307	2312	2317	2323	2328	2333	2339	1	1	2	2	3	3	4	4	5
·37	2344	2350	2355	2360	2366	2371	2377	2382	2388	2393	1	1	2	2	3	3	4	4	5
·38	2399	2404	2410	2415	2421	2427	2432	2438	2443	2449	1	1	2	2	3	3	4	4	5
·39	2455	2460	2466	2472	2477	2483	2489	2495	2500	2506	1	1	2	2	3	3	4	5	5
·40	2512	2518	2523	2529	2535	2541	2547	2553	2559	2564	1	1	2	2	3	4	4	5	5
·41	2570	2576	2582	2588	2594	2600	2606	2612	2618	2624	1	1	2	2	3	4	4	5	5
·42	2630	2636	2642	2649	2655	2661	2667	2673	2679	2685	1	1	2	2	3	4	4	5	6
·43	2692	2698	2704	2710	2716	2723	2729	2735	2742	2748	1	1	2	3	3	4	4	5	6
·44	2754	2761	2767	2773	2780	2786	2793	2799	2805	2812	1	1	2	3	3	4	4	5	6
·45	2818	2825	2831	2838	2844	2851	2858	2864	2871	2877	1	1	2	3	3	4	5	5	6
·46	2884	2891	2897	2904	2911	2917	2924	2931	2938	2944	1	1	2	3	3	4	5	5	6
·47	2951	2958	2965	2972	2979	2985	2992	2999	3006	3013	1	1	2	3	3	4	5	5	6
·48	3020	3027	3034	3041	3048	3055	3062	3069	3076	3083	1	1	2	3	4	4	5	6	6
·49	3090	3097	3105	3112	3119	3126	3133	3141	3148	3155	1	1	2	3	4	4	5	6	6

ANTILOGARITHMS

	0	1	2	3	4	5	6	7	8	9	Mean Differences								
											1	2	3	4	5	6	7	8	9
·50	3162	3170	3177	3184	3192	3199	3206	3214	3221	3228	1	1	2	3	4	4	5	6	7
·51	3236	3243	3251	3258	3266	3273	3281	3289	3296	3304	1	2	2	3	4	5	5	6	7
·52	3311	3319	3327	3334	3342	3350	3357	3365	3373	3381	1	2	2	3	4	5	5	6	7
·53	3388	3396	3404	3412	3420	3428	3436	3443	3451	3459	1	2	2	3	4	5	6	6	7
·54	3467	3475	3483	3491	3499	3508	3516	3524	3532	3540	1	2	2	3	4	5	6	6	7
·55	3548	3556	3565	3573	3581	3589	3597	3606	3614	3622	1	2	2	3	4	5	6	7	7
·56	3631	3639	3648	3656	3664	3673	3681	3690	3698	3707	1	2	3	3	4	5	6	7	8
·57	3715	3724	3733	3741	3750	3758	3767	3776	3784	3793	1	2	3	3	4	5	6	7	8
·58	3802	3811	3819	3828	3837	3846	3855	3864	3873	3882	1	2	3	4	4	5	6	7	8
·59	3890	3899	3908	3917	3926	3936	3945	3954	3963	3972	1	2	3	4	5	5	6	7	8
·60	3981	3990	3999	4009	4018	4027	4036	4046	4055	4064	1	2	3	4	5	6	6	7	8
·61	4074	4083	4093	4102	4111	4121	4130	4140	4150	4159	1	2	3	4	5	6	7	8	9
·62	4169	4178	4188	4198	4207	4217	4227	4236	4246	4256	1	2	3	4	5	6	7	8	9
·63	4266	4276	4285	4295	4305	4315	4325	4335	4345	4355	1	2	3	4	5	6	7	8	9
·64	4365	4375	4385	4395	4406	4416	4426	4436	4446	4457	1	2	3	4	5	6	7	8	9
·65	4467	4477	4487	4498	4508	4519	4529	4539	4550	4560	1	2	3	4	5	6	7	8	9
·66	4571	4581	4592	4603	4613	4624	4634	4645	4656	4667	1	2	3	4	5	6	7	9	10
·67	4677	4688	4699	4710	4721	4732	4742	4753	4764	4775	1	2	3	4	5	7	8	9	10
·68	4786	4797	4808	4819	4831	4842	4853	4864	4875	4887	1	2	3	4	6	7	8	9	10
·69	4898	4909	4920	4932	4943	4955	4966	4977	4989	5000	1	2	3	5	6	7	8	9	10
·70	5012	5023	5035	5047	5058	5070	5082	5093	5105	5117	1	2	4	5	6	7	8	9	11
·71	5129	5140	5152	5164	5176	5188	5200	5212	5224	5236	1	2	4	5	6	7	8	10	11
·72	5248	5260	5272	5284	5297	5309	5321	5333	5346	5358	1	2	4	5	6	7	9	10	11
·73	5370	5383	5395	5408	5420	5433	5445	5458	5470	5483	1	3	4	5	6	8	9	10	11
·74	5495	5508	5521	5534	5546	5559	5572	5585	5598	5610	1	3	4	5	6	8	9	10	12
·75	5623	5636	5649	5662	5675	5689	5702	5715	5728	5741	1	3	4	5	7	8	9	10	12
·76	5754	5768	5781	5794	5808	5821	5834	5848	5861	5875	1	3	4	5	7	8	9	11	12
·77	5888	5902	5916	5929	5943	5957	5970	5984	5998	6012	1	3	4	5	7	8	10	11	12
·78	6026	6039	6053	6067	6081	6095	6109	6124	6138	6152	1	3	4	6	7	8	10	11	13
·79	6166	6180	6194	6209	6223	6237	6252	6266	6281	6295	1	3	4	6	7	9	10	11	13
·80	6310	6324	6339	6353	6368	6383	6397	6412	6427	6442	1	3	4	6	7	9	10	12	13
·81	6457	6471	6486	6501	6516	6531	6546	6561	6577	6592	2	3	5	6	8	9	11	12	14
·82	6607	6622	6637	6653	6668	6683	6699	6714	6730	6745	2	3	5	6	8	9	11	12	14
·83	6761	6776	6792	6808	6823	6839	6855	6871	6887	6902	2	3	5	6	8	9	11	13	14
·84	6918	6934	6950	6966	6982	6998	7015	7031	7047	7063	2	3	5	6	8	10	11	13	15
·85	7079	7096	7112	7129	7145	7161	7178	7194	7211	7228	2	3	5	7	8	10	12	13	15
·86	7244	7261	7278	7295	7311	7328	7345	7362	7379	7396	2	3	5	7	8	10	12	13	15
·87	7413	7430	7447	7464	7482	7499	7516	7534	7551	7568	2	3	5	7	9	10	12	14	16
·88	7586	7603	7621	7638	7656	7674	7691	7709	7727	7745	2	4	5	7	9	11	12	14	16
·89	7762	7780	7798	7816	7834	7852	7870	7889	7907	7925	2	4	5	7	9	11	13	14	16
·90	7943	7962	7980	7998	8017	8035	8054	8072	8091	8110	2	4	6	7	9	11	13	15	17
·91	8128	8147	8166	8185	8204	8222	8241	8260	8279	8299	2	4	6	8	9	11	13	15	17
·92	8318	8337	8356	8375	8395	8414	8433	8453	8472	8492	2	4	6	8	10	12	14	15	17
·93	8511	8531	8551	8570	8590	8610	8630	8650	8670	8690	2	4	6	8	10	12	14	16	18
·94	8710	8730	8750	8770	8790	8810	8831	8851	8872	8892	2	4	6	8	10	12	14	16	18
·95	8913	8933	8954	8974	8995	9016	9036	9057	9078	9099	2	4	6	8	10	12	15	17	19
·96	9120	9141	9162	9183	9204	9226	9247	9268	9290	9311	2	4	6	8	11	13	15	17	19
·97	9333	9354	9376	9397	9419	9441	9462	9484	9506	9528	2	4	7	9	11	13	15	17	20
·98	9550	9572	9594	9616	9638	9661	9683	9705	9727	9750	2	4	7	9	11	13	16	18	20
·99	9772	9795	9817	9840	9863	9886	9908	9931	9954	9977	2	5	7	9	11	14	16	18	20

Alphabetical Index