CAMBRIA STEEL

Emil Larsson

CAMBRIA STEEL.

A HANDBOOK OF INFORMATION RELATING TO

STRUCTURAL STEEL

MANUFACTURED BY THE

CAMBRIA IRON CO.

Containing useful tables, rules, data and formulæ for the use of

ENGINEERS, ARCHITECTS, BUILDERS AND MECHANICS.

GENERAL OFFICE, PHILADELPHIA: HARRISON BUILDING, S. W. COR. 15TH AND MARKET STREETS, OPPOSITE PENNA. R. R. OFFICES AND TERMINAL STATION.

WORKS AT JOHNSTOWN, PA.

1898.

PRICE, $2.00.

PRESS OF
MACCALLA & COMPANY INC.,
PHILADELPHIA, PA.

ERRATA.

Page 39, Last column, 8th line from bottom, change 1.88 to read 18.8.

Page 42, Sixth line of text, change "net tons" to read pounds.

Page 75, Safe load for 8″ 17.75 lb. I-Beam, span 16′ 0″, change 94080 to read 9480.

Page 96, Spacing for 15″ 80 lb. I-Beam, distance between supports 10′ 0″, change 02.2 to read 102.2.

Page 106, Spacing for 15″ 55 lb. I-Beam, distance between supports 12′ 0″, change 44.4 to read 40.4.

Page 129, Spacing for 15″ 75 lb. I-Beam, 24′ between supports, change 19.8 to read 9.8.

Page 138, Formula for Shear or Reaction at Right Support, insert letter l in denominator of first fraction.

Page 195, In signs for rivets flattened to ⅛″ high, second column, change $\dfrac{\text{Outside}}{\text{(Farside)}}$ to read $\dfrac{\text{Outside}}{\text{(Nearside)}}$.

Page 215, Column "Area at Root of Thread" for Diameter of Screw 2½″, change 3.175 to read 3.715.

Page 265, Decimal for 1″, change 0.833 to read .0833.

Page 278, In first column, eighteenth line, change 1½″ to 1⅛″.

Page 302, Change circumference 235.6336 for diameter 75.1 to read 235.9336.

Page 309, Secant 9° 20′, change 1.01432 to read 1.01342.

Page 334, Last line, last word, change "points" to pints.

Page 337, Linear Measure, Kilometre to Statute Miles, seventh line, change 7.34959 to read 4.34959.

PREFACE.

This, the fourth edition of our handbook, is much larger than the preceding ones, and in place of the tables of weights and dimensions of the earlier editions, it includes plates of sections, complete tables of weights, dimensions and properties of the principal structural shapes manufactured by us, together with various other data, formulæ and tables of value to engineers and others.

The tables pertaining to structural shapes were specially prepared for this edition, and those giving the properties of I Beams, Channels and Angles, safe loads of I Beams and Channels, and spacing of I Beams are given in detail for each section, so that required information can be obtained without interpolation, a feature which it is believed will add to their value and convenience.

The general mathematical tables, engineering formulæ, and information relating to materials not manufactured by us, have been carefully compiled from original or authentic sources, and have been amplified or condensed, corrected, or rearranged in a manner thought best to insure accuracy and convenience in use.

CONTENTS.

(For complete detail of Contents, see Index.)

GENERAL INFORMATION.

Our product is almost exclusively steel, made by the Bessemer or Open Hearth process as required, and of all qualities from the softest rivet stock to high carbon special spring material.

Our Beams and Channels are made to conform to the American Standards, adopted January, 1896, in which the flanges have a uniform slope of one to six, and the dimensions, proportions and weights are determined by a regular schedule, as shown on the diagrams on pages 22 and 23. The standard proportions of beams and channels are further shown on Plate 24.

The principal structural angles now made are limited in number to conform to the American Standards, adopted December, 1895, and include eleven base, or a total of sixty, sizes for equal leg angles, and nine base, or a total of seventy-four, sizes of unequal leg angles, all varying in thickness by one-sixteenth inch, as shown on Plates 12 and 14 and tables herein. It is believed that these standard angles include a sufficient range of sizes to meet all usual structural requirements, but at the same time we will continue the manufacture of angles of special sizes and proportions for those who require them as shown on Plates 13 and 15.

The method of increasing the sectional area of shapes from minimum or base sizes to intermediate and maximum sizes, is shown on page 21. For beams and channels the increase from the minimum adds equally to the web thickness and flange width, the weight of the increase being equal to that of a plate of the same depth as the section, and of a thickness equal to the increase of the dimensions stated.

The method of increasing the thickness of angles and Z Bars from the minimum has the effect of adding to the length of the legs, as shown on page 21, so that for intermediate and maximum sizes the legs will be somewhat longer than the minimum or nominal dimensions, except in a few cases for which we have finishing grooves. The plates of drawings of sections, pages 2 to 20 inclusive, show the minimum or base sizes of the various shapes. Sections shown on the plates or lists for which more than one weight is stated can be rolled of different thicknesses to produce the stated weights. Others for which only one weight is given cannot be varied. Each section shown herein is numbered, both in the plates and tables, for convenience in reference and ordering.

I Beams and Channels should be ordered of weights shown in the tables. Intermediate weights will be charged for at the next higher weight on the list.

Deliveries of shapes of standard weights and sizes which are kept in stock can be made more promptly than of special sizes made to order. Orders should specify either the thickness or weight, but not both.

All weights are stated per lineal foot of section. Weights of rolled sections are calculated on the basis of 489.6 pounds per cubic foot of steel, and 3.4 times the sectional area in square inches equals the weight in pounds per lineal foot. In calculating the weights, areas, and properties of I Beams, Channels, and structural angles for the lists and tables herewith, the fillets and smaller rounded corners were not considered.

Structural material unless otherwise ordered will be cut to length with variation not to exceed $\frac{3}{4}$ inch above that specified. For cutting to exact lengths or with less variation than $\frac{3}{4}$ inch an extra price will be charged.

All sections shown herein are steel.

GAUTIER STEEL DEPARTMENT

OF

CAMBRIA IRON CO.

MERCHANT BAR STEEL,

Including Tire, Toe Calk, Machinery, Carriage Spring, Railroad Spring, Hoe, Rake, Fork, etc.

AGRICULTURAL STEEL AND SHAPES,

Finger Bars, Knife Backs, Rake Teeth, Bundle Carrier Teeth, Tedder Forks and Springs, Spring Harrow Teeth, Harrow (Drag) Teeth, Seat Springs, etc.

PLOW STEEL,

Flat and Finished Plow Shapes, Digger Blades, Slabs (Penn and Pernot), Hammered Lay, Rolled Lay, etc.

COLD ROLLED STEEL,

Rounds, Squares, Flats, Shafting, and Special Shapes.

STEEL HARROW DISCS,

13″ to 20″ diameter with rolled bevel.

CAMBRIA LINK BARB WIRE.

For Gautier Steel Department Products not listed herein, see special Catalogue, or address,

GAUTIER DEPARTMENT,

Cambria Iron Company, Johnstown, Pa.

LOCAL OFFICES FOR THE SALE OF GAUTIER DEPARTMENT PRODUCTS.

NEW YORK .... 102 Chambers Street.
PHILADELPHIA .... Bourse Building.
CHICAGO .... Western Union Building.
ATLANTA .... 325 Decatur Street.

PLATES

OF

STRUCTURAL STEEL SHAPES

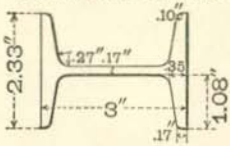
MANUFACTURED BY

CAMBRIA IRON CO.

STANDARD BEAMS

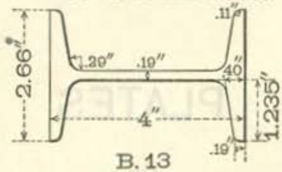
B. 5

WT. 5.5, 6.5 AND 7.5 LBS.



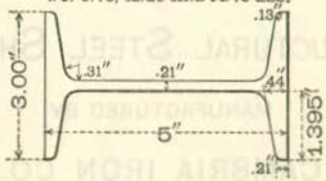
B. 9

WT. 7.5, 8.5, 9.5 AND 10.5 LBS.



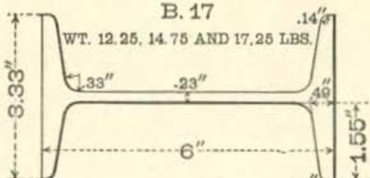
B. 13

WT. 9.75, 12.25 AND 14.75 LBS.



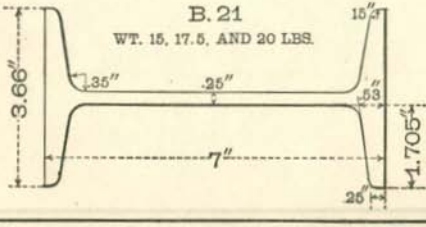
B. 17

WT. 12.25, 14.75 AND 17.25 LBS.



B. 21

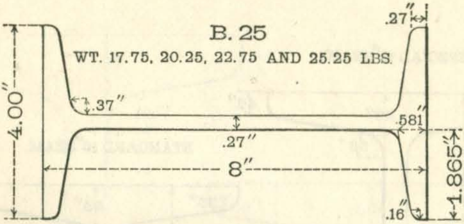
WT. 15, 17.5, AND 20 LBS.



STANDARD BEAMS.

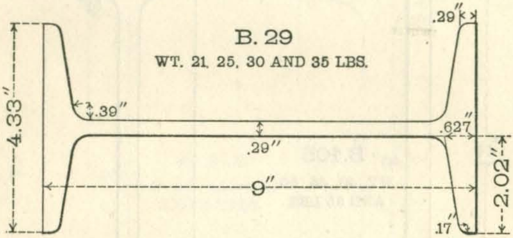
B. 25

WT. 17.75, 20.25, 22.75 AND 25.25 LBS.



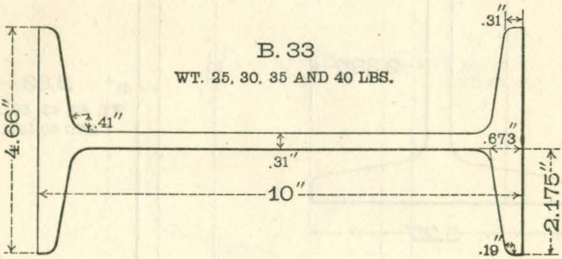
B. 29

WT. 21, 25, 30 AND 35 LBS.



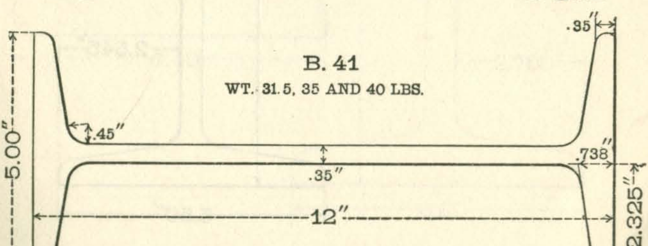
B. 33

WT. 25, 30, 35 AND 40 LBS.



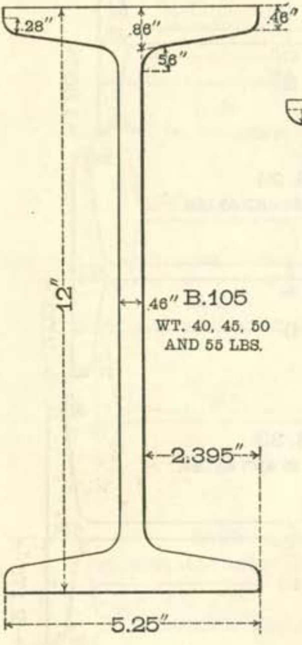
B. 41

WT. 31.5, 35 AND 40 LBS.

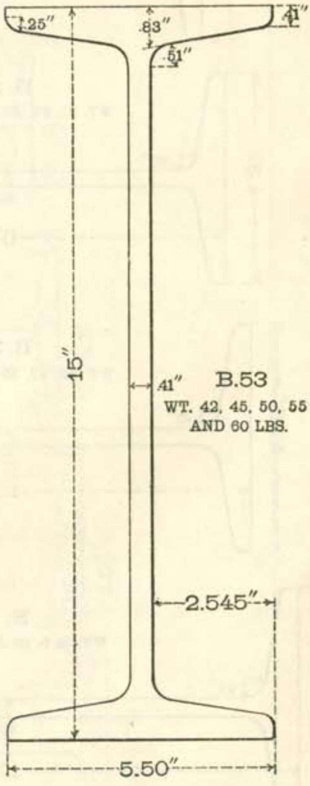


BEAMS.

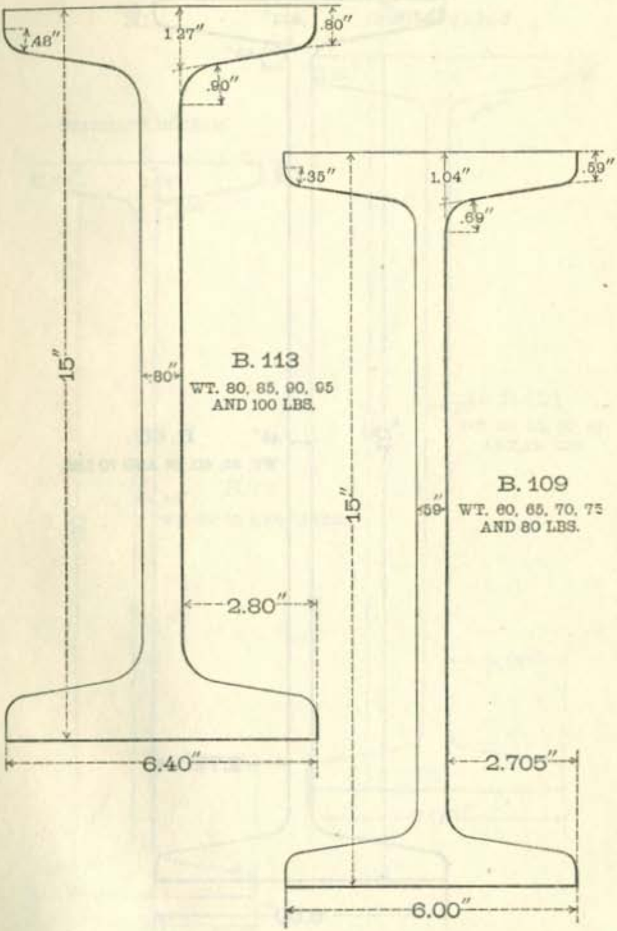
SPECIAL 12" BEAM.



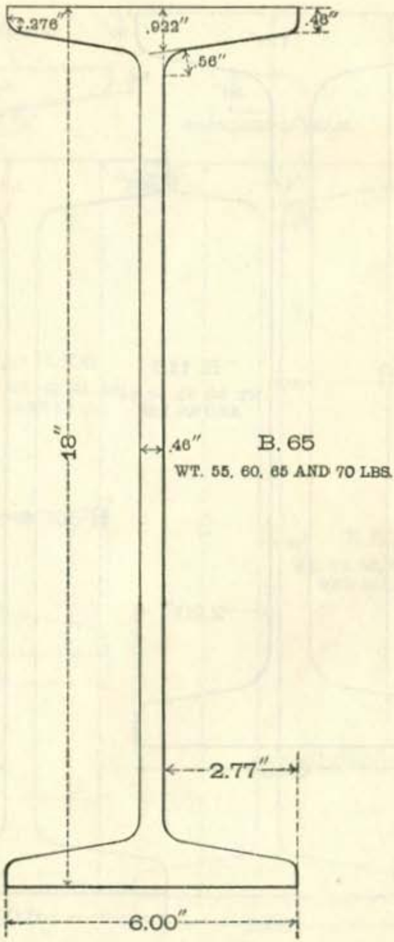
STANDARD 15" BEAM.



SPECIAL BEAMS.

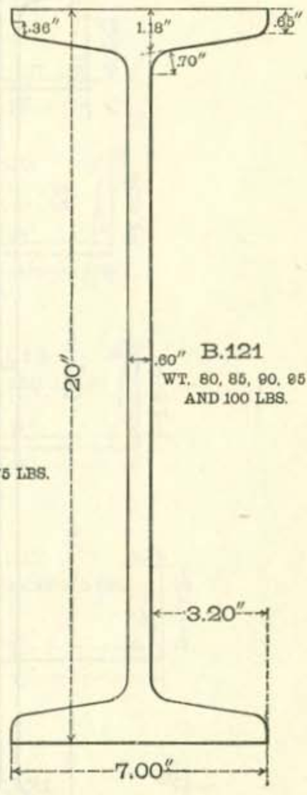


STANDARD BEAMS.



BEAMS.

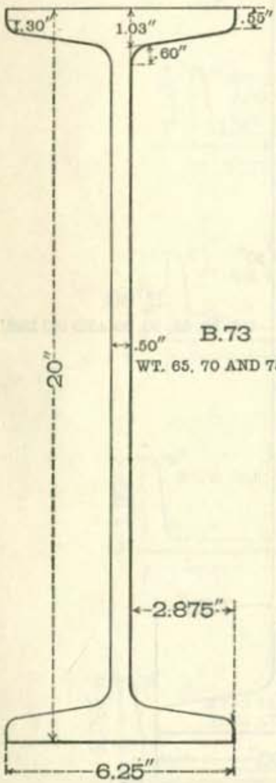
SPECIAL 20" BEAM.



B.121

WT. 80, 85, 90, 95 AND 100 LBS.

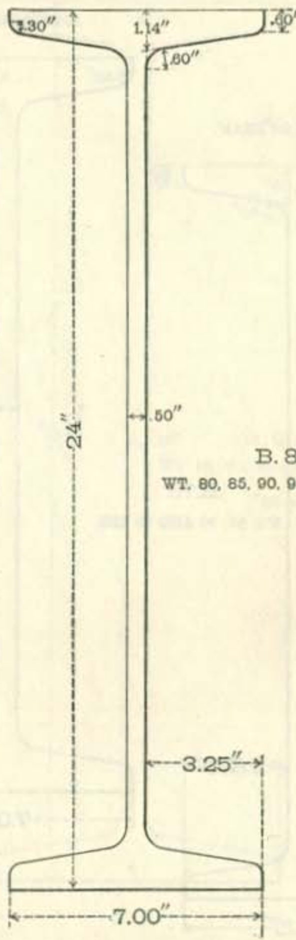
STANDARD 20" BEAM.



B.73

WT. 65, 70 AND 75 LBS.

STANDARD BEAMS.



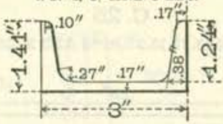
B. 89

WT. 80, 85, 90, 95 AND 100 LBS.

STANDARD CHANNELS.

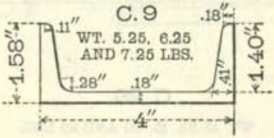
C. 5

WT. 4, 5 AND 6 LBS.



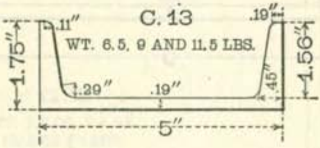
C. 9

WT. 5.25, 6.25 AND 7.25 LBS.



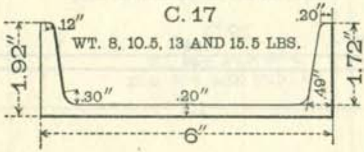
C. 13

WT. 6.5, 9 AND 11.5 LBS.



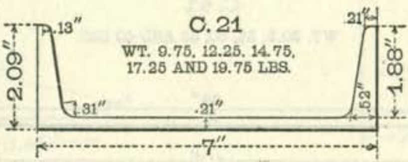
C. 17

WT. 8, 10.5, 13 AND 15.5 LBS.

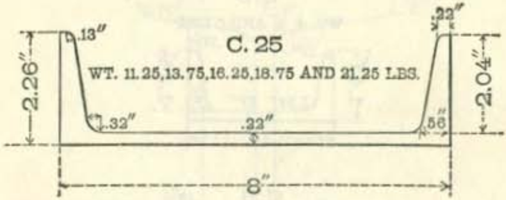


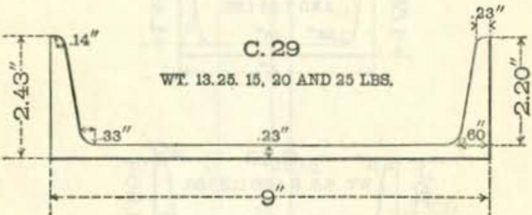
C. 21

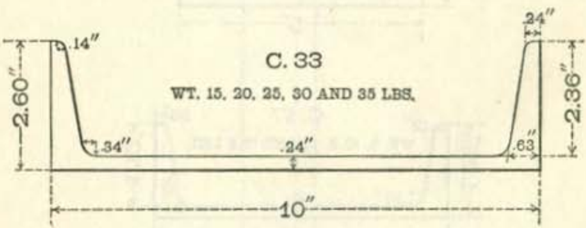
WT. 9.75, 12.25, 14.75, 17.25 AND 19.75 LBS.

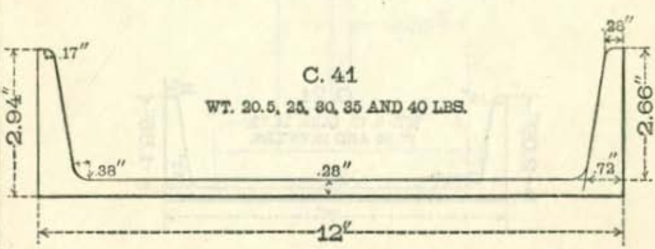


STANDARD CHANNELS.



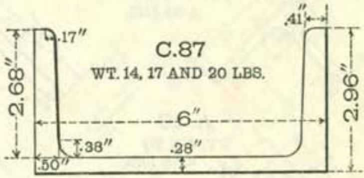




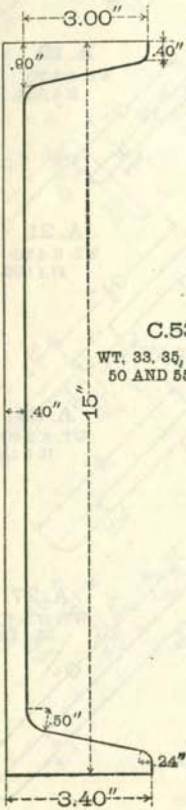


CHANNELS.

SPECIAL 6" CHANNEL.

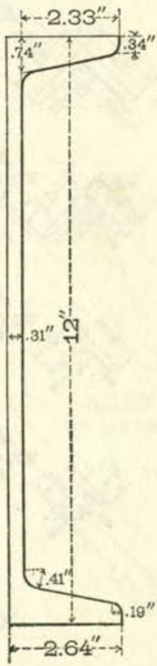


STANDARD 15" CHANNEL.



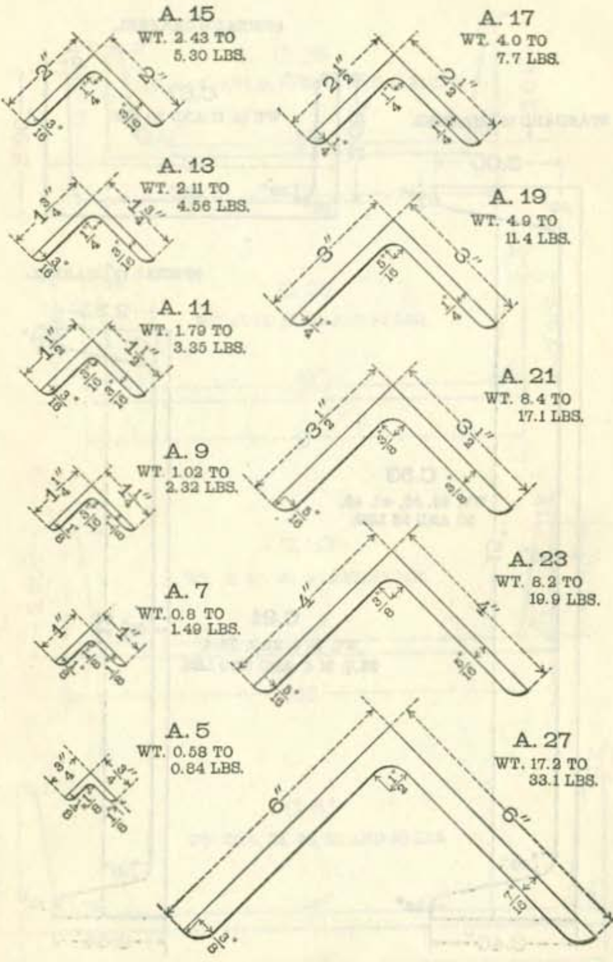
C.53
WT. 33, 35, 40, 45, 50 AND 55 LBS.

SPECIAL 12" CHANNEL.



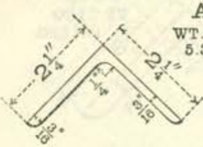
C.91
WT. 21.4, 23.9, 26.4, 28.9, 31.4 AND 33.9 LBS.

STANDARD ANGLES WITH EQUAL LEGS.

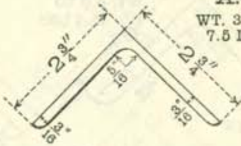


SPECIAL ANGLES.

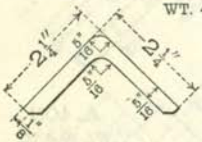
A.41
WT. 2.7 TO 5.3 LBS.



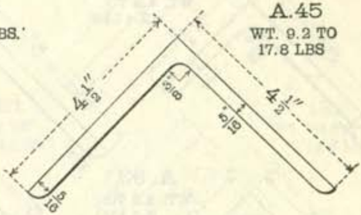
A.43
WT. 3.4 TO 7.5 LBS.



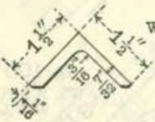
A.67
WT. 4.4 LBS.



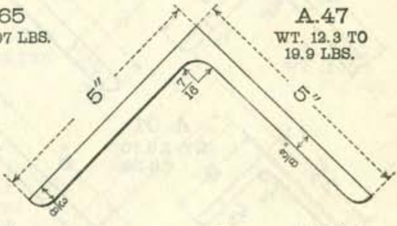
A.45
WT. 9.2 TO 17.8 LBS



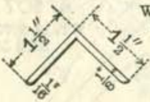
A.65
WT. 2.07 LBS.



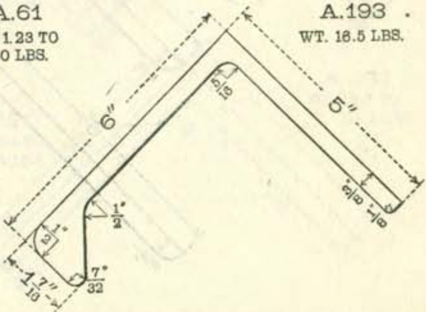
A.47
WT. 12.3 TO 19.9 LBS.



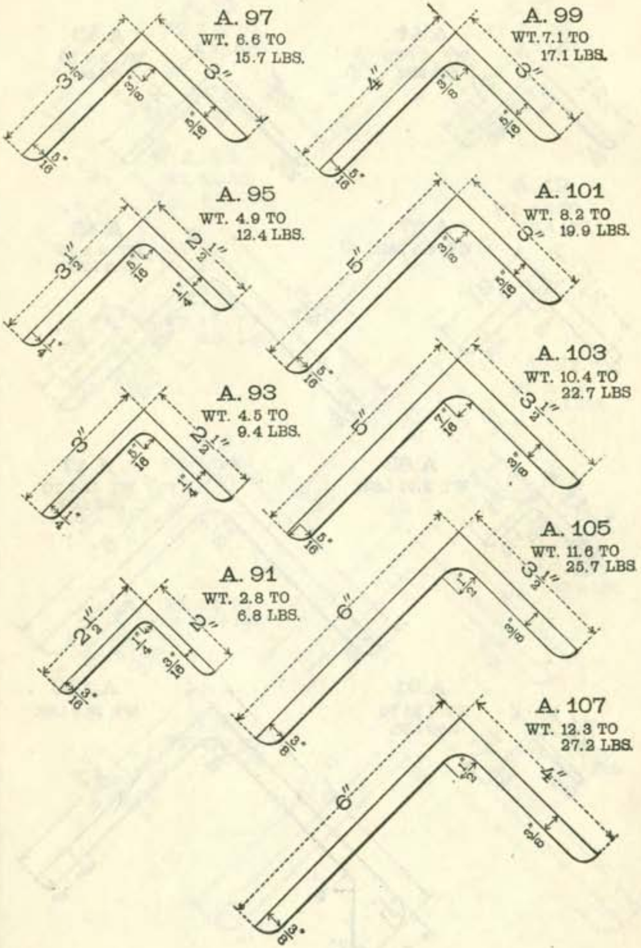
A.61
WT. 1.23 TO 1.80 LBS.



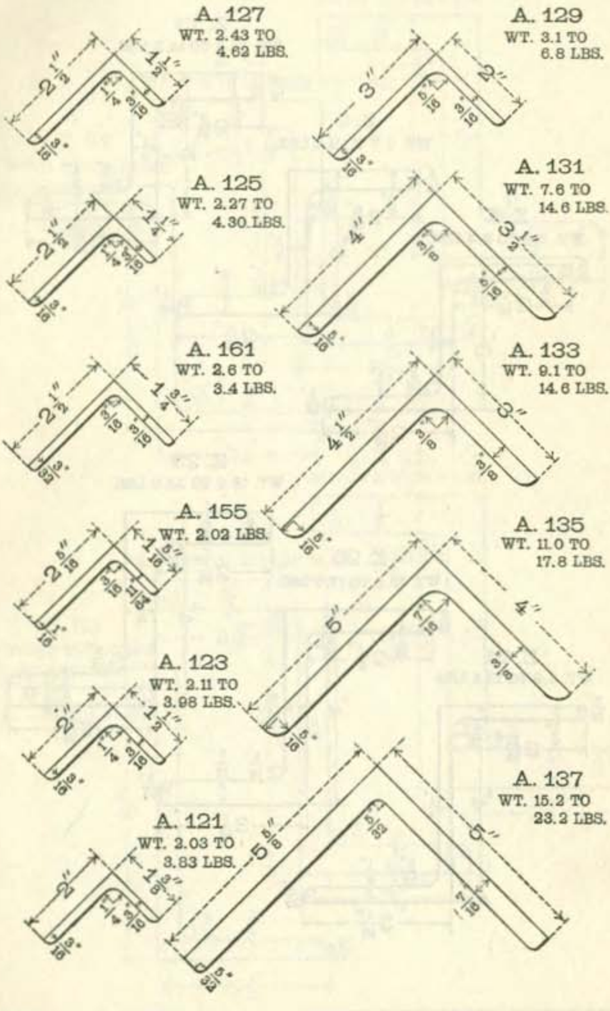
A.193
WT. 16.5 LBS.



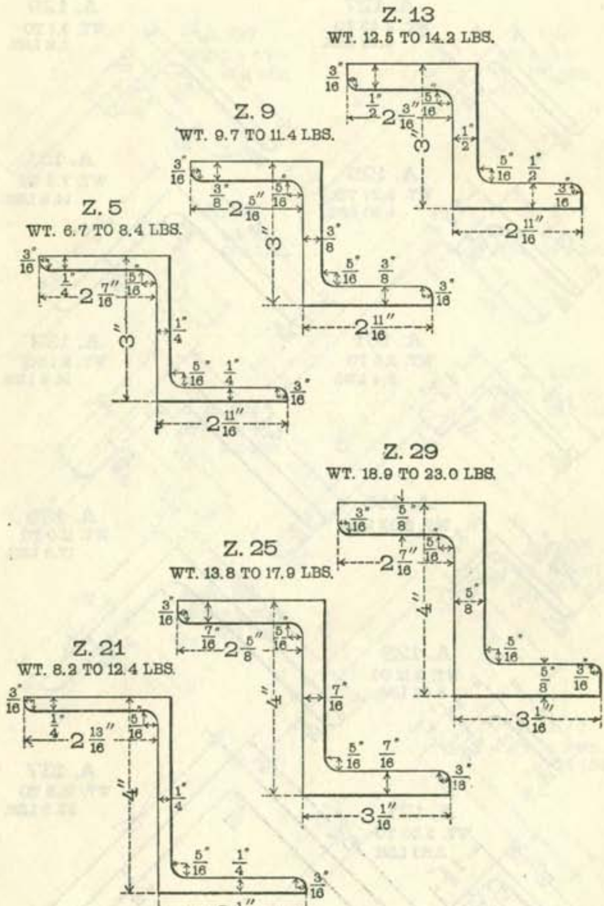
STANDARD ANGLES WITH UNEQUAL LEGS.



SPECIAL ANGLES WITH UNEQUAL LEGS.



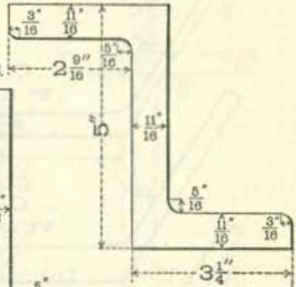
Z-BARS.


Z. 13
WT. 12.5 TO 14.2 LBS.
Z. 9
WT. 9.7 TO 11.4 LBS.
Z. 5
WT. 6.7 TO 8.4 LBS.
Z. 29
WT. 18.9 TO 23.0 LBS.
Z. 25
WT. 13.8 TO 17.9 LBS.
Z. 21
WT. 8.2 TO 12.4 LBS.

Z-BARS.

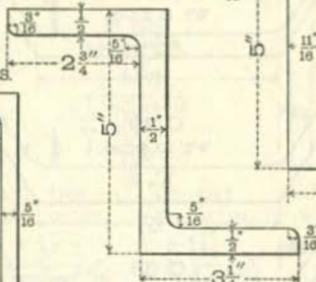
Z. 45

WT. 23.7 TO 28.3 LBS.



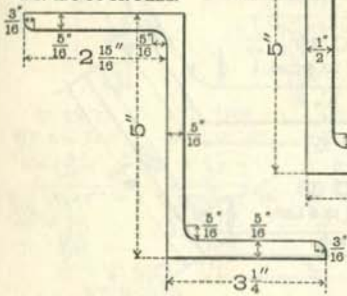
Z. 41

WT. 17.9 TO 22.6 LBS.



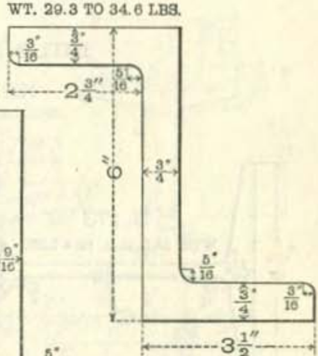
Z. 37

WT. 11.6 TO 16.4 LBS.



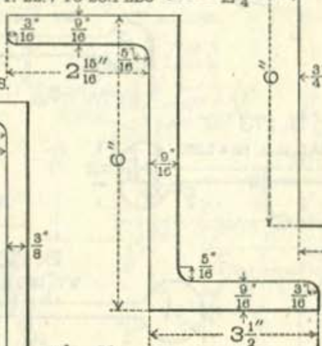
Z. 61

WT. 29.3 TO 34.6 LBS.



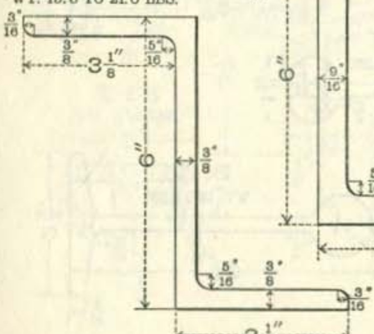
Z. 57

WT. 22.7 TO 28.1 LBS

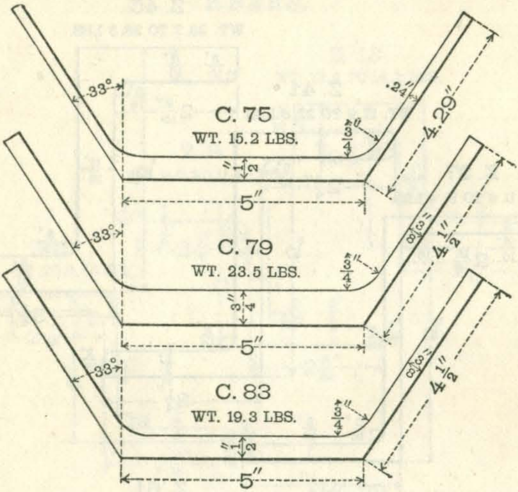


Z. 53

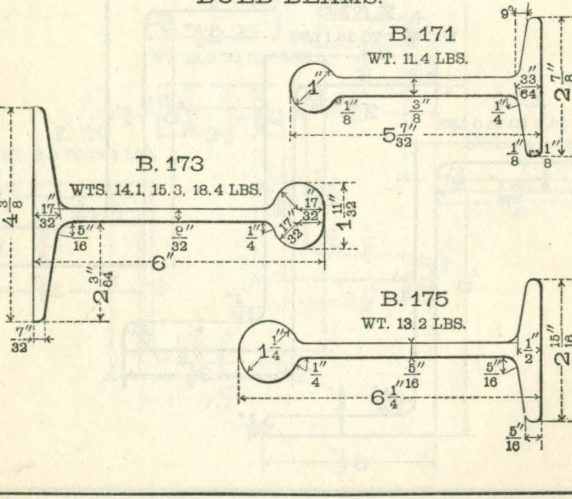
WT. 15.6 TO 21.0 LBS.



TROUGH CHANNELS.

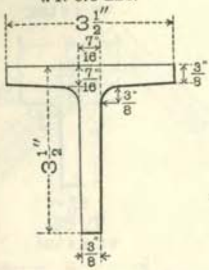


BULB BEAMS.

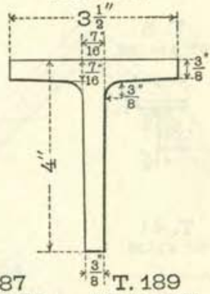


T-BARS.

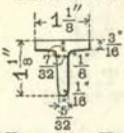
T. 97
WT. 9.3 LBS.



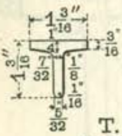
T. 101
WT. 9.9 LBS.



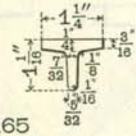
T. 181
WT. 1.39 LBS.



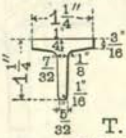
T. 183
WT. 1.53 LBS.



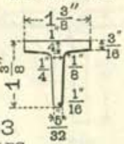
T. 185
WT. 1.49 LBS.



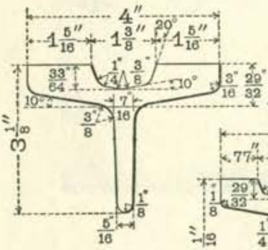
T. 187
WT. 1.61 LBS.



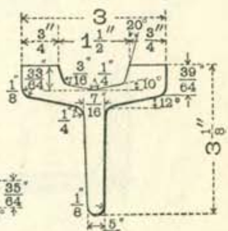
T. 189
WT. 1.85 LBS.



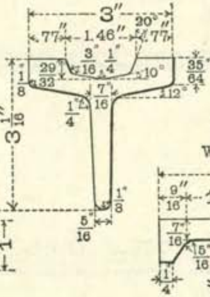
T. 165
WT. 11.0 LBS.



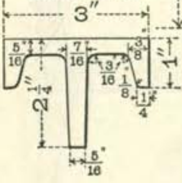
T. 163
WT. 8.6 LBS.



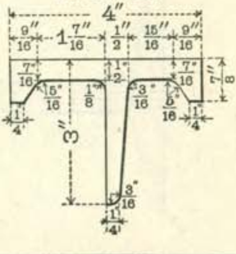
T. 161
WT. 8.3 LBS.



T. 171
WT. 7.14 LBS.

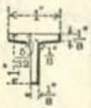


T. 167
WT. 10.7 LBS.

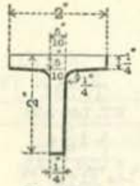


T-BARS.

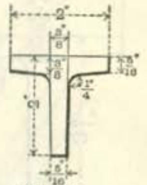
T. 5
WT. 0.89 LBS.



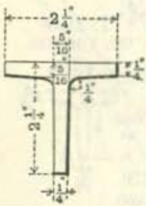
T. 37
WT. 3.7 LBS.



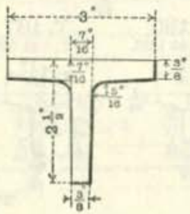
T. 39
WT. 4.3 LBS.



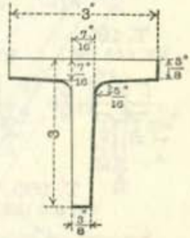
T. 41
WT. 4.1 LBS.



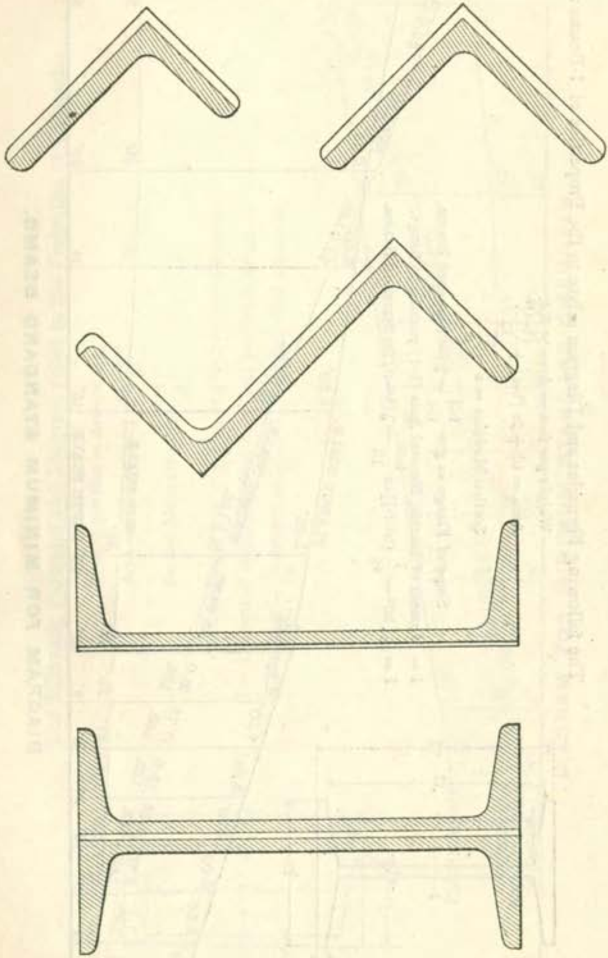
T. 65
WT. 7.2 LBS.



T. 69
WT. 7.8 LBS.

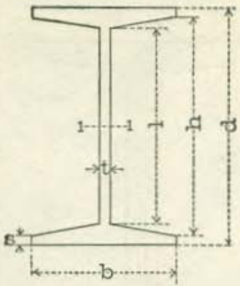


METHOD OF INCREASING SECTIONAL AREAS.



STANDARD BEAMS.

The following Formulas and Diagram relate to the Properties of I-Beams:



$$\text{Weight per foot} = \text{Area} \times 3.4.$$

$$\text{Area} = td + 2s\,(b-t) + \frac{(b-t)^2}{12}.$$

$$\text{Section Modulus} = s = \frac{2I}{d}.$$

$$\text{Slope of Flange} = g = \frac{h-l}{b-t} = \tfrac{1}{6} \text{ for Standard Beams.}$$

I = Moment of Inertia, Neutral Axis (1-1) parallel to flange.

$$I = \tfrac{1}{12}\left[bd^3 - \frac{1}{4g}\,(h^4 - l^4)\right] \text{ or } \frac{bd^3}{12} - \tfrac{1}{8}\,(h^4 - l^4) \text{ for Standard Beams.}$$

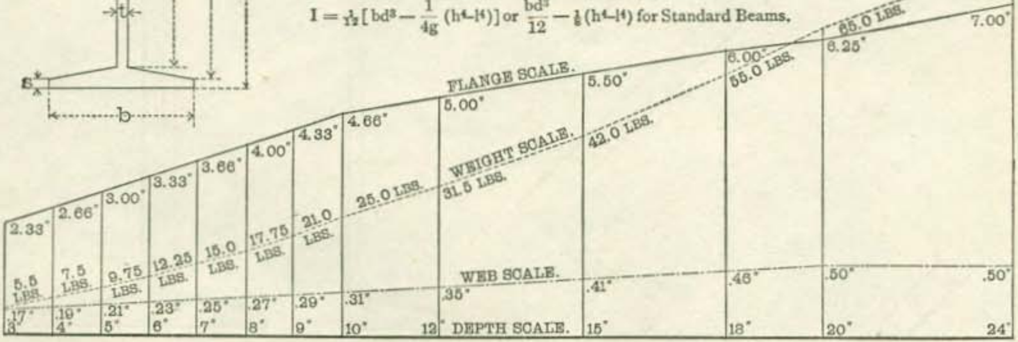
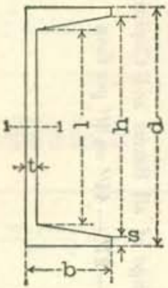


DIAGRAM FOR MINIMUM STANDARD BEAMS.

STANDARD CHANNELS.



The following Formulas and Diagram relate to the Properties of Channels:

Weight per foot = Area $\times$ 3.4.

Area $= td + 2s\,(b-t) + \frac{(b-t)^2}{6}$.

Section Modulus $= s = \frac{2I}{d}$.

Slope of Flange $= g = \frac{h-l}{2(b-t)}$, or $\frac{1}{6}$ for Standard Channels.

I = Moment of Inertia, Neutral Axis (1–1) parallel to flange.

$I = \frac{1}{12}\left[bd^3 - \frac{1}{8g}(h^4-l^4)\right]$ or $\frac{bd^3}{12} - \frac{h^4-l^4}{16}$ for Standard Channels.

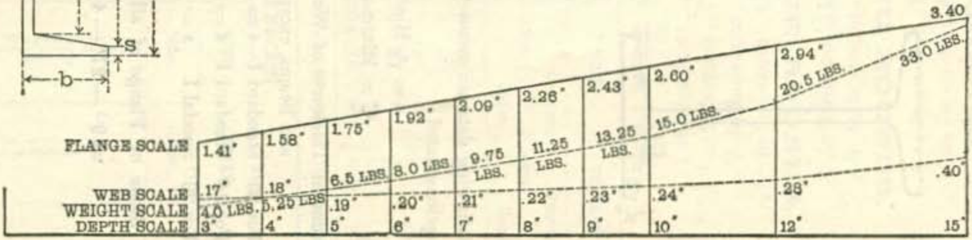
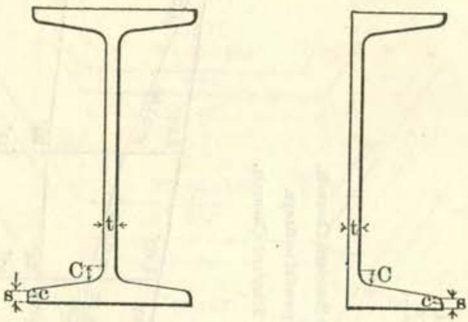


DIAGRAM FOR MINIMUM STANDARD CHANNELS.

STANDARD BEAMS AND CHANNELS.



The following data are common to all I-Beams and Channels, with the exceptions stated:

$c = \frac{6}{10}$ Minimum Web.

$C =$ Minimum Web $+ \frac{1}{16}$ inch.

s = Minimum Thickness of Web = t Minimum for all Channels and Beams, except 20″ I and 24″ I.

For 20″ Standard I s = .55″ t Minimum = .50″.

For 24″ Standard I s = .60″ t Minimum = .50″.

For 20″ Special I s = .65″ t Minimum = .60″.

The Slope of Flange of all Beams and Channels is $16\frac{2}{3}$ %

$= 9^\circ - 27' - 44'' = 2''$ per foot.

TABLES OF SQUARE, ROUND AND FLAT BARS ROLLED BY CAMBRIA IRON CO.

STEEL SQUARES.

All sizes from $\frac{3}{16}''$ to $3\frac{3}{8}''$ increasing by $\frac{1}{16}''$
All sizes from $3\frac{1}{2}''$ to $5\frac{1}{2}''$ increasing by $\frac{1}{8}''$

STEEL HAND ROUNDS.

All sizes from $\frac{3}{4}''$ to $3''$ increasing by $\frac{1}{16}''$
All sizes from $3\frac{1}{8}''$ to $6\frac{1}{2}''$ increasing by $\frac{1}{8}''$

STEEL GUIDE ROUNDS.

All sizes from $\frac{3}{16}''$ to $\frac{19}{32}''$ increasing by $\frac{1}{64}''$
All sizes from $\frac{5}{8}''$ to $\frac{3}{4}''$ increasing by $\frac{1}{32}''$
All sizes from $\frac{13}{16}''$ to $1\frac{3}{4}''$ increasing by $\frac{1}{16}''$
All sizes from $1\frac{7}{8}''$ to $2''$ increasing by $\frac{1}{8}''$

SHEARED PLATES.

WIDTH.		THICKNESS.		MAXIMUM LENGTHS.	WIDTH.		THICKNESS.		MAXIMUM LENGTHS.
Inches.	Increasing by Inches.	Inches.	Increasing by Inches.	Feet.	Inches.	Increasing by Inches.	Inches.	Increasing by Inches.	Feet.
6 to 8	$\frac{1}{8}$	$\frac{1}{16}$		12	12 to 16	$\frac{1}{8}$	$\frac{1}{16}$		8
" "	"	$\frac{3}{32}$		18	" "	"	$\frac{3}{32}$		15
" "	"	$\frac{1}{8}, \frac{5}{32}$		20	" "	"	$\frac{1}{8}$ to $\frac{3}{4}$	$\frac{1}{32}$	20 to 8
8 to 12	"	$\frac{1}{16}$		10	16 to 20	"	$\frac{3}{32}$		12
" "	"	$\frac{3}{32}$		15	" "	"	$\frac{1}{8}$ to $\frac{3}{4}$	$\frac{1}{32}$	20 to 6
" "	"	$\frac{1}{8}, \frac{5}{32}$		20	20 to 28	"	$\frac{1}{8}$ " $\frac{3}{4}$	"	20 " 4

Maximum weight of finished plate not to be over 400 pounds.

NUT IRON.

WIDTH.	THICKNESS.	WEIGHT PER FOOT.	WIDTH.	THICKNESS.	WEIGHT PER FOOT.
Inches.	Inches.	Pounds.	Inches.	Inches.	Pounds.
$\frac{3}{4}$	$\frac{1}{2}$	1.25	$1\frac{7}{8}$	$\frac{15}{16}$	5.86
$\frac{13}{16}$	$\frac{9}{16}$	1.52	$1\frac{7}{8}$	$1\frac{3}{8}$	8.59
1	$\frac{11}{16}$	2.29	$2\frac{1}{16}$	$1\frac{1}{2}$	10.31
$1\frac{3}{16}$	$\frac{13}{16}$	3.22	$2\frac{1}{4}$	$1\frac{5}{8}$	12.19
$1\frac{3}{8}$	$\frac{15}{16}$	4.30	$2\frac{7}{16}$	$1\frac{3}{4}$	14.22
$1\frac{9}{16}$	$1\frac{1}{16}$	5.53	$2\frac{5}{8}$	$1\frac{7}{8}$	16.41
$1\frac{11}{16}$	$1\frac{3}{16}$	6.68			

STEEL FLATS.

WIDTH. Inches.	Increasing by Inches.	THICKNESS. Inches.	Increasing by Inches.
1/4 to 23/64	1/64	3/16 to 11/32	1/64
3/8 " 31/64	"	.109	
" " "	"	7/64 to 15/32	"
1/2 " 63/64	"	.042	
" " "	"	3/64 to 7/8	"
1		.042	
"		3/64 to 7/8	"
1 1/64 " 1 1/8	"	1/16 " 1/2	"
1 1/16		9/16, 5/8	
1 1/8		17/32 to 1 1/8	1/32
1 9/64 " 1 15/64	"	No. 16 to No. 12 gauge.	gauge.
" " "	"	3/16 to 1/2	1/64
1 3/16		9/16, 5/8	
1 1/4 " 1 3/8	"	No. 16 to No. 12 gauge.	gauge.
" " "	"	3/16 to 1/2	1/64
" " "	1/32	17/32 " 1 3/8	1/32
1 25/64 " 1 31/64	1/64	No. 16 to No. 12 gauge.	gauge.
" " "	"	3/16 to 1/2	1/64
1 7/16		9/16, 5/8	
1 1/2		No. 16 to No. 12 gauge.	gauge.
"		1/8	
"		3/16 to 1/2	1/64
"		17/32 " 1 5/8	1/32
1 17/32 " 1 5/8	1/32	3/16 " 1 5/8	"
1 11/16		1/4 " 5/8	1/16
1 3/4 " 1 31/32	"	1/16 " 2	1/32
2 " 2 31/32	"	1/16 " 2 1/8	"
2 1/2 " 2 15/16	1/16	2 3/16 " 2 3/4	1/16

WIDTH. Inches.	Increasing by Inches.	THICKNESS. Inches.	Increasing by Inches.
3 to 3 31/32	1/32	1/16 to 1	1/32
" " 3 15/32	1/16	1 1/16 " 2 3/4	1/16
4 " 4 31/32	1/32	1/16 " 1	1/32
" " 4 15/16	1/16	1 1/16 " 2 3/4	1/16
5		1/16 " 1	1/32
"		1 1/16 " 2 3/4	1/16
5 1/32 " 5 31/32	1/32	1/16 " 1	1/32
6		1/16 " 1	1/32
"		1 1/16 " 2 1/4	1/16
6 1/32 " 6 31/32	"	5/32 " 5/8	1/32
7		" " "	"
"		11/16 " 2 1/8	1/16
7 1/32 " 7 31/32	"	5/32 " 5/8	1/32
8		" " "	"
"		11/16 " 2 1/2	1/16
8 1/32 " 8 31/32	"	3/16 " 3/8	1/32
9 " 9 31/32	"	" " "	"
10 " 10 31/32	"	" " "	"
11 " 11 31/32	"	" " "	"
12		" " "	"

SQUARE-CORNERED STEEL BILLETS.

1″ to 3 1/4″ increasing by 1/16″

ROUND-CORNERED STEEL BILLETS.

SIZE. Inches.	APPROXIMATE WEIGHT PER FOOT. Pounds.	SIZE. Inches.	APPROXIMATE WEIGHT PER FOOT. Pounds.	SIZE. Inches.	APPROXIMATE WEIGHT PER FOOT. Pounds.
3 x 3	31	4 1/2 x 4	61	5 x 5	85
3 1/2 x 3 1/2	42	5 x 4 1/2	77	5 1/2 x 5 1/2	103
4 x 4	54				

SQUARE STEEL BLOOMS.

6″ to 14″ increasing by ½″

RECTANGULAR STEEL BLOOMS AND SLABS.

WIDTH.		THICKNESS.		WIDTH.		THICKNESS.	
Inches.	Increasing by Inches.	Inches.	Increasing by Inches.	Inches.	Increasing by Inches.	Inches.	Increasing by Inches.
6, 7		2 to 4	¼	13		2½ to 12	1
8 to 14	1	2½ " 4	"	14		2½ " 13	"
6		4 " 5	1	15		2½ " 12	"
7		4 " 6	"	16		2½ " 11	"
8		4 " 7	"	17		2½ " 9	"
9		4 " 8	"	18		2½ " 7	"
10		3 " 9	"	19		2½ " 5	"
11		3 " 10	"	20		2½ " 4	"
12		2½ " 11	"				

STEEL INGOTS.

SIZE.	GRADE.
STANDARD. Top, 17½″ x 19¾″ Bottom, 20½″ x 22¾″ 6000 to 7000 lbs.	BESSEMER OR OPEN HEARTH.
SPECIAL. 15″ to 35″ square or round. 7000 to 35000 lbs. Maximum length 20 ft.	OPEN HEARTH.

WEIGHTS AND DIMENSIONS OF
STANDARD I-BEAMS.

Section Number.	Depth of Beam. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.	Thickness of Web. Inches.	Width of Flange. Inches.	Page Number of Section.
B 5	3	5.5	1.63	.17	2.33	2
"	"	6.5	1.91	.26	2.42	"
"	"	7.5	2.21	.36	2.52	"
B 9	4	7.5	2.21	.19	2.66	2
"	"	8.5	2.50	.26	2.73	"
"	"	9.5	2.79	.34	2.81	"
"	"	10.5	3.09	.41	2.88	"
B 13	5	9.75	2.87	.21	3.00	2
"	"	12.25	3.60	.36	3.15	"
"	"	14.75	4.34	.50	3.29	"
B 17	6	12.25	3.61	.23	3.33	2
"	"	14.75	4.34	.35	3.45	"
"	"	17.25	5.07	.47	3.57	"
B 21	7	15.0	4.42	.25	3.66	2
"	"	17.5	5.15	.35	3.76	"
"	"	20.0	5.88	.46	3.87	"
B 25	8	17.75	5.33	.27	4.00	3
"	"	20.25	5.96	.35	4.08	"
"	"	22.75	6.69	.44	4.17	"
"	"	25.25	7.43	.53	4.26	"
B 29	9	21.0	6.31	.29	4.33	3
"	"	25.0	7.35	.41	4.45	"
"	"	30.0	8.82	.57	4.61	"
"	"	35.0	10.29	.73	4.77	"
B 33	10	25.0	7.37	.31	4.66	3
"	"	30.0	8.82	.45	4.80	"
"	"	35.0	10.29	.60	4.95	"
"	"	40.0	11.76	.75	5.10	"
B 41	12	31.5	9.26	.35	5.00	3
"	"	35.0	10.29	.44	5.09	"
"	"	40.0	11.76	.56	5.21	"
B 53	15	42.0	12.48	.41	5.50	4
"	"	45.0	13.24	.46	5.55	"
"	"	50.0	14.71	.56	5.65	"
"	"	55.0	16.18	.66	5.75	"
"	"	60.0	17.65	.75	5.84	"

WEIGHTS AND DIMENSIONS OF STANDARD I-BEAMS.

Section Number.	Depth of Beam. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.	Thickness of Web. Inches.	Width of Flange. Inches.	Page Number of Section.
B 65	18	55.0	15.93	.46	6.00	6
"	"	60.0	17.65	.56	6.10	"
"	"	65.0	19.12	.64	6.18	"
"	"	70.0	20.59	.72	6.26	"
B 73	20	65.0	19.08	.50	6.25	7
"	"	70.0	20.59	.58	6.33	"
"	"	75.0	22.06	.65	6.40	"
B 89	24	80.0	23.32	.50	7.00	8
"	"	85.0	25.00	.57	7.07	"
"	"	90.0	26.47	.63	7.13	"
"	"	95.0	27.94	.69	7.19	"
"	"	100.0	29.41	.75	7.25	"

WEIGHTS AND DIMENSIONS OF SPECIAL I-BEAMS.

Section Number.	Depth of Beam. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. Inches.	Thickness of Web. Inches.	Width of Flange. Inches.	Page Number of Section.
B 105	12	40.0	11.84	.46	5.25	4
"	"	45.0	13.24	.58	5.37	"
"	"	50.0	14.71	.70	5.49	"
"	"	55.0	16.18	.82	5.61	"
B 109	15	60.0	17.67	.59	6.00	5
"	"	65.0	19.12	.69	6.10	"
"	"	70.0	20.59	.78	6.19	"
"	"	75.0	22.06	.88	6.29	"
"	"	80.0	23.53	.98	6.39	"
B 113	15	80.0	23.57	.80	6.40	5
"	"	85.0	25.00	.90	6.50	"
"	"	90.0	26.47	.99	6.59	"
"	"	95.0	27.94	1.09	6.69	"
"	"	100.0	29.41	1.19	6.79	"
B 121	20	80.0	23.73	.60	7.00	7
"	"	85.0	25.00	.66	7.06	"
"	"	90.0	26.47	.74	7.14	"
"	"	95.0	27.94	.81	7.21	"
"	"	100.0	29.41	.88	7.28	"

WEIGHTS AND DIMENSIONS OF STANDARD CHANNELS.

Section Number.	Depth of Channel.	Weight per Foot.	Area of Section.	Thickness of Web.	Width of Flange.	Page Number of Section.
	Inches.	Pounds.	Sq. In.	Inches.	Inches.	
C 5	3	4.0	1.19	.17	1.41	9
"	"	5.0	1.47	.26	1.50	"
"	"	6.0	1.76	.36	1.60	"
C 9	4	5.25	1.55	.18	1.58	9
"	"	6.25	1.84	.25	1.65	"
"	"	7.25	2.13	.33	1.73	"
C 13	5	6.50	1.95	.19	1.75	9
"	"	9.00	2.65	.33	1.89	"
"	"	11.50	3.38	.48	2.04	"
C 17	6	8.00	2.38	.20	1.92	9
"	"	10.50	3.09	.32	2.04	"
"	"	13.00	3.82	.44	2.16	"
"	"	15.50	4.56	.56	2.28	"
C 21	7	9.75	2.85	.21	2.09	9
"	"	12.25	3.60	.32	2.20	"
"	"	14.75	4.34	.42	2.30	"
"	"	17.25	5.07	.53	2.41	"
"	"	19.75	5.81	.63	2.51	"
C 25	8	11.25	3.35	.22	2.26	10
"	"	13.75	4.04	.31	2.35	"
"	"	16.25	4.78	.40	2.44	"
"	"	18.75	5.51	.49	2.53	"
"	"	21.25	6.25	.58	2.62	"
C 29	9	13.25	3.89	.23	2.43	10
"	"	15.00	4.41	.29	2.49	"
"	"	20.00	5.88	.45	2.65	"
"	"	25.00	7.35	.61	2.81	"
C 33	10	15.0	4.46	.24	2.60	10
"	"	20.0	5.88	.38	2.74	"
"	"	25.0	7.35	.53	2.89	"
"	"	30.0	8.82	.68	3.04	"
"	"	35.0	10.29	.82	3.18	"
C 41	12	20.5	6.03	.28	2.94	10
"	"	25.0	7.35	.39	3.05	"
"	"	30.0	8.82	.51	3.17	"
"	"	35.0	10.29	.64	3.30	"
"	"	40.0	11.76	.76	3.42	"

WEIGHTS AND DIMENSIONS OF STANDARD CHANNELS.

Section Number.	Depth of Channel. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. Ins.	Thickness of Web. Inches.	Width of Flange. Inches.	Page Number of Section.
C 53	15	33.0	9.90	.40	3.40	11
"	"	35.0	10.29	.43	3.43	"
"	"	40.0	11.76	.52	3.52	"
"	"	45.0	13.24	.62	3.62	"
"	"	50.0	14.71	.72	3.72	"
"	"	55.0	16.18	.82	3.82	"

WEIGHTS AND DIMENSIONS OF SPECIAL CHANNELS.

Section Number.	Depth of Channel. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.	Thickness of Web. Inches.	Width of Flange. Inches.	Thickness of Flange. Inches.	Increase in Web and Flange for each pound increase of weight. Inches.	Page Number of Section.
C 87	6	14.0	4.11	.28	2.96	.41	.049	11
"	"	17.0	5.00	.43	3.11	"	"	"
"	"	20.0	5.88	.58	3.26	"	"	"
C 91	12	21.4	6.30	.31	2.64	.34	.024	11
"	"	23.9	7.03	.37	2.70	"	"	"
"	"	26.4	7.77	.44	2.76	"	"	"
"	"	28.9	8.50	.50	2.82	"	"	"
"	"	31.4	9.24	.56	2.89	"	"	"
"	"	33.9	9.97	.62	2.95	"	"	"
	Width of Base.	**TROUGH CHANNELS.**						
C 75	5	15.2	4.46	.50	4.29	.24		18
C 79	"	23.5	6.91	.75	4.50	.375		"
C 83	"	19.3	5.68	.50	4.50	.375		"

WEIGHTS AND DIMENSIONS BULB BEAMS.

Section Number.	Depth of Beam. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.	Thickness of Web. Inches.	Width of Flange. Inches.	Diameter of Head. Inches.	Page Number of Section.
B 171	$5\frac{7}{32}$	11.4	3.36	$\frac{3}{8}$	$2\frac{7}{8}$	1	18
B 173	6	14.1	4.15	$\frac{9}{32}$	$4\frac{3}{8}$		"
"	"	15.3	4.50	$\frac{11}{32}$	$4\frac{7}{16}$		"
"	"	18.4	5.41	$\frac{1}{2}$	$4\frac{19}{32}$		"
B 175	$6\frac{1}{4}$	13.2	3.87	$\frac{5}{16}$	$2\frac{15}{16}$	$1\frac{1}{4}$	"

WEIGHTS AND DIMENSIONS OF STANDARD ANGLES.

EQUAL LEGS.

Section Number	Dimensions.	Thick-ness.	Weight per Foot.	Area of Section.	Section Number	Dimensions.	Thick-ness.	Weight per Foot.	Area of Section.
	Inches.	Inches.	Pounds.	Sq. In.		Inches.	Inches.	Pounds.	Sq. In.
A 5	3/4 x 3/4	1/8	.58	.17	A 19	3 x 3	1/4	4.9	1.44
"	3/4 x 3/4	3/16	.84	.25	"	3 x 3	5/16	6.0	1.78
					"	3 x 3	3/8	7.2	2.11
A 7	1 x 1	1/8	.80	.23	"	3 x 3	7/16	8.3	2.43
"	1 x 1	3/16	1.16	.34	"	3 x 3	1/2	9.4	2.75
"	1 x 1	1/4	1.49	.44	"	3 x 3	9/16	10.4	3.06
					"	3 x 3	5/8	11.4	3.36
A 9	1¼ x 1¼	1/8	1.02	.30					
"	1¼ x 1¼	3/16	1.47	.43	A 21	3½ x 3½	3/8	8.4	2.48
"	1¼ x 1¼	1/4	1.91	.56	"	3½ x 3½	7/16	9.8	2.87
"	1¼ x 1¼	5/16	2.32	.68	"	3½ x 3½	1/2	11.1	3.25
					"	3½ x 3½	9/16	12.3	3.62
A 11	1½ x 1½	3/16	1.79	.53	"	3½ x 3½	5/8	13.5	3.98
"	1½ x 1½	1/4	2.34	.69	"	3½ x 3½	11/16	14.8	4.34
"	1½ x 1½	5/16	2.86	.84	"	3½ x 3½	3/4	15.9	4.69
"	1½ x 1½	3/8	3.35	.98	"	3½ x 3½	13/16	17.1	5.03
A 13	1¾ x 1¾	3/16	2.11	.62	A 23	4 x 4	5/16	8.2	2.40
"	1¾ x 1¾	1/4	2.77	.81	"	4 x 4	3/8	9.7	2.86
"	1¾ x 1¾	5/16	3.39	1.00	"	4 x 4	7/16	11.2	3.31
"	1¾ x 1¾	3/8	3.98	1.17	"	4 x 4	1/2	12.8	3.75
"	1¾ x 1¾	7/16	4.56	1.34	"	4 x 4	9/16	14.2	4.18
					"	4 x 4	5/8	15.7	4.61
A 15	2 x 2	3/16	2.43	.71	"	4 x 4	11/16	17.1	5.03
"	2 x 2	1/4	3.19	.94	"	4 x 4	3/4	18.5	5.44
"	2 x 2	5/16	3.92	1.15	"	4 x 4	13/16	19.9	5.84
"	2 x 2	3/8	4.62	1.36					
"	2 x 2	7/16	5.30	1.56	A 27	6 x 6	7/16	17.2	5.06
					"	6 x 6	1/2	19.6	5.75
A 17	2½ x 2½	1/4	4.0	1.19	"	6 x 6	9/16	21.9	6.43
"	2½ x 2½	5/16	5.0	1.46	"	6 x 6	5/8	24.2	7.11
"	2½ x 2½	3/8	5.9	1.73	"	6 x 6	11/16	26.4	7.78
"	2½ x 2½	7/16	6.8	2.00	"	6 x 6	3/4	28.7	8.44
"	2½ x 2½	1/2	7.7	2.25	"	6 x 6	13/16	30.9	9.09
....	......	....	....	....	"	6 x 6	7/8	33.1	9.73

Standard Angles vary only by 1/16 inch. Sections shown on page 12.

WEIGHTS AND DIMENSIONS OF STANDARD ANGLES.

UNEQUAL LEGS.

Section Number	Dimensions. Inches.	Thickness. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.
A 91	$2\frac{1}{2} \times 2$	$\frac{3}{16}$	2.8	.81
"	$2\frac{1}{2} \times 2$	$\frac{1}{4}$	3.6	1.06
"	$2\frac{1}{2} \times 2$	$\frac{5}{16}$	4.5	1.31
"	$2\frac{1}{2} \times 2$	$\frac{3}{8}$	5.3	1.55
"	$2\frac{1}{2} \times 2$	$\frac{7}{16}$	6.0	1.78
"	$2\frac{1}{2} \times 2$	$\frac{1}{2}$	6.8	2.00
A 93	$3 \times 2\frac{1}{2}$	$\frac{1}{4}$	4.5	1.31
"	$3 \times 2\frac{1}{2}$	$\frac{5}{16}$	5.5	1.62
"	$3 \times 2\frac{1}{2}$	$\frac{3}{8}$	6.5	1.92
"	$3 \times 2\frac{1}{2}$	$\frac{7}{16}$	7.5	2.21
"	$3 \times 2\frac{1}{2}$	$\frac{1}{2}$	8.5	2.50
"	$3 \times 2\frac{1}{2}$	$\frac{9}{16}$	9.4	2.78
A 95	$3\frac{1}{2} \times 2\frac{1}{2}$	$\frac{1}{4}$	4.9	1.44
"	$3\frac{1}{2} \times 2\frac{1}{2}$	$\frac{5}{16}$	6.0	1.78
"	$3\frac{1}{2} \times 2\frac{1}{2}$	$\frac{3}{8}$	7.2	2.11
"	$3\frac{1}{2} \times 2\frac{1}{2}$	$\frac{7}{16}$	8.3	2.43
"	$3\frac{1}{2} \times 2\frac{1}{2}$	$\frac{1}{2}$	9.4	2.75
"	$3\frac{1}{2} \times 2\frac{1}{2}$	$\frac{9}{16}$	10.4	3.06
"	$3\frac{1}{2} \times 2\frac{1}{2}$	$\frac{5}{8}$	11.4	3.36
"	$3\frac{1}{2} \times 2\frac{1}{2}$	$\frac{11}{16}$	12.4	3.65
A 97	$3\frac{1}{2} \times 3$	$\frac{5}{16}$	6.6	1.93
"	$3\frac{1}{2} \times 3$	$\frac{3}{8}$	7.8	2.30
"	$3\frac{1}{2} \times 3$	$\frac{7}{16}$	9.0	2.65
"	$3\frac{1}{2} \times 3$	$\frac{1}{2}$	10.2	3.00
"	$3\frac{1}{2} \times 3$	$\frac{9}{16}$	11.4	3.34
"	$3\frac{1}{2} \times 3$	$\frac{5}{8}$	12.5	3.67
"	$3\frac{1}{2} \times 3$	$\frac{11}{16}$	13.6	4.00
"	$3\frac{1}{2} \times 3$	$\frac{3}{4}$	14.7	4.31
"	$3\frac{1}{2} \times 3$	$\frac{13}{16}$	15.7	4.62
A 99	4×3	$\frac{5}{16}$	7.1	2.09
"	4×3	$\frac{3}{8}$	8.5	2.48
"	4×3	$\frac{7}{16}$	9.8	2.87

Section Number	Dimensions. Inches.	Thickness. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.
A 99	4×3	$\frac{1}{2}$	11.1	3.25
"	4×3	$\frac{9}{16}$	12.3	3.62
"	4×3	$\frac{5}{8}$	13.6	3.98
"	4×3	$\frac{11}{16}$	14.8	4.34
"	4×3	$\frac{3}{4}$	15.9	4.69
"	4×3	$\frac{13}{16}$	17.1	5.03
A 101	5×3	$\frac{5}{16}$	8.2	2.40
"	5×3	$\frac{3}{8}$	9.7	2.86
"	5×3	$\frac{7}{16}$	11.3	3.31
"	5×3	$\frac{1}{2}$	12.8	3.75
"	5×3	$\frac{9}{16}$	14.2	4.18
"	5×3	$\frac{5}{8}$	15.7	4.61
"	5×3	$\frac{11}{16}$	17.1	5.03
"	5×3	$\frac{3}{4}$	18.5	5.44
"	5×3	$\frac{13}{16}$	19.9	5.84
A 103	$5 \times 3\frac{1}{2}$	$\frac{3}{8}$	10.4	3.05
"	$5 \times 3\frac{1}{2}$	$\frac{7}{16}$	12.0	3.53
"	$5 \times 3\frac{1}{2}$	$\frac{1}{2}$	13.6	4.00
"	$5 \times 3\frac{1}{2}$	$\frac{9}{16}$	15.2	4.46
"	$5 \times 3\frac{1}{2}$	$\frac{5}{8}$	16.7	4.92
"	$5 \times 3\frac{1}{2}$	$\frac{11}{16}$	18.3	5.37
"	$5 \times 3\frac{1}{2}$	$\frac{3}{4}$	19.8	5.81
"	$5 \times 3\frac{1}{2}$	$\frac{13}{16}$	21.2	6.25
"	$5 \times 3\frac{1}{2}$	$\frac{7}{8}$	22.7	6.67
A 105	$6 \times 3\frac{1}{2}$	$\frac{3}{8}$	11.6	3.42
"	$6 \times 3\frac{1}{2}$	$\frac{7}{16}$	13.5	3.96
"	$6 \times 3\frac{1}{2}$	$\frac{1}{2}$	15.3	4.50
"	$6 \times 3\frac{1}{2}$	$\frac{9}{16}$	17.1	5.03
"	$6 \times 3\frac{1}{2}$	$\frac{5}{8}$	18.9	5.55
"	$6 \times 3\frac{1}{2}$	$\frac{11}{16}$	20.6	6.06
"	$6 \times 3\frac{1}{2}$	$\frac{3}{4}$	22.3	6.56
"	$6 \times 3\frac{1}{2}$	$\frac{13}{16}$	24.0	7.06
"	$6 \times 3\frac{1}{2}$	$\frac{7}{8}$	25.7	7.55

Standard Angles vary only by $\frac{1}{16}$ inch. Sections shown on page 14.

WEIGHTS AND DIMENSIONS OF STANDARD ANGLES.

UNEQUAL LEGS.—Continued.

Section Number	Dimensions. Inches.	Thickness. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.	Section Number	Dimensions. Inches.	Thickness. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.
A 107	6 x 4	3/8	12.3	3.61	A 107	6 x 4	11/16	21.8	6.40
"	6 x 4	7/16	14.2	4.18	"	6 x 4	3/4	23.6	6.94
"	6 x 4	1/2	16.2	4.75	"	6 x 4	13/16	25.4	7.46
"	6 x 4	9/16	18.1	5.31	"	6 x 4	7/8	27.2	7.98
"	6 x 4	5/8	19.9	5.86	....	......	...	....	....

Standard Angles vary only by 1/16 inch. Sections shown on page 14.

WEIGHTS AND DIMENSIONS OF SPECIAL ANGLES.

EQUAL LEGS.

Section Number	Dimensions. Inches.	Thickness. Inches.	Weight per Foot. Pounds	Area of Section. Sq. In.	Section Number	Dimensions. Inches.	Thickness. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.
A 41	2¼ x 2¼	3/16	2.7	.81	A 47	5 x 5	3/8	12.3	3.61
"	2¼ x 2¼	1/4	3.6	1.06	"	5 x 5	7/16	14.2	4.18
"	2¼ x 2¼	5/16	4.4	1.31	"	5 x 5	1/2	16.2	4.75
"	2¼ x 2¼	3/8	5.3	1.55	"	5 x 5	9/16	18.0	5.31
					"	5 x 5	5/8	19.9	5.86
A 43	2¾ x 2¾	3/16	3.4	1.00					
"	2¾ x 2¾	1/4	4.5	1.31	A 61	1½ x 1½	1/8	1.23	.36
"	2¾ x 2¾	5/16	5.5	1.62	"	1½ x 1½	3/16	1.80	.53
"	2¾ x 2¾	3/8	6.5	1.92					
"	2¾ x 2¾	7/16	7.5	2.21	A 65	1½ x 1½	7/32	2.07	.61
A 45	4½ x 4½	5/16	9.2	2.71	A 67	2¼ x 2¼	5/16	4.3	1.27
"	4½ x 4½	3/8	11.0	3.23					
"	4½ x 4½	7/16	12.7	3.75	A 193	6 x 5	3/8	16.5	4.85
"	4½ x 4½	1/2	14.5	4.25	....	......	....	....	....
"	4½ x 4½	9/16	16.1	4.75	....	......	....	....	....
"	4½ x 4½	5/8	17.8	5.23	....	......	....	....	....

Sections shown on page 13.

WEIGHTS AND DIMENSIONS OF SPECIAL ANGLES.

UNEQUAL LEGS.

Section Number	Dimensions. Inches.	Thickness. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.	Section Number	Dimensions. Inches.	Thickness. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.
A 121	2 x $1\frac{3}{8}$	$\frac{3}{16}$	2.03	.60	A 131	4 x $3\frac{1}{2}$	$\frac{5}{16}$	7.6	2.25
"	2 x $1\frac{3}{8}$	$\frac{1}{4}$	2.66	.78	"	4 x $3\frac{1}{2}$	$\frac{3}{8}$	9.1	2.67
"	2 x $1\frac{3}{8}$	$\frac{5}{16}$	3.25	.96	"	4 x $3\frac{1}{2}$	$\frac{7}{16}$	10.5	3.09
"	2 x $1\frac{3}{8}$	$\frac{3}{8}$	3.83	1.13	"	4 x $3\frac{1}{2}$	$\frac{1}{2}$	11.9	3.50
					"	4 x $3\frac{1}{2}$	$\frac{9}{16}$	13.3	3.90
A 123	2 x $1\frac{1}{2}$	$\frac{3}{16}$	2.11	.62	"	4 x $3\frac{1}{2}$	$\frac{5}{8}$	14.6	4.30
"	2 x $1\frac{1}{2}$	$\frac{1}{4}$	2.76	.81					
"	2 x $1\frac{1}{2}$	$\frac{5}{16}$	3.39	1.00	A 133	$4\frac{1}{2}$ x 3	$\frac{3}{8}$	9.1	2.67
"	2 x $1\frac{1}{2}$	$\frac{3}{8}$	3.98	1.17	"	$4\frac{1}{2}$ x 3	$\frac{7}{16}$	10.5	3.09
					"	$4\frac{1}{2}$ x 3	$\frac{1}{2}$	11.9	3.50
A 155	$2\frac{5}{16}$ x $1\frac{5}{16}$	$\frac{11}{64}$	2.02	.59	"	$4\frac{1}{2}$ x 3	$\frac{9}{16}$	13.3	3.90
					"	$4\frac{1}{2}$ x 3	$\frac{5}{8}$	14.6	4.30
A 125	$2\frac{1}{2}$ x $1\frac{1}{4}$	$\frac{3}{16}$	2.27	.67					
"	$2\frac{1}{2}$ x $1\frac{1}{4}$	$\frac{1}{4}$	2.98	.88	A 135	5 x 4	$\frac{3}{8}$	11.0	3.23
"	$2\frac{1}{2}$ x $1\frac{1}{4}$	$\frac{5}{16}$	3.65	1.07	"	5 x 4	$\frac{7}{16}$	12.7	3.75
"	$2\frac{1}{2}$ x $1\frac{1}{4}$	$\frac{3}{8}$	4.30	1.27	"	5 x 4	$\frac{1}{2}$	14.5	4.25
					"	5 x 4	$\frac{9}{16}$	16.1	4.75
A 127	$2\frac{1}{2}$ x $1\frac{1}{2}$	$\frac{3}{16}$	2.43	.71	"	5 x 4	$\frac{5}{8}$	17.8	5.23
"	$2\frac{1}{2}$ x $1\frac{1}{2}$	$\frac{1}{4}$	3.19	.94					
"	$2\frac{1}{2}$ x $1\frac{1}{2}$	$\frac{5}{16}$	3.92	1.15	A 137	$5\frac{5}{8}$ x 5	$\frac{7}{16}$	15.2	4.46
"	$2\frac{1}{2}$ x $1\frac{1}{2}$	$\frac{3}{8}$	4.62	1.36	"	$5\frac{5}{8}$ x 5	$\frac{1}{2}$	17.2	5.06
					"	$5\frac{5}{8}$ x 5	$\frac{9}{16}$	19.2	5.66
A 161	$2\frac{1}{2}$ x $1\frac{3}{4}$	$\frac{3}{16}$	2.6	.76	"	$5\frac{5}{8}$ x 5	$\frac{5}{8}$	21.3	6.25
"	$2\frac{1}{2}$ x $1\frac{3}{4}$	$\frac{1}{4}$	3.4	1.00	"	$5\frac{5}{8}$ x 5	$\frac{11}{16}$	23.2	6.83
A 129	3 x 2	$\frac{3}{16}$	3.1	.90	....	....	....	....	....
"	3 x 2	$\frac{1}{4}$	4.0	1.19	....	....	....	....	....
"	3 x 2	$\frac{5}{16}$	5.0	1.46	....	....	....	....	....
"	3 x 2	$\frac{3}{8}$	5.9	1.73	....	....	....	....	....
"	3 x 2	$\frac{7}{16}$	6.8	2.00	....	....	....	....	....

Sections shown on page 15.

WEIGHTS AND DIMENSIONS OF
REGULAR T-BARS.
EQUAL LEGS.

Section Number	Width of Flange. Inches.	Depth of Bar. Inches.	Thickness of Flange. Inches.	Thickness of Stem. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.	Page Number of Section.
T 5	1	1	$\frac{1}{8}$ to $\frac{5}{32}$	$\frac{1}{8}$ to $\frac{5}{32}$	0.89	.26	20 A
T 181	$1\frac{1}{8}$	$1\frac{1}{8}$	$\frac{3}{16}$ " $\frac{7}{32}$	$\frac{5}{32}$ " $\frac{7}{32}$	1.39	.41	19
T 183	$1\frac{3}{16}$	$1\frac{3}{16}$	$\frac{3}{16}$ " $\frac{1}{4}$	$\frac{5}{32}$ " $\frac{7}{32}$	1.53	.45	"
T 187	$1\frac{1}{4}$	$1\frac{1}{4}$	$\frac{3}{16}$ " $\frac{1}{4}$	$\frac{5}{32}$ " $\frac{1}{4}$	1.61	.47	"
T 189	$1\frac{3}{8}$	$1\frac{3}{8}$	$\frac{3}{16}$ " $\frac{1}{4}$	$\frac{5}{32}$ " $\frac{1}{4}$	1.85	.54	"
T 37	2	2	$\frac{1}{4}$ " $\frac{5}{16}$	$\frac{1}{4}$ " $\frac{5}{16}$	3.7	1.05	20 A
T 39	2	2	$\frac{5}{16}$ " $\frac{3}{8}$	$\frac{5}{16}$ " $\frac{3}{8}$	4.3	1.26	"
T 41	$2\frac{1}{4}$	$2\frac{1}{4}$	$\frac{1}{4}$ " $\frac{5}{16}$	$\frac{1}{4}$ " $\frac{5}{16}$	4.1	1.19	"
T 69	3	3	$\frac{3}{8}$ " $\frac{7}{16}$	$\frac{3}{8}$ " $\frac{7}{16}$	7.8	2.27	"
T 97	$3\frac{1}{2}$	$3\frac{1}{2}$	$\frac{3}{8}$ " $\frac{7}{16}$	$\frac{3}{8}$ " $\frac{7}{16}$	9.3	2.74	19

WEIGHTS AND DIMENSIONS OF
REGULAR T-BARS.
UNEQUAL LEGS.

Section Number.	Width of Flange. Inches.	Depth of Bar. Inches.	Thickness of Flange. Inches.	Thickness of Stem. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.	Page Number of Section.
T 185	$1\frac{1}{4}$	$1\frac{1}{16}$	$\frac{3}{16}$ to $\frac{1}{4}$	$\frac{5}{32}$ to $\frac{7}{32}$	1.49	.44	19
T 65	3	$2\frac{1}{2}$	$\frac{3}{8}$ " $\frac{7}{16}$	$\frac{3}{8}$ " $\frac{7}{16}$	7.2	2.07	20 A
T 101	$3\frac{1}{2}$	4	$\frac{3}{8}$ " $\frac{7}{16}$	$\frac{3}{8}$ " $\frac{7}{16}$	9.9	2.91	19

WEIGHTS AND DIMENSIONS OF
MISCELLANEOUS T-BARS.

Section Number.	Width of Flange. Inches.	Depth of Bar. Inches.	Weight per Foot. Pounds.	Area of Section. Sq. In.	Page Number of Section.
T 161	3	$3\frac{1}{16}$	8.3	2.43	19
T 163	3	$3\frac{1}{8}$	8.6	2.53	"
T 165	4	$3\frac{1}{8}$	11.0	3.24	"
T 167	4	3	10.7	3.15	"
T 171	3	$2\frac{1}{4}$	7.1	2.10	"

WEIGHTS AND DIMENSIONS OF

Z-BARS.

Section Number.	Depth of Bar.	Length of Legs.	Thickness of Web and Legs.	Weight per Foot.	Area of Section.	Page Number of Section.
	Inches.	Inches.	Inches.	Pounds.	Sq. Ins.	
Z 5	3	$2\frac{11}{16}$	$\frac{1}{4}$	6.7	1.97	16
"	$3\frac{1}{16}$	$2\frac{3}{4}$	$\frac{5}{16}$	8.4	2.48	"
Z 9	3	$2\frac{11}{16}$	$\frac{3}{8}$	9.7	2.86	16
"	$3\frac{1}{16}$	$2\frac{3}{4}$	$\frac{7}{16}$	11.4	3.36	"
Z 13	3	$2\frac{11}{16}$	$\frac{1}{2}$	12.5	3.69	16
"	$3\frac{1}{16}$	$2\frac{3}{4}$	$\frac{9}{16}$	14.2	4.18	"
Z 21	4	$3\frac{1}{16}$	$\frac{1}{4}$	8.2	2.41	16
"	$4\frac{1}{16}$	$3\frac{1}{8}$	$\frac{5}{16}$	10.3	3.03	"
"	$4\frac{1}{8}$	$3\frac{3}{16}$	$\frac{3}{8}$	12.4	3.66	"
Z 25	4	$3\frac{1}{16}$	$\frac{7}{16}$	13.8	4.05	16
"	$4\frac{1}{16}$	$3\frac{1}{8}$	$\frac{1}{2}$	15.8	4.66	"
"	$4\frac{1}{8}$	$3\frac{3}{16}$	$\frac{9}{16}$	17.9	5.27	"
Z 29	4	$3\frac{1}{16}$	$\frac{5}{8}$	18.9	5.55	16
"	$4\frac{1}{16}$	$3\frac{1}{8}$	$\frac{11}{16}$	20.9	6.14	"
"	$4\frac{1}{8}$	$3\frac{3}{16}$	$\frac{3}{4}$	23.0	6.75	"
Z 37	5	$3\frac{1}{4}$	$\frac{5}{16}$	11.6	3.40	17
"	$5\frac{1}{16}$	$3\frac{5}{16}$	$\frac{3}{8}$	13.9	4.10	"
"	$5\frac{1}{8}$	$3\frac{3}{8}$	$\frac{7}{16}$	16.4	4.81	"
Z 41	5	$3\frac{1}{4}$	$\frac{1}{2}$	17.9	5.25	17
"	$5\frac{1}{16}$	$3\frac{5}{16}$	$\frac{9}{16}$	20.2	5.94	"
"	$5\frac{1}{8}$	$3\frac{3}{8}$	$\frac{5}{8}$	22.6	6.64	"
Z 45	5	$3\frac{1}{4}$	$\frac{11}{16}$	23.7	6.96	17
"	$5\frac{1}{16}$	$3\frac{5}{16}$	$\frac{3}{4}$	26.0	7.64	"
"	$5\frac{1}{8}$	$3\frac{3}{8}$	$\frac{13}{16}$	28.3	8.33	"
Z 53	6	$3\frac{1}{2}$	$\frac{3}{8}$	15.6	4.59	17
"	$6\frac{1}{16}$	$3\frac{9}{16}$	$\frac{7}{16}$	18.3	5.39	"
"	$6\frac{1}{8}$	$3\frac{5}{8}$	$\frac{1}{2}$	21.0	6.19	"
Z 57	6	$3\frac{1}{2}$	$\frac{9}{16}$	22.7	6.68	17
"	$6\frac{1}{16}$	$3\frac{9}{16}$	$\frac{5}{8}$	25.4	7.46	"
"	$6\frac{1}{8}$	$3\frac{5}{8}$	$\frac{11}{16}$	28.1	8.25	"
Z 61	6	$3\frac{1}{2}$	$\frac{3}{4}$	29.3	8.63	17
"	$6\frac{1}{16}$	$3\frac{9}{16}$	$\frac{13}{16}$	31.9	9.39	"
"	$6\frac{1}{8}$	$3\frac{5}{8}$	$\frac{7}{8}$	34.6	10.17	"

STANDARD CONNECTION ANGLES FOR I-BEAMS AND CHANNELS.

Standard angle connections for all sizes of beams and channels are shown on page 40. These are of sufficient strength for all usual connections of the various sizes shown, figured on the basis of 10,000 pounds per square inch, as the allowable unit stress for single shear of rivets or bolts, and 20,000 pounds per square inch as the allowable unit stress for double shear, and bearing value of the parts connected by the rivets.

When beams of very short spans are loaded to their full capacity, the end shear or reaction which has to be transmitted through the connections becomes so great that stronger connections than the standard should be used.

The following tables give the limits of length below which the standard connections do not apply and for which special designs should be made. For all lengths greater than those given in the tables the standard connections are sufficiently strong.

MINIMUM SPANS OF STANDARD CHANNELS FOR WHICH STANDARD CONNECTION ANGLES MAY BE SAFELY USED WITH CHANNELS UNIFORMLY LOADED TO THEIR FULL CAPACITY, IN ACCORDANCE WITH TABLES OF SAFE LOADS, FOR FIBER STRESS OF 16000 LBS. PER SQUARE INCH.

Section Number	Depth of Channel	Weight per Foot.	Minimum Safe Span.
	Inches.	Pounds.	Feet.
C 5	3	4.0	1.2
"	"	5.0	.9
"	"	6.0	.7
C 9	4	5.25	1.9
"	"	6.25	1.5
"	"	7.25	1.3
C13	5	6.5	2.8
"	"	9.0	2.0
"	"	11.5	1.6
C17	6	8.0	3.9
"	"	10.5	2.9
"	"	13.0	2.4
"	"	15.5	2.1
C21	7	9.75	5.1

Section Number	Depth of Channel	Weight per Foot.	Minimum Safe Span.
	Inches.	Pounds.	Feet.
C21	7	12.25	3.9
"	"	14.75	3.3
"	"	17.25	2.9
"	"	19.75	2.9
C25	8	11.25	6.6
"	"	13.75	5.3
"	"	16.25	4.5
"	"	18.75	4.0
"	"	21.25	3.7
C29	9	13.25	8.2
"	"	15.00	7.0
"	"	20.00	5.4
"	"	25.00	4.8
C33	10	15.0	9.9
"	"	20.0	7.4

Section Number	Depth of Channel	Weight per Foot.	Minimum Safe Span.
	Inches.	Pounds.	Feet.
C33	10	25.0	6.2
"	"	30.0	6.3
"	"	35.0	7.0
C41	12	20.5	9.1
"	"	25.0	7.3
"	"	30.0	6.3
"	"	35.0	6.1
"	"	40.0	6.6
C53	15	33.0	12.4
"	"	35.0	11.9
"	"	40.0	10.5
"	"	45.0	10.1
"	"	50.0	10.8
"	"	55.0	11.6

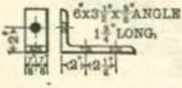
MINIMUM SPANS OF I-BEAMS FOR WHICH STANDARD CONNECTION ANGLES MAY BE SAFELY USED WITH I-BEAMS UNIFORMLY LOADED TO THEIR FULL CAPACITY, IN ACCORDANCE WITH TABLES OF SAFE LOADS, FOR FIBER STRESS OF 16 000 LBS. PER SQUARE INCH.

Section Number	Depth of Beam. Inches.	Weight per Foot. Pounds.	Minimum Safe Span. Feet.	Section Number	Depth of Beam. Inches.	Weight per Foot. Pounds.	Minimum Safe Span. Feet.	Section Number	Depth of Beam. Inches.	Weight per Foot. Pounds.	Minimum Safe Span. Feet.
B 5	3	5.5	1.8	B29	9	30.0	4.8	B113	15	80.0	12.7
"	"	6.5	1.3	"	"	35.0	5.0	"	"	85.0	13.2
"	"	7.5	1.0					"	"	90.0	13.6
				B33	10	25.0	9.4	"	"	95.0	14.1
B 9	4	7.5	2.8	"	"	30.0	7.0	"	"	100.0	14.5
"	"	8.5	2.2	"	"	35.0	5.9				
"	"	9.5	1.8	"	"	40.0	6.4	B65	18	55.0	13.7
"	"	10.5	1.6					"	"	60.0	12.0
				B41	12	31.5	7.3	"	"	65.0	11.9
B13	5	9.75	4.1	"	"	35.0	6.2	"	"	70.0	12.4
"	"	12.25	2.8	"	"	40.0	5.3				
"	"	14.75	2.2					B73	20	65.0	16.7
				B105	12	40.0	7.0	"	"	70.0	15.1
B17	6	12.25	5.7	"	"	45.0	5.9	"	"	75.0	15.4
"	"	14.75	4.1	"	"	50.0	6.1				
"	"	17.25	3.3	"	"	55.0	6.5	B121	20	80.0	17.7
								"	"	85.0	18.3
B21	7	15.0	4.9	B53	15	42.0	10.3	"	"	90.0	1.88
"	"	17.5	3.8	"	"	45.0	9.4	"	"	95.0	19.4
"	"	20.0	3.2	"	"	50.0	8.3	"	"	100.0	20.0
				"	"	55.0	8.3				
B25	8	17.75	6.3	"	"	60.0	8.7	B89	24	80.0	20.7
"	"	20.25	5.2					"	"	85.0	18.8
"	"	22.75	4.4	B109	15	60.0	9.8	"	"	90.0	18.8
"	"	25.25	3.8	"	"	65.0	10.3	"	"	95.0	19.4
				"	"	70.0	10.7	"	"	100.0	20.0
B29	9	21.0	7.8	"	"	75.0	11.2				
"	"	25.0	6.0	"	"	80.0	11.6				

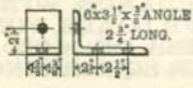
STANDARD CONNECTION ANGLES

I-BEAMS.

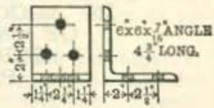
For 3″ Standard.
" 4″ Standard.



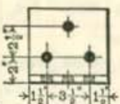
For 5″ Standard.
" 6″ Standard.



For 7″ Standard.
" 8″ Standard.
" 9″ Standard.

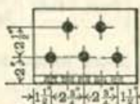


For 10″ Standard.



6″x6″x7/16″ ANGLE-6½″ LONG.

For 12″ Standard.
" 12″ Special.

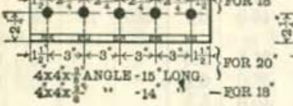


6″x6″x7/16″ ANGLE-8½″ LONG.

For 15″ Standard.
" 15″ Special.

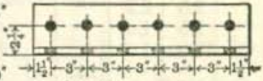
6″x6″x7/16″ ANGLE-10″ LONG.

For 18″ Standard.
" 20″ Standard.
" 20″ Special.



4″x4″x⅜″ ANGLE-15″ LONG.
4″x4″x⅜″ " -14″ " —FOR 18″

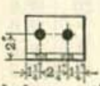
For 24″ Standard.



4″x4″x⅜″ ANGLE-18″ LONG.

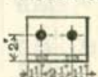
CHANNELS.

For 7″ Standard.



3½″x3½″x⅜″ ANGLE-4¾″ LONG.

For 8″ Standard.
9″ Standard.



3½″x3½″x⅜″ ANGLE-5″ LONG.

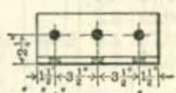
For 10″ Standard.

3½″x3½″x⅜″ ANGLE-6½″ LONG.

For 12″ Standard.

4″x4″x⅜″ ANGLE-8½″ LONG.

For 15″ Standard.

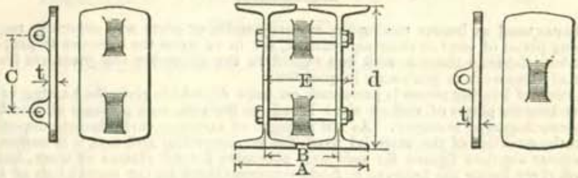


4″x4″x⅜″ ANGLE-10″ LONG.

Connections for 3″, 4″, 5″ and 6″ I-Beams apply also to Channels.

All Bolts or Rivets to be ¾″.

CAST IRON SEPARATORS FOR I-BEAMS.



SEPARATORS WITH ONE BOLT.

Section Number	Beams. Depth. d In.	Weight per Foot. Pounds.	Out to Out of Flanges of Beams. A Inches.	Center to Center of Beams. B Inches.	Separators. Thickness. t In.	Weight. Pounds.	Increase of Weight for each inch additional spread of Beams. Pounds.	Bolts, Square Heads and Hex Nuts. Diameter. In.	Center to Center of Bolts. C In.	Length. E In.	Weight of Bolts and Nuts. Pounds.	Increase of Weight of Bolts for each in. additional spread of Beams. Pounds
B 5	3	5.5	$5\frac{5}{16}$	3	$\frac{3}{8}$	1.1	.29	$\frac{5}{8}$		$3\frac{7}{8}$	.94	.085
B 9	4	7.5	$5\frac{7}{8}$	$3\frac{1}{4}$	"	1.6	.38	$\frac{3}{4}$		$4\frac{1}{4}$	.98	.123
B 13	5	9.75	$6\frac{1}{2}$	$3\frac{1}{2}$	"	2.0	.49	"		$4\frac{1}{2}$	1.01	"
B 17	6	12.25	$7\frac{5}{16}$	4	$\frac{1}{2}$	3.3	.78	"		5	1.07	"
B 21	7	15.0	$7\frac{7}{8}$	$4\frac{1}{4}$	"	3.9	.92	"		$5\frac{1}{4}$	1.10	"
B 25	8	17.75	$8\frac{1}{2}$	$4\frac{1}{2}$	"	4.7	1.06	"		$5\frac{5}{8}$	1.15	"
B 29	9	21.0	$9\frac{5}{16}$	5	"	5.9	1.20	"		$6\frac{1}{8}$	1.21	"
B 33	10	25.0	$9\frac{7}{8}$	$5\frac{1}{4}$	"	6.8	1.33	"		$6\frac{3}{8}$	1.24	"
B 41	12	31.5	$10\frac{3}{4}$	$5\frac{3}{4}$	"	8.8	1.61	"		$6\frac{7}{8}$	1.30	"
B105	12	40.0	$11\frac{1}{4}$	6	"	8.9	1.58	"		$7\frac{1}{4}$	1.35	"

SEPARATORS WTH TWO BOLTS.

Section Number	Beams. Depth. d In.	Weight per Foot. Pounds.	Out to Out of Flanges of Beams. A Inches.	Center to Center of Beams. B Inches.	Separators. Thickness. t In.	Weight. Pounds.	Increase of Weight for each inch additional spread of Beams. Pounds.	Bolts, Square Heads and Hex Nuts. Diameter. In.	Center to Center of Bolts. C In.	Length. E In.	Weight of Bolts and Nuts. Pounds.	Increase of Weight of Bolts for each in. additional spread of Beams. Pounds
B 41	12	31.5	$10\frac{3}{4}$	$5\frac{3}{4}$	$\frac{1}{2}$	9.5	1.61	$\frac{3}{4}$	$6\frac{1}{2}$	$6\frac{7}{8}$	2.61	.246
B105	12	40.0	$11\frac{1}{4}$	6	"	9.5	1.58	"	"	$7\frac{1}{4}$	2.70	"
B 53	15	42.0	$11\frac{3}{4}$	$6\frac{1}{4}$	"	12.5	2.02	"	7	$7\frac{1}{2}$	2.76	"
B109	15	60.0	$12\frac{3}{4}$	$6\frac{3}{4}$	"	13.0	1.97	"	"	$8\frac{1}{8}$	2.92	"
B113	15	80.0	$13\frac{3}{8}$	$7\frac{1}{4}$	"	13.2	1.91	"	"	$8\frac{7}{8}$	3.10	"
B 65	18	55.0	$12\frac{3}{4}$	$6\frac{3}{4}$	$\frac{5}{8}$	19.8	2.41	"	9	8	2.89	"
B 73	20	65.0	$13\frac{1}{4}$	7	"	22.9	3.37	$\frac{7}{8}$	10	$8\frac{3}{8}$	4.20	.334
B121	20	80.0	$14\frac{3}{4}$	$7\frac{3}{4}$	"	24.6	3.34	"	"	$9\frac{1}{4}$	4.49	"
B 89	24	80.0	$14\frac{3}{4}$	$7\frac{3}{4}$	"	30.3	4.07	"	12	$9\frac{1}{8}$	4.45	"

Lengths and weights of separator bolts in above table are for girders composed of two beams of minimum section as shown. Lengths of bolts for intermediate and maximum sizes of beams may be obtained by adding twice the increase of web thickness to the lengths given.

BEARING PLATES FOR SHAPES USED AS BEAMS.

Shapes used as beams resting on masonry walls or piers will generally require bearing plates of steel or their equivalents, set in or upon the masonry to properly distribute the load thereon with due regard to the allowable safe pressures for the class of stonework or brickwork in question.

A table of bearing plates is presented on page 43, which gives the bearing values in net tons for plates of various sizes based on the safe unit pressure allowable on different classes of masonry. As the strength of masonry varies largely dependent upon the qualities of the material used, the workmanship and age, it is impossible to present absolute figures for safe unit pressures for all classes of work, but the values given below are believed to fairly represent these for the usual kinds of ordinary architectural masonry. The strength of ordinary masonry generally depends upon the crushing value of the mortar or cement used and does not bear any fixed relation to the ultimate strength of the brick or stone entering into the construction.

The table of bearing plates gives the bearing values of various sizes of plates when used with different classes of masonry, but the thickness of the plate should be computed for each case.

For a plate of given length and breadth the thickness depends upon the allowable load and unit stress, and the width of the flange of the beam or channel resting upon it.

The thickness may be determined by the following formula:

$$t = .866\,(l - b)\sqrt{\frac{R}{pb'l}}$$

t = thickness of plate in inches.
l = length of plate in a direction perpendicular to the axis of the beam or channel in inches.
b = width of flange of beam or channel in inches.
R = reaction at point of support in pounds.
For uniformly distributed loads R = one-half of the load given in Tables of Safe Loads, pages 73 to 89 inclusive.
p = allowable stress in pounds per square inch on extreme fibre of plate.
b' = width of plate in the direction of the axis of the beam or channel; *i. e.*, bearing on wall in inches.

If $p = 16\,000$ lbs. for steel we have

$$t = .00685\,(l - b)\sqrt{\frac{R}{b'l}}$$

EXAMPLES.

What is the proper size of steel bearing plate to be used in a wall of good brick laid in lime mortar to support the end of a 10-inch standard I-Beam, weighing 25 pounds per foot, of 16-foot span, subjected to its safe load uniformly distributed?

On page 76 in the Table of Safe Loads Uniformly Distributed for Cambria I-Beams, the total load is found to be 16280 pounds, and half of this, or 8140 pounds, will be the reaction at each end.

On referring to the Table of Bearing Plates, on page 43, the proper size for this load on the class of masonry in question is found to be 6″ x 10″. The width of flange of a 10-inch 25 lb. standard beam is 4.66 inches.

Substituting these values in the formula for thickness gives

$$t = .00685\,(10 - 4.66)\sqrt{\frac{8140}{6 \times 10}} = .426$$

The nearest commercial size above this is $\frac{7}{16}$ inch, which is the thickness required.

If a shorter plate would suit the location better it may be seen from the table that a plate 8″ x 8″ will give the necessary bearing value and the thickness of this would be

$$t = .00685\,(8 - 4.66)\sqrt{\frac{8140}{8 \times 8}} = .258$$

and the nearest commercial size above this is $\frac{5}{16}$″, which is the thickness required.

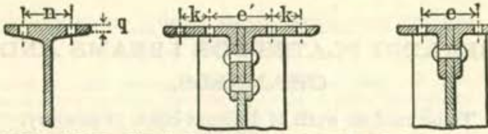
BEARING PLATES FOR I-BEAMS AND CHANNELS.

To be used on walls of different kinds of masonry.

Bearing on Wall. Inches.	Size of Plate, Inches.	Safe Bearing Value of Plate in Pounds. Ordinary Stone Masonry.	Good Stone Masonry.	Brick in Lime Mortar.	Brick in Cement Mortar.	Bearing on Wall. Inches.	Size of Plate, Inches.	Safe Bearing Value of Plate in Pounds. Ordinary Stone Masonry.	Good Stone Masonry.	Brick in Lime Mortar.	Brick in Cement Mortar.
4	4×4	2880	4800	2400	3200	14	14×14	35280	58800	29400	39200
4	4×6	4320	7200	3600	4800	14	14×16	40320	67200	33600	44800
4	4×8	5760	9600	4800	6400	14	14×18	45360	75600	37800	50400
						14	14×20	50400	84000	42000	56000
6	6×6	6480	10800	5400	7200						
6	6×8	8640	14400	7200	9600	16	16×16	46080	76800	38400	51200
6	6×10	10800	18000	9000	12000	16	16×18	51840	86400	43200	57600
						16	16×20	57600	96000	48000	64000
8	8×8	11520	19200	9600	12800	16	16×22	63360	105600	52800	70400
8	8×10	14400	24000	12000	16000						
8	8×12	17280	28800	14400	19200	18	18×18	58320	97200	48600	64800
						18	18×20	64800	108000	54000	72000
10	10×10	18000	30000	15000	20000	18	18×22	71280	118800	59400	79200
10	10×12	21600	36000	18000	24000	18	18×24	77760	129600	64800	86400
10	10×14	25200	42000	21000	28000						
						20	20×20	72000	120000	60000	80000
12	12×12	25920	43200	21600	28800	20	20×22	79200	132000	66000	88000
12	12×14	30240	50400	25200	33600	20	20×24	86400	144000	72000	96000
12	12×16	34560	57600	28800	38400	20	20×26	93600	156000	78000	104000
12	12×18	38880	64800	32400	43200						

Bearing values are based on the following allowed pressures :

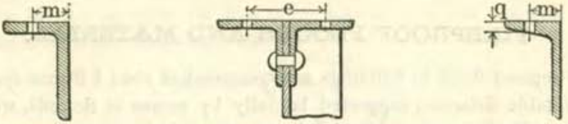
Masonry.	Allowable Pressure. Pounds per Square Inch.	Tons per Square Foot.
Ordinary Stone	180	12.96
Good Stone	300	21.60
Brick in Lime Mortar......................	150	10.80
Brick in Cement Mortar	200	14.40



STANDARD SPACING OF RIVET AND BOLT HOLES THROUGH FLANGES AND CONNECTION ANGLES OF I-BEAMS.

Depth of Beam and Section Number.	Weight per Foot, Pounds.	n in Inches.	e or e′ in Inches.	q in Inches	Depth of Beam and Section Number.	Weight per Foot, Pounds.	n in Inches.	e or e′ in Inches.	q in Inches
3″ B5	5.5	1 7/16	4 3/16	1/4	12″ B105	50.0	3	4 23/32	21/32
	6.5	"	4 9/32	1/4		55.0	"	4 27/32	11/16
	7.5	"	4 3/8	1/4	15″ B53	42.0	3	4 7/16	5/8
4″ B9	7.5	1 1/2	4 7/32	9/32		45.0	"	4 15/32	5/8
	8.5	"	4 9/32	9/32		50.0	"	4 9/16	5/8
	9.5	"	4 11/32	5/16		55.0	"	4 21/32	5/8
	10.5	"	4 7/16	5/16		60.0	"	4 25/32	21/32
5″ B13	9.75	1 3/4	4 7/32	5/16	15″ B109	60.0	3 1/4	4 19/32	13/16
	12.25	"	4 3/8	5/16		65.0	"	4 11/16	13/16
	14.75	"	4 17/32	11/32		70.0	"	4 13/16	27/32
6″ B17	12.25	2	4 1/4	11/32		75.0	"	4 29/32	27/32
	14.75	"	4 3/8	11/32		80.0	"	5	29/32
	17.25	"	4 1/2	3/8	15″ B113	80.0	3 3/4	4 13/16	1 1/32
7″ B21	15.0	2 1/4	4 1/4	3/8		85.0	"	4 29/32	1 1/32
	17.5	"	4 3/8	3/8		90.0	"	5	1 1/32
	20.0	"	4 15/32	3/8		95.0	"	5 3/32	1 1/32
8″ B25	17.75	2 1/4	4 9/32	13/32		100.0	"	5 7/32	1 1/16
	20.25	"	4 3/8	7/16	18″ B65	55.0	3 1/4	4 31/32	11/16
	22.75	"	4 15/32	7/16		60.0	"	5 1/16	11/16
	25.25	"	4 17/32	7/16		65.0	"	5 5/32	23/32
9″ B29	21.0	2 1/2	4 5/16	7/16		70.0	"	5 7/32	23/32
	25.0	"	4 13/32	7/16	20″ B73	65.0	3 1/2	5	25/32
	30.0	"	4 19/32	15/32		70.0	"	5 3/32	25/32
	35.0	"	4 3/4	15/32		75.0	"	5 5/32	25/32
10″ B33	25.0	2 5/8	4 5/16	15/32	20″ B121	80.0	4	5 1/8	29/32
	30.0	"	4 15/32	1/2		85.0	"	5 3/16	29/32
	35.0	"	4 5/8	1/2		90.0	"	5 1/4	29/32
	40.0	"	4 3/4	17/32		95.0	"	5 5/16	29/32
12″ B41	31.5	2 3/4	4 3/8	17/32		100.0	"	5 13/32	15/16
	35.0	"	4 7/16	17/32	24″ B89	80.0	4	5	27/32
	40.0	"	4 9/16	9/16		85.0	"	5 3/32	27/32
12″ B105	40.0	3	4 15/32	21/32		90.0	"	5 5/32	7/8
	45.0	"	4 19/32	21/32		95.0	"	5 7/32	7/8
						100.0	"	5 9/32	7/8

NOTE:—k=2½ inches.



STANDARD SPACING OF RIVET AND BOLT HOLES IN ANGLES AND IN FLANGES AND CONNECTION ANGLES OF CHANNELS.

Angles.

Depth of Leg Inches.	m in Inches.
3/4	7/16
1	9/16
1 1/4	11/16
1 5/16	3/4
1 3/8	3/4
1 1/2	13/16
1 3/4	15/16
2	1 1/8
2 1/4	1 1/4
2 5/16	1 1/4
2 1/2	1 3/8
2 3/4	1 1/2
3	1 3/4
3 1/2	2
4	2 1/4
4 1/2	2 1/2
5	2 3/4
5 5/8	3 1/4
6	3 1/2

Standard Channels.

Depth of Channel. Inches	Weight per Foot. Pounds.	m in Inches	e in Inches	q in Inches
3	4.0	15/16	4 3/16	1/4
"	5.0	"	4 9/32	1/4
"	6.0	"	4 3/8	9/32
4	5.25	1	4 3/16	9/32
"	6.25	"	4 9/32	9/32
"	7.25	"	4 11/32	5/16
5	6.5	1	4 7/32	5/16
"	9.0	1 1/4	4 11/32	9/32
"	11.5	"	4 1/2	5/16
6	8.0	1 1/8	4 7/32	11/32
"	10.5	"	4 11/32	11/32
"	13.0	1 3/8	4 15/32	11/32
"	15.5	"	4 9/16	11/32
7	9.75	1 1/4	4 7/32	11/32
"	12.25	"	4 11/32	3/8
"	14.75	"	4 7/16	3/8
"	17.25	1 1/2	4 17/32	3/8
"	19.75	"	4 21/32	3/8
8	11.25	1 1/4	4 1/4	3/8
"	13.75	"	4 5/16	13/32
"	16.25	1 1/2	4 13/32	3/8
8	18.75	1 1/2	4 1/2	13/32
"	21.25	"	4 19/32	13/32
9	13.25	1 3/8	4 1/4	13/32
"	15.00	"	4 5/16	13/32
"	20.00	1 3/4	4 15/32	3/8
"	25.00	"	4 5/8	13/32
10	15.0	1 1/2	4 1/4	7/16
"	20.0	"	4 13/32	7/16
"	25.0	2	4 17/32	3/8
"	30.0	"	4 11/16	13/32
"	35.0	"	4 27/32	7/16
12	20.5	1 3/4	4 13/16	15/32
"	25.0	"	4 29/32	1/2
"	30.0	2	5 1/32	15/32
"	35.0	"	5 5/32	1/2
"	40.0	"	5 9/32	17/32
15	33.0	1 7/8	4 29/32	21/32
"	35.0	"	4 15/16	21/32
"	40.0	"	5 1/32	11/16
"	45.0	2 1/4	5 1/8	5/8
"	50.0	"	5 1/4	21/32
"	55.0	"	5 11/32	21/32

MAXIMUM SIZE OF RIVETS IN BEAMS, CHANNELS, AND ANGLES.

I-Beams.						Channels.			Angles.			
Depth of Beam Ins.	Weight per Foot. Pounds.	Size of Rivet. Ins.	Depth of Beam. Inches	Weig't per Foot. Pounds	Size of Rivet. Inches.	Depth of Channel. Inches.	Weight per Foot. Pounds.	Size of Rivet. Inches.	Length of Leg. Inches.	Size of Rivet. Inches.	Length of Leg. Inches.	Size of Rivet. Ins.
3	5.5	3/8	15	42.0	3/4	3	4.0	3/8	3/4	1/4	2 1/2	3/4
4	7.5	1/2	15	60.0	3/4	4	5.25	1/2	1	3/8	2 3/4	3/4
5	9.75	1/2	15	80.0	7/8	5	6.50	1/2	1 1/4	1/2	3	7/8
6	12.25	5/8	18	55.0	7/8	6	8.0	5/8	1 5/16	1/2	3 1/2	1
7	15.0	5/8	20	65.0	1	7	9.75	5/8	1 3/8	1/2	4	1
8	17.75	3/4	20	80.0	1	8	11.25	3/4	1 1/2	1/2	4 1/2	1
9	21.0	3/4	24	80.0	1	9	13.25	3/4	1 3/4	5/8	5	1
10	25.0	3/4				10	15.0	3/4	2	5/8	5 5/8	1
12	31.5	3/4				12	20.50	3/4	2 1/4	3/4	6	1
12	40.0	3/4				15	33.0	3/4	2 5/16	3/4		

FIREPROOF FLOORS AND MATERIAL.

Fireproof floors in buildings are composed of steel I-Beams spaced at suitable distances, supported laterally by means of tie rods, which are usually from ⅝″ to ⅞″ in diameter and from 4 to 6 feet or more apart, or at distances not greater than twenty times the flange width. Reasons for this, explaining the necessity for supporting beams laterally and a table relating thereto, are given on pages 60 and 61. The tie rods should be located in the line of thrust of the arch, which is ordinarily below the centre line of the beam, and in some cases is near the bottom flange.

Between the beams are laid fireproof arches, usually of hollow tile, which should be so constructed as to wholly enclose the steel and cover it to a sufficient thickness to insure the fireproof character of the construction.

THRUST OF ARCHES.

The horizontal thrust of segmental floor arches, on the assumption of uniform loading, may be found by the following formula:

$$T = \frac{3WL^2}{2R}$$

in which

T = pressure or thrust in pounds per lineal foot of arch.

W = load on arch in pounds per square foot, uniformly distributed.

L = span of arch in feet.

R = rise of segmental arch in inches.

For a concentrated load at the centre, of weight P, the thrust

$$T = \frac{3PL}{R}$$

For arches with flat tops and bottoms, such as are used in floors, the voussoir joints on each side of the central key are usually laid out on parallel lines, and in these cases the thrust may be determined approximately by using for R in the above formula the effective depth of the arch.

For segmental arches the rise R is the vertical distance from the highest part of the intrados to the plane of the springing line. If the radius of the intrados for segmental arches is r, the rise may be obtained from the following formula:

$$R = r - \sqrt{r^2 - \frac{L^2}{4}}$$

$$\text{conversely, } r = \frac{R}{2} + \frac{L^2}{8R}$$

TIE RODS.

Although in the completed structure the horizontal thrusts of adjoining arches may counterbalance each other, the tie rods should be so proportioned and spaced as to withstand the entire thrust of the arches, thus tying the structure together and facilitating the construction.

BEAM TABLES.

Tables of safe loads and spacings of I-Beams for floors are given with explanatory notes on pages **68** to **133**.

BEAMS AS GIRDERS.

In some cases two or more beams may be bolted together side by side to form a girder, in which case cast iron separators with bolts should be used to hold the various members together. Separators should be placed at each end of the girder, at points of concentrated loading, and for uniform loading should be located at distances apart not greater than twenty times the width of the smallest beam flange, in order to laterally support the upper flanges which are in compression and prevent their failure by buckling. The separators should fit closely between the beam flanges so as to unite the beams forming the girder and thereby cause them to act together in resisting the load. A table of separators is given on page **41**.

CONNECTION ANGLES.

When beams are coped or fitted together at right angles, connection angles are generally used, standards for which, covering usual cases, are shown on page **40**. Explanations and tables of limiting spans for which these standards may be used are given on pages **38** and **39**. Beams may be fitted together thus with flush tops or bottoms or in intermediate positions, as required in cases where the girder or trimmer beam is the larger. In cases where the girder or trimmer beam is the smaller, special stirrups or other connections are required.

LIVE LOADS FOR FLOORS.

The following loads per square foot, exclusive of weight of floor materials, show the range assumed in usual practice:

Dwellings.................... 70 lbs. per sq. ft.
Offices....................... 70 to 100 lbs. per sq. ft.
Buildings for public assembly..120 to 150 lbs. per sq. ft.
Stores, warehouses, etc.........150 to 250 lbs. and upwards per sq. ft.

On page 193 are given in detail the safe loads for which floors should be designed in accordance with the building laws of various cities.

FLOOR ARCHES.

Hollow tile floor arches and fireproofing material used in connection with the structural steel work of buildings are now made of various classes, the principal ones being known as "hard clay" and "porous terra-cotta," both of which are moulded and burned in a manner similar to that used in making bricks. Various new forms of floor arches, composed of cement concrete with or without skeletons of wire, wire cloth, T-Bars, I-Beams, and metal rods of various shapes and arrangements, have also been brought out in recent years.

Hard clay floor arches and fireproof materials weigh somewhat more than the porous terra-cotta materials of similar sizes.

POROUS TERRA-COTTA.

Porous terra-cotta, which is now largely used for fireproof floor arches, beam, girder, and column protection, roof and ceiling tile, etc., is a mixture of clay and sawdust, or other equivalent combustible matter. After the compound is properly mixed, the brick or tiles are moulded, and when sufficiently dry are placed in a kiln prepared for the purpose and subjected to an intense heat, adequate to consume all the combustible material, leaving the brick porous, and at the same time reducing the weight materially, the fireproof qualities remaining intact. This material admits driving of nails and receives and holds plaster.

END CONSTRUCTION.

The end construction floor arches, in which the hollow spaces are at right angles to the beams, are stronger and lighter than the old style construction, in which the openings are parallel with the beams.

Approximate weights of hollow tile floor arches and fireproof materials are given in the following table:

WEIGHTS OF HOLLOW TILE FLOOR ARCHES AND FIREPROOF MATERIALS.

END CONSTRUCTION, FLAT ARCH.

Width of Span Between Beams.	Depth of Arch.	Weight per Square Foot.
5 feet to 6 feet.	8 inches.	27 pounds.
6 " 7 "	9 "	29 "
7 " 8 "	10 "	33 "
8 " 9 "	12 "	38 "

HOLLOW BRICK FOR FLAT ARCHES (SIDE CONSTRUCTION).

Width of Span Between Beams.	Depth of Arch.	Weight per Square Foot.
3 feet 6 inches to 4 feet 0 inches.	6 inches.	27 pounds.
4 " 0 " 4 " 6 "	7 "	29 "
4 " 6 " 5 " 0 "	8 "	32 "
5 " 6 " 6 " 0 "	9 "	36 "
6 " 0 " 6 " 6 "	10 "	39 "
6 " 6 " 7 " 0 "	12 "	44 "

PARTITIONS.

	Thickness.	Weight per Square Foot.
Hollow Brick (Clay) Partitions	2 inches.	11 pounds.
" " " "	3 "	14 "
" " " "	4 "	15 "
" " " "	5 "	19 "
" " " "	6 "	20 "
" " " "	8 "	27 "
Porous Terra-Cotta Partitions	3 "	16 "
" " "	4 "	19 "
" " "	5 "	22 "
" " "	6 "	23 "
" " "	8 "	33 "

FURRING, ROOFING AND CEILING.

	Thickness.	Weight per Square Foot.
Porous Terra-Cotta Furring	2 inches.	8 pounds.
" " " Roofing	2 "	12 "
" " " "	3 "	15 "
" " " "	4 "	19 "
" " " Ceiling	2 "	11 "
" " " "	3 "	15 "
" " " "	4 "	19 "

6 inch Segmental Arches, 27 pounds per square foot.
8- " " " 33 " " " "
2-inch Porous Terra-Cotta Partition, 8 pounds per square foot.

TESTS OF FLOOR ARCHES.

Reports of tests of various forms of floor arches may be found in the *American Architect*, March, 1891.

One of the most recent and complete papers on this subject is entitled "Tests of Fire-proof Flooring Material," published in the *Transactions of the American Society of Civil Engineers*, with discussions, in Vols. xxxiv and xxxv, dated 1895 and 1896.

A summary of the principal data and results of the tests which were the subject of the latter paper is given in the following table:

BREAKING LOAD OF HOLLOW TILE ARCHES.

Depth of Arch.	Rise.	Span.	Length.	Total Load.	Load per Sq. Foot.	Total Horizontal Thrust.	Horizontal Thrust per Ft. of Arch.	BLOCKS. Style.	BLOCKS. Material.	Character of Load.	Manner of Laying Joints.
Ins.	Ins.	Ins.	Ins.	Lbs.	Lbs.	Lbs.					
6.	3.5	60	48.	13750	688	29474	7369	E	Hard	Dis.	Port.
7.5	5.	46	11.5	9000	2452	10367	10818	"	"	"	N. M.
7.5	5.	60	35.2	11250	767	33750	11505	"	"	Cen.	Port.
7.5	5.	60	36.5	13000	855	39000	12822	"	Porous	"	"
8.	7.	60	38.25	14500	910	31071	9747	"	"	"	"
8.	7.	60	38.25	15750	989	33750	10588	"	Hard	"	"
12.	10.	60	41.	16400	961	24600	7200	"	"	"	"
12.	8.75	60	10.	3100	743	5314	6377	"	"	"	N. M.
12.	9.	60	10.	5000	1199	8333	10000	"	"	"	"
12.	9.	60	10.	15100	3630	12583	15100	"	"	Dis.	"
12.	9.5	60	10.	2500	600	3947	4736	"	"	Cen.	......
8.	5.5	46	11.5	2500	681	2614	2727	S	"	Dis.	N. M.
8.	5.	45	11.5	1300	362	1463	1526	"	"	"	"
8.	6.	60	36.	10000	667	25000	8333	"	"	Cen.	Port.
8.	5.	60	36.	5700	380	8550	2850	"	"	Dis.	"
8.	5.	60	12.	3500	700	5250	5250	"	"	"	N. M.
8.	5.5	60	12.	10000	2000	13636	13636	"	"	"	"
8.	5.5	60	12.	2500	500	6818	6818	"	"	Cen.	"
8.	5.5	60	24.	9950	995	13568	6784	"	"	Dis.	"
8.	5.5	60	24.	2500	250	6818	3209	"	"	Cen.	"
10.	7.5	60	36.	13500	900	13500	4500	"	"	Dis.	Port.
10.	8.	60	37.	14500	940	13594	4408	"	"	"	......

NOTE.—In the above table the following abbreviations are used: "E," End Construction; "S," Side Construction; "Hard," Hard Clay; "Porous," Porous Terra-Cotta; "Dis.," Distributed Load; "Cen.," Concentrated Load at Centre; "Port.," Portland Cement, and "N. M.," No Mortar.

The Loads per Sq. Foot in the above table were obtained in all cases by dividing the Total Load by the superficial area of the arch in square feet. The Horizontal Thrust for distributed and Central Loads were obtained by formulæ similar to those given therefor on one of the preceding pages, and for Central Loads this is double that for a distributed load of the same weight.

The conclusions drawn from the above tests by the author of the paper, Mr. George W. Hill, Consulting Engineer, are as follows:

First.—That the side construction arch requires a skew in which the inclined member on the line of the arch thrust runs back to a solid support against either the fillet or the flange of the skewback beam.

Second.—The end-construction arch requires good mortar and reasonably good bedding to make the joints which transmit the pressure adequate to their duty, the weak point being the mortar in the end joints.

Third.—When well bedded, the end-construction arch is very much the stronger.

SAFE LOADS FOR FLOOR ARCHES.

Two tables of safe loads for hollow tile arches have been prepared, based on an average of the results of the tests given on the preceding page, using a safety factor of six.

The first of these tables gives the gross safe loads of various sized arches for different spans, including the weight of the hollow tiles, and the second gives the safe load superimposed or net loads for similar conditions, exclusive of the weights of the arches.

The former table may be used for flat arches of any weight by deducting the weight of the arch per square foot from the tabular safe load, which will give the safe net or superimposed load per square foot, while the latter table gives at once the safe superimposed load for arches of weights specified, corresponding to the tabulated weights of arches given on page 49.

These tables refer to flat hollow tile arches, the bottoms of which project below the beams in order to provide for fire protection of their lower flanges.

This projection varies from $1\frac{3}{4}''$ to $3''$ for different sizes and makes of hollow tiles, the average for the sizes given being 2 4 inches, which is assumed to be the amount by which the nominal depth is decreased in order to obtain the effective depth or rise for calculation of the thrust by means of the formula therefor given on page 46.

The formula for safe load used in computing the tables below is as follows:

$$W = 840 \frac{R}{L^2}$$

in which

W = safe load per square foot of arch in pounds.

R = rise or effective depth of arch in inches.

L = span of arch in feet.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR HOLLOW TILE FLOOR ARCHES.

Gross loads in pounds per square foot, *i. e.*, including the weight of the arch. Safety Factor 6.

Nominal Depth.	Effective Depth. R	Span of Arch in Feet = L					
Inches.	Inches.	3	4	5	6	7	8
6	3.6	336	189	121			
7	4.6	429	242	155			
8	5.6	523	294	188	131		
9	6.6	616	347	222	154	113	
10	7.6	709	399	255	177	130	100
12	9.6	896	504	323	224	165	126

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR HOLLOW TILE FLOOR ARCHES.

Net loads in pounds per square foot, *i. e.*, excluding the weight of the arch. Safety Factor 6.

Nominal Depth.	Effective Depth. R	Weight of Arch per Square Foot.	Span of Arch in Feet = L.					
Inches.	Inches.	Pounds.	3	4	5	6	7	8
6	3.6	27	309	162	94			
7	4.6	29	400	213	126			
8	5.6	32	481	262	156	99		
9	6.6	36	580	311	186	118	77	
10	7.6	39	670	360	216	136	91	61
12	9.6	44	852	460	279	180	121	82

SPACING OF TIE RODS FOR TILE ARCHES.

The table on the next page was computed from the following formula, which was obtained from that giving the thrust of arches on page 46.

$$B = \frac{A \times R \times 10\,000}{WL^2}$$

in which

B = spacing of tie rods in feet.

A = net area of rod in square inches.

R = rise of arch in inches.

W = load in pounds per square foot of the arch.

L = span of arch in feet.

The above formula gives the spacing of tie rods corresponding to a tensile stress in the rods of 15 000 pounds per square inch, without considering the flexure of the beams.

In spacing tie rods, the lateral strength of beams, for flexure due to the thrust of the arches should be taken into consideration, explanations for which are given on pages 56 to 59 herein.

Spacings for other loads than that of the table may be found by proportion, thus:

$$\text{Required spacing} = \frac{100 + \text{weight of arch in pounds per square foot.}}{\text{New load in lbs. per sq. ft.} + \text{Weight of arch in lbs. per sq. ft.}} \times \text{spacing from table.}$$

Weights of tile arches per square foot are given on page 49.

As noted under the heading "Lateral Strength of Beams," on pages 60 and 61, care should be taken that the spacing of tie rods is not greater than twenty times the least flange width, otherwise the safe loads should be reduced to compensate for the strains produced by flexure of the upper flange considered as a column in compression.

SPACING OF TIE RODS FOR TILE ARCHES.

For a uniform load of 100 lbs. per square foot in addition to the weight of the arch.

Span of Arch. Feet.	Diameter of Tie Rods. Inches.	Nominal Depth of Arch. Inches.					
		6	7	8	9	10	12
		Effective Depth or Rise of Arch. Inches.					
		3.6	4.6	5.6	6.6	7.6	9.6
3	5/8	6.4	8.0	9.5	10.9	12.3	15.0
"	3/4	9.5	12.0	14.2	16.3	18.3	22.4
"	7/8	13.2	16.6	19.8	22.6	25.5	31.1
4	5/8	3.6	4.5	5.4	6.1	6.9	8.4
"	3/4	5.4	6.7	8.0	9.2	10.3	12.6
"	7/8	7.4	9.4	11.1	12.7	14.3	17.5
5	5/8	2.3	2.9	3.4	3.9	4.4	5.4
"	3/4	3.4	4.3	5.1	5.9	6.6	8.0
"	7/8	4.8	6.0	7.1	8.1	9.2	11.2
6	5/8	..	2.0	2.4	2.7	3.1	3.7
"	3/4	..	3.0	3.6	4.1	4.6	5.6
"	7/8	..	4.2	4.9	5.7	6.4	7.8
7	5/8	..	..	..	2.0	2.3	2.8
"	3/4	..	..	..	3.0	3.4	4.1
"	7/8	..	..	..	4.2	4.7	5.7
8	5/8	..	..	..	..	1.7	2.1
"	3/4	..	..	..	..	2.6	3.1
"	7/8	..	..	..	..	3.6	4.4

LATERAL STRENGTH OF BEAMS TO RESIST FLEXURE DUE TO THRUST OF ARCHES, ETC.

In special cases where the thrust of a floor arch is exerted against a beam, channel, angle or other shape without other lateral support than the tie rods, or braces, this will produce lateral flexure and stresses in addition to those caused by the vertical loading. Throughout the body of the floor the thrusts of the adjoining arches when completed will usually counterbalance each other, but in the outer beams around shafts or elsewhere if unsupported sideways the stresses due to the lateral forces should be considered.

The total allowable stress per square inch for the extreme fibres of beams has been placed at 16 000 pounds per square inch, and in order that this may not be exceeded owing to lateral stresses, the stress due to vertical loading should be correspondingly reduced so that the resultant intensity shall not exceed the allowable limit. This may be calculated by considering the beam as continuous and laterally supported at intervals by the tie rods, the spans being equal to the spacing of the rods.

In this case the fibre stress due to the lateral forces is:

$$p' = \frac{wx_1B^2}{I'} \qquad (1)$$

in which

p' = fibre stress in pounds per square inch due to lateral forces.

w = lateral load or thrust in pounds per lineal foot of section used as a beam.

x_1 = distance of the extreme fibre from the neutral axis in inches.

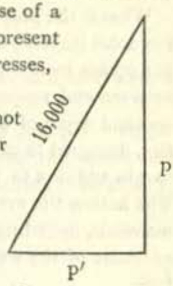
B = distance between tie rods or lateral supports in feet.

I' = moment of inertia about the vertical axis of the section or that one at right angles to the line of application of the lateral forces.

For I-Beams with the web placed vertically as usual x_1 becomes equal to $\frac{b}{2}$, where b is the width of the flange in inches. In this case the above formula for intensity of unit stress due to lateral load becomes:

$$p' = \frac{wbB^2}{2I'} \qquad (2)$$

The resultant fibre stress from the horizontal or lateral and the vertical loads may be represented by the hypothenuse of a right angle triangle, the two sides of which represent the intensities of the horizontal and vertical stresses, thus:



In order that the total resultant stress shall not exceed the allowable limit of 16 000 pounds per square inch, the stress due to vertical loading should therefore be reduced to equal the following:

$$p = \sqrt{16\,000^2 - p'^2} \qquad (3)$$

Having thus obtained the reduced vertical stress p, the safe vertical load of the tables corresponding to this stress should accordingly be reduced by multiplying it by the ratio $\frac{p}{16\,000}$ and similarly for other stresses and corresponding loads, thus making proper allowance for the additional stresses produced by the lateral forces.

If the reduction of the safe loads on this account is a considerable proportion of the original amount due to vertical loading only, it would be more economical to provide lateral braces or tie rods at shorter intervals, thus avoiding .he use of an excessive amount of material in the beam.

As the stresses due to vertical forces for usual cases of loading are a maximum at the centre of the span it will ordinarily be sufficient to space the tie rods or braces at shorter intervals near the centre in order to allow for the combined stresses due to vertical loading and horizontal thrusts.

The above method of calculation is not exact when considering the lateral thrust of arches, or loads from similar materials which do not exert a uniform pressure throughout their surfaces of contact with the sustaining beam on account of the friction and bond of their component parts, but this analysis of the stresses may serve as a guide in designing.

The above formulæ should be used in connection with the tables and formula given on pages 60 and 61 relating to the lateral strength of beams, due to compression of the upper flange figured as a column between points of lateral support.

EXAMPLE.

What is the proper size of I-Beam without other lateral support than the usual tie rods, corresponding to a total fibre stress of 16 000 pounds per square inch under the following conditions? The beam is 18 feet between end supports and carries a tile arch on one side having a nominal depth of 9 inches, effective depth of 6.6 inches, a span of 5 feet, designed to carry a superimposed load of 100 pounds per square foot in addition to the weight of the arch and other floor materials. The hollow tile arch weighs 36 pounds per square foot and the other materials, including plastering, weigh 14 pounds, making a total load, exclusive of the weight of the beam, equal to 150 pounds per square foot.

For tie rods of ¾″ diameter the spacing between them would be 5.9 feet, as shown by the table of Spacing of Tie Rods on page 55, in which the safe stresses in the rods only are considered.

Substituting the proper values in the formula for lateral thrust of arches, given on page 46, this will be

$$T = \frac{3 \times 150 \times 5^2}{2 \times 6.6} = 852 \text{ lbs. per lineal foot.}$$

Substituting this value for w in formula (2) page 56, we have

$$p' = \frac{852 \times 4.66 \times 5.9^2}{2 \times 6.89} = 10\,029 \text{ lbs. per sq. in.}$$

Therefore $\quad p = \sqrt{16\,000^2 - 10\,029^2} = 12\,466$ lbs. per sq. in.

Hence the safe load as determined by the consideration of vertical loads only, should be reduced to $\frac{12\,466}{16\,000}$, or approximately ¾ of the amount given by the Tables of Safe Loads in case the spacing of the tie rods is not changed.

Assume a 10″ beam 25 lbs. per foot, the moment of inertia of which is 6.89, as given in the Tables of Properties of I-Beams, page 156.

The safe vertical load for a 10″ beam, weighing 25 lbs. per foot, 18 feet long between supports, for fibre stress of 16 000 lbs. per square inch, is 14 470 lbs. uniformly distributed, including the weight of the beam as given in the Tables of Safe Loads, on page 76, or 14 020 exclusive of the weight of the beam, and ¾ of this is 10 515 lbs., which is the vertical load it can safely carry in order that the total stress due to it and the lateral thrust shall not exceed 16 000 lbs. per square inch.

The actual vertical load on the beam under consideration is as follows:

$$\frac{5}{2} \times 18 \times 150 = 6\,750 \text{ lbs.},$$

which is less than the allowable amount, 10 515 lbs., as figured above, so that a smaller beam may suffice.

Therefore, assume a 9-inch beam, weighing 21 lbs. per foot, the moment of inertia of which about an axis coincident with centre line of web is found in the Table of Properties, on page 156, to be 5.16.

In this case

$$p' = \frac{852 \times 4.33 \times 5.9^2}{2 \times 5.16} = 12\,444 \text{ lbs. per sq. in.}$$

Substituting this in the formula for p we have

$$p = \sqrt{16\,000^2 - 12\,444^2} = 10\,106 \text{ lbs. per sq. in.}$$

Therefore the safe vertical load will be $\frac{10\,106}{16\,000}$, or approximately $\frac{5}{8}$ of the tabular safe load.

The safe vertical load for a 9″ 21 lb. beam, 18 feet long, for a fibre stress of 16 000 lbs. per square inch is 11 180 lbs., as given in the Tables of Safe Loads, on page 76, and $\frac{5}{8}$ of this is 6 987 lbs., which is slightly greater than the actual amount, 6 750 lbs., as calculated above, so that the 9″ 21 lb. beam will suffice.

If the spacing of the tie rods at the centre be reduced from 5.9 feet to 4 feet it may be found in a manner similar to that used in the above calculations, that the safe vertical load for an 8″ I-Beam, weighing 17.75 lbs. per foot, is reduced to $\frac{7}{8}$ of its tabular value of 8 430 lbs., or 7 376 lbs., and as this amount is greater than the actual load as above, namely 6 750 lbs., the 8″ beam would answer the purpose, under the changed conditions as to spacing of tie rods. As this beam might deflect beyond the limit for plastered ceilings, it should be examined in accordance with the rule or formula given for obtaining safe deflections in the explanation of the Tables of Safe Loads, and elsewhere herein.

Calculating this by the rule given on page 69, the safe load for the allowable limit of deflection is

$$W = \frac{9480 \times 16^2}{18^2} = 7\,491 \text{ lbs.},$$

which is greater than the actual amount, 6 750 lbs., so that the 8″ beam is sufficient and proper if the spacing of central tie rods be changed to 4 feet, as assumed in the last case.

LATERAL STRENGTH OF BEAMS,
WITHOUT LATERAL SUPPORT.

The Tables of Safe Loads for Cambria I-Beams and Channels and Tables of Spacing of Cambria I-Beams, on pages 73 to 133, are calculated on the assumption that proper provision is made for preventing lateral deflection by means of tie rods or other braces. In order to prevent undue strains in the compression flange, considered as a column, the beams should be supported laterally at distances not exceeding twenty times the flange width, this ratio being determined by the following formula, which gives the safe load for solid columns of soft steel:

$$p = \frac{18000}{1 + \frac{l^2}{3000b^2}}$$

in which

p = allowable stress in pounds per square inch.
l = length between lateral supports in inches.
b = width of flange in inches.

Substituting 16 000 for p in the above formula, which is the allowable unit stress of the safe load tables, it is found that the ratio $\frac{l}{b} = 19.37$, from which it may be seen that the compression flange should be supported laterally at distances not exceeding twenty times the flange width as stated above.

Beams which are not thus supported laterally should not be loaded to their full transverse capacity. The allowable fibre stresses and proportions of their full loads which they can safely carry when laterally supported at various distances is given in the following table:

REDUCTION IN VALUES OF ALLOWABLE FIBRE STRESS AND SAFE LOADS FOR SHAPES USED AS BEAMS DUE TO LATERAL FLEXURE.

Ratio of Span or Distance between Lateral Supports to Flange Width. $\frac{l}{b}$	Allowable Unit Stress for Direct Flexure in Extreme Fibre. p	Proportion of Tabular Safe Load to be Used.	Ratio of Span or Distance between Lateral Supports to Flange Width. $\frac{l}{b}$	Allowable Unit Stress for Direct Flexure in Extreme Fibre. p	Proportion of Tabular Safe Load to be Used.
19.37	16000	1.0	65	7474	.47
20	15882	.97	70	6835	.43
25	14897	.93	75	6261	.39
30	13846	.87	80	5745	.36
35	12781	.80	85	5281	.33
40	11739	.73	90	4865	.30
45	10746	.67	95	4595	.29
50	9818	.61	100	4154	.26
55	8963	.56	105	3850	.24
60	8182	.51	110	3576	.22

The above table should be used in connection with the Tables of Safe Loads Uniformly Distributed for Cambria I-Beams and Channels, on pages 73 to 89 inclusive, and limits the values found therein under the conditions given above.

EXAMPLE.

Required the safe load for a 15-inch standard I-Beam weighing 42 pounds per foot for a span of 30 feet without lateral supports:

From the data the ratio $\frac{l}{b} = \frac{30 \times 12}{5.5} = 65$

From the above table the proportion of the safe load which the beam can safely support under these conditions is .47. From the Table of Safe Loads for I-Beams, page 78, the safe load for this beam when properly supported laterally is 20 940 pounds, which multiplied by .47 gives 9 842 pounds as the safe load uniformly distributed under the conditions given, including the weight of the beam or 8 582 pounds superimposed load.

LIMITING SPANS AND MAXIMUM LOADS OF I-BEAMS AND CHANNELS DUE TO CRIPPLING OF THE WEB.

I-Beams and Channels when used as beams for very short spans in which the ratio of length of span to depth of beam is small, should be examined for safe strength of the web considered as a column, subjected to crippling, due to the shearing strains.

The Tables of Safe Loads of Beams and Channels are computed with regard to the safe unit stresses due to flexure, and with one or two exceptions, as indicated by dotted lines and accompanying footnotes, the lengths of spans tabulated are such that the limitation due to web crippling does not appear. The shearing stresses acting in the web of a beam may be considered to consist of two stresses of equal intensity acting at right angles to each other, and at angles of 45 degrees with the neutral axis. The intensity of each of these stresses is equal to the intensity of the vertical shear, which is a maximum at the points of support for uniform loading, and uniform throughout from the point of loading to the supports for a superimposed concentrated load at the centre.

The vertical shears for different systems of loading may be obtained by the use of moments in the usual way, and these are given for various cases on pages 136 to 139 inclusive.

The shearing stresses which act at angles of 45 degrees with the neutral axis are equivalent to compressive and tensile forces, and the former will tend to buckle the web, which should therefore be figured as composed of a series of columns of a length equal to its diagonal depth.

If l is the vertical depth of the web in the clear between the fillets which connect it with the flanges, the square of the length of the column to be considered will be $2\,l^2$.

Substituting this value for l^2 in the formula for long columns

$$p = \frac{12000}{1 + \frac{l^2}{3000\,t^2}}$$

we have

$$p = \frac{12000}{1 + \frac{l^2}{1500\,t^2}}$$

in which

p = intensity of vertical shear, in pounds per square inch = $\dfrac{\text{Total shear in pounds}}{\text{dt.}}$

l = depth of web in clear between fillets, in inches.

t = thickness of web, in inches.

d = depth of beam, in inches.

This formula is also applicable for computing the safe shearing stress in the webs of plate girders, in which case the length l is the vertical distance between centres of upper and lower rows of rivet holes connecting the webs and flanges.

The webs of plate girders should be reinforced by stiffening angles at points of support and concentrated loading, and in cases where the intensity of shear exceeds that given by the above formula the web should be provided with stiffeners spaced at distances apart equal to the depth of the girder.

The following tables have been prepared based upon the above formula for safe unit shearing stress in the webs of beams and channels.

MAXIMUM SAFE LOADS FOR I-BEAMS OF ANY LENGTH AND CORRESPONDING MINIMUM SAFE SPANS BASED UPON CRIPPLING OF THE WEB.

For loads in pounds uniformly distributed exclusive of weight of beam.

Section Number	Depth of Beam.	Weight per Foot.	Maximum Safe Load.	Minimum Span.
	Inches.	Pounds.	Pounds.	Feet.
B 5	3	5.5	10644	1.7
		6.5	16983	1.1
		7.5	23884	.9
B 9	4	7.5	15045	2.1
		8.5	21809	1.6
		9.5	29349	1.2
		10.5	35847	1.1
B 13	5	9.75	19773	2.6
		12.25	37984	1.5
		14.75	54380	1.2
B 17	6	12.25	24826	3.1
		14.75	42634	2.0
		17.25	59857	1.6
B 21	7	15	30192	3.7
		17.5	47720	2.5
		20	66478	1.9
B 25	8	17.75	35925	4.2
		20.25	52072	3.1
		22.75	69914	2.4
		25.25	87403	2.1
B 29	9	21	41992	4.8
		25	69224	3.1
		30	104631	2.3
		35	139074	1.9
B 33	10	25	48406	5.4
		30	83739	3.4
		35	120792	2.6
		40	156930	2.2
B 41	12	31.5	62193	6.2
		35	89412	4.5
		40	125695	3.5
B105	12	40	97469	4.9
		45	133560	3.8
B105	12	50	168991	3.2
		55	203806	2.8
B 53	15	42	85591	7.3
		45	104200	6.2
		50	142044	4.8
		55	179929	4.0
		60	213732	3.6
B109	15	60	157484	5.5
		65	195147	4.6
		70	228658	4.1
		75	265452	3.7
		80	301820	3.4
B113	15	80	240024	4.6
		85	275411	4.2
		90	308939	3.9
		95	344691	3.6
		100	380169	3.4
B 65	18	55	107758	8.8
		60	152031	6.6
		65	188299	5.5
		70	224737	4.9
B 73	20	65	127592	9.6
		70	178434	7.3
		75	201484	6.7
B121	20	80	179940	8.7
		85	210096	7.7
		90	250558	6.6
		95	285966	6.0
		100	321253	5.5
B 89	24	80	126012	14.7
		85	163791	11.8
		90	197821	10.1
		95	232873	8.8
		100	268596	7.9

MAXIMUM SAFE LOAD FOR STANDARD CHANNELS OF ANY LENGTH AND CORRESPONDING MINIMUM SAFE SPANS BASED UPON CRIPPLING OF THE WEB.

For loads in pounds uniformly distributed exclusive of weight of Channel.

Section Number	Depth of Beam. Inches.	Weight per Foot. Pounds.	Maximum Load. Pounds.	Minimum Span. Feet.
C5	3	4	10692	1.1
		5	17016	0.8
		6	23909	.6
C9	4	5.25	14032	1.4
		6.25	20868	1.1
		7.25	28424	.9
C13	5	6.5	19231	1.6
		9	34382	1.1
		11.5	52036	.9
C17	6	8	20024	2.3
		10.5	38027	1.4
		13	55414	1.1
		15.5	72401	1.0
C21	7	9.75	22865	2.8
		12.25	42273	1.7
		14.75	59506	1.4
		17.25	78006	1.2
		19.75	94532	1.1
C25	8	11.25	25494	3.4
		13.75	43638	2.2
		16.25	61676	1.7
C25	8	18.75	79348	1.5
		21.25	96698	1.3
C29	9	13.25	28044	4.0
		15	41483	2.9
		20	77711	1.8
		25	115740	1.4
C33	10	15	30461	4.7
		20	65360	2.6
		25	102947	1.9
		30	139563	1.6
		35	173036	1.4
C41	12	20.5	41173	5.5
		25	73588	3.5
		30	109976	2.6
		35	148961	2.1
		40	184279	1.9
C53	15	33	82528	5.4
		35	93615	4.9
		40	114450	4.3
		45	165466	3.2
		50	203148	2.8
		55	245311	2.5

COEFFICIENTS FOR DEFLECTION IN INCHES FOR CAMBRIA SHAPES, USED AS BEAMS SUBJECTED TO SAFE LOADS UNIFORMLY DISTRIBUTED.

Distance between Supports in feet.	Coefficient for Fibre Stress of 16 000 lbs. per Square Inch.	Coefficient for Fibre Stress of 12 500 lbs. per Square Inch.	Distance between Supports in Feet.	Coefficient for Fibre Stress of 16 000 lbs. per Square Inch.	Coefficient for Fibre Stress of 12 500 lbs. per Square Inch.
L	H	H′	L	H	H′
4	.265	.207	23	8.756	6.841
5	.414	.323	24	9.534	7.448
6	.596	.466	25	10.345	8.082
7	.811	.634	26	11.189	8.741
8	1.059	.828	27	12.066	9.427
9	1.341	1.047	28	12.977	10.138
10	1.655	1.293	29	13.920	10.875
11	2.003	1.565	30	14.897	11.638
12	2.383	1.862	31	15.906	12.427
13	2.797	2.185	32	16.949	13.241
14	3.244	2.534	33	18.025	14.082
15	3.724	2.909	34	19.134	14.948
16	4.237	3.310	35	20.276	15.841
17	4.783	3.737	36	21.451	16.759
18	5.363	4.190	37	22.659	17.703
19	5.975	4.668	38	23.901	18.672
20	6.621	5.172	39	25.175	19.668
21	7.299	5.703	40	26.483	20.690
22	8.011	6.259			

The above coefficients are for use in obtaining the deflection of steel shapes subjected to transverse strain, under their uniformly distributed safe loads for extreme fibre stresses of 16 000 pounds and 12 500 pounds per square inch; the modulus of elasticity being 29 000 000.

To find the deflection of any shape that is symmetrical about its neutral axis under the above conditions of loading when used as a beam, such as I-Beams, Channels, etc., divide the coefficient in the table corresponding to the given span and fibre stress, by the depth of the beam in inches. The result will be the deflection in inches.

To find the deflection of any shape that is unsymmetrical about its neutral axis when used as a beam, under the above conditions of loading such as T-Bars, Angles, etc., divide the coefficient in the table corresponding to the given span and fibre stress by twice the distance of the most remote fibre from the neutral axis, expressed in inches.

If in construction, the beam is placed in position in the usual manner upon its end supports without special scaffolding or falsework between them, it will deflect somewhat by reason of its own weight, and upon the addition of external loading a further deflection will occur.

The deflections obtained as above described are the total deflections due to the weight of the beam itself and the superimposed safe load uniformly distributed.

Thus to find from the preceding table the deflection in inches for Cambria shapes used as beams under their safe loads uniformly distributed including the weight of the beam:

Let D = deflection in inches.

L = length between supports in feet.

H = coefficient for deflection from table for fibre stress of 16 000 pounds per square inch.

H′ = coefficient for deflection from table for fibre stress of 12 500 pounds per square inch.

d = depth of beam in inches for symmetrical sections.

x_1 = distances in inches from neutral axis to most remote fibre for unsymmetrical sections.

For Symmetrical Sections.

For fibre stress of 16 000 pounds per square inch $D = \frac{H}{d}$

For fibre stress of 12 500 pounds per square inch $D = \frac{H'}{d}$

For Unsymmetrical Sections.

For fibre stress of 16 000 pounds per square inch $D = \frac{H}{2x_1}$

For fibre stress of 12 500 pounds per square inch $D = \frac{H'}{2x_1}$

Examples.

Case I.—To find the deflection of a 9″ I-Beam weighing 30 pounds per foot, for a span of 15 feet and a maximum fibre stress of 16 000 pounds per square inch, under its safe load uniformly distributed.

From the above table the deflection coefficient for this case is found to be 3.724, which divided by 9, the depth of the beam in inches, gives .414, which is the required deflection in inches.

The safe load for this beam under the conditions named is 16 100 pounds including the weight of the beam itself as stated in the Tables of Safe Loads for Cambria I-Beams on page 76.

Case II.—To find the deflection of a 6″ × 4″ × ½″ angle, supported at the ends on its short leg as a horizontal base, for a span of 9 feet and a maximum fibre stress of 16 000 pounds per square inch under its safe load uniformly distributed including its own weight.

From the table of "Properties of Angles" on page 172 the distance x′ from the neutral axis to the back of the shorter leg is found to be, 1.99 inches, which subtracted from the length of long leg, 6 inches gives 4.01 as the distance x_1 from the neutral axis to the most remote fibre. From the above table the deflection coefficient for this case is found to be 1.341, which divided by 8.02, twice x_1, gives .167, which is the required deflection in inches.

Note.—For deflections of Beams, Channels and Z-Bars due to any central or uniform load see coefficients of deflection N and N′ in the Tables of Properties relating to these sections and the accompanying explanations.

For deflections of any symmetrical beams due to various systems of loading, see general formulæ and diagrams on pages 134 to 139 inclusive.

TABLES OF SAFE LOADS FOR CAMBRIA I-BEAMS AND CHANNELS AND SPACING FOR CAMBRIA I-BEAMS, PAGES 73 TO 133 INCLUSIVE.

TABLES OF SAFE LOADS.

The tables of Safe Loads for Cambria I-Beams and Channels have been calculated for all sizes and weights of both standard and standard-special sections, and give the safe loads in pounds uniformly distributed for all usual spans, based upon extreme fibre stresses of 16 000 pounds per square inch.

These loads include the weight of the beam or channel which should be deducted in order to obtain the net load which the beam will safely carry. In order to obtain the net live load which the beam is capable of safely sustaining the weight of the floor materials should also be deducted. Weights of hollow tile floor arches and fire-proofing material are given on page 49, to which should be added the weight of plastering, filling on top of arches and the weight of the material forming the surface of the floor, in order to obtain the dead load of materials in figuring fire-proof floors, in addition to the weight of the beam.

A table of superimposed loads per square foot, exclusive of the weight of materials in accordance with the usual practice for different classes of buildings, is given on page 48.

The Tables of Safe Loads for Cambria I-Beams and Channels and Tables of Spacing of Cambria I-Beams are calculated on the assumption that proper provision has been made for preventing lateral deflection by means of tie rods or other braces, spaced at distances apart not greater than twenty times the flange width. If the lateral supports are spaced at greater distances than this the unit stresses and safe loads should be reduced in accordance with the table therefor, on page 61.

The thrust of floor arches, which is considerable, particularly in the case of long spans or distances between tie rods, should be taken into account where it tends to produce lateral flexure of the floor beams. Throughout the body of the floor the thrusts will ordinarily counterbalance each other, but in the extreme beams, where unsupported laterally, between the tie rods or braces, this additional stress should be provided for by a corresponding reduction in the stresses due to vertical loading.

Explanations of this and a formula for reducing the unit stresses from vertical loading, on account of the additional stresses caused by horizontal forces, are given on pages 56 to 60 inclusive.

In some instances the allowable deflection will govern the design rather than the transverse strength, as in the case of beams carrying plastered ceilings, in which the deflection should be limited to $\frac{1}{30}$ inch per foot of span, or $\frac{1}{360}$ of the distance between supports in order to avoid cracking the plaster.

This limit of deflection is indicated in the tables by full horizontal lines, the figures below which correspond to loads or spacings for the given spans that will produce greater deflections than the allowable limit for plastered ceilings.

The deflection limits of the Tables of Safe Loads have been calculated for the total loads, including the weight of the beam. The superimposed live load will not produce all of this deflection, and therefore the deflection limit of the tables includes an element of safety for the reason that the beams will be deflected, after being put in place, by their own weight and that of the floor materials before the plastering is applied.

In cases where the deflection limits the use of the beam for the safe loads corresponding to the fibre stresses of the tables, the beam may be used with a less load such as to produce only the allowable deflection. The lesser load corresponding to the limit of deflection may be obtained for any span from the Table of Safe Loads as follows:

$$W = \frac{W_s \times L^2}{L_1^2}$$

in which

W = safe load in pounds for the limit of deflection for plastered ceilings = $\frac{1}{360}$ of the span.

W_s = safe load of tables next above the line giving the limit of deflection.

L = length of span in feet corresponding to W_s from the table.

L_1 = length of span for the case under consideration.

This may also be expressed by the following:

RULE.

Multiply the safe load next above the heavy line of the tables by the square of the corresponding span in feet and divide the product *by the square of the required span. The result will be the required load corresponding to the limit of allowable deflection for plastered ceilings.*

A Table of Deflections for Cambria shapes used as beams, subjected to their safe loads uniformly distributed, and accompanying explanations with examples, is given on pages 66 and 67.

Tables of Spacing of Cambria I-Beams.

Tables of Spacing of I-Beams for intensities of loading of 100, 125, 150 and 175 pounds per square foot, corresponding to spans from 4 to 36 feet, are given on pages 90 to 133 inclusive.

For any given size of beam the spacing or distances from centers to centers for different intensities of loading varies inversely as the load, so that the spacing for any intensity of loading may be found from the tabular spacing by proportion as stated in the notes at the foot of the tables.

EXAMPLES OF APPLICATION OF TABLES OF SAFE LOADS AND TABLES OF SPACING.

Example I.

What is the proper size of beam with a clear span of 24 feet to carry a superimposed load of 30 000 pounds uniformly distributed, the deflection to be such as not to crack a plastered ceiling?

From the Tables of Safe Loads for Cambria I-Beams, page 78, it is found that a 15-inch standard beam of this length, weighing 60 pounds per foot, will carry a gross load of 31 910 pounds, and the weight of the beam itself is $60 \times 24 = 1440$ pounds. Thus the net load may be 30 470 pounds, so that this is the proper size for the conditions named, as its deflection is within the allowable limit, which is shown to be at a span of 30 feet as indicated by the horizontal line on the table.

Similarly it may be found from page 79 that a 15 inch special beam, of 60 pounds per foot, will more than suffice, but as this section is not regularly kept in stock the standard 15-inch 60 pound beam should be ordered if prompt delivery is wanted.

It may also be found from page 81 that an 18 inch 55-pound beam will amply suffice, and as this is both stiffer and lighter than the 15-inch 60-pound beams, it could be used with economy if otherwise suitable for the location.

Example II.

What is the safe load for an 8 inch standard I-Beam weighing 17.75 pounds per foot for a span of 20 feet, the deflection to be such as not to crack a plastered ceiling?

From the Tables of Safe Loads, page 75, it is found that the safe load for the beam in question is 7 580 pounds, but this value is below the line which indicates the span corresponding to the allowable limit of deflection.

Substituting the proper values in the formula for obtaining the reduced load corresponding to the allowable deflection, as given on page 69, we have

$$W = \frac{W_s \times L^2}{L_1^2} = \frac{9\,480 \times 16^2}{20^2} = 6\,067 \text{ pounds,}$$

which is the safe load required.

Example III.

Required the best arrangement of beams for the floor system of a building 40 feet wide x 88 feet deep to safely support a live load of 100 pounds per square foot, using 10-inch tile arches resting on 12-inch I-Beams.

The weight of the floor materials will be about 50 pounds per square foot, allowing 39 pounds for the arch and 11 pounds for the other materials, or a total load of 150 pounds per square foot to be carried by the beams.

From the Table of Spacing for I-Beams for a uniform load of 150 pounds per square foot, page 116, it is seen that 12-inch standard I-Beams weighing 31.5 pounds per foot, and spaced 6.4 feet apart from centers to centers, can be used with a span of 20 feet.

This will require one row of interior columns lengthwise of building.

To support the beams at the center of the building will require a line of girder beams resting on the columns. Assume the columns 22 feet apart, thus dividing the building into 8 bays, four on each side of the center.

The load on each girder will be

$$\frac{40}{2} \times 22 \times 150 = 66\,000 \text{ pounds.}$$

From the Table of Safe Loads, page 78, it is found that this will require two 15-inch standard I-Beams, each weighing 60 pounds per foot.

On account of the advisability of spacing the floor beams equally this arrangement of columns and girders would reduce their distances to $\frac{22}{4} = 5\frac{1}{2}$ feet center to center, so that 10-inch I-Beams weighing 35 pounds per foot might be used for the body of the floor, as may be seen by reference to the Table of Spacing of Cambria I-Beams, page 115, which gives the allowable spacing for these conditions to be 5.2 feet. The 10-inch 35-pound beams under these conditions will, however, deflect to the allowable limit for plastered ceilings, besides which they are heavier than the 12-inch 31.5 pound beams first considered, so that the latter will be the stiffest and most economical.

Although the load on the girder is not uniformly distributed, but concentrated at three points between the supports, the bending moment in this case will be the same as if the load were figured to be distributed uniformly, and for similar cases with different spacings the moments would be very nearly identical.

Example IV.

What is the proper spacing between centers of 10-inch standard I-Beams weighing 25 pounds per foot for a span of 18 feet to carry a superimposed load of 100 pounds per square foot in addition to the weight of the floor materials, consisting of an 8-inch tile arch with filling and flooring weighing about 50 lbs. per square foot, this being equivalent to a total load of 150 pounds per square foot?

From the Tables of Spacings of Cambria I-Beams, page 115, it is found that the proper distance from center to center of beams is 5.4 feet, so that a spacing of 5 feet apart will be proper.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA I-BEAMS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of beam.

STANDARD I-BEAMS.

Distance between supports in feet.	3 Inch No. B 5.			4 Inch No. B 9.			
	5.5 lbs.	6.5 lbs.	7.5 lbs.	7.5 lbs.	8.5 lbs.	9.5 lbs.	10.5 lbs.
4	4410	4780	5180	7950	8470	9000	9520
5	3530	3830	4140	6360	6780	7200	7610
6	2940	3190	3450	5300	5650	6000	6350
7	2520	2730	2960	4540	4840	5140	5440
8	2210	2390	2590	3980	4240	4500	4760
9	1960	2130	2300	3530	3770	4000	4230
10	1770	1910	2070	3180	3390	3600	3810
11	1600	1740	1880	2890	3080	3270	3460
12	1470	1590	1730	2650	2820	3000	3170
13	1360	1470	1590	2450	2610	2770	2930
14	1260	1370	1480	2270	2420	2570	2720
15	1180	1280	1380	2120	2260	2400	2540
16	1100	1200	1290	1990	2120	2250	2380
17	1040	1130	1220	1870	1990	2120	2240
18	980	1060	1150	1770	1880	2000	2120
19	930	1010	1090	1670	1780	1890	2000
20	880	960	1040	1590	1690	1800	1900
21	840	910	990	1510	1610	1710	1810

For safe loads below the heavy lines, the deflections will be greater than the allowable limit for plastered ceilings $= \frac{1}{360}$ span.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA I BEAMS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of beam.

STANDARD I-BEAMS.

Distance between supports in feet.	5 Inch No. B 13.			6 Inch No. B 17.		
	9.75 lbs.	12.25 lbs.	14.75 lbs.	12.25 lbs.	14.75 lbs.	17.25 lbs.
4	12900	14520	16160	19370	21320	23280
5	10320	11620	12930	15490	17050	18620
6	8600	9680	10770	12910	14210	15520
7	7370	8300	9230	11070	12180	13300
8	6450	7260	8080	9680	10660	11640
9	5730	6460	7180	8610	9470	10350
10	5160	5810	6460	7750	8530	9310
11	4690	5280	5880	7040	7750	8460
12	4300	4840	5390	6460	7110	7760
13	3970	4470	4970	5960	6560	7160
14	3680	4150	4620	5530	6090	6650
15	3440	3870	4310	5160	5680	6210
16	3220	3630	4040	4840	5330	5820
17	3030	3420	3800	4560	5020	5480
18	2870	3230	3590	4300	4740	5170
19	2720	3060	3400	4080	4490	4900
20	2580	2900	3230	3870	4260	4660
21	2460	2770	3080	3690	4060	4430
22	2340	2640	2940	3520	3880	4230
23	2240	2530	2810	3370	3710	4050
24	2150	2420	2690	3230	3550	3880
25	2060	2320	2590	3100	3410	3720
26	1980	2230	2490	2980	3280	3580
27	1910	2150	2390	2870	3160	3450
28	....	....	....	2770	3050	3330
29	....	....	....	2670	2940	3210

For safe loads below the heavy lines, the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA I-BEAMS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of beam.

STANDARD I-BEAMS.

Distance between supports in feet.	7 Inch No. B 21.			8 Inch No. B 25.			
	15 lbs.	17.5 lbs.	20 lbs.	17.75 lbs.	20.25 lbs.	22.75 lbs.	25.25 lbs.
4	27600	29850	32140	37920	40130	42740	45360
5	22080	23880	25710	30330	32100	34190	36290
6	18400	19900	21430	25280	26750	28500	30240
7	15770	17060	18370	21670	22930	24420	25920
8	13800	14930	16070	18960	20060	21370	22680
9	12270	13270	14280	16850	17830	19000	20160
10	11040	11940	12860	15170	16050	17100	18140
11	10040	10860	11690	13790	14590	15540	16490
12	9200	9950	10710	12640	13380	14250	15120
13	8490	9190	9890	11670	12350	13150	13960
14	7890	8530	9180	10830	11470	12210	12960
15	7360	7960	8570	10110	10700	11400	12100
16	6900	7460	8030	94080	10030	10690	11340
17	6490	7020	7560	8920	9440	10060	10670
18	6130	6630	7140	8430	8920	9500	10080
19	5810	6280	6770	7980	8450	9000	9550
20	5520	5970	6430	7580	8030	8550	9070
21	5260	5690	6120	7220	7640	8140	8640
22	5020	5430	5840	6890	7300	7770	8250
23	4800	5190	5590	6590	6980	7430	7890
24	4600	4980	5360	6320	6690	7120	7560
25	4420	4780	5140	6070	6420	6840	7260
26	4250	4590	4940	5830	6170	6580	6980
27	4090	4420	4760	5620	5940	6330	6720
28	3940	4260	4590	5420	5720	6110	6480
29	3810	4120	4430	5230	5530	5900	6260

For safe loads below the heavy lines, the deflections will be greater than the allowable limit for plastered ceilings $= \frac{1}{360}$ span.

Safe loads above dotted line are greater than safe loads for web crippling as shown on pages 62 to 65 inclusive.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA I-BEAMS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of beam.

STANDARD I-BEAMS.

Distance between supports in feet.	9 Inch No. B 29.				10 Inch No. B 33.			
	21 lbs.	25 lbs.	30 lbs.	35 lbs.	25 lbs.	30 lbs.	35 lbs.	40 lbs.
8	25160	27240	30180	33120	....	....	....	....
9	22370	24210	26830	29440	....	....	....	....
10	20130	21790	24150	26500	26050	28620	31240	33850
11	18300	19810	21950	24090	23680	26020	28400	30780
12	16770	18160	20120	22080	21710	23850	26030	28210
13	15480	16760	18570	20380	20040	22020	24030	26040
14	14380	15570	17250	18930	18610	20450	22310	24180
15	13420	14530	16100	17670	17360	19080	20830	22570
16	12580	13620	15090	16560	16280	17890	19520	21160
17	11840	12820	14200	15590	15320	16840	18380	19910
18	11180	12110	13410	14720	14470	15900	17350	18810
19	10590	11470	12710	13950	13710	15070	16440	17820
20	10064	10900	12070	13250	13020	14310	15620	16930
21	9590	10380	11500	12620	12400	13630	14880	16120
22	9150	9910	10980	12050	11840	13010	14200	15390
23	8750	9480	10500	11520	11320	12450	13580	14720
24	8390	9080	10060	11040	10850	11930	13020	14110
25	8050	8720	9660	10600	10420	11450	12500	13540
26	7740	8380	9290	10190	10020	11010	12020	13020
27	7460	8070	8940	9810	9650	10600	11570	12540
28	7190	7780	8620	9460	9300	10220	11160	12090
29	6940	7510	8330	9140	8980	9870	10770	11670
30	6710	7260	8050	8830	8680	9540	10410	11280
31	6490	7030	7790	8550	8400	9230	10080	10920
32	....	....	....	....	8140	8950	9760	10580
33	....	....	....	....	7890	8670	9470	10260

For safe loads below the heavy lines, the deflections will be greater than the allowable limit for plastered ceilings $= \frac{1}{360}$ span.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA I BEAMS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of beam.

Distance between supports in feet.	STANDARD I-BEAMS. 12 Inch No. B 41.			STANDARD-SPECIAL I-BEAMS. 12 Inch No. B 105.			
	31.5 lbs.	35 lbs.	40 lbs.	40 lbs.	45 lbs.	50 lbs.	55 lbs.
10	38370	40580	43720	47810	50790	53930	57070
11	34880	36890	39740	43470	46180	49030	51880
12	31970	33820	36430	39840	42330	44940	47560
13	29510	31220	33630	36780	39070	41480	43900
14	27400	28990	31230	34150	36280	38520	40760
15	25580	27050	29140	31880	33860	35950	38040
16	23980	25360	27320	29880	31750	33710	35670
17	22570	23870	25720	28130	29880	31720	33570
18	21310	22540	24290	26560	28220	29960	31700
19	20190	21360	23010	25160	26730	28380	30040
20	19180	20290	21860	23910	25400	26960	28530
21	18270	19320	20820	22770	24190	25680	27170
22	17440	18450	19870	21730	23090	24510	25940
23	16680	17640	19010	20790	22080	23450	24810
24	15990	16910	18220	19920	21160	22470	23780
25	15350	16230	17490	19130	20320	21570	22830
26	14760	15610	16810	18390	19540	20740	21950
27	14210	15030	16190	17710	18810	19970	21140
28	13700	14490	15610	17080	18140	19260	20380
29	13230	13990	15070	16490	17510	18600	19680
30	12790	13530	14570	15940	16930	17980	19020
31	12380	13090	14100	15420	16380	17400	18410
32	11990	12680	13660	14940	15870	16850	17830
33	11630	12300	13250	14490	15390	16340	17290
34	11280	11940	12860	14060	14940	15860	16780
35	10960	11590	12490	13660	14510	15410	16300
36	10660	11270	12140	13280	14110	14980	15850

For safe loads below the heavy lines, the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA I-BEAMS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of beam.

STANDARD I-BEAMS.

Distance between supports in feet.	15 Inch No. B 53.				
	42 lbs.	45 lbs.	50 lbs.	55 lbs.	60 lbs.
10	62830	64830	68750	72670	76600
11	57120	58940	62500	66070	69630
12	52360	54030	57290	60560	63830
13	48330	49870	52890	55900	58920
14	44880	46310	49110	51910	54710
15	41880	43220	45840	48450	51060
16	39270	40520	42970	45420	47870
17	36960	38140	40440	42750	45060
18	34900	36020	38200	40370	42550
19	33070	34120	36190	38250	40310
20	31410	32420	34380	36340	38300
21	29920	30870	32740	34610	36470
22	28560	29470	31250	33030	34820
23	27320	28190	29890	31600	33300
24	26180	27010	28650	30280	31910
25	25130	25930	27500	29070	30640
26	24160	24940	26440	27950	29460
27	23270	24010	25460	26920	28370
28	22440	23150	24550	25960	27360
29	21660	22360	23710	25060	26410
30	20940	21610	22920	24220	25530
31	20270	20910	22180	23440	24710
32	19630	20260	21490	22710	23940
33	19040	19650	20830	22020	23210
34	18480	19070	20220	21370	22530
35	17950	18520	19640	20760	21880
36	17450	18010	19100	20190	21280

For safe loads below the heavy lines, the deflections will be greater than the allowable limit for plastered ceilings $= \frac{1}{360}$ span.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA I-BEAMS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of beam.

STANDARD-SPECIAL I-BEAMS.

Distance between supports in feet.	15 Inch No. B 109.				
	60 lbs.	65 lbs.	70 lbs.	75 lbs.	80 lbs.
10	86610	90470	94390	98310	102230
11	78740	82240	85810	89370	92940
12	72180	75390	78660	81920	85190
13	66630	69590	72610	75620	78640
14	61870	64620	67420	70220	73020
15	57740	60310	62920	65540	68150
16	54130	56540	58990	61440	63890
17	50950	53220	55520	57830	60140
18	48120	50260	52440	54620	56790
19	45590	47610	49680	51740	53810
20	43310	45230	47190	49150	51120
21	41240	43080	44950	46810	48680
22	39370	41120	42900	44690	46470
23	37660	39330	41040	42740	44450
24	36090	37690	39330	40960	42600
25	34650	36190	37750	39320	40890
26	33310	34790	36300	37810	39320
27	32080	33510	34960	36410	37860
28	30930	32310	33710	35110	36510
29	29870	31200	32550	33900	35250
30	28870	30160	31460	32770	34080
31	27940	29180	30450	31710	32980
32	27070	28270	29500	30720	31950
33	26250	27410	28600	29790	30980
34	25470	26610	27760	28910	30070
35	24750	25850	26970	28090	29210
36	24060	25130	26220	27310	28400

For safe loads below the heavy lines, the deflections will be greater than the allowable limit for plastered ceilings $= \frac{1}{360}$ span.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA I-BEAMS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of beam.

STANDARD-SPECIAL I-BEAMS.

Distance between supports in feet.	15 Inch No. B 113.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	112230	116030	119960	123880	127800
11	102030	105490	109050	112620	116180
12	93520	96700	99960	103230	106500
13	86330	89260	92270	95290	98310
14	80160	82880	85680	88480	91280
15	74820	77360	79970	82580	85200
16	70140	72520	74970	77420	79870
17	66020	68260	70560	72870	75180
18	62350	64460	66640	68820	71000
19	59070	61070	63130	65200	67260
20	56110	58020	59980	61940	63900
21	53440	55250	57120	58990	60860
22	51010	52740	54530	56310	58090
23	48800	50450	52150	53860	55560
24	46760	48350	49980	51620	53250
25	44890	46410	47980	49550	51120
26	43170	44630	46140	47650	49150
27	41570	42980	44430	45880	47330
28	40080	41440	42840	44240	45640
29	38700	40010	41360	42720	44070
30	37410	38680	39990	41290	42600
31	36200	37430	38700	39960	41230
32	35070	36260	37490	38710	39940
33	34010	35160	36350	37540	38730
34	33010	34130	35280	36430	37590
35	32070	33150	34270	35390	36510
36	31170	32230	33320	34410	35500

For safe loads below the heavy lines, the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA I-BEAMS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of beam.

STANDARD I-BEAMS.

Distance between supports in feet.	18 Inch No. B 65.				20 Inch No. B 73.		
	55 lbs.	60 lbs.	65 lbs.	70 lbs.	65 lbs.	70 lbs.	75 lbs.
10	94290	99770	104470	109180	124750	130110	135340
11	85720	90700	94980	99250	113410	118280	123040
12	78570	83140	87060	90980	103960	108430	112780
13	72530	76740	80360	83980	95960	100090	104110
14	67350	71260	74620	77990	89110	92940	96670
15	62860	66510	69650	72790	83170	86740	90230
16	58930	62360	65300	68240	77970	81320	84590
17	55460	58650	61460	64220	73380	76540	79610
18	52380	55430	58040	60660	69310	72280	75190
19	49630	52510	54990	57460	65660	68480	71230
20	47140	49880	52240	54590	62370	65060	67670
21	44900	47510	49750	51990	59400	61960	64450
22	42860	45350	47490	49630	56700	59140	61520
23	40990	43380	45420	47470	54240	56570	58840
24	39290	41570	43530	45490	51980	54210	56390
25	37720	39910	41790	43670	49900	52040	54140
26	36260	38370	40180	41990	47980	50040	52050
27	34920	36950	38690	40440	46200	48190	50130
28	33670	35630	37310	38990	44550	46470	48340
29	32510	34400	36030	37650	43020	44870	46670
30	31430	33260	34820	36390	41580	43370	45110
31	30420	32180	33700	35220	40240	41970	43660
32	29460	31200	32650	34120	38980	40660	42290
33	28570	30230	31660	33080	37800	39430	41010
34	27730	29340	30730	32110	36690	38270	39810
35	26940	28510	29850	31190	35640	37170	38670
36	26190	27710	29020	30330	34650	36140	37590

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA I-BEAMS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of beam.

STANDARD-SPECIAL I-BEAMS.

Distance between supports in feet.	20 Inch No. B 121.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	156410	160910	166140	171370	176600
11	142190	146280	151040	155790	160540
12	130340	134090	138450	142810	147160
13	120310	123780	127800	131820	135840
14	111720	114940	118670	122410	126140
15	104270	107270	110760	114250	117730
16	97750	100570	103840	107100	110370
17	92000	94650	97730	100800	103880
18	86890	89390	92300	95200	98110
19	82320	84690	87440	90190	92950
20	78200	80460	83070	85680	88300
21	74480	76620	79110	81600	84090
22	71090	73140	75520	77890	80270
23	68000	69960	72230	74510	76780
24	65170	67050	69220	71400	73580
25	62560	64360	66460	68550	70640
26	60160	61890	63900	65910	67920
27	57930	59600	61530	63470	65410
28	55860	57470	59340	61200	63070
29	53930	55490	57290	59090	60900
30	52140	53640	55380	57120	58870
31	50450	51910	53590	55280	56970
32	48880	50280	51920	53550	55190
33	47400	48760	50350	51930	53510
34	46000	47330	48860	50400	51940
35	44690	45970	47470	48960	50460
36	43450	44700	46150	47600	49050

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA I-BEAMS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of beam.

STANDARD I-BEAMS.

Distance between supports in feet.	24 Inch No. B 89.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	185530	192700	198970	205240	211520
11	168660	175180	180880	186590	192290
12	154610	160580	165810	171040	176270
13	142720	148230	153050	157880	162710
14	132520	137640	142120	146600	151080
15	123690	128460	132650	136830	141010
16	115960	120430	124360	128280	132200
17	109140	113350	117040	120730	124420
18	103070	107050	110540	114020	117510
19	97650	101420	104720	108020	111330
20	92770	96350	99480	102620	105760
21	88350	91760	94750	97740	100720
22	84330	87590	90440	93290	96140
23	80670	83780	86510	89240	91960
24	77300	80290	82900	85520	88130
25	74210	77080	79590	82100	84610
26	71360	74110	76530	78940	81350
27	68720	71370	73690	76020	78340
28	66260	68820	71060	73300	75540
29	63980	66450	68610	70770	72940
30	61840	64230	66320	68410	70510
31	59850	62160	64180	66210	68230
32	57980	60220	62180	64140	66100
33	56220	58390	60290	62200	64100
34	54570	56680	58520	60370	62210
35	53010	55060	56850	58640	60430
36	51540	53530	55270	57010	58760

Safe loads above dotted line are greater than safe loads for web crippling, as shown on pages 62 to 65 inclusive.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA CHANNELS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of channel.

STANDARD CHANNELS.

Distance between supports in feet.	3 Inch No. C 5.			4 Inch No. C 9.			5 Inch No. C 13.		
	4 lbs.	5 lbs.	6 lbs.	5.25 lbs.	6.25 lbs.	7.25 lbs.	6.5 lbs.	9 lbs.	11.5 lbs.
4	2910	3290	3680	5060	5570	6090	7910	9460	11100
5	2330	2630	2940	4050	4450	4870	6330	7570	8880
6	1940	2190	2450	3370	3710	4060	5270	6310	7400
7	1660	1880	2100	2890	3180	3480	4520	5410	6340
8	1450	1640	1840	2530	2780	3050	3960	4730	5550
9	1290	1460	1630	2250	2470	2510	3520	4210	4930
10	1160	1310	1470	2020	2230	2440	3160	3790	4440
11	1060	1190	1340	1840	2020	2210	2880	3440	4040
12	970	1100	1230	1690	1860	2030	2640	3150	3700
13	890	1010	1130	1560	1710	1870	2430	2910	3410
14	830	940	1050	1440	1590	1740	2260	2700	3170
15	780	880	980	1350	1480	1620	2110	2520	2960
16	730	820	920	1260	1390	1520	1980	2370	2770
17	680	770	870	1190	1310	1430	1860	2230	2610
18	650	730	820	1120	1240	1350	1760	2100	2470
19	610	690	770	1060	1170	1280	1670	1990	2340
20	580	660	740	1010	1110	1220	1580	1890	2220
21	550	630	700	960	1060	1160	1510	1800	2110
22	530	600	670	920	1010	1110	1440	1720	2020
23	510	570	640	880	970	1060	1380	1650	1930
24	480	550	610	840	930	1020	1320	1580	1850
25	470	530	590	810	890	970	1270	1510	1780

For safe loads below the heavy lines, the deflections will be greater than the allowable limit for plastered ceilings $= \frac{1}{360}$ span.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA CHANNELS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of channel.

STANDARD CHANNELS.

Distance between supports in feet.	6 Inch No. C 17.				7 Inch No. C 21.				
	8 lbs.	10.5 lbs.	13 lbs.	15.5 lbs.	9.75 lbs.	12.25 lbs.	14.75 lbs.	17.25 lbs.	19.75 lbs.
4	11550	13440	15400	17360	16070	18410	20700	22990	25280
5	9240	10750	12320	13890	12850	14730	16560	18390	20220
6	7700	8960	10270	11570	10710	12280	13800	15330	16850
7	6600	7680	8800	9920	9180	10520	11830	13140	14440
8	5780	6720	7700	8680	8030	9210	10350	11490	12640
9	5130	5970	6840	7720	7140	8180	9200	10220	11230
10	4620	5380	6160	6940	6430	7370	8280	9200	10110
11	4200	4890	5600	6310	5840	6700	7530	8360	9190
12	3850	4480	5130	5790	5360	6140	6900	7660	8430
13	3550	4130	4740	5340	4940	5670	6370	7070	7780
14	3300	3840	4400	4960	4590	5260	5910	6570	7220
15	3080	3580	4110	4630	4280	4910	5520	6130	6740
16	2890	3360	3850	4340	4020	4600	5180	5750	6320
17	2720	3160	3620	4080	3780	4330	4870	5410	5950
18	2570	2990	3420	3860	3570	4090	4600	5110	5620
19	2430	2830	3240	3650	3380	3880	4360	4840	5320
20	2310	2690	3080	3470	3210	3680	4140	4600	5060
21	2200	2560	2930	3310	3060	3510	3940	4380	4810
22	2100	2440	2800	3160	2920	3350	3760	4180	4600
23	2010	2340	2680	3020	2790	3200	3600	4000	4400
24	1930	2240	2570	2890	2680	3070	3450	3830	4210
25	1850	2150	2460	2780	2570	2950	3310	3680	4040

For safe loads below the heavy lines, the deflections will be greater than the allowable limit for plastered ceilings $= \frac{1}{360}$ span.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA CHANNELS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of channel.

STANDARD CHANNELS.

Distance between supports in feet.	8 Inch No. C 25.					9 Inch No. C 29.			
	11.25 lbs.	13.75 lbs.	16.25 lbs.	18.75 lbs.	21.25 lbs.	13.25 lbs.	15 lbs.	20 lbs.	25 lbs.
4	21530	24000	26610	29230	31840	28040	30130	36020	41900
5	17230	19200	21290	23380	25470	22430	24110	28810	33520
6	14360	16000	17740	19480	21230	18690	20090	24010	27930
7	12310	13710	15210	16700	18200	16020	17220	20580	23940
8	10770	12000	13310	14610	15920	14020	15070	18010	20950
9	9570	10670	11830	12990	14150	12460	13390	16010	18620
10	8610	9600	10650	11690	12740	11220	12050	14410	16760
11	7830	8730	9680	10630	11580	10200	10960	13100	15240
12	7180	8000	8870	9740	10610	9350	10040	12010	13970
13	6630	7380	8190	8990	9800	8630	9270	11080	12890
14	6150	6860	7600	8350	9100	8010	8610	10290	11970
15	5740	6400	7100	7790	8490	7480	8040	9600	11170
16	5380	6000	6650	7310	7960	7010	7530	9000	10470
17	5070	5650	6260	6880	7490	6600	7090	8470	9860
18	4790	5330	5910	6490	7080	6230	6700	8000	9310
19	4530	5050	5600	6150	6700	5900	6340	7580	8820
20	4310	4800	5320	5850	6370	5610	6030	7200	8380
21	4100	4570	5070	5570	6070	5340	5740	6860	7980
22	3920	4360	4840	5310	5790	5100	5480	6550	7620
23	3750	4170	4630	5080	5540	4880	5240	6260	7290
24	3590	4000	4440	4870	5310	4670	5020	6000	6980
25	3450	3840	4260	4680	5090	4490	4820	5760	6700

For safe loads below the heavy lines, the deflections will be greater than the allowable limit for plastered ceilings $= \frac{1}{360}$ span.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA CHANNELS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of channel.

STANDARD CHANNELS.

Distance between supports in feet.	10 Inch No. C 33.				
	15 lbs.	20 lbs.	25 lbs.	30 lbs.	35 lbs.
10	14270	16790	19410	22020	24640
11	12970	15270	17640	20020	22400
12	11890	14000	16170	18350	20530
13	10980	12920	14930	16940	18950
14	10190	12000	13860	15730	17600
15	9510	11200	12940	14680	16430
16	8920	10500	12130	13760	15400
17	8390	9880	11420	12950	14490
18	7930	9330	10780	12240	13690
19	7510	8840	10220	11590	12970
20	7130	8400	9700	11010	12320
21	6790	8000	9240	10490	11730
22	6490	7630	8820	10010	11200
23	6200	7300	8440	9580	10710
24	5940	7000	8090	9180	10270
25	5710	6720	7760	8810	9860
26	5490	6460	7460	8470	9480
27	5280	6220	7190	8160	9130
28	5100	6000	6930	7870	8800
29	4920	5790	6690	7590	8500
30	4760	5600	6470	7340	8210

For safe loads below the heavy lines, the deflections will be greater than the allowable limit for plastered ceilings $= \frac{1}{360}$ span.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA CHANNELS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of channel.

STANDARD CHANNELS.

Distance between supports in feet.	12 Inch No. C 41.				
	20.5 lbs.	25 lbs.	30 lbs.	35 lbs.	40 lbs.
10	22780	25600	28740	31870	35010
11	20700	23270	26120	28980	31830
12	18980	21330	23950	26560	29180
13	17520	19690	22110	24520	26930
14	16270	18290	20530	22770	25010
15	15180	17070	19160	21250	23340
16	14230	16000	17960	19920	21880
17	13400	15060	16900	18750	20600
18	12650	14220	15970	17710	19450
19	11990	13470	15120	16780	18430
20	11390	12800	14370	15940	17510
21	10850	12190	13680	15180	16670
22	10350	11640	13060	14490	15910
23	9900	11130	12490	13860	15220
24	9490	10670	11970	13280	14590
25	9110	10240	11490	12750	14000
26	8760	9850	11050	12260	13470
27	8440	9480	10640	11810	12970
28	8130	9140	10260	11380	12500
29	7850	8830	9910	10990	12070
30	7590	8530	9580	10620	11670

For safe loads below the heavy lines, the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED FOR CAMBRIA CHANNELS.

Safe loads below are figured for fibre stress of 16 000 pounds per square inch and include weight of channel.

STANDARD CHANNELS.

15 Inch No. C 53.

Distance between supports in feet.	33 lbs.	35 lbs.	40 lbs.	45 lbs.	50 lbs.	55 lbs.
10	44450	45500	49420	53350	57270	61190
11	40410	41370	44930	48500	52060	55630
12	37040	37920	41190	44460	47720	50990
13	34190	35000	38020	41040	44050	47070
14	31750	32500	35300	38100	40910	43710
15	29630	30340	32950	35560	38180	40790
16	27780	28440	30890	33340	35790	38240
17	26150	26770	29070	31380	33690	35990
18	24700	25280	27460	29640	31820	33990
19	23400	23950	26010	28080	30140	32210
20	22230	22750	24710	26670	28630	30590
21	21170	21670	23540	25400	27270	29140
22	20210	20680	22470	24250	26030	27810
23	19330	19780	21490	23190	24900	26600
24	18520	18960	20590	22230	23860	25500
25	17780	18200	19770	21340	22910	24480
26	17100	17500	19010	20520	22030	23530
27	16460	16850	18310	19760	21210	22660
28	15880	16250	17650	19050	20450	21850
29	15330	15690	17040	18400	19750	21100
30	14820	15170	16470	17780	19090	20400

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 100 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.

Maximum fibre stress 16 000 pounds per square inch.

Distance beween supports in feet.	STANDARD I-BEAMS.						
	3 Inch No. B 5.			4 Inch No. B 9.			
	5.5 lbs.	6.5 lbs.	7.5 lbs.	7.5 lbs.	8.5 lbs.	9.5 lbs.	10.5 lbs.
4	11.0	12.0	12.9	19.9	21.2	22.5	23.8
5	7.1	7.7	8.3	12.7	13.6	14.4	15.2
6	4.9	5.3	5.8	8.8	9.4	10.0	10.6
7	3.6	3.9	4.2	6.5	6.9	7.3	7.8
8	2.8	3.0	3.2	5.0	5.3	5.6	5.9
9	2.2	2.4	2.6	3.9	4.2	4.4	4.7
10	1.8	1.9	2.1	3.2	3.4	3.6	3.8
11	1.5	1.6	1.7	2.6	2.8	3.0	3.1
12	1.2	1.3	1.4	2.2	2.4	2.5	2.6
13	1.0	1.1	1.2	1.9	2.0	2.1	2.3
14	....	1.0	1.1	1.6	1.7	1.8	1.9
15	....	....	....	1.4	1.5	1.6	1.7
16	....	....	....	1.2	1.3	1.4	1.5
17	....	....	....	1.1	1.2	1.2	1.3
18	....	....	....	1.0	1.0	1.1	1.2
19	....	....	....	....	....	1.0	1.1
20	....	....	....	....	....	....	1.0

For spacings below the heavy lines the deflections vill be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 100 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.					
	5 Inch No. B 13.			6 Inch No. B 17.		
	9.75 lbs.	12.25 lbs.	14.75 lbs.	12.25 lbs.	14.75 lbs.	17.25 lbs.
4	32.2	36.3	40.4	48.4	53.3	58.2
5	20.6	23.2	25.9	31.0	34.1	37.2
6	14.3	16.1	18.0	21.5	23.7	25.9
7	10.5	11.9	13.2	15.8	17.4	19.0
8	8.1	9.1	10.1	12.1	13.3	14.5
9	6.4	7.2	8.0	9.6	10.5	11.5
10	5.2	5.8	6.5	7.7	8.5	9.3
11	4.3	4.8	5.3	6.4	7.0	7.7
12	3.6	4.0	4.5	5.4	5.9	6.5
13	3.1	3.4	3.8	4.6	5.0	5.5
14	2.6	3.0	3.3	4.0	4.4	4.8
15	2.3	2.6	2.9	3.4	3.8	4.1
16	2.0	2.3	2.5	3.0	3.3	3.6
17	1.8	2.0	2.2	2.7	3.0	3.2
18	1.6	1.8	2.0	2.4	2.6	2.9
19	1.4	1.6	1.8	2.1	2.4	2.6
20	1.3	1.5	1.6	1.9	2.1	2.3
21	1.2	1.3	1.5	1.8	1.9	2.1
22	1.1	1.2	1.3	1.6	1.8	1.9
23	1.0	1.1	1.2	1.5	1.6	1.8
24	....	1.0	1.1	1.3	1.5	1.6
25	....	....	1.0	1.2	1.4	1.5
26	....	....	1.0	1.1	1.3	1.4
27	....	....	....	1.1	1.2	1.3
28	....	....	....	1.0	1.1	1.2
29	....	....	....	....	1.0	1.1

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 100 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.						
	7 Inch No. B 21.			8 Inch No. B 25.			
	15 lbs.	17.5 lbs.	20 lbs.	17.75 lbs.	20.25 lbs.	22.75 lbs.	25.25 lbs.
4	69.0	74.6	80.3	94.8	100.3	106.9	113.4
5	44.2	47.8	51.4	60.7	64.2	68.4	72.6
6	30.7	33.2	35.7	42.1	44.6	47.5	50.4
7	22.5	24.4	26.2	31.0	32.8	34.9	37.0
8	17.3	18.7	20.1	23.7	25.1	26.7	28.3
9	13.6	14.7	15.9	18.7	19.8	21.1	22.4
10	11.0	11.9	12.9	15.2	16.1	17.1	18.1
11	9.1	9.9	10.6	12.5	13.3	14.1	15.0
12	7.7	8.3	8.9	10.5	11.1	11.9	12.6
13	6.5	7.1	7.6	9.0	9.5	10.1	10.7
14	5.6	6.1	6.6	7.7	8.2	8.7	9.3
15	4.9	5.3	5.7	6.7	7.1	7.6	8.1
16	4.3	4.7	5.0	5.9	6.3	6.7	7.1
17	3.8	4.1	4.4	5.2	5.6	5.9	6.3
18	3.4	3.7	4.0	4.7	5.0	5.3	5.6
19	3.1	3.3	3.6	4.2	4.4	4.7	5.0
20	2.8	3.0	3.2	3.8	4.0	4.3	4.5
21	2.5	2.7	2.9	3.4	3.6	3.9	4.1
22	2.3	2.5	2.7	3.1	3.3	3.5	3.7
23	2.1	2.3	2.4	2.9	3.0	3.2	3.4
24	1.9	2.1	2.2	2.6	2.8	3.0	3.1
25	1.8	1.9	2.1	2.4	2.6	2.7	2.9
26	1.6	1.8	1.9	2.2	2.4	2.5	2.7
27	1.5	1.6	1.8	2.1	2.2	2.3	2.5
28	1.4	1.5	1.6	1.9	2.0	2.2	2.3
29	1.3	1.4	1.5	1.8	1.9	2.0	2.2

For spacings above the dotted lines the safe loads for bending are greater than the safe loads for web crippling, as explained on pages 62 to 65 inclusive.

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 100 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.							
	9 Inch No. B 29.				10 Inch No. B 33.			
	21 lbs.	25 lbs.	30 lbs.	35 lbs.	25 lbs.	30 lbs.	35 lbs.	40 lbs.
8	31.5	34.1	37.7	41.4	....	....	....	....
9	24.9	26.9	29.8	32.7	....	....	....	....
10	20.1	21.8	24.1	26.5	26.0	28.6	31.2	33.9
11	16.6	18.0	20.0	21.9	21.5	23.7	25.8	28.0
12	14.0	15.1	16.8	18.4	18.1	19.9	21.7	23.5
13	11.9	12.9	14.3	15.7	15.4	16.9	18.5	20.0
14	10.3	11.1	12.3	13.5	13.3	14.6	15.9	17.3
15	8.9	9.7	10.7	11.8	11.6	12.7	13.9	15.0
16	7.9	8.5	9.4	10.4	10.2	11.2	12.2	13.2
17	7.0	7.5	8.4	9.2	9.0	9.9	10.8	11.7
18	6.2	6.7	7.5	8.2	8.0	8.8	9.6	10.4
19	5.6	6.0	6.7	7.3	7.2	7.9	8.7	9.4
20	5.0	5.4	6.0	6.6	6.5	7.2	7.8	8.5
21	4.6	4.9	5.5	6.0	5.9	6.5	7.1	7.7
22	4.2	4.5	5.0	5.5	5.4	5.9	6.5	7.0
23	3.8	4.1	4.6	5.0	4.9	5.4	5.9	6.4
24	3.5	3.8	4.2	4.6	4.5	5.0	5.4	5.9
25	3.2	3.5	3.9	4.2	4.2	4.6	5.0	5.4
26	3.0	3.2	3.6	3.9	3.9	4.2	4.6	5.0
27	2.8	3.0	3.3	3.6	3.6	3.9	4.3	4.6
28	2.6	2.8	3.1	3.4	3.3	3.7	4.0	4.3
29	2.4	2.6	2.9	3.2	3.1	3.4	3.7	4.0
30	2.2	2.4	2.7	2.9	2.9	3.2	3.5	3.8
31	2.1	2.3	2.5	2.8	2.7	3.0	3.3	3.5
32	....	....	....	....	2.5	2.8	3.1	3.3
33	....	....	....	....	2.4	2.6	2.9	3.1

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 100 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAM. 12 Inch No. B 41.			SPECIAL I-BEAM. 12 Inch No. B 105.			
	31.5 lbs.	35 lbs.	40 lbs.	40 lbs.	45 lbs.	50 lbs.	55 lbs.
10	38.4	40.6	43.7	47.8	50.8	53.9	57.1
11	31.7	33.5	36.1	39.5	42.0	44.6	47.2
12	26.6	28.2	30.4	33.2	35.3	37.5	39.6
13	22.7	24.0	25.9	28.3	30.1	31.9	33.8
14	19.6	20.7	22.3	24.4	25.9	27.5	29.1
15	17.1	18.0	19.4	21.3	22.6	24.0	25.4
16	15.0	15.9	17.1	18.7	19.8	21.1	22.3
17	13.3	14.0	15.1	16.5	17.6	18.7	19.7
18	11.8	12.5	13.5	14.8	15.7	16.6	17.6
19	10.6	11.2	12.1	13.2	14.1	14.9	15.8
20	9.6	10.1	10.9	12.0	12.7	13.5	14.3
21	8.7	9.2	9.9	10.8	11.5	12.2	12.9
22	7.9	8.4	9.0	9.9	10.5	11.1	11.8
23	7.3	7.7	8.3	9.0	9.6	10.2	10.8
24	6.7	7.0	7.6	8.3	8.8	9.4	9.9
25	6.1	6.5	7.0	7.7	8.1	8.6	9.1
26	5.7	6.0	6.5	7.1	7.5	8.0	8.4
27	5.3	5.6	6.0	6.6	7.0	7.4	7.8
28	4.9	5.2	5.6	6.1	6.5	6.9	7.3
29	4.6	4.8	5.2	5.7	6.0	6.4	6.8
30	4.3	4.5	4.9	5.3	5.6	6.0	6.3
31	4.0	4.2	4.5	5.0	5.3	5.6	5.9
32	3.7	4.0	4.3	4.7	5.0	5.3	5.6
33	3.5	3.7	4.0	4.4	4.7	5.0	5.2
34	3.3	3.5	3.8	4.1	4.4	4.7	4.9
35	3.1	3.3	3.6	3.9	4.1	4.4	4.7
36	3.0	3.1	3.4	3.7	3.9	4.2	4.4

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings $= \frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 100 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAM. 15 Inch No. B 53.				
	42 lbs.	45 lbs.	50 lbs.	55 lbs.	60 lbs.
10	62.8	64.8	68.8	72.7	76.6
11	51.9	53.6	56.8	60.1	63.3
12	43.6	45.0	47.7	50.5	53.2
13	37.2	38.4	40.7	43.0	45.3
14	32.0	33.1	35.1	37.1	39.1
15	27.9	28.8	30.6	32.3	34.0
16	24.5	25.3	26.9	28.4	29.9
17	21.7	22.4	23.8	25.1	26.5
18	19.4	20.0	21.2	22.4	23.6
19	17.4	18.0	19.0	20.1	21.2
20	15.7	16.2	17.2	18.2	19.1
21	14.2	14.7	15.6	16.5	17.4
22	13.0	13.4	14.2	15.0	15.8
23	11.9	12.3	13.0	13.7	14.5
24	10.9	11.3	11.9	12.6	13.3
25	10.1	10.4	11.0	11.6	12.3
26	9.3	9.6	10.2	10.8	11.3
27	8.6	8.9	9.4	10.0	10.5
28	8.0	8.3	8.8	9.3	9.8
29	7.5	7.7	8.2	8.6	9.1
30	7.0	7.2	7.6	8.1	8.5
31	6.5	6.7	7.2	7.6	8.0
32	6.1	6.3	6.7	7.1	7.5
33	5.8	6.0	6.3	6.7	7.0
34	5.4	5.6	5.9	6.3	6.6
35	5.1	5.3	5.6	5.9	6.3
36	4.8	5.0	5.3	5.6	5.9

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 100 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16000 pounds per square inch.

Distance between supports in feet.	SPECIAL I-BEAM. 15 Inch No. B 109.				
	60 lbs.	65 lbs.	70 lbs.	75 lbs.	80 lbs.
10	86.6	90.5	94.4	98.3	02.2
11	71.6	74.8	78.0	81.2	84.5
12	60.1	62.8	65.5	68.3	71.0
13	51.3	53.5	55.9	58.2	60.5
14	44.2	46.2	48.2	50.2	52.2
15	38.5	40.2	41.9	43.7	45.4
16	33.8	35.3	36.9	38.4	39.9
17	30.0	31.3	32.7	34.0	35.4
18	26.7	27.9	29.1	30.3	31.6
19	24.0	25.1	26.1	27.2	28.3
20	21.7	22.6	23.6	24.6	25.6
21	19.6	20.5	21.4	22.3	23.2
22	17.9	18.7	19.5	20.3	21.1
23	16.4	17.1	17.8	18.6	19.3
24	15.0	15.7	16.4	17.1	17.7
25	13.9	14.5	15.1	15.7	16.4
26	12.8	13.4	14.0	14.5	15.1
27	11.9	12.4	12.9	13.5	14.0
28	11.0	11.5	12.0	12.5	13.0
29	10.3	10.8	11.2	11.7	12.2
30	9.6	10.1	10.5	10.9	11.4
31	9.0	9.4	9.8	10.2	10.6
32	8.5	8.8	9.2	9.6	10.0
33	8.0	8.3	8.7	9.0	9.4
34	7.5	7.8	8.2	8.5	8.8
35	7.1	7.4	7.7	8.0	8.3
36	6.7	7.0	7.3	7.6	7.9

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 100 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	SPECIAL I-BEAM. 15 Inch No. B 113.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	112.2	116.0	120.0	123.9	127.8
11	92.8	95.9	99.1	102.4	105.6
12	77.9	80.6	83.3	86.0	88.7
13	66.4	68.7	71.0	73.3	75.6
14	57.3	59.2	61.2	63.2	65.2
15	49.9	51.6	53.3	55.1	56.8
16	43.8	45.3	46.9	48.4	49.9
17	38.8	40.2	41.5	42.9	44.2
18	34.6	35.8	37.0	38.2	39.4
19	31.1	32.1	33.2	34.3	35.4
20	28.1	29.0	30.0	31.0	31.9
21	25.4	26.3	27.2	28.1	29.0
22	23.2	24.0	24.8	25.6	26.4
23	21.2	21.9	22.7	23.4	24.2
24	19.5	20.1	20.8	21.5	22.2
25	18.0	18.6	19.2	19.8	20.4
26	16.6	17.2	17.7	18.3	18.9
27	15.4	15.9	16.5	17.0	17.5
28	14.3	14.8	15.3	15.8	16.3
29	13.3	13.8	14.3	14.7	15.2
30	12.5	12.9	13.3	13.8	14.2
31	11.7	12.1	12.5	12.9	13.3
32	11.0	11.3	11.7	12.1	12.5
33	10.3	10.7	11.0	11.4	11.7
34	9.7	10.0	10.4	10.7	11.1
35	9.2	9.5	9.8	10.1	10.4
36	8.7	9.0	9.3	9.6	9.9

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 100 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.						
	18 Inch No. B 65.				20 Inch No. B 73.		
	55 lbs.	60 lbs.	65 lbs.	70 lbs.	65 lbs.	70 lbs.	75 lbs.
10	94.3	99.8	104.5	109.2	124.7	130.1	135.3
11	77.9	82.5	86.3	90.2	103.1	107.5	111.9
12	65.5	69.3	72.6	75.8	86.6	90.4	94.0
13	55.8	59.0	61.8	64.6	73.8	77.0	80.1
14	48.1	50.9	53.3	55.7	63.6	66.4	69.1
15	41.9	44.3	46.4	48.5	55.4	57.8	60.2
16	36.8	39.0	40.8	42.6	48.7	50.8	52.9
17	32.6	34.5	36.2	37.8	43.2	45.0	46.8
18	29.1	30.8	32.2	33.7	38.5	40.2	41.8
19	26.1	27.6	28.9	30.2	34.6	36.0	37.5
20	23.6	24.9	26.1	27.3	31.2	32.5	33.8
21	21.4	22.6	23.7	24.8	28.3	29.5	30.7
22	19.5	20.6	21.6	22.6	25.8	26.9	28.0
23	17.8	18.9	19.7	20.6	23.6	24.6	25.6
24	16.4	17.3	18.1	19.0	21.7	22.6	23.5
25	15.1	16.0	16.7	17.5	20.0	20.8	21.7
26	13.9	14.8	15.5	16.2	18.5	19.2	20.0
27	12.9	13.7	14.3	15.0	17.1	17.8	18.6
28	12.0	12.7	13.3	13.9	15.9	16.6	17.3
29	11.2	11.9	12.4	13.0	14.8	15.5	16.1
30	10.5	11.1	11.6	12.1	13.9	14.5	15.0
31	9.8	10.4	10.9	11.4	13.0	13.5	14.1
32	9.2	9.7	10.2	10.7	12.2	12.7	13.2
33	8.7	9.2	9.6	10.0	11.5	11.9	12.4
34	8.2	8.6	9.0	9.4	10.8	11.3	11.7
35	7.7	8.1	8.5	8.9	10.2	10.6	11.0
36	7.3	7.7	8.1	8.4	9.6	10.0	10.4

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 100 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	SPECIAL I-BEAM. 20 Inch No. B 121.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	156.4	160.9	166.1	171.4	176.6
11	129.3	133.0	137.3	141.6	145.9
12	108.6	111.7	115.4	119.0	122.6
13	92.5	95.2	98.3	101.4	104.5
14	79.8	82.1	84.8	87.4	90.1
15	69.5	71.5	73.8	76.2	78.5
16	61.1	62.9	64.9	66.9	69.0
17	54.1	55.7	57.5	59.3	61.1
18	48.3	49.7	51.3	52.9	54.5
19	43.3	44.6	46.0	47.5	48.9
20	39.1	40.2	41.5	42.8	44.1
21	35.5	36.5	37.7	38.9	40.0
22	32.3	33.2	34.3	35.4	36.5
23	29.6	30.4	31.4	32.4	33.4
24	27.2	27.9	28.8	29.8	30.7
25	25.0	25.7	26.6	27.4	28.3
26	23.1	23.8	24.6	25.4	26.1
27	21.5	22.1	22.8	23.5	24.2
28	19.9	20.5	21.2	21.9	22.5
29	18.6	19.1	19.8	20.4	21.0
30	17.4	17.9	18.5	19.0	19.6
31	16.3	16.7	17.3	17.8	18.4
32	15.3	15.7	16.2	16.7	17.2
33	14.4	14.8	15.3	15.7	16.2
34	13.5	13.9	14.4	14.8	15.3
35	12.8	13.1	13.6	14.0	14.4
36	12.1	12.4	12.8	13.2	13.6

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 100 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.				
	24 Inch No. B 89.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	185.5	192.7	199.0	205.2	211.5
11	153.3	159.3	164.4	169.6	174.8
12	128.8	133.8	138.2	142.5	146.9
13	109.8	114.0	117.7	121.4	125.2
14	94.7	98.3	101.5	104.7	107.9
15	82.5	85.6	88.4	91.2	94.0
16	72.5	75.3	77.7	80.2	82.6
17	64.2	66.7	68.8	71.0	73.2
18	57.3	59.5	61.4	63.3	65.3
19	51.4	53.4	55.1	56.9	58.6
20	46.4	48.2	49.7	51.3	52.9
21	42.1	43.7	45.1	46.5	48.0
22	38.3	39.8	41.1	42.4	43.7
23	35.1	36.4	37.6	38.8	40.0
24	32.2	33.5	34.5	35.6	36.7
25	29.7	30.8	31.8	32.8	33.8
26	27.4	28.5	29.4	30.4	31.3
27	25.5	26.4	27.3	28.2	29.0
28	23.7	24.6	25.4	26.2	27.0
29	22.1	22.9	23.7	24.4	25.2
30	20.6	21.4	22.1	22.8	23.5
31	19.3	20.1	20.7	21.4	22.0
32	18.1	18.8	19.4	20.0	20.7
33	17.0	17.7	18.3	18.8	19.4
34	16.0	16.7	17.2	17.8	18.3
35	15.1	15.7	16.2	16.8	17.3
36	14.3	14.9	15.4	15.8	16.3

For spacings above the dotted lines the safe loads for bending are greater than the safe loads for web crippling, as explained on pages 62 to 65 inclusive.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 125 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.						
	3 Inch No. B. 5.			4 Inch No. B 9.			
	5.5 lbs.	6.5 lbs.	7.5 lbs.	7.5 lbs.	8.5 lbs.	9.5 lbs.	10.5 lbs.
4	8.8	9.6	10.4	15.9	16.9	18.0	19.0
5	5.6	6.1	6.6	10.2	10.8	11.5	12.2
6	3.9	4.3	4.6	7.1	7.5	8.0	8.5
7	2.9	3.1	3.4	5.2	5.5	5.9	6.2
8	2.2	2.4	2.6	4.0	4.2	4.5	4.8
9	1.7	1.9	2.0	3.1	3.3	3.6	3.8
10	1.4	1.5	1.7	2.5	2.7	2.9	3.0
11	1.2	1.3	1.4	2.1	2.2	2.4	2.5
12	1.0	1.1	1.2	1.8	1.9	2.0	2.1
13	....	....	1.0	1.5	1.6	1.7	1.8
14	....	....	....	1.3	1.4	1.5	1.6
15	....	....	....	1.1	1.2	1.3	1.4
16	....	....	....	1.0	1.1	1.1	1.2
17	....	....	....	....	....	1.0	1.1

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I BEAMS FOR UNIFORM LOAD OF 125 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.					
	5 Inch No. B 13.			6 Inch No. B 17.		
	9.75 lbs.	12.25 lbs.	14.75 lbs.	12.25 lbs.	14.75 lbs.	17.25 lbs.
4	25.8	29.0	32.3	38.7	42.6	46.6
5	16.5	18.6	20.7	24.8	27.3	29.8
6	11.5	12.9	14.4	17.2	18.9	20.7
7	8.4	9.5	10.6	12.6	13.9	15.2
8	6.4	7.3	8.1	9.7	10.7	11.6
9	5.1	5.7	6.4	7.7	8.4	9.2
10	4.1	4.6	5.2	6.2	6.8	7.4
11	3.4	3.8	4.3	5.1	5.6	6.2
12	2.9	3.2	3.6	4.3	4.7	5.2
13	2.4	2.8	3.1	3.7	4.0	4.4
14	2.1	2.4	2.6	3.2	3.5	3.8
15	1.8	2.1	2.3	2.8	3.0	3.3
16	1.6	1.8	2.0	2.4	2.7	2.9
17	1.4	1.6	1.8	2.1	2.4	2.6
18	1.3	1.4	1.6	1.9	2.1	2.3
19	1.1	1.3	1.4	1.7	1.9	2.1
20	1.0	1.2	1.3	1.5	1.7	1.9
21	....	1.1	1.2	1.4	1.5	1.7
22	....	1.0	1.1	1.3	1.4	1.5
23	....	....	1.0	1.2	1.3	1.4
24	....	....	....	1.1	1.2	1.3
25	....	....	....	1.0	1.1	1.2
26	....	....	....	....	1.0	1.1
27	....	....	....	....	....	1.0
28	....	....	....	....	....	1.0

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 125 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.						
	7 Inch No. B 21.			8 Inch No. B 25.			
	15 lbs.	17.5 lbs.	20 lbs.	17.75 lbs.	20.25 lbs.	22.75 lbs.	25.25 lbs.
4	55.2	59.7	64.3	75.8	80.3	85.5	90.7
5	35.5	38.2	41.1	48.5	51.4	54.7	58.1
6	24.5	26.5	28.6	33.7	35.7	38.0	40.3
7	18.0	19.5	21.0	24.8	26.2	27.9	29.6
8	13.8	13.9	16.1	19.0	20.1	21.4	22.7
9	10.9	11.8	12.7	15.0	15.9	16.9	17.9
10	8.8	9.5	10.3	12.1	12.8	13.7	14.5
11	7.3	7.9	8.5	10.0	10.6	11.3	12.0
12	6.1	6.6	7.1	8.4	8.9	9.5	10.1
13	5.2	5.7	6.1	7.2	7.6	8.1	8.6
14	4.5	4.9	5.2	6.2	6.6	7.0	7.4
15	3.9	4.2	4.6	5.4	5.7	6.1	6.5
16	3.5	3.7	4.0	4.7	5.0	5.3	5.7
17	3.1	3.3	3.6	4.2	4.4	4.7	5.0
18	2.7	2.9	3.2	3.7	4.0	4.2	4.5
19	2.4	2.6	2.8	3.4	3.6	3.8	4.0
20	2.2	2.4	2.6	3.0	3.2	3.4	3.6
21	2.0	2.2	2.3	2.8	2.9	3.1	3.3
22	1.8	2.0	2.1	2.5	2.7	2.8	3.0
23	1.7	1.8	1.9	2.3	2.4	2.6	2.7
24	1.5	1.7	1.8	2.1	2.2	2.4	2.5
25	1.4	1.5	1.6	1.9	2.0	2.2	2.3
26	1.3	1.4	1.5	1.8	1.9	2.0	2.1
27	1.2	1.3	1.4	1.7	1.8	1.9	2.0
28	1.1	1.2	1.3	1.5	1.6	1.7	1.9
29	1.1	1.1	1.2	1.4	1.5	1.6	1.7

For spacings above the dotted lines the safe loads for bending are greater than the safe loads for web crippling, as explained on pages 62 to 65 inclusive.

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 125 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.							
	9 Inch No. 29.				10 Inch No. 33.			
	21 lbs.	25 lbs.	30 lbs.	35 lbs.	25 lbs.	30 lbs.	35 lbs.	40 lbs.
8	25.2	27.2	30.2	33.1	...	...	...	...
9	19.9	21.5	23.8	26.2	...	...	...	...
10	16.1	17.4	19.3	21.2	20.8	22.9	25.0	27.1
11	13.3	14.4	16.0	17.5	17.2	18.9	20.7	22.4
12	11.2	12.1	13.4	14.7	14.5	15.9	17.4	18.8
13	9.5	10.3	11.4	12.5	12.3	13.6	14.8	16.0
14	8.2	8.9	9.9	10.8	10.6	11.7	12.8	13.8
15	7.2	7.7	8.6	9.4	9.3	10.2	11.1	12.0
16	6.3	6.8	7.5	8.3	8.1	8.9	9.8	10.6
17	5.6	6.0	6.7	7.3	7.2	7.9	8.6	9.4
18	5.0	5.4	6.0	6.5	6.4	7.1	7.7	8.4
19	4.5	4.8	5.4	5.9	5.8	6.3	6.9	7.5
20	4.0	4.4	4.8	5.3	5.2	5.7	6.2	6.8
21	3.6	4.0	4.4	4.8	4.7	5.2	5.7	6.1
22	3.3	3.6	4.0	4.4	4.3	4.7	5.2	5.6
23	3.0	3.3	3.7	4.0	3.9	4.3	4.7	5.1
24	2.8	3.0	3.4	3.7	3.6	4.0	4.3	4.7
25	2.6	2.8	3.1	3.4	3.3	3.7	4.0	4.3
26	2.4	2.6	2.9	3.1	3.1	3.4	3.7	4.0
27	2.2	2.4	2.7	2.9	2.9	3.1	3.4	3.7
28	2.1	2.2	2.5	2.7	2.7	2.9	3.2	3.5
29	1.9	2.1	2.3	2.5	2.5	2.7	3.0	3.2
30	1.8	1.9	2.1	2.4	2.3	2.5	2.8	3.0
31	1.7	1.8	2.0	2.2	2.2	2.4	2.6	2.8
32	...	...	...	...	2.0	2.2	2.4	2.6
33	...	...	...	...	1.9	2.1	2.3	2.5

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 125 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAM. 12 Inch No. B 41.			SPECIAL I-BEAM. 12 Inch No. B 105.			
	31.5 lbs.	35 lbs.	40 lbs.	40 lbs.	45 lbs.	50 lbs.	55 lbs.
10	30.7	32.5	35.0	38.3	40.6	43.1	45.7
11	25.4	26.8	28.9	31.6	33.6	35.7	37.7
12	21.3	22.5	24.3	26.6	28.2	30.0	31.7
13	18.2	19.2	20.7	22.6	24.0	25.5	27.0
14	15.7	16.6	17.8	19.5	20.7	22.0	23.3
15	13.6	14.4	15.5	17.0	18.1	19.2	20.3
16	12.0	12.7	13.7	14.9	15.9	16.9	17.8
17	10.6	11.2	12.1	13.2	14.1	14.9	15.8
18	9.5	10.0	10.8	11.8	12.5	13.3	14.1
19	8.5	9.0	9.7	10.6	11.3	12.0	12.6
20	7.7	8.1	8.7	9.6	10.1	10.8	11.4
21	7.0	7.4	7.9	8.7	9.2	9.8	10.4
22	6.3	6.7	7.2	7.9	8.4	8.9	9.4
23	5.8	6.1	6.6	7.2	7.7	8.2	8.6
24	5.3	5.6	6.1	6.6	7.1	7.5	7.9
25	4.9	5.2	5.6	6.1	6.5	6.9	7.3
26	4.5	4.8	5.2	5.7	6.0	6.4	6.8
27	4.2	4.5	4.8	5.2	5.6	5.9	6.3
28	3.9	4.1	4.5	4.9	5.2	5.5	5.8
29	3.6	3.9	4.2	4.5	4.8	5.1	5.4
30	3.4	3.6	3.9	4.3	4.5	4.8	5.1
31	3.2	3.4	3.6	4.0	4.2	4.5	4.8
32	3.0	3.2	3.4	3.7	4.0	4.2	4.5
33	2.8	3.0	3.2	3.5	3.7	4.0	4.2
34	2.7	2.8	3.0	3.3	3.5	3.7	3.9
35	2.5	2.7	2.9	3.1	3.3	3.5	3.7
36	2.4	2.5	2.7	3.0	3.1	3.3	3.5

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 125 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAM. 15 Inch No. B 53.				
	42 lbs.	45 lbs.	50 lbs.	55 lbs.	60 lbs.
10	50.3	51.9	55.0	58.1	61.3
11	41.5	42.9	45.5	48.0	50.6
12	34.9	36.0	38.2	44.4	42.6
13	29.7	30.7	32.5	34.4	36.3
14	25.6	26.5	28.1	29.7	31.3
15	22.3	23.1	24.4	25.8	27.2
16	19.6	20.3	21.5	22.7	23.9
17	17.4	17.9	19.0	20.1	21.2
18	15.5	16.0	17.0	17.9	18.9
19	13.9	14.4	15.2	16.1	17.0
20	12.6	13.0	13.8	14.5	15.3
21	11.4	11.8	12.5	13.2	13.9
22	10.4	10.7	11.4	12.0	12.7
23	9.5	9.8	10.4	11.0	11.6
24	8.7	9.0	9.5	10.1	10.6
25	8.0	8.3	8.8	9.3	9.8
26	7.4	7.7	8.1	8.6	9.1
27	6.9	7.1	7.5	8.0	8.4
28	6.4	6.6	7.0	7.4	7.8
29	6.0	6.2	6.5	6.9	7.3
30	5.6	5.8	6.1	6.5	6.8
31	5.2	5.4	5.7	6.1	6.4
32	4.9	5.1	5.4	5.7	6.0
33	4.6	4.8	5.1	5.3	5.6
34	4.3	4.5	4.8	5.0	5.3
35	4.1	4.2	4.5	4.7	5.0
36	3.9	4.0	4.2	4.5	4.7

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 125 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	SPECIAL I-BEAM. 15 Inch No. B 109. 60 lbs.	65 lbs.	70 lbs.	75 lbs.	80 lbs.
10	69.3	72.4	75.5	78.6	81.8
11	57.3	59.8	62.4	65.0	67.6
12	48.1	50.3	52.4	54.6	56.8
13	41.0	42.8	44.7	46.5	48.4
14	35.4	36.9	38.5	40.1	41.7
15	30.8	32.2	33.6	35.0	36.3
16	27.1	28.3	29.5	30.7	31.9
17	24.0	25.0	26.1	27.2	28.3
18	21.4	22.3	23.3	24.3	25.2
19	19.2	20.0	20.9	21.8	22.7
20	17.3	18.1	18.9	19.7	20.4
21	15.7	16.4	17.1	17.8	18.5
22	14.3	15.0	15.6	16.2	16.9
23	13.1	13.7	14.3	14.9	15.5
24	12.0	12.6	13.1	13.7	14.2
25	11.1	11.6	12.1	12.6	13.1
26	10.3	10.7	11.2	11.6	12.1
27	9.5	9.9	10.4	10.8	11.2
28	8.8	9.2	9.6	10.0	10.4
29	8.2	8.6	9.0	9.4	9.7
30	7.7	8.0	8.4	8.7	9.1
31	7.2	7.5	7.9	8.2	8.5
32	6.8	7.1	7.4	7.7	8.0
33	6.4	6.7	6.9	7.2	7.5
34	6.0	6.3	6.5	6.8	7.1
35	5.7	5.9	6.1	6.4	6.8
36	5.3	5.6	5.8	6.1	6.3

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 125 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	SPECIAL I-BEAM. 15 Inch No. B 113.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	89.8	92.8	96.0	99.1	102.2
11	74.2	76.7	79.3	81.9	84.5
12	62.3	64.5	66.6	68.8	71.0
13	53.1	54.9	56.8	58.6	60.5
14	45.8	47.4	49.0	50.6	52.2
15	39.9	41.3	42.7	44.0	45.4
16	35.1	36.3	37.5	38.7	39.9
17	31.1	32.1	33.2	34.3	35.4
18	27.7	28.7	29.6	30.6	31.6
19	24.9	25.7	26.6	27.5	28.3
20	22.4	23.2	24.0	24.8	25.6
21	20.4	21.0	21.8	22.5	23.2
22	18.6	19.2	19.8	20.5	21.1
23	17.0	17.5	18.1	18.7	19.3
24	15.6	16.1	16.7	17.2	17.7
25	14.4	14.9	15.4	15.9	16.4
26	13.3	13.7	14.2	14.7	15.1
27	12.3	12.7	13.2	13.6	14.0
28	11.5	11.8	12.2	12.6	13.0
29	10.7	11.0	11.4	11.8	12.2
30	10.0	10.3	10.7	11.0	11.4
31	9.3	9.7	10.0	10.3	10.6
32	8.8	9.1	9.4	9.7	10.0
33	8.2	8.5	8.8	9.1	9.4
34	7.8	8.0	8.3	8.6	8.8
35	7.3	7.6	7.8	8.1	8.3
36	6.9	7.2	7.4	7.6	7.9

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 125 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.						
	18 Inch No. B 65.				20 Inch No. B 73.		
	55 lbs.	60 lbs.	65 lbs.	70 lbs.	65 lbs.	70 lbs.	75 lbs.
10	75.4	79.8	83.6	87.3	99.8	104.1	108.3
11	62.3	66.0	69.1	72.2	82.5	86.0	89.5
12	52.4	55.4	58.0	60.7	69.3	72.3	75.2
13	44.6	47.2	49.5	51.7	59.1	61.6	64.1
14	38.5	40.7	42.6	44.6	50.9	53.1	55.2
15	33.5	35.5	37.1	38.8	44.4	46.3	48.1
16	29.5	31.2	32.6	34.1	39.0	40.7	42.3
17	26.1	27.6	28.9	30.2	34.5	36.0	37.5
18	23.3	24.6	25.8	27.0	30.8	32.1	33.4
19	20.9	22.1	23.2	24.2	27.6	28.8	30.0
20	18.9	20.0	20.9	21.8	24.9	26.0	27.1
21	17.1	18.1	19.0	19.8	22.6	23.6	24.6
22	15.6	16.5	17.3	18.0	20.6	21.5	22.4
23	14.3	15.1	15.8	16.5	18.9	19.7	20.5
24	13.1	13.9	14.5	15.2	17.3	18.1	18.8
25	12.1	12.8	13.4	14.0	16.0	16.7	17.3
26	11.2	11.8	12.4	12.9	14.8	15.4	16.0
27	10.3	10.9	11.5	12.0	13.7	14.3	14.9
28	9.6	10.2	10.7	11.1	12.7	13.3	13.8
29	9.0	9.5	9.9	10.4	11.9	12.4	12.9
30	8.4	8.9	9.3	9.7	11.1	11.6	12.0
31	7.8	8.3	8.7	9.1	10.4	10.8	11.3
32	7.4	7.8	8.2	8.5	9.7	10.2	10.6
33	6.9	7.3	7.7	8.0	9.2	9.6	9.9
34	6.5	6.9	7.2	7.6	8.6	9.0	9.4
35	6.2	6.5	6.8	7.1	8.1	8.5	8.8
36	5.8	6.2	6.4	6.7	7.7	8.0	8.4

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 125 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	SPECIAL I-BEAM. 20 Inch No. B 121.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	125.1	128.7	132.9	137.1	141.3
11	103.4	106.4	109.8	113.3	116.8
12	86.9	89.4	92.3	95.2	98.1
13	74.0	76.2	78.6	81.1	83.6
14	63.8	65.7	67.8	69.9	72.1
15	55.6	57.2	59.1	60.9	62.8
16	48.9	50.3	51.9	53.6	55.2
17	43.3	44.5	46.0	47.4	48.9
18	38.6	39.7	41.0	42.3	43.6
19	34.7	35.7	36.8	38.0	39.1
20	31.3	32.2	33.2	34.3	35.3
21	28.4	29.2	30.1	31.1	32.0
22	25.9	26.6	27.5	28.3	29.2
23	23.7	24.3	25.1	25.9	26.7
24	21.7	22.3	23.1	23.8	24.5
25	20.0	20.6	21.3	21.9	22.6
26	18.5	19.0	19.7	20.3	20.9
27	17.2	17.7	18.2	18.8	19.4
28	16.0	16.4	17.0	17.5	18.0
29	14.9	15.3	15.8	16.3	16.8
30	13.9	14.3	14.8	15.2	15.7
31	13.0	13.4	13.8	14.3	14.7
32	12.2	12.6	13.0	13.4	13.8
33	11.5	11.8	12.2	12.6	13.0
34	10.8	11.1	11.5	11.9	12.2
35	10.2	10.5	10.8	11.2	11.5
36	9.7	9.9	10.3	10.6	10.9

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 125 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAM. 24 Inch No. B 89. 80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	148.4	154.2	159.2	164.2	169.2
11	122.7	127.4	131.6	135.7	139.8
12	103.1	107.1	110.5	114.0	117.5
13	87.8	91.2	94.2	97.2	100.1
14	75.7	78.7	81.2	83.8	86.3
15	66.0	68.5	70.7	73.0	75.2
16	58.0	60.2	62.2	64.1	66.1
17	51.4	53.3	55.1	56.8	58.6
18	45.8	47.6	49.1	50.7	52.2
19	41.1	42.7	44.1	45.5	46.9
20	37.1	38.5	39.8	41.0	42.3
21	33.7	35.0	36.1	37.2	38.4
22	30.7	31.9	32.9	33.9	35.0
23	28.1	29.1	30.1	31.0	32.0
24	25.8	26.8	27.6	28.5	29.4
25	23.7	24.7	25.5	26.3	27.1
26	22.0	22.8	23.5	24.3	25.0
27	20.4	21.1	21.8	22.5	23.2
28	18.9	19.7	20.3	20.9	21.6
29	17.6	18.3	18.9	19.5	20.1
30	16.5	17.1	17.7	18.2	18.8
31	15.4	16.0	16.6	17.1	17.6
32	14.5	15.1	15.5	16.0	16.5
33	13.6	14.2	14.6	15.1	15.5
34	12.8	13.3	13.8	14.2	14.6
35	12.1	12.6	13.0	13.4	13.8
36	11.5	11.9	12.3	12.7	13.1

For spacings above the dotted lines the safe loads for bending are greater than the safe loads for web crippling, as explained on pages 62 to 65 inclusive.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 150 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.						
	3 Inch No. B 5.			4 Inch No. B 9.			
	5.5 lbs.	6.5 lbs.	7.5 lbs.	7.5 lbs.	8.5 lbs.	9.5 lbs.	10.5 lbs.
4	7.4	8.0	8.6	13.3	14.1	15.0	15.9
5	4.7	5.1	5.5	8.5	9.0	9.6	10.2
6	3.3	3.5	3.8	5.9	6.3	6.7	7.1
7	2.4	2.6	2.8	4.3	4.6	4.9	5.2
8	1.8	2.0	2.2	3.3	3.5	3.7	4.0
9	1.5	1.6	1.7	2.6	2.8	3.0	3.1
10	1.2	1.3	1.4	2.1	2.3	2.4	2.5
11	1.0	1.1	1.1	1.8	1.9	2.0	2.1
12	...	...	1.0	1.5	1.6	1.7	1.8
13	...	...	...	1.3	1.3	1.4	1.5
14	...	...	...	1.1	1.2	1.2	1.3
15	...	...	...	...	1.0	1.1	1.1
16	...	...	...	...	...	...	1.0

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 150 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.					
	5 Inch No. B 13.			6 Inch No. B 17.		
	9.75 lbs.	12.25 lbs.	14.75 lbs.	12.25 lbs.	14.75 lbs.	17.25 lbs.
4	21.5	24.2	26.9	32.3	35.5	38.8
5	13.8	15.5	17.2	20.7	22.7	24.8
6	9.6	10.8	12.0	14.3	15.8	17.2
7	7.0	7.9	8.8	10.5	11.6	12.7
8	5.4	6.1	6.7	8.1	8.9	9.7
9	4.2	4.8	5.3	6.4	7.0	7.7
10	3.4	3.9	4.3	5.2	5.7	6.2
11	2.8	3.2	3.6	4.3	4.7	5.1
12	2.4	2.7	3.0	3.6	3.9	4.3
13	2.0	2.3	2.5	3.1	3.4	3.7
14	1.8	2.0	2.2	2.6	2.9	3.2
15	1.5	1.7	1.9	2.3	2.5	2.8
16	1.3	1.5	1.7	2.0	2.2	2.4
17	1.2	1.3	1.5	1.8	2.0	2.1
18	1.1	1.2	1.3	1.6	1.8	1.9
19	1.0	1.1	1.2	1.4	1.6	1.7
20	....	1.0	1.1	1.3	1.4	1.6
21	....	....	1.0	1.2	1.3	1.4
22	....	....	....	1.1	1.2	1.3
23	....	....	....	1.0	1.1	1.2
24	....	....	....	....	1.0	1.1
25	....	....	....	....	....	1.0

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 150 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

STANDARD I-BEAMS.

Distance between supports in feet.	7 Inch No. B 21.			8 Inch No. B 25.			
	15 lbs.	17.5 lbs.	20 lbs.	17.75 lbs.	20.25 lbs.	22.75 lbs.	25.25 lbs.
4	46.0	49.8	53.6	63.2	66.9	71.2	75.6
5	29.4	31.8	34.3	40.4	42.8	45.6	48.4
6	20.4	22.1	23.8	28.1	29.7	31.7	33.6
7	15.0	16.2	17.5	20.6	21.8	23.3	24.7
8	11.5	12.4	13.4	15.8	16.7	17.8	18.9
9	9.1	9.8	10.6	12.5	13.2	14.1	14.9
10	7.4	8.0	8.6	10.1	10.7	11.4	12.1
11	6.1	6.6	7.1	8.4	8.8	9.4	10.0
12	5.1	5.5	6.0	7.0	7.4	7.9	8.4
13	4.4	4.7	5.1	6.0	6.3	6.7	7.2
14	3.8	4.1	4.4	5.2	5.5	5.8	6.2
15	3.3	3.5	3.8	4.5	4.8	5.1	5.4
16	2.9	3.1	3.3	3.9	4.2	4.5	4.7
17	2.5	2.8	3.0	3.5	3.7	3.9	4.2
18	2.3	2.5	2.6	3.1	3.3	3.5	3.7
19	2.0	2.2	2.4	2.8	3.0	3.2	3.4
20	1.8	2.0	2.1	2.5	2.7	2.8	3.0
21	1.7	1.8	1.9	2.3	2.4	2.6	2.7
22	1.5	1.6	1.8	2.1	2.2	2.4	2.5
23	1.4	1.5	1.6	1.9	2.0	2.2	2.3
24	1.3	1.4	1.5	1.8	1.9	2.0	2.1
25	1.2	1.3	1.4	1.6	1.7	1.8	1.9
26	1.1	1.2	1.3	1.5	1.6	1.7	1.8
27	1.0	1.1	1.2	1.4	1.5	1.6	1.7
28	....	1.0	1.1	1.3	1.4	1.5	1.5
29	....	....	1.0	1.2	1.3	1.4	1.4

For spacings above the dotted lines the safe loads for bending are greater than the safe loads for web crippling, as explained on pages 62 to 65 inclusive.

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 150 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.							
	9 Inch No. B 29.				10 Inch No. B 33.			
	21 lbs.	25 lbs.	30 lbs.	35 lbs.	25 lbs.	30 lbs.	35 lbs.	40 lbs.
8	21.0	22.7	25.2	27.6	....	....	....	....
9	16.6	17.9	19.9	21.8	....	....	....	....
10	13.4	14.5	16.1	17.7	17.4	19.1	20.8	22.6
11	11.1	12.0	13.3	14.6	14.4	15.8	17.2	18.7
12	9.3	10.1	11.2	12.3	12.1	13.3	14.5	15.7
13	7.9	8.6	9.5	10.5	10.3	11.3	12.3	13.3
14	6.8	7.4	8.2	9.0	8.9	9.7	10.6	11.5
15	6.0	6.5	7.2	7.9	7.7	8.5	9.3	10.0
16	5.2	5.7	6.3	6.9	6.8	7.5	8.1	8.8
17	4.6	5.0	5.6	6.1	6.0	6.6	7.2	7.8
18	4.1	4.5	5.0	5.5	5.4	5.9	6.4	7.0
19	3.7	4.0	4.5	4.9	4.8	5.3	5.8	6.3
20	3.4	3.6	4.0	4.4	4.4	4.8	5.2	5.6
21	3.0	3.3	3.7	4.0	3.9	4.3	4.7	5.1
22	2.8	3.0	3.3	3.7	3.6	3.9	4.3	4.7
23	2.5	2.7	3.0	3.3	3.3	3.6	3.9	4.3
24	2.3	2.5	2.8	3.1	3.0	3.3	3.6	3.9
25	2.1	2.3	2.6	2.8	2.8	3.1	3.3	3.6
26	2.0	2.1	2.4	2.6	2.6	2.8	3.1	3.3
27	1.8	2.0	2.2	2.4	2.4	2.6	2.9	3.1
28	1.7	1.9	2.1	2.3	2.2	2.4	2.7	2.9
29	1.6	1.7	1.9	2.1	2.1	2.3	2.5	2.7
30	1.5	1.6	1.8	2.0	1.9	2.1	2.3	2.5
31	1.4	1.5	1.7	1.8	1.8	2.0	2.2	2.3
32	....	....	....	....	1.7	1.9	2.0	2.2
33	....	....	....	....	1.6	1.8	1.9	2.1

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 150 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAM. 12 Inch No. B 41.			SPECIAL I-BEAM. 12 Inch No. B 105.			
	31.5 lbs.	35 lbs.	40 lbs.	40 lbs.	45 lbs.	50 lbs.	55 lbs.
10	25.6	27.1	29.1	31.9	33.9	36.9	38.0
11	21.1	22.4	24.1	26.3	28.0	29.7	31.4
12	17.8	18.8	20.2	22.1	23.5	25.0	26.4
13	15.1	16.0	17.2	18.9	20.0	21.3	22.5
14	13.1	13.8	14.9	16.3	17.3	18.3	19.4
15	11.4	12.0	13.0	14.2	15.1	16.0	16.9
16	10.0	10.6	11.4	12.5	13.2	14.0	14.9
17	8.9	9.4	10.1	11.0	11.7	12.4	13.2
18	7.9	8.3	9.0	9.8	10.5	11.1	11.7
19	7.1	7.5	8.1	8.8	9.4	10.0	10.5
20	6.4	6.8	7.3	8.0	8.5	9.0	9.5
21	5.8	6.1	6.6	7.2	7.7	8.2	8.6
22	5.3	5.6	6.0	6.6	7.0	7.4	7.9
23	4.8	5.1	5.5	6.0	6.4	6.8	7.2
24	4.4	4.7	5.1	5.5	5.9	6.2	6.6
25	4.1	4.3	4.7	5.1	5.4	5.8	6.1
26	3.8	4.0	4.3	4.7	5.0	5.3	5.6
27	3.5	3.7	4.0	4.4	4.6	4.9	5.2
28	3.3	3.5	3.7	4.1	4.3	4.6	4.9
29	3.0	3.2	3.5	3.8	4.0	4.3	4.5
30	2.8	3.0	3.2	3.5	3.8	4.0	4.2
31	2.7	2.8	3.0	3.3	3.5	3.7	4.0
32	2.5	2.6	2.8	3.1	3.3	3.5	3.7
33	2.3	2.5	2.7	2.9	3.1	3.3	3.5
34	2.2	2.3	2.5	2.8	2.9	3.1	3.3
35	2.1	2.2	2.4	2.6	2.8	2.9	3.1
36	2.0	2.1	2.2	2.5	2.6	2.8	2.9

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 150 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS. 15 Inch No. B 53.				
	42 lbs.	45 lbs.	50 lbs.	55 lbs.	60 lbs.
10	41.9	43.2	45.8	48.4	51.1
11	34.6	35.7	37.9	40.0	42.1
12	29.1	30.0	31.8	33.6	35.5
13	24.8	25.6	27.1	28.7	30.2
14	21.4	22.1	23.4	24.7	26.1
15	18.6	19.2	20.4	21.5	22.7
16	16.4	16.9	17.9	18.9	19.9
17	14.5	15.0	15.9	16.8	17.7
18	12.9	13.3	14.1	15.0	15.8
19	11.6	12.0	12.7	13.4	14.1
20	10.5	10.8	11.5	12.1	12.8
21	9.5	9.8	10.4	11.0	11.6
22	8.7	8.9	9.5	10.0	10.6
23	7.9	8.2	8.7	9.2	9.7
24	7.3	7.5	8.0	8.4	8.9
25	6.7	6.9	7.3	7.8	8.2
26	6.2	6.4	6.8	7.2	7.6
27	5.7	5.9	6.3	6.6	7.0
28	5.3	5.5	5.8	6.2	6.5
29	5.0	5.1	5.5	5.8	6.1
30	4.7	4.8	5.1	5.4	5.7
31	4.4	4.5	4.8	5.0	5.3
32	4.1	4.2	4.5	4.7	5.0
33	3.8	4.0	4.2	4.4	4.7
34	3.6	3.7	4.0	4.2	4.4
35	3.4	3.5	3.7	4.0	4.2
36	3.2	3.3	3.5	3.8	3.9

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 150 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	SPECIAL I-BEAM. 15 Inch No. B 109.				
	60 lbs.	65 lbs.	70 lbs.	75 lbs.	80 lbs.
10	57.7	60.3	62.9	65.5	68.2
11	47.7	49.8	52.0	54.2	56.3
12	40.1	41.9	43.7	45.5	47.3
13	34.2	35.7	37.2	38.8	40.3
14	29.5	30.8	32.1	33.4	34.8
15	25.7	26.8	28.0	29.1	30.3
16	22.6	23.6	24.6	25.6	26.6
17	20.0	20.9	21.8	22.7	23.6
18	17.8	18.6	19.4	20.2	21.0
19	16.0	16.7	17.4	18.2	18.9
20	14.4	15.1	15.7	16.4	17.0
21	13.1	13.7	14.3	14.9	15.5
22	11.9	12.5	13.0	13.5	14.1
23	10.9	11.4	11.9	12.4	12.9
24	10.0	10.5	10.9	11.4	11.8
25	9.2	9.6	10.1	10.5	10.9
26	8.5	8.9	9.3	9.7	10.1
27	7.9	8.3	8.6	9.0	9.3
28	7.4	7.7	8.0	8.4	8.7
29	6.9	7.2	7.5	7.8	8.1
30	6.4	6.7	7.0	7.3	7.6
31	6.0	6.3	6.5	6.8	7.1
32	5.6	5.9	6.1	6.4	6.7
33	5.3	5.5	5.8	6.0	6.3
34	5.0	5.2	5.4	5.7	5.9
35	4.7	4.9	5.1	5.4	5.6
36	4.5	4.7	4.9	5.1	5.3

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 150 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	SPECIAL I-BEAM. 15 Inch No. B 113.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	74.8	77.4	80.0	82.6	85.2
11	61.8	63.9	66.1	68.3	70.4
12	52.0	53.7	55.5	57.4	59.2
13	44.3	45.8	47.3	48.9	50.4
14	38.2	39.5	40.8	42.1	43.5
15	33.3	34.4	35.5	36.7	37.9
16	29.2	30.2	31.2	32.3	33.3
17	25.9	26.8	27.7	28.6	29.5
18	23.1	23.9	24.7	25.5	26.3
19	20.7	21.4	22.2	22.9	23.6
20	18.7	19.3	20.0	20.6	21.3
21	17.0	17.5	18.1	18.7	19.3
22	15.5	16.0	16.5	17.1	17.6
23	14.1	14.6	15.1	15.6	16.1
24	13.0	13.4	13.9	14.3	14.8
25	12.0	12.4	12.8	13.2	13.6
26	11.1	11.4	11.8	12.2	12.6
27	10.3	10.6	11.0	11.3	11.7
28	9.5	9.9	10.2	10.5	10.9
29	8.9	9.2	9.5	9.8	10.1
30	8.3	8.6	8.9	9.2	9.5
31	7.8	8.0	8.3	8.6	8.9
32	7.3	7.6	7.8	8.1	8.3
33	6.9	7.1	7.3	7.6	7.8
34	6.5	6.7	6.9	7.1	7.4
35	6.1	6.3	6.5	6.7	7.0
36	5.8	6.0	6.2	6.4	6.6

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 150 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.						
	18 Inch No. B 65.				20 Inch No. B 73.		
	55 lbs.	60 lbs.	65 lbs.	70 lbs.	65 lbs.	70 lbs.	75 lbs.
10	62.9	66.5	69.6	72.8	83.2	86.7	90.2
11	51.9	55.0	57.6	60.2	68.7	71.7	74.6
12	43.7	46.2	48.4	50.5	57.8	60.2	62.7
13	37.2	39.4	41.2	43.1	49.2	51.3	53.4
14	32.1	33.9	35.5	37.1	42.4	44.3	46.0
15	27.9	29.6	31.0	32.3	37.0	38.5	40.1
16	24.6	26.0	27.2	28.4	32.5	33.9	35.2
17	21.8	23.0	24.1	25.2	28.8	30.0	31.2
18	19.4	20.5	21.5	22.5	25.7	26.8	27.8
19	17.4	18.4	19.3	20.2	23.0	24.0	25.0
20	15.7	16.6	17.4	18.2	20.8	21.7	22.6
21	14.3	15.1	15.8	16.5	18.9	19.7	20.5
22	13.0	13.7	14.4	15.0	17.2	17.9	18.6
23	11.9	12.6	13.2	13.8	15.7	16.4	17.1
24	10.9	11.5	12.1	12.6	14.4	15.1	15.7
25	10.1	10.6	11.1	11.6	13.3	13.9	14.4
26	9.3	9.8	10.3	10.8	12.3	12.8	13.3
27	8.6	9.1	9.6	10.0	11.4	11.9	12.4
28	8.0	8.5	8.9	9.3	10.6	11.1	11.5
29	7.5	7.9	8.3	8.7	9.9	10.3	10.7
30	7.0	7.4	7.7	8.1	9.2	9.6	10.0
31	6.5	6.9	7.2	7.6	8.7	9.0	9.4
32	6.1	6.5	6.8	7.1	8.1	8.5	8.8
33	5.8	6.1	6.4	6.7	7.6	8.0	8.3
34	5.4	5.8	6.0	6.3	7.2	7.5	7.8
35	5.1	5.4	5.7	5.9	6.8	7.1	7.4
36	4.9	5.1	5.4	5.6	6.4	6.7	7.0

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 150 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	SPECIAL I-BEAM. 20 Inch No. B 121.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	104.3	107.3	110.8	114.2	117.7
11	86.2	88.7	91.5	94.4	97.3
12	72.4	74.5	76.9	79.3	81.8
13	61.7	63.5	65.5	67.6	69.7
14	53.2	54.7	56.5	58.3	60.1
15	46.3	47.7	49.2	50.8	52.3
16	40.7	41.9	43.3	44.6	46.0
17	36.1	37.1	38.3	39.5	40.7
18	32.2	33.1	34.2	35.3	36.3
19	28.9	29.7	30.7	31.6	32.6
20	26.1	26.8	27.7	28.6	29.4
21	23.6	24.3	25.1	25.9	26.7
22	21.5	22.2	22.9	23.6	24.3
23	19.7	20.3	20.9	21.6	22.3
24	18.1	18.6	19.2	19.8	20.4
25	16.7	17.2	17.7	18.3	18.8
26	15.4	15.9	16.4	16.9	17.4
27	14.3	14.7	15.2	15.7	16.1
28	13.3	13.7	14.1	14.6	15.0
29	12.4	12.8	13.2	13.6	14.0
30	11.6	11.9	12.3	12.7	13.1
31	10.9	11.2	11.5	11.9	12.3
32	10.2	10.5	10.8	11.2	11.5
33	9.6	9.9	10.2	10.5	10.8
34	9.0	9.3	9.6	9.9	10.2
35	8.5	8.8	9.0	9.3	9.6
36	8.0	8.3	8.5	8.8	9.1

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 150 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS. 24 Inch No. B 89.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	123.7	128.5	132.6	136.8	141.0
11	102.2	106.2	109.6	113.1	116.5
12	85.9	89.2	92.1	95.0	97.9
13	73.2	76.0	78.5	81.0	83.4
14	63.1	65.5	67.7	69.8	71.9
15	55.0	57.1	59.0	60.8	62.7
16	48.3	50.2	51.8	53.4	55.1
17	42.8	44.5	45.9	47.3	48.8
18	38.2	39.6	40.9	42.2	43.5
19	34.3	35.6	36.7	37.9	39.1
20	30.9	32.1	33.2	34.2	35.3
21	28.0	29.1	30.1	31.0	32.0
22	25.6	26.5	27.4	28.3	29.1
23	23.4	24.3	25.1	25.9	26.7
24	21.5	22.3	23.0	23.8	24.5
25	19.8	20.6	21.2	21.9	22.6
26	18.3	19.0	19.6	20.2	20.9
27	17.0	17.6	18.2	18.8	19.3
28	15.8	16.4	16.9	17.5	18.0
29	14.7	15.3	15.8	16.3	16.8
30	13.7	14.3	14.7	15.2	15.7
31	12.9	13.4	13.8	14.2	14.7
32	12.1	12.5	13.0	13.4	13.8
33	11.4	11.8	12.2	12.6	12.9
34	10.7	11.1	11.5	11.8	12.2
35	10.1	10.5	10.8	11.2	11.5
36	9.5	9.9	10.2	10.6	10.9

For spacings above the dotted lines the safe loads for bending are greater than the safe loads for web crippling, as explained on pages 62 to 65 inclusive.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I BEAMS FOR UNIFORM LOAD OF 175 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.						
	3 Inch No. B 5.			4 Inch No. B 9.			
	5.5 lbs.	6.5 lbs.	7.5 lbs.	7.5 lbs.	8.5 lbs.	9.5 lbs.	10.5 lbs.
4	6.3	6.8	7.4	11.4	12.1	12.9	13.6
5	4.0	4.4	4.7	7.3	7.7	8.2	8.7
6	2.8	3.0	3.3	5.0	5.4	5.7	6.0
7	2.1	2.2	2.7	3.7	4.0	4.2	4.4
8	1.6	1.7	1.8	2.8	3.0	3.2	3.4
9	1.2	1.4	1.5	2.2	2.4	2.5	2..7
10	1.0	1.1	1.2	1.8	1.9	2.1	2 2
11	....	....	1.0	1.5	1.6	1.7	1.8
12	....	....	....	1.3	1.3	1.4	1.5
13	....	....	....	1.1	1.1	1.2	1.3
14	....	....	....	....	1.0	1.0	1.1
15	....	....	....	....	....	....	1.0

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings $= \frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I BEAMS FOR UNI FORM LOAD OF 175 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.					
	5 Inch No. B 13.			6 Inch No. B 17.		
	9.75 lbs.	12.25 lbs.	14.75 lbs.	12.25 lbs.	14.75 lbs.	17.25 lbs.
4	18.4	20.7	23.1	27.7	30.5	33.3
5	11.8	13.3	14.8	17.7	19.5	21.3
6	8.2	9.2	10.3	12.3	13.5	14.8
7	6.0	6.8	7.5	9.0	9.9	10.9
8	4.6	5.2	5.8	6.9	7.6	8.3
9	3.6	4.1	4.6	5.5	6.0	6.6
10	2.9	3.3	3.7	4.4	4.9	5.3
11	2.4	2.7	3.1	3.7	4.0	4.4
12	2.0	2.3	2.6	3.1	3.4	3.7
13	1.7	2.0	2.2	2.6	2.9	3.1
14	1.5	1.7	1.9	2.3	2.5	2.7
15	1.3	1.4	1.6	2.0	2.2	2.4
16	1.2	1.3	1.4	1.7	1.9	2.1
17	1.0	1.1	1.3	1.5	1.7	1.8
18	....	1.0	1.1	1.4	1.5	1.6
19	....	....	1.0	1.2	1.3	1.5
20	....	....	....	1.1	1.2	1.3
21	....	....	....	1.0	1.1	1.2
22	....	....	....	....	1.0	1.1
23	....	....	....	....	....	1.0

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings $= \frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 175 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.						
	7 Inch No. B 21.			8 Inch No. B 25.			
	15 lbs.	17.5 lbs.	20 lbs.	17.75 lbs.	20.25 lbs.	22.75 lbs.	25.25 lbs.
4	39.4	42.6	45.9	54.2	57.3	61.1	64.8
5	25.2	27.3	29.4	34.7	36.7	39.1	41.5
6	17.5	19.0	20.4	24.1	25.5	27.1	28.8
7	12.9	13.9	15.0	17.7	18.7	19.9	21.2
8	9.9	10.7	11.5	13.5	14.3	15.3	16.2
9	7.8	8.4	9.1	10.7	11.3	12.1	12.8
10	6.3	6.8	7.3	8.7	9.2	9.8	10.4
11	5.2	5.6	6.1	7.2	7.6	8.1	8.6
12	4.4	4.7	5.1	6.0	6.4	6.8	7.2
13	3.7	4.0	4.3	5.1	5.4	5.8	6.1
14	3.2	3.5	3.7	4.4	4.7	5.0	5.3
15	2.8	3.0	3.3	3.9	4.1	4.3	4.6
16	2.5	2.7	2.9	3.4	3.6	3.8	4.0
17	2.2	2.4	2.5	3.0	3.2	3.4	3.6
18	1.9	2.1	2.3	2.7	2.8	3.0	3.2
19	1.7	1.9	2.0	2.4	2.5	2.7	2.9
20	1.6	1.7	1.8	2.2	2.3	2.4	2.6
21	1.4	1.5	1.7	2.0	2.1	2.2	2.4
22	1.3	1.4	1.5	1.8	1.9	2.0	2.1
23	1.2	1.3	1.4	1.6	1.7	1.8	2.0
24	1.1	1.2	1.3	1.5	1.6	1.7	1.8
25	1.0	1.1	1.2	1.4	1.5	1.6	1.7
26	...	1.0	1.1	1.3	1.4	1.4	1.5
27	...	...	1.0	1.2	1.3	1.3	1.4
28	...	...	...	1.1	1.2	1.2	1.3
29	...	...	...	1.0	1.1	1.2	1.2

For spacings above the dotted lines the safe loads for bending are greater than the safe loads for web crippling, as explained on pages 62 to 65 inclusive.

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 175 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.							
	9 Inch No. B 29.				10 Inch No. B 33.			
	21 lbs.	25 lbs.	30 lbs.	35 lbs.	25 lbs.	30 lbs.	35 lbs.	40 lbs.
8	18.0	19.5	21.6	23.7	...	...	...	...
9	14.2	15.4	17.4	18.7	...	...	...	...
10	11.5	12.5	13.8	15.1	14.9	16.4	17.9	19.3
11	9.5	10.3	11.4	12.5	12.3	13.5	14.8	16.0
12	8.0	8.6	9.6	10.5	10.3	11.4	12.4	13.4
13	6.8	7.4	8.2	9.0	8.8	9.7	10.6	11.4
14	5.9	6.4	7.0	7.7	7.6	8.3	9.1	9.9
15	5.1	5.5	6.1	6.7	6.6	7.3	7.9	8.6
16	4.5	4.9	5.4	5.9	5.8	6.4	7.0	7.6
17	4.0	4.3	4.8	5.2	5.2	5.7	6.2	6.7
18	3.6	3.8	4.3	4.7	4.6	5.0	5.5	6.0
19	3.2	3.4	3.8	4.2	4.1	4.5	4.9	5.4
20	2.9	3.1	3.4	3.8	3.7	4.1	4.5	4.8
21	2.6	2.8	3.1	3.4	3.4	3.7	4.1	4.4
22	2.4	2.6	2.9	3.1	3.1	3.4	3.7	4.0
23	2.2	2.4	2.6	2.9	2.8	3.1	3.4	3.7
24	2.0	2.2	2.4	2.6	2.6	2.8	3.1	3.4
25	1.8	2.0	2.2	2.4	2.4	2.6	2.9	3.1
26	1.7	1.8	2.0	2.2	2.2	2.4	2.6	2.9
27	1.6	1.7	1.9	2.1	2.0	2.2	2.4	2.7
28	1.5	1.6	1.8	1.9	1.9	2.1	2.3	2.5
29	1.4	1.5	1.6	1.8	1.8	1.9	2.1	2.3
30	1.3	1.4	1.5	1.7	1.7	1.8	2.0	2.1
31	1.2	1.3	1.4	1.6	1.6	1.7	1.9	2.0
32	...	...	...	...	1.5	1.6	1.7	1.9
33	...	...	...	...	1.4	1.5	1.6	1.8

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 175 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAM. 12 Inch No. B 41.			SPECIAL I-BEAM. 12 Inch No. B 105.			
	31.5 lbs.	35 lbs.	40 lbs.	40 lbs.	45 lbs.	50 lbs.	55 lbs.
10	21.9	23.2	25.0	27.3	29.0	30.8	32.6
11	18.1	19.2	20.6	22.6	24.0	25.5	27.0
12	15.2	16.1	17.3	19.0	20.2	21.4	22.6
13	13.0	13.7	14.8	16.2	17.2	18.2	19.3
14	11.2	11.8	12.7	13.9	14.8	15.7	16.6
15	9.7	10.3	11.1	12.1	13.0	13.7	14.5
16	8.6	9.1	9.8	10.7	11.3	12.0	12.7
17	7.6	8.0	8.6	9.5	10.0	10.7	11.3
18	6.8	7.2	7.7	8.4	9.0	9.5	10.1
19	6.1	6.4	6.9	7.6	8.0	8.5	9.0
20	5.5	5.8	6.2	6.9	7.3	7.7	8.2
21	5.0	5.3	5.7	6.2	6.6	7.0	7.4
22	4.5	4.8	5.2	5.6	6.0	6.4	6.7
23	4.1	4.4	4.7	5.2	5.5	5.8	6.2
24	3.8	4.0	4.3	4.7	5.0	5.4	5.7
25	3.5	3.7	4.0	4.4	4.6	4.9	5.2
26	3.2	3.4	3.7	4.0	4.3	4.6	4.8
27	3.0	3.2	3.4	3.7	4.0	4.2	4.5
28	2.8	3.0	3.2	3.5	3.7	3.9	4.2
29	2.6	2.8	3.0	3.2	3.5	3.7	3.9
30	2.4	2.6	2.8	3.0	3.2	3.4	3.6
31	2.3	2.4	2.6	2.8	3.0	3.2	3.4
32	2.1	2.3	2.4	2.7	2.8	3.0	3.2
33	2.0	2.1	2.3	2.5	2.7	2.8	3.0
34	1.9	2.0	2.2	2.4	2.5	2.7	2.8
35	1.8	1.9	2.0	2.2	2.4	2.5	2.7
36	1.7	1.8	1.9	2.1	2.2	2.4	2.5

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 175 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.				
	15 Inch No. B 53.				
	42 lbs.	45 lbs.	50 lbs.	55 lbs.	60 lbs.
10	35.9	37.0	39.3	41.5	43.8
11	29.7	30.6	32.5	34.3	36.1
12	24.9	25.7	27.3	28.8	30.4
13	21.2	21.9	23.2	24.6	25.9
14	18.3	18.9	20.0	21.2	22.3
15	16.0	16.5	17.5	18.5	19.5
16	14.0	14.5	15.3	16.2	17.1
17	12.4	12.8	13.6	14.4	15.1
18	11.1	11.4	12.1	12.8	13.5
19	9.9	10.3	10.9	11.5	12.1
20	9.0	9.3	9.8	10.4	10.9
21	8.1	8.4	8.9	9.4	9.9
22	7.4	7.7	8.1	8.6	9.0
23	6.8	7.0	7.4	7.9	8.3
24	6.2	6.4	6.8	7.2	7.6
25	5.7	5.9	6.3	6.6	7.0
26	5.3	5.5	5.8	6.1	6.5
27	4.9	5.1	5.5	5.7	6.0
28	4.6	4.7	5.0	5.3	5.6
29	4.3	4.4	4.7	4.9	5.2
30	4.0	4.1	4.4	4.6	4.9
31	3.7	3.9	4.1	4.3	4.6
32	3.5	3.6	3.8	4.1	4.3
33	3.3	3.4	3.6	3.8	4.0
34	3.1	3.2	3.4	3.6	3.8
35	2.9	3.0	3.2	3.4	3.6
36	2.8	2.9	3.0	3.2	3.4

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 175 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	SPECIAL I-BEAM. 15 Inch No. B 109.				
	60 lbs.	65 lbs.	70 lbs.	75 lbs.	80 lbs.
10	49.5	51.7	53.9	56.2	58.4
11	40.9	42.7	44.6	46.4	48.3
12	34.4	35.9	37.5	39.0	40.6
13	29.3	30.6	31.9	33.2	34.6
14	25.3	26.4	27.5	28.7	29.8
15	22.0	23.0	24.0	25.0	26.0
16	19.3	20.2	21.1	21.9	22.8
17	17.1	17.9	18.7	19.4	20.2
18	15.3	16.0	16.7	17.3	18.0
19	13.7	14.3	14.9	15.6	16.2
20	12.4	12.9	13.5	14.0	14.6
21	11.2	11.7	12.2	12.7	13.2
22	10.2	10.7	11.1	11.6	12.1
23	9.4	9.8	10.2	10.6	11.0
24	8.6	9.0	9.4	19.8	10.1
25	7.9	8.3	8.6	9.0	9.3
26	7.3	7.6	8.0	8.3	8.6
27	6.8	7.1	7.4	7.7	8.0
28	6.3	6.6	6.9	7.2	7.5
29	5.9	6.1	6.4	6.7	6.9
30	5.5	5.7	6.0	6.2	6.5
31	5.2	5.4	5.6	5.8	6.1
32	4.8	5.0	5.3	5.5	5.7
33	4.5	4.7	5.0	5.2	5.4
34	4.3	4.5	4.7	4.9	5.1
35	4.0	4.2	4.4	4.6	4.8
36	3.8	4.0	4.2	4.3	4.5

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings $= \frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 175 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	SPECIAL I-BEAM. 15 Inch No. B 113.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	64.1	66.3	68.5	70.8	73.0
11	53.0	54.8	56.6	58.5	60.4
12	44.5	46.0	47.6	49.2	50.7
13	37.9	39.2	40.6	41.9	43.2
14	32.7	33.8	35.0	36.1	37.3
15	28.5	29.5	30.5	31.5	32.5
16	25.1	25.9	26.8	27.7	28.5
17	22.2	22.9	23.7	24.5	25.3
18	19.8	20.5	21.2	21.8	22.5
19	17.8	18.4	19.0	19.6	20.2
20	16.0	16.6	17.1	17.7	18.3
21	14.5	15.0	15.5	16.1	16.6
22	13.3	13.7	14.2	14.6	15.1
23	12.1	12.5	13.0	13.4	13.8
24	11.1	11.5	11.9	12.3	12.7
25	10.3	10.6	11.0	11.3	11.7
26	9.5	9.8	10.1	10.5	10.8
27	8.8	9.1	9.4	9.7	10.0
28	8.2	8.5	8.7	9.0	9.3
29	7.6	7.9	8.2	8.4	8.7
30	7.1	7.4	7.6	7.9	8.1
31	6.7	6.9	7.1	7.4	7.6
32	6.3	6.5	6.7	6.9	7.1
33	5.9	6.1	6.3	6.5	6.7
34	5.5	5.7	5.9	6.1	6.3
35	5.2	5.4	5.6	5.8	6.0
36	4.9	5.1	5.3	5.5	5.6

For spacings below the heavy lines the deflections will be greater than the allowable limit for plastered ceilings = $\frac{1}{360}$ span.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 175 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAMS.						
	18 Inch No. B 65.				20 Inch No. B 73.		
	55 lbs.	60 lbs.	65 lbs.	70 lbs.	65 lbs.	70 lbs.	75 lbs.
10	53.9	57.0	59.7	62.4	71.3	74.3	77.3
11	44.5	47.1	49.3	51.6	58.9	61.4	63.9
12	37.4	39.6	41.5	43.3	49.5	51.6	53.7
13	31.9	33.7	35.3	36.9	42.2	44.0	45.8
14	27.5	29.1	30.5	31.8	36.4	37.9	39.5
15	23.9	25.3	26.5	27.7	31.7	33.0	34.4
16	21.0	22.3	23.3	24.4	27.8	29.0	30.2
17	18.6	19.7	20.7	21.6	24.7	25.7	26.8
18	16.6	17.6	18.4	19.3	22.0	22.9	23.9
19	14.9	15.8	16.5	17.3	19.7	20.6	21.4
20	13.5	14.3	14.9	15.6	17.8	18.6	19.3
21	12.2	12.9	13.5	14.1	16.2	16.9	17.5
22	11.1	11.8	12.3	12.9	14.7	15.4	16.0
23	10.2	10.8	11.3	11.8	13.5	14.1	14.6
24	9.4	9.9	10.4	10.8	12.4	12.9	13.4
25	8.6	9.1	9.6	10.0	11.4	11.9	12.4
26	8.0	8.4	8.8	9.2	10.5	11.0	11.4
27	7.4	7.8	8.2	8.6	9.8	10.2	10.6
28	6.9	7.3	7.6	8.0	9.1	9.5	9.9
29	6.4	6.8	7.1	7.4	8.5	8.8	9.2
30	6.0	6.3	6.6	6.9	7.9	8.3	8.6
31	5.6	5.9	6.2	6.5	7.4	7.7	8.0
32	5.3	5.6	5.8	6.1	7.0	7.3	7.6
33	4.9	5.2	5.5	5.7	6.5	6.8	7.1
34	4.7	4.9	5.2	5.4	6.2	6.4	6.7
35	4.4	4.7	4.9	5.1	5.8	6.1	6.3
36	4.2	4.4	4.6	4.8	5.5	5.7	6.0

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 175 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	SPECIAL I-BEAM. 20 Inch No. B 121.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	89.4	91.9	94.9	97.9	100.9
11	73.9	76.0	78.5	80.9	83.4
12	62.1	63.9	65.9	68.0	70.1
13	52.9	54.4	56.2	57.9	59.7
14	45.6	46.9	48.4	50.0	51.5
15	39.7	40.9	42.2	43.5	44.8
16	34.9	35.9	37.1	38.3	39.4
17	30.9	31.8	32.8	33.9	34.9
18	27.6	28.4	29.3	30.2	31.1
19	24.8	25.5	26.3	27.1	28.0
20	22.3	23.0	23.7	24.5	25.2
21	20.3	20.8	21.5	22.2	22.9
22	18.5	19.0	19.6	20.2	20.8
23	16.9	17.4	17.9	18.5	19.1
24	15.5	16.0	16.5	17.0	17.5
25	14.3	14.7	15.2	15.7	16.1
26	13.2	13.6	14.0	14.5	14.9
27	12.3	12.6	13.0	13.4	13.8
28	11.4	11.7	12.1	12.5	12.9
29	10.6	10.9	11.3	11.6	12.0
30	9.9	10.2	10.5	10.9	11.2
31	9.3	9.6	9.9	10.2	10.5
32	8.7	9.0	9.3	9.6	9.9
33	8.2	8.4	8.7	9.0	9.3
34	7.7	8.0	8.2	8.5	8.7
35	7.3	7.5	7.7	8.0	8.2
36	6.9	7.1	7.3	7.6	7.8

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

SPACING OF CAMBRIA I-BEAMS FOR UNIFORM LOAD OF 175 LBS. PER SQUARE FOOT.

Proper distance in feet, center to center of Beams.
Maximum fibre stress 16 000 pounds per square inch.

Distance between supports in feet.	STANDARD I-BEAM. 24 Inch No. B 89.				
	80 lbs.	85 lbs.	90 lbs.	95 lbs.	100 lbs.
10	106.0	110.1	113.7	117.3	120.9
11	87.6	91.0	94.0	96.9	99.9
12	73.6	76.5	79.0	81.4	83.9
13	62.7	65.2	67.3	69.4	71.5
14	54.1	56.2	58.0	59.8	61.7
15	47.1	48.9	50.5	52.1	53.7
16	41.4	43.0	44.7	45.8	47.2
17	36.7	38.1	39.3	40.6	41.8
18	32.7	34.0	35.1	36.2	37.3
19	29.4	30.5	31.5	32.5	33.5
20	26.5	27.5	28.4	29.3	30.2
21	24.0	25.0	25.8	26.6	27.4
22	21.9	22.8	23.5	24.2	25.0
23	20.0	20.8	21.5	22.2	22.8
24	18.4	19.1	19.7	20.4	21.0
25	17.0	17.6	18.2	18.8	19.3
26	15.7	16.3	16.8	17.3	17.9
27	14.5	15.1	15.6	16.1	16.6
28	13.5	14.0	14.5	15.0	15.4
29	12.6	13.1	13.5	13.9	14.4
30	11.8	12.2	12.6	13.0	13.4
31	11.0	11.5	11.8	12.2	12.6
32	10.4	10.8	11.1	11.5	11.8
33	9.7	10.1	10.4	10.8	11.1
34	9.2	9.5	9.8	10.1	10.5
35	8.7	9.0	9.3	9.6	9.9
36	8.2	8.5	8.8	9.0	9.3

For spacings above the dotted lines the safe loads for bending are greater than the safe loads for web crippling, as explained on pages 62 to 65 inclusive.

Spacings for other intensities of loading may be obtained from those in tables as follows:

$$\text{Required spacing} = \frac{\text{Intensity of loading from table}}{\text{New intensity of loading}} \times \text{Computed spacing from table.}$$

GENERAL FORMULÆ FOR FLEXURE OF BEAMS.

NOTATION.

A = Area of Section in square inches.
d = Depth of Cross Section in inches.
l = Length of Span in inches.
L = Length of Span in feet.
p = Stress in extreme fibre of section in pounds per square inch.
X_1 = Distance of Center of Gravity of Section from extreme fibre in inches.
W = Total Load, in pounds, Uniformly Distributed, including the Weight of Beam.
W_1 = Total Superimposed or Live Load, in pounds, Uniformly Distributed.
W_2 = Total Weight of Beam, in pounds, Uniformly Distributed.
W_s = Total Safe Load, in pounds, Uniformly Distributed.
P = Load, in pounds, concentrated at any point.
F = Coefficient of Strength of the Tables of Properties = Safe Load, in pounds, for a fibre stress of 16 000 pounds per square inch for a span of one foot.
F' = Coefficient of Strength of the Tables of Properties = Safe Load, in pounds, for a fibre stress of 12 500 pounds per square inch for a span of one foot.
D = Total Deflection of Beam, in inches, due to weight W.
Dw_1 and D_p = Deflections of Beams, in inches, due to the weights W_1 and P respectively.
N = Coefficient of Deflection of the Tables of Properties = Deflection, in inches, due to a total load of 1 000 pounds uniformly distributed for a span of one foot.
N' = Coefficient of Deflection of the Tables of Properties = Deflection, in inches, due to a superimposed load of 1 000 pounds, concentrated at the middle of a Beam with a span of one foot.
H = Coefficient of Deflection, in inches, for fibre stress of 16 000 pounds per square inch, for any section used as a Beam subjected to its safe load Uniformly Distributed. (See table, page 66.)
H' = Coefficient of Deflection, in inches, for fibre stress of 12 500 pounds per square inch for any section used as a Beam subjected to its safe load Uniformly Distributed. (See table, page 66.)
M = Total Bending Moment, in inch pounds, due to the Weight of Beam and Superimposed Load.
I = Moment of Inertia, in inches^4, Axis through Center of Gravity.
I_1 = Moment of Inertia, in inches^4 Axis parallel to above but not through Center of Gravity.
v = Distance, in inches, between these Axes.
S = Section Modulus in inches^3.
r = Radius of Gyration in inches.
E = Modulus of Elasticity, in pounds, per square inch (Steel = 29 000 000).

GENERAL FORMULÆ.

$$S = \frac{I}{X_1} \qquad I_1 = I + Av^2 \qquad r = \sqrt{\frac{I}{A}}$$

$$M = \frac{pI}{X_1} = pS \quad \therefore \quad p = \frac{MX_1}{I} = \frac{M}{S}. \quad \text{Or for Symmetrical Section } M = \frac{2pI}{d}$$

For Beam supported at both ends and Uniformly Loaded:

$$M = \frac{Wl}{8} = \frac{(W_1 + W_2)\,l}{8} \quad \therefore \quad W = (W_1 + W_2) = \frac{8\,M}{l} = \frac{8pI}{lX_1} = \frac{8pS}{l}$$

SAFE LOADS.

$$F = \frac{8pS}{l} \text{ where } p = 16\,000 \text{ pounds and } l = 12'' \text{ therefore } F = \frac{2}{3}\,16\,000\,S$$

$$F' = \frac{8pS}{l} \text{ where } p = 12\,500 \text{ pounds and } l = 12'' \text{ therefore } F' = \frac{2}{3}\,12\,500\,S$$

To obtain the Safe Load for any span in feet, for fibre stress of 16 000 pounds per square inch:

$$\text{Safe Load} = W_s = \frac{2}{3}\,\frac{16\,000\,S}{L} = \frac{F}{L}$$

To obtain the Safe Load for any span in feet, for fibre stress of 12 500 pounds per square inch:

$$\text{Safe Load} = W_s = \frac{2}{3}\,\frac{12\,500\,S}{L} = \frac{F'}{L}$$

GENERAL FORMULÆ FOR FLEXURE OF BEAMS. Continued.

DEFLECTIONS.

(1) Beam supported at both ends and Uniformly Loaded:

$$\text{Deflection for Total Load} = D = \frac{5}{384}\frac{Wl^3}{EI} = \frac{5}{384}\frac{(W_1 + W_2)\,l^3}{EI}$$

$$\text{Deflection for Superimposed Load} = Dw_1 = \frac{5}{384}\frac{W_1 l^3}{EI}$$

(2) Beam supported at both ends with load concentrated at the middle:

$$\text{Deflection for Total Load} = D = \frac{Pl^3}{48EI} + \frac{5}{384}\frac{W_2 l^3}{EI}$$

$$\text{Deflection for Superimposed Load} = D_p = \frac{Pl^3}{48EI}$$

(3) Beam fixed at one end, unsupported at the other, and Uniformly Loaded:

$$\text{Deflection for Total Load} = D = \frac{Wl^3}{8EI} = \frac{(W_1 + W_2)\,l^3}{8EI}$$

$$\text{Deflection for Superimposed Load} = Dw_1 = \frac{W_1 l^3}{8EI}$$

(4) Beam fixed at one end, and unsupported at the other, with load concentrated at the unsupported end:

$$\text{Deflection for Total Load} = D = \frac{Pl^3}{3EI} + \frac{W_2 l^3}{8EI}$$

$$\text{Deflection for Superimposed Load} = D_p = \frac{Pl^3}{3EI}$$

$N = \frac{5}{384}\frac{Wl^3}{EI} = \frac{5}{384}\frac{(W_1 + W_2)\,l^3}{EI}$, where $W = (W_1 + W_2) = 1\,000$ pounds and $l = 12''$

$$N' = \frac{Pl^3}{48EI}, \text{ where } P = 1\,000 \text{ pounds and } l = 12''$$

Total Deflection, in inches, due to a Beam Uniformly Loaded for any span in feet $= D = \frac{NWL^3}{1\,000} = \frac{N\,(W_1 + W_2)\,L^3}{1\,000}$

Total Deflection, in inches, due to a Superimposed Load P and the Weight of Beam W_2 for any span in feet $= D = \frac{N'PL^3}{1\,000} + \frac{NW_2L^3}{1\,000}$

$$H = \frac{12}{725}L^2 \qquad\qquad H' = \frac{3}{232}L^2$$

FOR SYMMETRICAL SECTIONS.

Total Deflection, in inches, for a fibre stress of 16 000 lbs. per square inch $= D = \frac{H}{d}$

Total Deflection, in inches, for a fibre stress of 12 500 lbs. per square inch $= D = \frac{H'}{d}$

FOR UNSYMMETRICAL SECTIONS.

Total Deflection, in inches, for a fibre stress of 16 000 pounds per square inch $= D = \frac{H}{2X_1}$

Total Deflection, in inches, for a fibre stress of 12 500 pounds per square inch $= D = \frac{H'}{2X_1}$

BENDING MOMENTS AND DEFLECTIONS FOR BEAMS OF UNIFORM SECTION.

W = Total Load, in lbs., uniformly distributed, including the weight of beam.

W_1 = Total Superimposed or Live Load, in lbs., uniformly distributed.

W_2 = Total Weight of Beam or Dead Load, in lbs., uniformly distributed.

P, P_1, P_2, P_3 = Loads, in lbs., concentrated at any points.

M = Total Bending Moment, in inch-lbs.

M_{w1}, M_p = Bending Moments, in inch-lbs., due to Weights W_1 and P respectively.

I = Moment of Intertia, in inches⁴.

l = Length of Span, in inches.

E = Modulus of Elasticity, in lbs. per square inch = 29 000 000 for steel.

W_s = Total Safe Load, in lbs., uniformly distributed, including weight of beam = Total Safe Load of Tables.

The ordinates in diagrams give the bending moments for corresponding points on beam. For superimposed load only, make W_2 in formulæ equal to zero.

(1) Beam Supported at both ends and Uniformly Loaded.

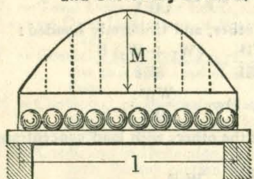


Diagram for Total Load :—

Draw parabola having $M = \frac{Wl}{8}$

Safe Superimposed Load, in lbs., uniformly distributed, $W'_s = W_s - W_2$.

Maximum Bending Moment at middle of beam $= M = \frac{Wl}{8} = \frac{(W_1 + W_2)\,l}{8}$.

Maximum Shear at points of support $= \frac{W}{2} = \frac{W_1 + W_2}{2}$.

Maximum Deflection $= \frac{5}{384}\,\frac{Wl^3}{EI} = \frac{5}{384}\,\frac{(W_1 + W_2)\,l^3}{EI}$.

(2) Beam Supported at both ends with Load Concentrated at the Middle.

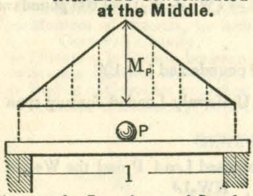


Diagram for Superimposed Load :—

Draw triangle having $M_p = \frac{Pl}{4}$

Diagram for Dead Load similar to Case(1)

Safe Superimposed Load, in lbs., concentrated, $P_s = \frac{W_s - W_2}{2}$.

Maximum Bending Moment at middle of beam $= M = \frac{Pl}{4} + \frac{W_2\,l}{8}$.

Maximum Shear at points of support $= \frac{P + W_2}{2}$.

Max. Deflection $= \frac{Pl_3}{48EI} + \frac{5}{384}\,\frac{W_2\,l^3}{EI}$.

(3) Beam fixed at one end, Unsupported at the other and Uniformly Loaded.

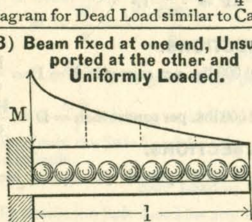


Diagram for Total Load :—

Draw Parabola having $M = \frac{Wl}{2}$

Safe Superimposed Load, in lbs., uniformly distributed, $W'_s = \frac{W_s - W_2}{4}$.

Maximum Bending Moment at point of support $= \frac{Wl}{2} = \frac{(W_1 + W_2)\,l}{2}$.

Maximum Shear at point of support $= W = W_1 + W_2$.

Max. Deflection $= \frac{Wl^3}{8EI} = \frac{(W_1 + W_2)\,l^3}{8EI}$.

BENDING MOMENTS AND DEFLECTIONS FOR BEAMS OF UNIFORM SECTION.

W = Total Load, in lbs., uniformly distributed, including the weight of beam.

W_1 = Total Superimposed or Live Load, in lbs., uniformly distributed.

W_2 = Total Weight of Beam or Dead Load, in lbs., uniformly distributed.

P, P_1, P_2, P_3 = Loads, in lbs., concentrated at any points.

M = Total Bending Moment, in inch-lbs.

M_{w1}, M_p = Bending Moments, in inch-lbs., due to Weights W_1 and P respectively.

I = Moment of Inertia, in inches^4.

l = Length of Span, in inches.

E = Modulus of Elasticity, in lbs. per square inch = 29 000 000 for steel.

W_s = Total Safe Load, in lbs., uniformly distributed, including weight of beam = Total Safe Load of Tables.

The ordinates in diagrams give the bending moments for corresponding points on beam. For superimposed load only, make W_2 in formulæ equal to zero.

(4) Beam fixed at one end, and Unsupported at the other, with Load Concentrated at the free end.

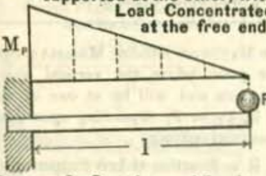


Diagram for Superimposed Load:— Draw triangle having $M_p = Pl$.

Diagram for Dead Load similar to Case (3)

Safe Superimposed Load, in lbs., concentrated, $P_s = \frac{W_s - 4W_2}{8}$.

Maximum Bending Moment at point of support $= Pl + \frac{W_2 l}{2}$.

Maximum Shear at point of support $= P + W_2$.

Maximum Deflection $= \frac{Pl^3}{3EI} + \frac{W_2 l^3}{8EI}$.

(5) Beam Supported at both ends with Load Concentrated at any point.

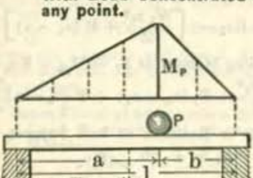


Diagram for Superimposed Load:—

Draw triangle having $M_p = \frac{Pab}{l}$.

Diagram for Dead Load similar to Case (1)

Safe Superimposed Load, in lbs., concentrated, $P_s = \frac{W_s l^2 - 4a\,W_2\,(l-a)}{8ab}$.

Maximum Bending Moment under load $= \frac{a\,(2\,Pb + W_2 l - W_2 a)}{2l}$.

Max. Shear at Sup. near a $= \frac{Pb}{l} + \frac{W_2}{2}$.

Max. Shear at Sup. near b $= \frac{Pa}{l} + \frac{W_2}{2}$.

Deflection at distance x from left support $= \frac{Pb}{3EI}\left(\frac{2al - a^2}{3}\right)^{\frac{3}{2}} + \frac{W_2}{24EI}\left[\frac{2al\,(2l-a)}{3} + \left(\frac{2al - a^2}{3}\right)^{\frac{3}{2}} + l^3\right]$

$x = \sqrt{\frac{2al - a^2}{3}}$ = Distance, from left support, of point of maximum deflection for superimposed load.

(6) Beam Supported at both ends with two Symmetrical Loads.

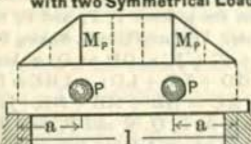


Diagram for Superimposed Load:— Draw trapezoid having $M_p = Pa$.

Diagram for Dead Load similar to Case (1)

Safe Superimposed Load, in lbs., concentrated, each, $P_s = \frac{W_s l - W_2 l}{8a}$.

Maximum Bending Moments between loads $= Pa + \frac{W_2 l}{8}$.

Maximum Shear at points of support $= \frac{2P + W_2}{2}$.

Maximum Deflection $= \frac{Pa}{24EI}\left(3l^2 - 4a^2\right) + \frac{5}{384}\,\frac{W_2\,l^3}{EI}$.

BENDING MOMENTS AND DEFLECTIONS FOR BEAMS OF UNIFORM SECTION.

W = Total Load, in lbs., uniformly distributed, including the weight of beam.

W_1 = Total Superimposed or Live Load, in lbs., uniformly distributed.

W_2 = Total Weight of Beam or Dead Load, in lbs., uniformly distributed.

P, P_1, P_2, P_3 = Loads, in lbs., concentrated at any points.

M = Total Bending Moment, in inch-lbs.

M_{w1}, M_p = Bending Moments, in inch-lbs., due to Weights W_1 and P respectively.

I = Moment of Inertia, in inches⁴.

l = Length of Span, in inches.

E = Modulus of Elasticity, in lbs., per square inch = 29 000 000 for steel.

W_s = Total Safe Load, in lbs., uniformly distributed, including the weight of beam = Total Safe Load of Tables.

The ordinates in diagrams give the bending moments for corresponding points on beam. For superimposed load only, make W_2 in formulæ equal to zero.

(7) Beam Supported at both ends with Loads Concentrated at various Points.

The total bending moment at any point produced by all the weights is equal to the sum of the moments at that point produced by each of the weights separately.

Diagram for Dead Load similar to Case (1)

The Maximum Bending Moment occurs at the point where the vertical shear equals zero and will be at one of the loads P, P_1, or P_2 depending upon their amounts and spacing.

Let R = Reaction at Left Support.

Bending Moment at P =

$$M_p = Ra - \frac{W_2\, a^2}{2l}.$$

Bending Moment at P_1 =

$$M_{p1} = Ra_1 - \left[\frac{W_2\, a_1^2}{2l} + P\,(a_1 - a)\right].$$

Bending Moment at $P_2 = M_{p2} = Ra_2 -$

$$\left[\frac{W_2\, a_2^2}{2l} + P_1\,(a_2 - a_1) + P\,(a_2 - a)\right].$$

Shear or Reaction at Left Support =

$$\frac{P_2\, b_2 + P_1\, b_1 + Pb}{l} + \frac{W_2}{2}.$$

Shear or Reaction at Right Support =

$$\frac{P_2\, a_2 + P_1\, a_1 + Pa}{l} + \frac{W_2}{2}.$$

Diagram for Superimposed Load:— Draw as in Case (5) the Ordinates FC, GD and HE representing the bending moments due to loads P, P_1 and P_2 respectively. Produce FC to P, making PC = FC + IC + JC; GD to Q, making QD = GD + KD + LD; and HE to R, making RE = HE + ME + NE. Join the points A, P, Q, R and B, then the ordinates between A B and polygon A P Q R B will represent the bending moments for corresponding points on beam.

BENDING MOMENTS AND DEFLECTIONS FOR BEAMS OF UNIFORM SECTION.

W = Total Load, in lbs., uniformly distributed, including the weight of beam.

W_1 = Total Superimposed or Live Load, in lbs., uniformly distributed.

W_2 = Total Weight of Beam or Dead Load, in lbs., uniformly distributed.

P, P_1, P_2, P_3 = Loads, in lbs., concentrated at any points.

M = Total Bending Moment, in inch-lbs.

M_{w1}, M_p = Bending Moments, in inch-lbs., due to Weights W_1 and P respectively.

I = Moment of Inertia, in inches^4.

l = Length of Span, in inches.

E = Modulus of Elasticity, in lbs., per square inch = 29 000 000 for steel.

W_s = Total Safe Load, in lbs., uniformly distributed, including the weight of beam = Total Safe Load of Tables.

The ordinates in diagrams give the bending moments for corresponding points on beam. For superimposed load only, make W_2 in formulæ equal to zero.

(8) Beam Fixed at both ends and Uniformly Loaded.

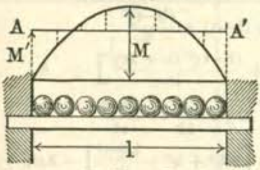


Diagram for Total Load:—Draw parabola having $M = \frac{Wl}{8}$. Also A A′ parallel to base and at a distance $M' = \frac{Wl}{12}$. The Vertical distances between the parabola and line A A′ are the moments for corresponding points on beam.

Safe Superimposed Load, in lbs., uniformly distributed, $W'_s = \frac{3}{2} W_s - W_2$.

Distance of points of contra-flexure from supports = .2113l.

Maximum Bending Moment at points of support $= \frac{Wl}{12} = \frac{(W_1 + W_2)\,l}{12}$.

Bending Moment at middle of beam $= \frac{Wl}{24} = \frac{(W_1 + W_2)\,l}{24}$.

Maximum Shear at points of support $= \frac{W_1 + W_2}{2}$.

Maximum Deflection $= \frac{Wl^3}{384EI} = \frac{(W_1 + W_2)\,l^3}{384EI}$

(9) Beam Fixed at both ends with Load Concentrated at the Middle.

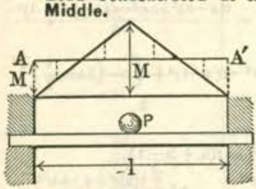


Diagram for Superimposed Load:—Draw triangle having $M = \frac{Pl}{4}$. Also A A′ parallel to base and at a distance $M' = \frac{Pl}{8}$. The Vertical distances between the triangle and line A A′ are the moments for corresponding points on beam.

Diagram for Dead Load similar to Case (8)

Safe Superimposed Load, in lbs., concentrated, $P_s = W_s - \frac{2}{3} W_2$.

Distance of points of contra-flexure from supports = $\frac{1}{4}$l.

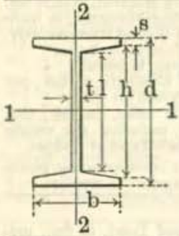
Maximum Bending Moment at points of support $= \frac{Pl}{8} + \frac{W_2 l}{12}$.

Bending Moment at middle of beam $= \frac{Pl}{8} + \frac{W_2 l}{24}$.

Maximum Shear at points of support $= \frac{P + W_2}{2}$.

Maximum Deflection $= \frac{Pl^3}{192EI} + \frac{W_2 l^3}{384EI}$.

VALUES OF MOMENTS OF INERTIA FOR STANDARD AND CAMBRIA SECTIONS.



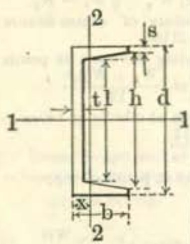
$$A = td + 2s\,(b-t) + \frac{(b-t)^2}{12}.$$

$$I, \text{ Axis } 1-1 = \frac{bd^3}{12} - \frac{h^4-l^4}{8}.$$

$$I', \text{ Axis } 2-2 = \frac{b^3s}{6} + \frac{lt^3}{12} + \frac{b^4-t^4}{288}.$$

$$\text{Slope of flange} = g = \frac{h-l}{b-t} = \frac{1}{6} \text{ for standard sections.}$$

$$h = d - 2s. \qquad l = h - g(b-t).$$



$$A = td + 2s\,(b-t) + \frac{(b-t)^2}{6}.$$

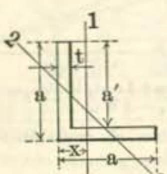
$$x = \left[b^2s + \frac{ht^2}{2} + \frac{(b-t)^2\,(b+2t)}{18}\right] \div A.$$

$$I, \text{ Axis } 1-1 = \frac{bd^3}{12} - \frac{h^4-l^4}{16}.$$

$$I', \text{ Axis } 2-2 = \frac{1}{3}\left[2sb^3 + lt^3 + \frac{b^4-t^4}{12}\right] - Ax^2.$$

$$\text{Slope of flange} = g = \frac{h-l}{2(b-t)} = \frac{1}{6} \text{ for standard sections.}$$

$$h = d - 2s. \qquad l = h - 2g(b-t).$$

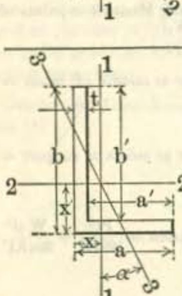


$$A = t\,(2a-t).$$

$$x = \frac{a^2+at-t^2}{2(2a-t)}.$$

$$I, \text{ Axis } 1-1 = \frac{t(a-x)^3+ax^3-(a-t)\,(x-t)^3}{3}.$$

$$I'', \text{ Axis } 2-2 = \frac{2x^4-2(x-t)^4+t\left[a-\left(2x-\frac{t}{2}\right)\right]^3}{3}$$



$$A = t(a+b-t).$$

$$x = \frac{t(2a'+b)+a'^2}{2(a'+b)}. \qquad x' = \frac{t(2b'+a)+b'^2}{2(b'+a)}.$$

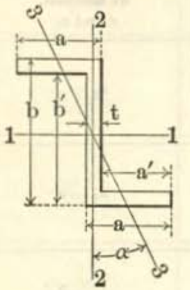
$$\text{Tan. } 2\alpha = -\frac{[(2x-t)b(b-2x')+(2x'-t)(a-t)(a+t-2x)]t}{2(I'-I)}.$$

$$I, \text{ Axis } 1-1 = \frac{t(a-x)^3+bx^3-(b-t)(x-t)^3}{3}.$$

$$I', \text{ Axis } 2-2 = \frac{t(b-x')^3+ax'^3-(a-t)(x'-t)^3}{3}.$$

$$I'', \text{ Axis } 3-3 = \frac{I\cos^2\alpha - I'\sin^2\alpha}{\cos 2\alpha}$$

VALUES OF MOMENTS OF INERTIA FOR STANDARD AND CAMBRIA SECTIONS.



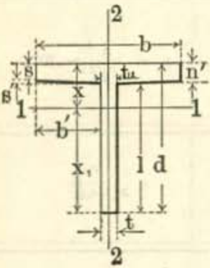
$$A = [b + 2(a - t)]\, t.$$

$$\text{Tan. } 2\alpha = -\frac{(bt - t^2)(a^2 - at)}{I - I'}.$$

$$\text{I, Axis } 1-1 = \frac{ab^3 - a'(b - 2t)^3}{12}.$$

$$\text{I}', \text{ Axis } 2-2 = \frac{b(a + a')^3 - 2a'^3 b - 6a'a^2 b}{12}.$$

$$\text{I}'' \text{ Minimum, Axis } 3-3 = \frac{I' \cos^2\alpha - I \sin^2\alpha}{\cos 2\alpha}.$$

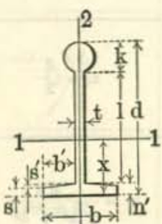


$$A = \frac{l(t + t_1)}{2} + n' t_1 + b'(s + n').$$

$$x = \frac{3s^2(b - t_1) + 2b' s'(s' + 3s) + 3t_1 d^2 - l(t_1 - t)(3d - l)}{6A}.$$

$$\text{I, Axis } 1-1 = \frac{l^3(3t + t_1) + 4bn'^3 - 2b's'^3}{12} - A(x - n')^2$$

$$\text{I}', \text{ Axis } 2-2 = \frac{sb^3 + s't_1^3 + lt^3}{12} + \frac{s'b'[2b'^2 + (2b' + 3t_1)^2]}{36} + \frac{l(t_1 - t)[(t_1 - t)^2 + 2(t_1 + 2t)^2]}{144}.$$



e = Area of head.

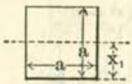
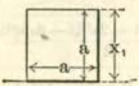
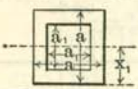
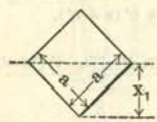
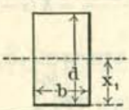
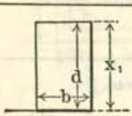
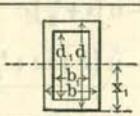
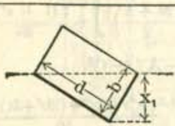
$$A = e + t(d - k) + (b - t)\left(s + \frac{s'}{2}\right).$$

$$x = \frac{e(2d - k) + t(d - k)^2 + (b - t)\left(s^2 + ss' + \frac{s'^2}{3}\right)}{2A}.$$

$$\text{I, Axis } 1-1 = e\left[\frac{k^2}{16} + \left(d - \frac{2s + k}{2}\right)^2\right] + \frac{t(l + s')^3}{3} + \frac{b's'^3 + 2bs^3}{6} - A(x - s)^2.$$

$$\text{I}', \text{Axis } 2-2 = \frac{ek^2}{16} + \frac{t^3(l + s') + sb^3}{12} + \frac{s'b'[2b'^2 + (2b' + 3t)^2]}{36}$$

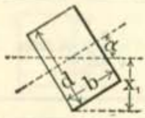
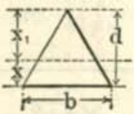
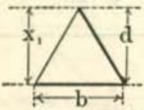
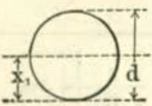
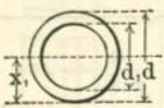
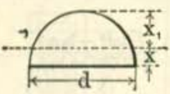
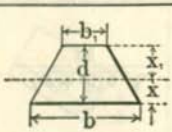
PROPERTIES OF VARIOUS SECTIONS.

Sections.	Area of Section. A	Distance from Neutral Axis to Extremities of Section. x and x_1
	a^2	$x_1 = \frac{a}{2}$
	a^2	$x_1 = a$
	$a^2 - a_1^2$	$x_1 = \frac{a}{2}$
	a^2	$x_1 = \frac{a}{\sqrt{2}} = .707a$
	bd	$x_1 = \frac{d}{2}$
	bd	$x_1 = d$
	$bd - b_1d_1$	$x_1 = \frac{d}{2}$
	bd	$x_1 = \frac{b\,d}{\sqrt{b^2 + d^2}}$

PROPERTIES OF VARIOUS SECTIONS.

Moment of Inertia. I	Section Modulus. $S = \frac{I}{x_1}$.	Radius of Gyration. $r = \sqrt{\frac{I}{A}}$.
$\frac{a^4}{12}$	$\frac{a^3}{6}$	$\frac{a}{\sqrt{12}} = .289a$
$\frac{a^4}{3}$	$\frac{a^3}{3}$	$\frac{a}{\sqrt{3}} = .577a$
$\frac{a^4 - a_1^4}{12}$	$\frac{a^4 - a_1^4}{6a}$	$\sqrt{\frac{a^2 + a_1^2}{12}}$
$\frac{a^4}{12}$	$\frac{a^3}{6\sqrt{2}} = .118a^3$	$\frac{a}{\sqrt{12}} = .289a$
$\frac{bd^3}{12}$	$\frac{bd^2}{6}$	$\frac{d}{\sqrt{12}} = .289d$
$\frac{bd^3}{3}$	$\frac{bd^2}{3}$	$\frac{d}{\sqrt{3}} = .577d$
$\frac{bd^3 - b_1d_1^3}{12}$	$\frac{bd^3 - b_1d_1^3}{6d}$	$\sqrt{\frac{bd^3 - b_1d_1^3}{12(bd - b_1d_1)}}$
$\frac{b^3d^3}{6(b^2 + d^2)}$	$\frac{b^2d^2}{6\sqrt{b^2 + d^2}}$	$\frac{bd}{\sqrt{6(b^2 + d^2)}}$

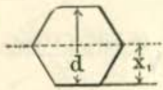
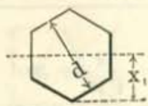
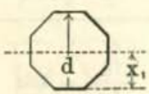
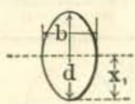
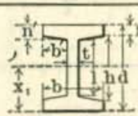
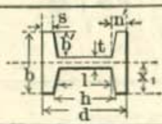
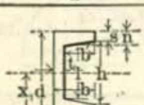
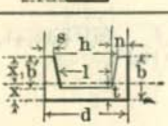
PROPERTIES OF VARIOUS SECTIONS.

Sections.	Area of Section. A	Distance from Neutral Axis to Extremities of Section. x and x_1
	bd	$x_1 = \frac{b}{2 \sin \alpha}$
	$\frac{bd}{2}$	$x = \frac{d}{3}$ $x_1 = \frac{2d}{3}$
	$\frac{bd}{2}$	$x_1 = d$
	$\frac{\pi d^2}{4} = .785d^2$	$x_1 = \frac{d}{2}$
	$\frac{\pi (d^2 - d_1^2)}{4} = .785\,(d^2 - d_1^2)$	$x_1 = \frac{d}{2}$
	$\frac{\pi d^2}{8} = .393d^2$	$x = \frac{2d}{3\pi} = .212d$ $x_1 = \frac{(3\pi - 4)\,d}{6\pi} = .288d$
	$\frac{b + b_1}{2} \cdot d$	$x = \frac{b + 2b_1}{b + b_1} \cdot \frac{d}{3}$ $x_1 = \frac{b_1 + 2b}{b + b_1} \cdot \frac{d}{3}$

PROPERTIES OF VARIOUS SECTIONS.

Moment of Inertia. I	Section Modulus. $S = \frac{I}{x_1}$.	Radius of Gyration. $r = \sqrt{\frac{I}{A}}$
$\frac{bd}{12} + (d^2 \cos^2 \alpha + b^2 \sin^2 \alpha)$	$\frac{d}{6} (d^2 \cos^2 \alpha \sin \alpha + b^2 \sin^3 \alpha$	$\sqrt{\frac{d^2 \cos^2 \alpha + b^2 \sin^2 \alpha}{12}}$
$\frac{bd^3}{36}$	$\frac{bd^2}{24}$	$\frac{d}{\sqrt{18}} = .236d$
$\frac{bd^3}{12}$	$\frac{bd^2}{12}$	$\frac{d}{\sqrt{6}} = .408d$
$\frac{\pi d^4}{64} = .049d^4$	$\frac{\pi d^3}{32} = .098d^3$	$\frac{d}{4}$
$\frac{\pi (d^4 - d_1^4)}{64} = .049 (d^4 - d_1^4)$	$\frac{\pi}{32} \frac{(d^4 - d_1^4)}{d} = .098 \frac{(d^4 - d_1^4)}{d}$	$\frac{\sqrt{d^2 + d_1^2}}{4}$
$\frac{9\pi^2 - 64}{1152\pi} \cdot d^4 = .007d^4$	$\frac{9\pi^2 - 64}{192 (3\pi - 4)} \cdot d^3 = .024d^3$	$\frac{\sqrt{9\pi^2 - 64}}{12\pi} \cdot d = .132d$
$\frac{b^2 + 4bb_1 + b^2_1}{36 (b + b_1)} \cdot d^3$	$\frac{b^2 + 4bb_1 + b_1^2}{12 (b_1 + 2b)} \cdot d^2$	$\frac{d}{6(b+b_1)} \sqrt{2(b^2 + 4bb_1 + b_1^2)}$

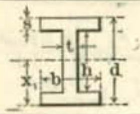
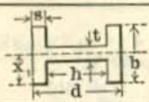
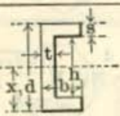
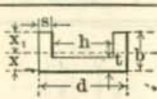
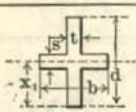
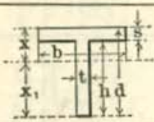
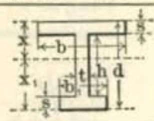
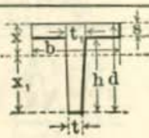
PROPERTIES OF VARIOUS SECTIONS.

Sections.	Area of Section. A	Distance from Neutral Axis to Extremities of Section. x and x_1
	$\frac{3}{2}\,d^2 \tan. 30^\circ = .866d^2$	$x_1 = \frac{d}{2}$
	$\frac{3}{2}\,d^2 \tan. 30^\circ = .866d^2$	$x_1 = \frac{d}{2 \cos 30^\circ} = .577d$
	$2d^2 \tan. 22\frac{1}{2}^\circ = .828d^2$	$x_1 = \frac{d}{2}$
	$\frac{\pi bd}{4} = .785\ bd$	$x_1 = \frac{d}{2}$
	$td + 2b'\,(s + n')$	$x_1 = \frac{d}{2}$
	$td + 2b'\,(s + n')$	$x_1 = \frac{b}{2}$
	$td + b'\,(s + n')$	$x_1 = \frac{d}{2}$
	$td + b'\,(s + n')$	$x = [b^2s + \frac{ht^2}{2} + \frac{g}{3}\,(b-t)^2\,(b + 2t)] \div A$ $x_1 = b - x$

PROPERTIES OF VARIOUS SECTIONS.

Moment of Inertia. I	Section Modulus. $S = \frac{I}{x_1}$	Radius of Gyration. $r = \sqrt{\frac{I}{A}}$
$\frac{A}{12}\left[\frac{d^2\,(1 + 2\cos^2 30^\circ)}{4\cos^2 30^\circ}\right] = .06d^4$	$\frac{A}{6}\left[\frac{d(1+2\cos^2 30^\circ)}{4\cos^2 30^\circ}\right] = 12d^3$	$\frac{d}{4\cos 30^\circ}\sqrt{\frac{1+2\cos^2 30^\circ}{3}} = .264d$
$\frac{A}{12}\left[\frac{d^2\,(1 + 2\cos^2 30^\circ)}{4\cos^2 30^\circ}\right] = .06d^4$	$\frac{A}{6}\left[\frac{d\,(1 + 2\cos^2 30^\circ)}{4\cos 30^\circ}\right] = .104d^3$	$\frac{d}{4\cos 30^\circ}\sqrt{\frac{1+2\cos^2 30^\circ}{3}} = .264d$
$\frac{A}{12}\left[\frac{d^2\,(1 + 2\cos^2 22\frac{1}{2}^\circ)}{4\cos^2 22\frac{1}{2}^\circ}\right] = .055d^4$	$\frac{A}{6}\left[\frac{d\,(1 + 2\cos^2 22\frac{1}{2}^\circ)}{4\cos 22\frac{1}{2}^\circ}\right] = .109d^3$	$\frac{d}{4\cos 22\frac{1}{2}^\circ}\sqrt{\frac{1+2\cos^2 22\frac{1}{2}^\circ}{3}} = .257d$
$\frac{\pi bd^3}{64} = .049bd^3$	$\frac{\pi bd^2}{32} = .098bd^2$	$\frac{d}{4}$
$\frac{1}{12}\left[bd^3 + \frac{1}{4g}\,(h^4 - l^4)\right]$	$\frac{2I}{d}$	$r = \sqrt{\frac{I}{A}}$
$\frac{1}{12}\left[b^3\,(d - h) + lt^3 + \frac{g}{4}\,(b^4 - t^4)\right]$	$\frac{2I}{b}$	$r = \sqrt{\frac{I}{A}}$
$\frac{1}{12}\left[bd^3 - \frac{1}{8g}\,(h^4 - l^4)\right]$	$\frac{2I}{d}$	$r = \sqrt{\frac{I}{A}}$
$\frac{1}{3}\left[2sb^3 + lt^3 + \frac{g}{2}(b^4 - t^4)\right] - Ax^2$	$\frac{I}{b - x}$	$r = \sqrt{\frac{I}{A}}$

PROPERTIES OF VARIOUS SECTIONS.

Sections.	Area of Section. A	Distance from Neutral Axis to Extremities of Section. x and x_1
	$bd - h(b - t)$	$x_1 = \frac{d}{2}$
	$bd - h(b - t)$	$x_1 = \frac{b}{2}$
	$bd - h(b - t)$	$x_1 = \frac{d}{2}$
	$bd - h(b - t)$	$x = \frac{2b^2s + ht^2}{2A}$ $x_1 = b - x$
	$td + s(b - t)$	$x_1 = \frac{d}{2}$
	$bs + ht$	$x = \frac{d^2t + s^2(b - t)}{2A}$ $x_1 = d - x$
	$bs + ht + b_1s$	$x = \frac{td^2 + s^2(b - t) + s(b_1 - t)(2d - s)}{2A}$ $x_1 = d - x$
	$bs + \frac{h(t + t_1)}{2}$	$x = \frac{3bs^2 + 3th^2 + h(t_1 - t)(h + 3s)}{6A}$ $x_1 = d - x$

PROPERTIES OF VARIOUS SECTIONS.

Moment of Inertia. I	Section Modulus. $S = \frac{I}{x_1}$	Radius of Gyration. $r = \sqrt{\frac{I}{A}}$
$\frac{bd^3 - h^3(b-t)}{12}$	$\frac{bd^3 - h^3(b-t)}{6d}$	$\sqrt{\frac{bd^3 - h^3(b-t)}{12[bd - h(b-t)]}}$
$\frac{2sb^3 + ht^3}{12}$	$\frac{2sb^3 + ht^3}{6b}$	$\sqrt{\frac{2sb^3 + ht^3}{12[bd - h(b-t)]}}$
$\frac{bd^3 - h^3(b-t)}{12}$	$\frac{bd^3 - h^3(b-t)}{6d}$	$\sqrt{\frac{bd^3 - h^3(b-t)}{12[bd - h(b-t)]}}$
$\frac{2sb^3 + ht^3}{3} - Ax^2$	$\frac{I}{b-x}$	$\sqrt{\frac{I}{A}}$
$\frac{td^3 + s^3(b-t)}{12}$	$\frac{td^3 + s^3(b-t)}{6d}$	$\sqrt{\frac{td^3 + s^3(b-t)}{12[td + s(b-t)]}}$
$\frac{tx_1^3 + bx^3 - (b-t)(x-s)^3}{3}$	$\frac{I}{d-x}$	$\sqrt{\frac{tx_1^3 + bx^3 - (b-t)(x-s)^3}{3(bs+ht)}}$
$\frac{bx^3 + b_1x_1^3 - (b-t)(x-s)^3}{3} - \frac{(b_1-t)(x_1-s)^3}{3}$	$\frac{I}{d-x}$	$\left[\frac{bx^3 + b_1x_1^3 - (b-t)(x-s)^3}{3(bs+ht+b_1s)} - \frac{(b_1-t)(x_1-s)^3}{3(bs+ht+b_1s)}\right]^{\frac{1}{2}}$
$\frac{4bs^3 + h^3(3t + t_1)}{12} - A(x-s)^2$	$\frac{I}{d-x}$	$\sqrt{\frac{I}{A}}$

EXPLANATIONS OF THE TABLES OF PROPERTIES OF STANDARD AND SPECIAL I-BEAMS, STANDARD AND SPECIAL CHANNELS, STANDARD AND SPECIAL ANGLES WITH EQUAL AND UNEQUAL LEGS, Z-BARS AND T-BARS.

PROPERTIES OF I-BEAMS.

PAGES 156 TO 159.

The figures or values in the various columns give the section numbers, dimensions, weights, areas and properties of the sections as noted in the different headings.

The columns which require special explanation are as follows:

SECTION MODULUS—Column 8.

This is obtained from the moment of inertia in column 7 by dividing it by the distance from the neutral axis to the most remote fibre, which in this case is one-half the depth of the beam.

COEFFICIENTS OF STRENGTH—Columns 13 and 14.

The coefficients of strength F and F′ have been computed for fibre stresses of 16 000 and 12 500 pounds per square inch respectively, as stated in the headings of the columns, and are the safe loads in pounds uniformly distributed, including its own weight for a beam one foot long. Thus the safe load for any span may be obtained by dividing the proper coefficient by the length of the span in feet.

The coefficients of strength were obtained from the following formulæ:

$$F = \tfrac{8}{3} \times 16\,000 \times S$$

$$F' = \tfrac{8}{3} \times 12\,500 \times S$$

in which S is the section modulus.

COEFFICIENTS OF DEFLECTION—Columns 15 and 16.

The coefficients of Deflection N and N′ for centre and uniform loads, respectively, were obtained from the following formulæ:

$$N = \frac{Pl^3}{48EI} \qquad N' = \frac{Wl^3}{76.8EI}$$

in which

P and W = 1 000 pounds.

l = 12 inches.

E = 29 000 000.

I = moment of inertia about axis 1-1.

These coefficients are therefore the deflections in inches of a beam one foot long with a load of 1 000 pounds. The deflection of a beam for any load and span may therefore be obtained by multiplying the proper coefficient by the cube of the span in feet, and by the number of 1 000-pound units in the given load.

PROPERTIES OF STANDARD AND SPECIAL CHANNELS.

PAGES 160 TO 163 INCLUSIVE.

The various columns in the Tables of Properties of Standard Channels are similar to those in the Tables of Properties of I-Beams, as explained above, with the addition of column 11, which gives the Section Modulus about an axis through the center of gravity parallel to the web, and column 13, which gives the distance of the center of gravity from the outside of the web. In this case the Section Modulus $S' = \frac{I'}{b - x}$ the notation being as given at the heads of the columns.

PROPERTIES OF SPECIAL TROUGH CHANNELS.

PAGES 162 AND 163.

These are similar to the Tables of Properties of Special Channels, but with columns 9, 10 and 11 omitted, for the reason that these shapes are ordinarily used with the web in a horizontal position. As these channels are only rolled to the weights specified, column 16, relating to increase of thickness of web for each pound increase in weight, is also omitted.

PROPERTIES OF T-BARS.

A Table of Properties of Cambria T-Bars is also given on pages 162 and 163.

PROPERTIES OF ANGLES.

The values in the Tables of Properties of Standard and Special Angles, with Equal Legs, pages 164 to 169, are as stated in the headings, and those in the Tables of Properties of Standard and Special Angles, with Unequal Legs, on pages 170 to 175, are similar, but with the addition of values for I″, S″ and r″ about the inclined axis 3–3, the position of which, in order to give the minimum values, was determined by the formula on page 140, for the value of the tangent of 2α. After determining the position of the inclined axis, the properties corresponding thereto were obtained by the formulæ on page 140.

PROPERTIES OF Z-BARS.

The Tables of Properties of Z-Bars, on pages 176 and 177, are similar to those for Beams and Channels with the addition of values in column 13 for determining the position of the inclined axis 3–3 to give the minimum values of the radius of gyration, as shown in column 14, these values being obtained in a manner similar to that used in calculating like quantities for the Tables of Properties of Angles with Unequal Legs, as explained above.

MOMENTS OF INERTIA OF RECTANGLES.

A Table of Moments of Inertia of Rectangles is added on pages 178 and 179 for convenience in calculating the Moments of Inertia, Section Moduli, and Radii of Gyration for compound shapes in which plates are used.

GENERAL FORMULÆ FOR PROPERTIES AND FLEXURE.

Formulæ for obtaining the Properties of Standard Sections are given on pages 140 and 141, and for various usual sections on pages 142 to 149 inclusive.

General formulæ for Flexure of Beams, Bending Moments, and Deflections for various cases of loading are given on pages 134 to 138 inclusive.

EXAMPLES OF APPLICATION OF THE TABLES OF PROPERTIES.

EXAMPLE I.

What is the proper size of I-Beam to carry a load of 35 000 pounds concentrated at the center of a span of 25 feet, the fibre stress not to exceed 16 000 pounds per square inch?

In the Tables of Properties of Standard I-Beams, the column headed F gives the coefficient of strength for a uniform load corresponding to a fibre stress of 16 000 pounds per square inch.

The coefficient of strength for a concentrated load at the center is twice that for the same load uniformly distributed, hence the coefficient necessary to meet the conditions is $35\,000 \times 25 \times 2 = 1\,750\,000$. From the Table of Properties of Standard I-Beams, page 159, column 13, the coefficient F for a 24-inch 80-pound beam is found to be 1 855 310. The weight of the beam itself is $80 \times 25 = 2000$ pounds, which corresponds to a coefficient of $2000 \times 25 = 50\,000$, which deducted from 1 855 310 gives a net coefficient of 1 800 310. A 24-inch beam weighing 80 pounds per foot is therefore the proper size.

EXAMPLE II.

What is the deflection of the beam in the preceding example under the given load?

In the Table of Properties of Standard I-Beams, pages 156 to 159 inclusive, the coefficient of deflection for beams with center loads is given in column 15. To obtain the required deflection it is only necessary to multiply the coefficient by the cube of the span and the number of 1 000 pound units contained in the load.

Thus for the given example the deflection in inches =

$$.0000006 \times 25^3 \times \frac{35\,000}{1\,000} = .328 \text{ inch.}$$

Example III.

What is the safe load uniformly distributed that can be placed on an 8-inch standard channel weighing 11.25 pounds per foot, with a clear span of 15 feet for a maximum fibre stress of 12 500 pounds per square inch, the web to be placed vertically?

From the Table of Properties of Standard Channels, page 161, column F, the coefficient of strength for the given channel under the conditions named is found to be 67 300. Hence the total load may be $67\,300 \div 15 = 4487$ pounds, and as the channel itself weighs 169 pounds, the net superimposed load which it can safely carry under the given conditions is 4318 pounds.

Example IV.

What is the fibre stress in a 5″ x 3″ angle weighing 8.2 pounds per foot is loaded at the center with a weight of 1500 pounds used as a beam with a span of 6 feet, the 5-inch leg to be placed vertically?

The bending moment at the center will be

$$\frac{W_1\,l}{4} + \frac{W_2\,l}{8} = \frac{1\,500 \times 72}{4} + \frac{8.2 \times 6 \times 72}{8} = 27\,443 \text{ inch pounds.}$$

Referring to the Table of Properties of Standard Angles, Unequal Legs, on page 173, the Section Modulus for this angle, corresponding to the axis 2—2, is found to be 1.89.

The maximum fibre stress is obtained by dividing the bending moment by the section modulus, thus: $\frac{27\,443}{1.89} = 14\,520$, which is the maximum fibre stress in pounds per square inch at the point most remote from the neutral axis, which in this case is the extremity of the longer leg of the angle.

The second term in the above expression for the bending moment is that due to the weight of the angle itself and is inconsiderable, so that in practice it might be neglected for short spans, but should be taken into consideration for the longer ones.

PROPERTIES OF COMPOUND SHAPES.

The moments of inertia, section moduli and radii of gyration of compound shapes used as beams or columns, composed of plates and angles, channels, beams, Z-bars, T-bars, or any combination of these, may be obtained with the aid of the Tables of Properties as follows:

The first step is to find the center of gravity of the proposed section, which in the case of symmetrical sections is at the center of the figure.

For unsymmetrical sections the position of the center of gravity may be determined by multiplying the areas of the component parts by the distances of their centers of gravity from any convenient line, taken as an axis, and dividing this product by the sum of the areas, which will give the distance of the centre of gravity of the compound section from the assumed axis.

The position of the center of gravity for all sizes of angles, channels, and T-bars is given in the Tables of Properties for these shapes, and is given for various geometrical sections on pages 142 to 149 inclusive, in connection with their other properties.

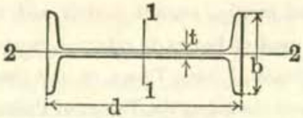
After determining the position of the center of gravity of a compound shape as explained above, the moment of inertia about an axis through its center of gravity may be found by taking the sums of the moments of inertia of each component part about an axis through its own center of gravity parallel to the axis of the compound section, and the sums of products of the area of each component part by the square of the distance of its center of gravity from the axis of the compound section.

Having thus obtained the moment of inertia of the compound section, the section modulus may be obtained by dividing this moment of inertia by the distance from the neutral axis to the most remote extremity of the section.

The square of the radius of gyration for the compound section may be obtained by dividing the moment of inertia by the total area.

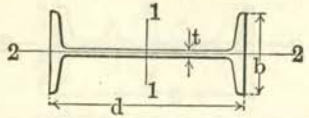
The moment of inertia of a compound section about any axis other than that through its center of gravity may be found in a manner similar to that above described.

PROPERTIES OF STANDARD I-BEAMS.



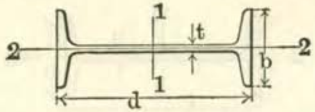
1	2	3	4	5	6	7	8	9	10	11
Section Number.	Depth of Beam.	Weight per Foot.	Area of Section.	Thickness of Web.	Width of Flange.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.	Radius of Gyration Axis 1-1.	Moment of Inertia Axis 2-2.	Radius of Gyration Axis 2-2.
	d		A	t	b	I	S	r	I′	r′
	Inches.	Pounds.	Sq. Inches	Inches.	Inches.	Inches.^4	Inches.^3	Inches.	Inches.^4	Inches
B 5	3	5.5	1.63	.17	2.33	2.5	1.7	1.23	.46	.53
"	"	6.5	1.91	.26	2.42	2.7	1.8	1.19	.53	.52
"	"	7.5	2.21	.36	2.52	2.9	1.9	1.15	.60	.52
B 9	4	7.5	2.21	.19	2.66	6.0	3.0	1.64	.77	.59
"	"	8.5	2.50	.26	2.73	6.4	3.2	1.59	.85	.58
"	"	9.5	2.79	.34	2.81	6.7	3.4	1.54	.93	.58
"	"	10.5	3.09	.41	2.88	7.1	3.6	1.52	1.01	.57
B13	5	9.75	2.87	.21	3.00	12.1	4.8	2.05	1.23	.65
"	"	12.25	3.60	.36	3.15	13.6	5.4	1.94	1.45	.63
"	"	14.75	4.34	.50	3.29	15.1	6.1	1.87	1.70	.63
B17	6	12.25	3.61	.23	3.33	21.8	7.3	2.46	1.85	.72
"	"	14.75	4.34	.35	3.45	24.0	8.0	2.35	2.09	.69
"	"	17.25	5.07	.47	3.57	26.2	8.7	2.27	2.36	.68
B21	7	15.0	4.42	.25	3.66	36.2	10.4	2.86	2.67	.78
"	"	17.5	5.15	.35	3.76	39.2	11.2	2.76	2.94	.76
"	"	20.0	5.88	.46	3.87	42.2	12.1	2.68	3.24	.74
B25	8	17.75	5.33	.27	4.00	56.9	14.2	3.27	3.78	.84
"	"	20.25	5.96	.35	4.08	60.2	15.0	3.18	4.04	.82
"	"	22.75	6.69	.44	4.17	64.1	16.0	3.10	4.36	.81
"	"	25.25	7.43	.53	4.26	68.0	17.0	3.03	4.71	.80
B29	9	21.0	6.31	.29	4.33	84.9	18.9	3.67	5.16	.90
"	"	25.0	7.35	.41	4.45	91.9	20.4	3.54	5.65	.88
"	"	30.0	8.82	.57	4.61	101.9	22.6	3.40	6.42	.85
"	"	35.0	10.29	.73	4.77	111.8	24.8	3.30	7.31	.84
B33	10	25.0	7.37	.31	4.66	122.1	24.4	4.07	6.89	.97
"	"	30.0	8.82	.45	4.80	134.2	26.8	3.90	7.65	.93
"	"	35.0	10.29	.60	4.95	146.4	29.3	3.77	8.52	.91
"	"	40.0	11.76	.75	5.10	158.7	31.7	3.67	9.50	.90
B41	12	31.5	9.26	.35	5.00	215.8	36.0	4.83	9.50	1.01
"	"	35.0	10.29	.44	5.09	228.3	38.0	4.71	10.07	.99
"	"	40.0	11.76	.56	5.21	245.9	41.0	4.57	10.95	.96
B53	15	42.0	12.48	.41	5.50	441.8	58.9	5.95	14.62	1.08
"	"	45.0	13.24	.46	5.55	455.8	60.8	5.87	15.09	1.07
"	"	50.0	14.71	.56	5.65	483.4	64.5	5.73	16.04	1.04
"	"	55.0	16.18	.66	5.75	511.0	68.1	5.62	17.06	1.03
"	"	60.0	17.65	.75	5.84	538.6	71.8	5.52	18.17	1.01

PROPERTIES OF STANDARD I-BEAMS.



12	13	14	15	16	1
Increase of Thickness of Web for each Pound Increase in Weight	Coefficient of Strength. For Fibre Stress of 16 000 Pounds per Square Inch for Buildings.	Coefficient of Strength. For Fibre Stress of 12 500 Pounds per Square Inch for Bridges.	Coefficient of Deflection. Center Load.	Coefficient of Deflection. Uniform Load.	Section Number.
f	F	F′	N	N′	
.098	17650	13790	.00050006	.00031253	B 5
	19140	14950	.00046124	.00028827	"
	20710	16180	.00042630	.00026644	"
.074	31810	24850	.00020815	.00013009	B 9
	33890	26480	.00019535	.00012209	"
	35980	28110	.00018400	.00011500	"
	38070	29750	.00017389	.00010868	"
.059	51590	40300	.00010267	.00006417	B13
	58100	45390	.00009117	.00005698	"
	64630	50490	.00008195	.00005122	"
.049	77460	60520	.00005698	.00003561	B17
	85270	66610	.00005177	.00003235	"
	93110	72740	.00004741	.00002963	"
.042	110410	86260	.00003427	.00002142	B21
	119400	93290	.00003168	.00001980	"
	128560	100430	.00002943	.00001839	"
.037	151660	118490	.00002183	.00001364	B25
	160510	125400	.00002062	.00001289	"
	170970	133570	.00001936	.00001210	"
	181430	141740	.00001825	.00001140	"
.033	201300	157260	.00001462	.00000914	B29
	217930	170260	.00001350	.00000844	"
	241460	188640	.00001219	.00000762	"
	264990	207020	.00001110	.00000694	"
.029	260470	203500	.00001017	.00000635	B33
	286250	223630	.00000925	.00000578	"
	312390	244050	.00000848	.00000530	"
	338530	264480	.00000782	.00000489	"
.025	383670	299740	.00000575	.00000360	B41
	405800	317030	.00000544	.00000340	"
	437170	341540	.00000505	.00000316	"
.020	628270	490840	.00000281	.00000176	B53
	648310	506490	.00000272	.00000170	"
	687530	537130	.00000257	.00000161	"
	726740	567770	.00000243	.00000152	"
	765960	598410	.00000231	.00000144	"

PROPERTIES OF STANDARD I-BEAMS.

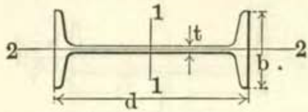


1	2	3	4	5	6	7	8	9	10	11
Section Number.	Depth of Beam.	Weight per Foot.	Area of Section.	Thickness of Web.	Width of Flange.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.	Radius of Gyration Axis 1-1.	Moment of Inertia Axis 2-2.	Radius of Gyration Axis 2-2.
	d		A	t	b	I	S	r	I′	r′
	Inches.	Pounds.	Sq.Inches	Inches.	Inches.	Inches.^{4}	Inches.^{3}	Inches.	Inches.^{4}	Inches.
B 65	18	55.0	15.93	.46	6.00	795.6	88.4	7.07	21.19	1.15
"	"	60.0	17.65	.56	6.10	841.8	93.5	6.91	22.38	1.13
"	"	65.0	19.12	.64	6.18	881.5	97.9	6.79	23.47	1.11
"	"	70.0	20.59	.72	6.26	921.2	102.4	6.69	24.62	1.09
B 73	20	65.0	19.08	.50	6.25	1169.5	117.0	7.83	27.86	1.21
"	"	70.0	20.59	.58	6.33	1219.8	122.0	7.70	29.04	1.19
"	"	75.0	22.06	.65	6.40	1268.8	126.9	7.58	30.25	1.17
B 89	24	80.0	23.32	.50	7.00	2087.2	173.9	9.46	42.86	1.36
"	"	85.0	25.00	.57	7.07	2167.8	180.7	9.31	44.35	1.33
"	"	90.0	26.47	.63	7.13	2238.4	186.5	9.20	45.70	1.31
"	"	95.0	27.94	.69	7.19	2309.0	192.4	9.09	77.10	1.30
"	"	100.0	29.41	.75	7.25	2379.6	198.3	8.99	48.55	1.28

PROPERTIES OF SPECIAL I-BEAMS.

B105	12	40.0	11.84	.46	5.25	268.9	44.8	4.77	13.81	1.08
"	"	45.0	13.24	.58	5.37	285.7	47.6	4.65	14.89	1.06
"	"	50.0	14.71	.70	5.49	303.4	50.6	4.54	16.12	1.05
"	"	55.0	16.18	.82	5.61	321.0	53.5	4.45	17.46	1.04
B109	15	60.0	17.67	.59	6.00	609.0	81.2	5.87	25.96	1.21
"	"	65.0	19.12	.69	6.10	636.1	84.8	5.77	27.42	1.20
"	"	70.0	20.59	.78	6.19	663.7	88.5	5.68	29.00	1.19
"	"	75.0	22.06	.88	6.29	691.2	92.2	5.60	30.68	1.18
"	"	80.0	23.53	.98	6.39	718.8	95.8	5.53	32.46	1.17
B113	15	80.0	23.57	.80	6.40	789.1	105.2	5.79	41.31	1.32
"	"	85.0	25.00	.90	6.50	815.9	108.8	5.71	43.46	1.32
"	"	90.0	26.47	.99	6.59	843.4	112.5	5.64	45.79	1.32
"	"	95.0	27.94	1.09	6.69	871.0	116.1	5.58	48.25	1.31
"	"	100.0	29.41	1.19	6.79	898.6	119.8	5.53	50.84	1.31
B121	20	80.0	23.73	.60	7.00	1466.3	146.6	7.86	45.81	1.39
"	"	85.0	25.00	.66	7.06	1508.5	150.9	7.77	47.25	1.37
"	"	90.0	26.47	.74	7.14	1557.5	155.8	7.67	48.98	1.36
"	"	95.0	27.94	.81	7.21	1606.6	160.7	7.58	50.78	1.35
"	"	100.0	29.41	.88	7.28	1655.6	165.6	7.50	52.65	1.34

PROPERTIES OF STANDARD I-BEAMS.



12	13	14	15	16	1
Increase of Thickness of Web for each Pound Increase in Weight.	Coefficient of Strength. For Fibre Stress of 16 000 Pounds per Square Inch for Buildings.	Coefficient of Strength. For Fibre Stress of 12 500 Pounds per Square Inch for Bridges.	Coefficient of Deflection. Center Load.	Coefficient of Deflection. Uniform Load.	Section Number.
f	F	F′	N	N′	
.016	942880	736620	.00000156	.00000098	B 65
	997680	779440	.00000148	.00000092	"
	1044740	816200	.00000141	.00000088	"
	1091800	852970	.00000135	.00000084	"
.015	1247490	974600	.00000106	.00000066	B 73
	1301110	1016490	.00000102	.00000064	"
	1353400	1057340	.00000098	.00000061	"
.0123	1855310	1449460	.00000060	.00000037	B 89
	1926950	1505430	.00000057	.00000036	"
	1989700	1554450	.00000056	.00000035	"
	2052440	1603470	.00000054	.00000034	"
	2115190	1652490	.00000052	.00000033	"

PROPERTIES OF SPECIAL I-BEAMS.

.025	478130	373540	.00000462	.00000288	B105
	507930	396820	.00000435	.00000272	"
	539300	421320	.00000409	.00000256	"
	570670	445830	.00000387	.00000242	"
.020	866130	676670	.00000204	.00000127	B109
	904660	706770	.00000195	.00000122	"
	943870	737400	.00000187	.00000117	"
	983090	768040	.00000180	.00000112	"
	1022300	798670	.00000173	.00000108	"
.020	1122290	876790	.00000157	.00000098	B113
	1160340	906520	.00000152	.00000095	"
	1199550	937150	.00000147	.00000092	"
	1238770	967790	.00000143	.00000089	"
	1277980	998420	.00000138	.00000086	"
.015	1564060	1221920	.00000085	.00000053	B121
	1609100	1257110	.00000082	.00000051	"
	1661390	1297960	.00000080	.00000050	"
	1713670	1338810	.00000077	.00000048	"
	1765960	1379660	.00000075	.00000047	"

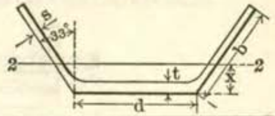
PROPERTIES OF STANDARD CHANNELS.

1	2	3	4	5	6	7	8	9	10	11	12
Section Number	Depth of Channel.	Weight per Foot.	Area of Section.	Thickness of Web.	Width of Flange.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.	Radius of Gyration Axis 1-1.	Moment of Inertia Axis 2-2.	Section Modulus Axis 2-2.	Radius of Gyration Axis 2-2.
	d		A	t	b	I	S	r	I′	S′	r′
	Inches.	Pounds.	Sq. Ins.	Inches.	Inches.	Inches.⁴	Inch's³	Inches.	Inches.⁴	Inches³	Inches.
C 5	3	4.00	1.19	.17	1.41	1.6	1.1	1.17	.20	.21	.41
"	"	5.00	1.47	.26	1.50	1.8	1.2	1.12	.25	.24	.41
"	"	6.00	1.76	.36	1.60	2.1	1.4	1.08	.31	.27	.42
C 9	4	5.25	1.55	.18	1.58	3.8	1.9	1.56	.32	.29	.45
"	"	6.25	1.84	.25	1.65	4.2	2.1	1.51	.38	.32	.45
"	"	7.25	2.13	.33	1.73	4.6	2.3	1.46	.44	.35	.46
C13	5	6.50	1.95	.19	1.75	7.4	3.0	1.95	.48	.38	.50
"	"	9.00	2.65	.33	1.89	8.9	3.5	1.83	.64	.45	.49
"	"	11.50	3.38	.48	2.04	10.4	4.2	1.75	.82	.54	.49
C17	6	8.00	2.38	.20	1.92	13.0	4.3	2.34	.70	.50	.54
"	"	10.50	3.09	.32	2.04	15.1	5.0	2.21	.88	.57	.53
"	"	13.00	3.82	.44	2.16	17.3	5.8	2.13	1.07	.65	.53
"	"	15.50	4.56	.56	2.28	19.5	6.5	2.07	1.28	.74	.53
C21	7	9.75	2.85	.21	2.09	21.1	6.0	2.72	.98	.63	.59
"	"	12.25	3.60	.32	2.20	24.2	6.9	2.59	1.19	.71	.57
"	"	14.75	4.34	.42	2.30	27.2	7.8	2.50	1.40	.79	.57
"	"	17.25	5.07	.53	2.41	30.2	8.6	2.44	1.62	.87	.56
"	"	19.75	5.81	.63	2.51	33.2	9.5	2.39	1.85	.96	.56
C25	8	11.25	3.35	.22	2.26	32.3	8.1	3.10	1.33	.79	.63
"	"	13.75	4.04	.31	2.35	36.0	9.0	2.98	1.55	.87	.62
"	"	16.25	4.78	.40	2.44	39.9	10.0	2.89	1.78	.95	.61
"	"	18.75	5.51	.49	2.53	43.8	11.0	2.82	2.01	1.02	.60
"	"	21.25	6.25	.58	2.62	47.8	11.9	2.76	2.25	1.11	.60
C29	9	13.25	3.89	.23	2.43	47.3	10.5	3.49	1.77	.97	.67
"	"	15.00	4.41	.29	2.49	50.9	11.3	3.40	1.95	1.03	.66
"	"	20.00	5.88	.45	2.65	60.8	13.5	3.21	2.45	1.19	.65
"	"	25.00	7.35	.61	2.81	70.7	15.7	3.10	2.98	1.36	.64
C33	10	15.00	4.46	.24	2.60	66.9	13.4	3.87	2.30	1.17	.72
"	"	20.00	5.88	.38	2.74	78.7	15.7	3.66	2.85	1.34	.70
"	"	25.00	7.35	.53	2.89	91.0	18.2	3.52	3.40	1.50	.68
"	"	30.00	8.82	.68	3.04	103.2	20.6	3.42	3.99	1.67	.67
"	"	35.00	10.29	.82	3.18	115.5	23.1	3.35	4.66	1.87	.67
C41	12	20.50	6.03	.28	2.94	128.1	21.4	4.61	3.91	1.75	.81
"	"	25.00	7.35	.39	3.05	144.0	24.0	4.43	4.53	1.91	.78
"	"	30.00	8.82	.51	3.17	161.6	26.9	4.28	5.21	2.09	.77
"	"	35.00	10.29	.64	3.30	179.3	29.9	4.17	5.90	2.27	.76
"	"	40.00	11.76	.76	3.42	196.9	32.8	4.09	6.63	2.46	.75
C53	15	33.00	9.90	.40	3.40	312.6	41.7	5.62	8.23	3.16	.91
"	"	35.00	10.29	.43	3.43	319.9	42.7	5.57	8.48	3.22	.91
"	"	40.00	11.76	.52	3.52	347.5	46.3	5.44	9.39	3.43	.89
"	"	45.00	13.24	.62	3.62	375.1	50.0	5.32	10.29	3.63	.88
"	"	50.00	14.71	.72	3.72	402.7	53.7	5.23	11.22	3.85	.87
"	"	55.00	16.18	.82	3.82	430.2	57.4	5.16	12.19	4.07	.87

PROPERTIES OF STANDARD CHANNELS.

13	14	15	16	17	18	1
Distance of Center of Gravity from Outside of Web.	Increase of Thickness of Web for each Pound Increase in Weight.	Coef. of Strength. Fibre Stress 16 000 Pounds per Sq. Inch for Buildings.	Coef. of Strength. Fibre Stress 12 500 Pounds per Sq. Inch. for Bridges.	Coef. of Deflection. Center Load.	Coef. of Deflection. Uniform Load.	Section Number.
x	f	F	F′	N	N′	
Inches.	Inches.					
.44	.098	11630	9090	.0007589	.0004743	C 5
.44		13140	10270	.0006718	.0004199	"
.46		14710	11490	.0006001	.0003751	"
.46	.074	20230	15800	.0003273	.0002046	C 9
.46		22270	17400	.0002973	.0001858	"
.46		24360	19030	.0002717	.0001698	"
.49	.059	31640	24720	.0001674	.0001046	C13
.48		37860	29570	.0001399	.0000875	"
.51		44390	34680	.0001193	.0000746	"
.52	.049	46210	36100	.0000855	.0000597	C17
.50		53750	42000	.0000821	.0000513	"
.52		61600	48120	.0000717	.0000448	"
.55		69440	54250	.0000636	.0000397	"
.55	.042	64270	50210	.0000588	.0000368	C21
.53		73650	57540	.0000714	.0000321	"
.53		82740	64690	.0000457	.0000286	"
.55		91950	71840	.0000411	.0000257	"
.58		101100	78990	.0000374	.0000234	"
.58	.037	86140	67300	.0000384	.0000240	C25
.56		95990	75000	.0000345	.0000216	"
.56		106450	83170	.0000311	.0000194	"
.57		116910	91340	.0000283	.0000177	"
.59		127370	99510	.0000260	.0000162	"
.61	.033	112170	87630	.0000262	.0000164	C29
.59		120540	94170	.0000244	.0000153	"
.58		144070	112550	.0000204	.0000128	"
.62		167590	130930	.0000176	.0000110	"
.64	.029	142680	111470	.0000186	.0000116	C33
.61		167940	131210	.0000158	.0000099	"
.62		194090	151630	.0000136	.0000085	"
.65		220230	172060	.0000120	.0000075	"
.69		246380	192480	.0000107	.0000067	"
.70	.025	227750	177930	.0000097	.0000061	C41
.68		256000	200000	.0000086	.0000054	"
.68		287370	224510	.0000077	.0000048	"
.69		318750	249020	.0000069	.0000043	"
.72		350120	273530	.0000063	.0000039	"
.79	.020	444520	347280	.0000040	.0000025	C53
.79		455030	355500	.0000039	.0000024	"
.78		494250	386130	.0000036	.0000022	"
.79		533470	416770	.0000033	.0000021	"
.80		572680	447410	.0000031	.0000019	"
.82		611900	478050	.0000029	.0000018	"

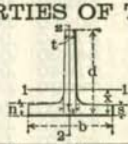
PROPERTIES OF SPECIAL CHANNELS.



1	2	3	4	5	6	7	8	9	10	11	12	13
Section Number.	Depth of Channel.	Weight per Foot.	Area of Section	Thickness of Web.	Width of Flange	Thickness of Flange	Slope of Flange	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.	Radius of Gyration Axis 1-1.	Mom't of Inertia Axis 2-2.	Section Modulus Axis 2-2.
	d		A	t	b	s	g	I	S	r	I′	S′
	Inch's	Pounds.	Sq.Ins.	Inches.	Inches.	Inches.		$Inches^4$	$Inch's^3$	Inches.	$Inch's^4$	$Inch's^3$
C87	6	14.00	4.11	.28	2.96	.41	.04	23.7	7.9	2.40	3.50	1.77
"	"	17.00	5.00	.43	3.11	"	"	26.4	8.8	2.30	. .	. .
"	"	20.00	5.88	.58	3.26	"	"	29.1	9.7	2.22	5.11	2.21
C91	12	21.4	6.30	.31	2.64	.34	.17	128.2	21.4	4.51	3.23	1.61
"	"	23.9	7.03	.37	2.70	"	"	137.0	22.8	4.41	. .	. .
"	"	26.4	7.77	.44	2.76	"	"	145.9	24.3	4.33	. .	. .
"	"	28.9	8.50	.50	2.82	"	"	154.7	25.8	4.27	. .	. .
"	"	31.4	9.24	.56	2.89	"	"	163.5	27.3	4.21	. .	. .
"	"	33.9	9.97	.62	2.95	"	"	172.3	28.7	4.16	4.69	2.04
C75	5	15.2	4.46	.50	4.29	.24	. .	. .	. .	. .	4.33	1.58
C79	"	23.5	6.91	.75	4.50	.375	. .	. .	. .	. .	7.48	2.66
C83	"	19.3	5.68	.50	4.50	.375	. .	. .	. .	. .	6.72	2.48

PROPERTIES OF T-BARS.

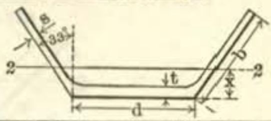
EQUAL



LEGS.

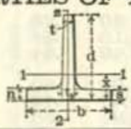
1	2	3	4	5	6	7	8	9	10
	Dimensions.								
Section Number.	Width of Flange.	Depth of Bar.	Thickness of Flange.	Thickness of Stem.	Weight per Foot.	Area of Section.	Distance of Center of Gravity from Outside of Flange.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.
	b	d	s to n′	t to t_1		A	x	I	S
	Inches.	Inches.	Inches.	Inches.	Pounds.	Sq. Ins.	Inches.	$Inches^4$.	$Inches^3$.
T 5	1	1	1/8 to 5/32	1/8 to 5/32	.89	.26	.29	.02	.03
T181	1 1/8	1 1/8	3/16 " 7/32	5/32 " 7/32	1.39	.41	.33	.04	.05
T183	1 3/16	1 3/16	3/16 " 1/4	5/32 " 7/32	1.53	.45	.34	.05	.06
T187	1 1/4	1 1/4	3/16 " 1/4	5/32 " 1/4	1.61	.47	.36	.06	.07
T189	1 3/8	1 3/8	3/16 " 1/4	5/32 " 1/4	1.85	.54	.39	.08	.08
T 37	2	2	1/4 " 5/16	1/4 " 5/16	3.7	1.05	.59	.37	.26
T 39	2	2	5/16 " 3/8	5/16 " 3/8	4.3	1.26	.61	.43	.31
T 41	2 1/4	2 1/4	1/4 " 5/16	1/4 " 5/16	4.1	1.19	.68	.51	.32
T 69	3	3	3/8 " 7/16	3/8 " 7/16	7.8	2.27	.88	1.82	.86
T 97	3 1/2	3 1/2	3/8 " 7/16	3/8 " 7/16	9.3	2.74	.99	3.1	1.23
UNEQUAL LEGS.									
T185	1 1/4	1 1/16	3/16 " 1/4	5/32 " 7/32	1.49	.44	.29	.04	.05
T 65	3	2 1/2	3/8 " 7/16	3/8 " 7/16	7.2	2.07	.71	1.08	.60
T101	3 1/2	4	3/8 " 7/16	3/8 " 7/16	9.9	2.91	1.20	4.3	1.54

PROPERTIES OF SPECIAL CHANNELS.



14	15	16	17	18	19	20	1
Radius of Gyration Axis 2-2.	Distance of Center of Gravity from Outside of Web.	Increase of Thickness of Web for each Lb. Increase in Weight.	Coef. of Strength. Fibre Stress 16 000 Pounds per Square Inch for Buildings.	Coef. of Strength. Fibre Stress 12 500 Pounds per Square Inch for Bridges.	Coef. of Deflection. Center Load.	Coef. of Deflection. Uniform Load.	Section Numb'r
r′	x	f	F	F′	N	N′	
Inches.	Inches.	Inches.					
.92	.99	.049	84440	65970	.0000523	.0000327	C87
. . .	. . .	"	93950	73400	.0000470	.0000294	"
.93	.94	"	103370	80750	.0000427	.0000267	"
.72	.63	.024	227950	178080	.0000097	.0000061	C91
. . .	. . .	"	243630	190340	.0000091	.0000057	"
. . .	. . .	"	259320	202590	.0000085	.0000053	"
. . .	. . .	"	275000	214850	.0000080	.0000050	"
. . .	. . .	"	290690	227100	.0000076	.0000048	"
.69	.65	"	306380	239360	.0000072	.0000045	"
.99	.99	. . .	16890	13190	.000287	.000179	C75
1.04	1.17	. . .	28370	22160	.000166	.000104	C79
1.08	1.28	. . .	26460	20680	.000186	.000116	C83

PROPERTIES OF T-BARS.



EQUAL LEGS.

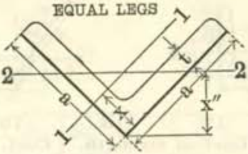
11	12	13	14	15	16	17
Radius of Gyration Axis 1-1.	Moment of Inertia Axis 2-2.	Section Modulus Axis 2-2.	Radius of Gyration Axis 2-2.	Coef. of Strength. For Fibre Stress of 12 000 lbs. per Square Inch.	Coef. of Strength. For Fibre Stress of 10 000 lbs. per Square Inch.	Section Number.
r	I′	S′	r′	F	F′	
Inches.	Inches⁴.	Inches³.	Inches.			
.30	.01	.02	.21	260	220	T 5
.32	.02	.04	.25	420	350	T181
.33	.03	.05	.26	470	390	T183
.35	.03	.05	.27	520	440	T187
.39	.05	.07	.29	660	550	T189
.59	.18	.18	.42	2070	1730	T 37
.59	.23	.23	.42	2500	2080	T 39
.65	.24	.22	.45	2580	2150	T 41
.90	.92	.61	.64	6890	5740	T 69
1.08	1.42	.81	.73	9850	8210	T 97

UNEQUAL LEGS.

.29	.03	.01	.28	380	310	T185
.64	.90	.60	.66	4800	4000	T 65
1.23	1.42	.81	.70	12350	10290	T101

PROPERTIES OF STANDARD ANGLES.

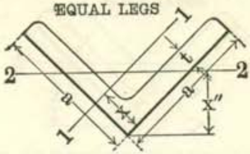
EQUAL LEGS



1	2	3	4	5	6	7	8
Section Number.	Dimensions.	Thickness.	Weight per Foot.	Area of Section.	Distance of Center of Gravity from Back of Flange.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.
	a x a	t		A	x	I	S
	Inches.	Inches.	Pounds.	Sq. In.	Inches.	Inches^4.	Inches^3.
A 5	¾ x ¾	⅛	.58	.17	.23	.009	.017
"	"	3/16	.84	.25	.25	.012	.024
A 7	1 x 1	⅛	.80	.23	.30	.022	.031
"	"	3/16	1.16	.34	.32	.030	.044
"	"	¼	1.49	.44	.34	.037	.056
A 9	1¼ x 1¼	⅛	1.02	.30	.36	.044	.049
"	"	3/16	1.47	.43	.38	.061	.071
"	"	¼	1.91	.56	.40	.077	.091
"	"	5/16	2.32	.68	.42	.090	.109
A11	1½ x 1½	3/16	1.79	.53	.44	.11	.104
"	"	¼	2.34	.69	.47	.14	.134
"	"	5/16	2.86	.84	.49	.16	.162
"	"	⅜	3.35	.98	.51	.19	.188
A13	1¾ x 1¾	3/16	2.11	.62	.51	.18	.14
"	"	¼	2.77	.81	.53	.23	.19
"	"	5/16	3.39	1.00	.55	.27	.23
"	"	⅜	3.98	1.17	.57	.31	.26
"	"	7/16	4.56	1.34	.59	.35	.30
A15	2 x 2	3/16	2.43	.71	.57	.27	.19
"	"	¼	3.19	.94	.59	.35	.25
"	"	5/16	3.92	1.15	.61	.42	.30
"	"	⅜	4.62	1.36	.64	.48	.35
"	"	7/16	5.30	1.56	.66	.54	.40
A17	2½ x 2½	¼	4.0	1.19	.72	.70	.39
"	"	5/16	5.0	1.46	.74	.85	.48
"	"	⅜	5.9	1.73	.76	.98	.57
"	"	7/16	6.8	2.00	.78	1.11	.65
"	"	½	7.7	2.25	.81	1.23	.72

PROPERTIES OF STANDARD ANGLES.

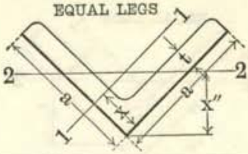
EQUAL LEGS



9	10	11	12	13	1
Radius of Gyration Axis 1-1.	Distance of Center of Gravity from External Apex on Line Inclined at 45° to Flange.	Least Moment of Inertia Axis 2-2.	Section Modulus Axis 2-2.	Least Radius of Gyration Axis 2-2.	Section Number.
r	x''	I''	S''	r''	
Inches.	Inches.	Inches⁴.	Inches³.	Inches.	
.22	.33	.004	.011	.14	A 5
.22	.36	.005	.014	.14	"
.30	.42	.009	.021	.19	A 7
.30	.45	.013	.028	.19	"
.29	.48	.016	.034	.19	"
.38	.51	.018	.035	.24	A 9
.38	.54	.025	.047	.24	"
.37	.57	.033	.057	.24	"
.36	.60	.040	.066	.24	"
.46	.63	.045	.072	.29	A11
.45	.66	.058	.088	.29	"
.44	.69	.070	.101	.29	"
.44	.72	.082	.114	.29	"
.54	.72	.073	.10	.34	A13
.53	.75	.094	.13	.34	"
.52	.78	.113	.15	.34	"
.51	.81	.133	.16	.34	"
.51	.84	.152	.18	.34	"
.62	.80	.11	.14	.39	A15
.61	.84	.14	.17	.39	"
.60	.87	.17	.20	.39	"
.59	.90	.20	.22	.39	"
.59	.93	.23	.25	.38	"
.77	1.01	.29	.28	.49	A17
.76	1.05	.35	.33	.49	"
.75	1.08	.41	.38	.48	"
.75	1.11	.46	.42	.48	"
.74	1.14	.52	.46	.48	"

PROPERTIES OF STANDARD ANGLES.

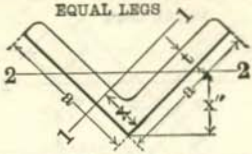
EQUAL LEGS



1	2	3	4	5	6	7	8
Section Number.	Dimensions.	Thickness.	Weight per Foot.	Area of Section.	Distance of Center of Gravity from Back of Flange.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.
	a x a	t		A	x	I	S
	Inches.	Inches.	Pounds.	Sq. In.	Inches.	Inches⁴.	Inches³.
A19	3 x 3	1/4	4.9	1.44	.84	1.24	.58
"	"	5/16	6.0	1.78	.87	1.51	.71
"	"	3/8	7.2	2.11	.89	1.76	.83
"	"	7/16	8.3	2.43	.91	1.99	.95
"	"	1/2	9.4	2.75	.93	2.22	1.07
"	"	9/16	10.4	3.06	.95	2.43	1.19
"	"	5/8	11.4	3.36	.98	2.62	1.30
A21	3½ x 3½	3/8	8.4	2.48	1.01	2.87	1.15
"	"	7/16	9.8	2.87	1.04	3.26	1.32
"	"	1/2	11.1	3.25	1.06	3.64	1.49
"	"	9/16	12.3	3.62	1.08	3.99	1.65
"	"	5/8	13.5	3.98	1.10	4.33	1.81
"	"	11/16	14.8	4.34	1.12	4.65	1.96
"	"	3/4	15.9	4.69	1.15	4.96	2.11
"	"	13/16	17.1	5.03	1.17	5.25	2.25
A23	4 x 4	5/16	8.2	2.40	1.12	3.71	1.29
"	"	3/8	9.7	2.86	1.14	4.36	1.52
"	"	7/16	11.2	3.31	1.16	4.97	1.75
"	"	1/2	12.8	3.75	1.18	5.56	1.97
"	"	9/16	14.2	4.18	1.21	6.12	2.19
"	"	5/8	15.7	4.61	1.23	6.66	2.40
"	"	11/16	17.1	5.03	1.25	7.17	2.61
"	"	3/4	18.5	5.44	1.27	7.66	2.81
"	"	13/16	19.9	5.84	1.29	8.14	3.01
A27	6 x 6	7/16	17.2	5.06	1.66	17.68	4.07
"	"	1/2	19.6	5.75	1.68	19.91	4.61
"	"	9/16	21.9	6.43	1.71	22.07	5.14
"	"	5/8	24.2	7.11	1.73	24.16	5.66
"	"	11/16	26.4	7.78	1.75	26.19	6.17
"	"	3/4	28.7	8.44	1.78	28.15	6.66
"	"	13/16	30.9	9.09	1.80	30.06	7.15
"	"	7/8	33.1	9.73	1.82	31.92	7.63

PROPERTIES OF STANDARD ANGLES.

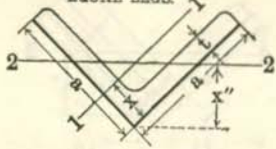
EQUAL LEGS



9	10	11	12	13	1
Radius of Gyration Axis 1-1.	Distance of Center of Gravity from External Apex on Line Inclined at 45° to Flange.	Least Moment of Inertia Axis 2-2.	Section Modulus Axis 2-2.	Least Radius of Gyration. Axis 2-2.	Section Number.
r	x″	I″	S″	r″	
Inches.	Inches.	Inches⁴.	Inches³.	Inches.	
.93	1.19	.50	.42	.59	A19
.92	1.22	.61	.50	.59	"
.91	1.26	.72	.57	.58	"
.91	1.29	.82	.64	.58	"
.90	1.32	.92	.70	.58	"
.89	1.35	1.02	.76	.58	"
.88	1.38	1.12	.81	.58	"
1.07	1.43	1.16	.81	.68	A21
1.07	1.46	1.33	.91	.68	"
1.06	1.50	1.50	1.00	.68	"
1.05	1.53	1.66	1.09	.68	"
1.04	1.56	1.82	1.17	.68	"
1.04	1.59	1.97	1.24	.67	"
1.03	1.62	2.13	1.31	.67	"
1.02	1.65	2.28	1.38	.67	"
1.24	1.58	1.50	.95	.79	A23
1.23	1.61	1.77	1.10	.79	"
1.23	1.64	2.02	1.23	.78	"
1.22	1.67	2.28	1.36	.78	"
1.21	1.71	2.52	1.48	.78	"
1.20	1.74	2.76	1.59	.77	"
1.19	1.77	3.00	1.70	.77	"
1.19	1.80	3.23	1.80	.77	"
1.18	1.83	3.46	1.89	.77	"
1.87	2.34	7.13	3.04	1.19	A27
1.86	2.38	8.04	3.37	1.18	"
1.85	2.41	8.94	3.70	1.18	"
1.84	2.45	9.81	4.01	1.17	"
1.83	2.48	10.67	4.31	1.17	"
1.83	2.51	11.52	4.59	1.17	"
1.82	2.54	12.35	4.86	1.17	"
1.81	2.57	13.17	5.12	1.16	"

PROPERTIES OF SPECIAL ANGLES.

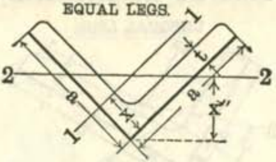
EQUAL LEGS.



1	2	3	4	5	6	7	8
Section Number.	Dimensions.	Thickness.	Weight per Foot.	Area of Section.	Distance of Center of Gravity from Back of Flange.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.
	a x a	t		A	x	I	S
	Inches.	Inches.	Pounds.	Sq. In.	Inches.	Inches^4.	Inches^3.
A41	2¼ x 2¼	3/16	2.7	.81	.63	.39	.24
"	"	¼	3.6	1.06	.65	.50	.32
"	"	5/16	4.4	1.31	.68	.61	.39
"	"	⅜	5.3	1.55	.70	.70	.45
A43	2¾ x 2¾	3/16	3.4	1.00	.76	.73	.37
"	"	¼	4.5	1.31	.78	.95	.48
"	"	5/16	5.5	1.62	.80	1.15	.59
"	"	⅜	6.5	1.92	.82	1.33	.69
"	"	7/16	7.5	2.21	.85	1.51	.79
A45	4½ x 4½	5/16	9.2	2.71	1.24	5.36	1.64
"	"	⅜	11.0	3.23	1.26	6.30	1.95
"	"	7/16	12.7	3.75	1.29	7.20	2.24
"	"	½	14.5	4.25	1.31	8.07	2.53
"	"	9/16	16.1	4.75	1.33	8.91	2.81
"	"	⅝	17.8	5.23	1.35	9.71	3.09
A47	5 x 5	⅜	12.3	3.61	1.39	8.74	2.42
"	"	7/16	14.2	4.18	1.41	10.02	2.79
"	"	½	16.2	4.75	1.43	11.25	3.16
"	"	9/16	18.0	5.31	1.46	12.44	3.51
"	"	⅝	19.9	5.86	1.48	13.58	3.86

PROPERTIES OF SPECIAL ANGLES.

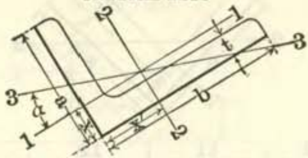
EQUAL LEGS.



9	10	11	12	13	1
Radius of Gyration Axis 1-1.	Distance of Center of Gravity from External Apex on Line Inclined at 45° to Flange.	Least Moment of Inertia Axis 2-2.	Section Modulus Axis 2-2.	Least Radius of Gyration Axis 2-2.	Section Number.
r	x''	I''	S''	r''	
Inches.	Inches.	Inches^4.	Inches^3.	Inches.	
.70	.89	.16	.25	.44	A41
.69	.92	.21	.31	.44	"
.68	.96	.25	.37	.44	"
.67	.99	.29	.42	.43	"
.86	1.07	.30	.39	.54	A43
.85	1.10	.38	.49	.54	"
.84	1.13	.47	.58	.54	"
.83	1.17	.55	.66	.53	"
.83	1.20	.63	.74	.53	"
1.40	1.75	2.16	1.74	.89	A45
1.40	1.79	2.54	2.01	.89	"
1.39	1.82	2.92	2.27	.88	"
1.38	1.85	3 29	2.51	.88	"
1.37	1.88	3.64	2.74	.88	"
1.36	1.91	3.99	2.95	.87	"
1.56	1.96	3.53	2.54	.99	A47
1.55	2.00	4.05	2.87	.98	"
1.54	2.03	4.56	3.18	.98	"
1.53	2.06	5.06	3.48	.98	"
1.52	2.09	5.55	3.76	.97	"

PROPERTIES OF STANDARD ANGLES.

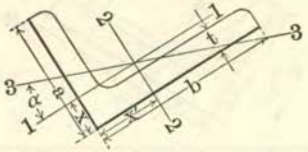
UNEQUAL LEGS



1	2	3	4	5	6	7	8
Section Number.	Dimensions.	Thickness.	Weight per Foot.	Area of Section.	Distance of Center of Gravity from Back of Longer Flange.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.
	b x a	t		A	x	I	S
	Inches.	Inches.	Pounds.	Sq. In.	Inches.	Inches⁴.	Inches³.
A91	2½ x 2	3/16	2.8	.81	.51	.29	.20
"	"	¼	3.6	1.06	.54	.37	.25
"	"	5/16	4.5	1.31	.56	.45	.31
"	"	⅜	5.3	1.55	.58	.51	.36
"	"	7/16	6.0	1.78	.60	.58	.41
"	"	½	6.8	2.00	.63	.64	.46
A93	3 x 2½	¼	4.5	1.31	.66	.74	.40
"	"	5/16	5.5	1.62	.68	.90	.49
"	"	⅜	6.5	1.92	.71	1.04	.58
"	"	7/16	7.5	2.21	.73	1.18	.66
"	"	½	8.5	2.50	.75	1.30	.74
"	"	9/16	9.4	2.78	.77	1.42	.82
A95	3½ x 2½	¼	4.9	1.44	.61	.78	.41
"	"	5/16	6.0	1.78	.64	.94	.50
"	"	⅜	7.2	2.11	.66	1.09	.59
"	"	7/16	8.3	2.43	.68	1.23	.68
"	"	½	9.4	2.75	.70	1.36	.76
"	"	9/16	10.4	3.06	.73	1.49	.84
"	"	⅝	11.4	3.36	.75	1.61	.92
"	"	11/16	12.4	3.65	.77	1.72	.99
A97	3½ x 3	5/16	6.6	1.93	.81	1.58	.72
"	"	⅜	7.8	2.30	.83	1.85	.85
"	"	7/16	9.0	2.65	.85	2.09	.98
"	"	½	10.2	3.00	.88	2.33	1.10
"	"	9/16	11.4	3.34	.90	2.55	1.21
"	"	⅝	12.5	3.67	.92	2.76	1.33
"	"	11/16	13.6	4.00	.94	2.96	1.44
"	"	¾	14.7	4.31	.96	3.15	1.54
"	"	13/16	15.7	4.62	.98	3.33	1.65
A99	4 x 3	5/16	7.1	2.09	.76	1.65	.73
"	"	⅜	8.5	2.48	.78	1.92	.87
"	"	7/16	9.8	2.87	.80	2.18	.99
"	"	½	11.1	3.25	.83	2.42	1.12
"	"	9/16	12.3	3.62	.85	2.66	1.23
"	"	⅝	13.6	3.98	.87	2.87	1.35
"	"	11/16	14.8	4.34	.89	3.08	1.46
"	"	¾	15.9	4.69	.92	3.28	1.57
"	"	13/16	17.1	5.03	.94	3.47	1.68

PROPERTIES OF STANDARD ANGLES.

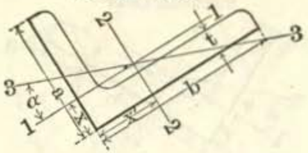
UNEQUAL LEGS



9	10	11	12	13	14	15	1
Radius of Gyration Axis 1-1.	Distance of Center of Gravity from Back of Shorter Flange.	Moment of Inertia Axis 2-2.	Section Modulus Axis 2-2.	Radius of Gyration Axis 2-2.	Tangent of Angle	Least Radius of Gyration Axis 3-3.	Section Number.
r	x′	I′	S′	r′	∝	r″	
Inches.	Inches.	Inches⁴.	Inches³.	Inches.		Inches.	
.60	.76	.51	.29	.79	.632	.43	A91
.59	.79	.65	.38	.78	.626	.42	"
.58	.81	.79	.47	.78	.620	.42	"
.58	.83	.91	.55	.77	.614	.42	"
.57	.85	1.03	.62	.76	.607	.42	"
.56	.88	1.14	.70	.75	.600	.42	"
.75	.91	1.17	.56	.95	.684	.53	A93
.74	.93	1.42	.69	.94	.680	.53	"
.74	.96	1.66	.81	.93	.676	.52	"
.73	.98	1.88	.93	.92	.672	.52	"
.72	1.00	2.08	1.04	.91	.666	.52	"
.72	1.02	2.28	1.15	.91	.661	.52	"
.74	1.11	1.80	.75	1.12	.506	.54	A95
.73	1.14	2.19	.93	1.11	.501	.54	"
.72	1.16	2.56	1.09	1.10	.496	.54	"
.71	1.18	2.91	1.26	1.09	.491	.54	"
.70	1.20	3.24	1.41	1.09	.486	.53	"
.70	1.23	3.55	1.56	1.08	.480	.53	"
.69	1.25	3.85	1.71	1.07	.472	.53	"
.69	1.27	4.13	1.85	1.06	.468	.53	"
.90	1.06	2.33	.95	1.10	.724	.63	A97
.90	1.08	2.72	1.13	1.09	.721	.62	"
.89	1.10	3.10	1.29	1.08	.718	.62	"
.88	1.13	3.45	1.45	1.07	.714	.62	"
.87	1.15	3.79	1.61	1.07	.711	.62	"
.87	1.17	4.11	1.76	1.06	.707	.62	"
.86	1.19	4.41	1.91	1.05	.703	.62	"
.85	1.21	4.70	2.05	1.04	.698	.62	"
.85	1.23	4.98	2.20	1.04	.694	.62	"
.89	1.26	3.38	1.23	1.27	.554	.65	A99
.88	1.28	3.96	1.46	1.26	.551	.64	"
.87	1.30	4.52	1.68	1.25	.547	.64	"
.86	1.33	5.05	1.89	1.25	.543	.64	"
.86	1.35	5.55	2.09	1.24	.538	.64	"
.85	1.37	6.03	2.30	1.23	.534	.64	"
.84	1.39	6.49	2.49	1.22	.529	.64	"
.84	1.42	6.93	2.68	1.22	.524	.64	"
.83	1.44	7.35	2.87	1.21	.518	.64	"

PROPERTIES OF STANDARD ANGLES.

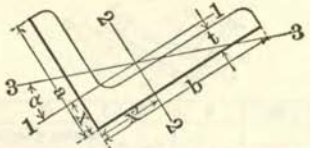
UNEQUAL LEGS



1	2	3	4	5	6	7	8
Section Number.	Dimensions.	Thickness.	Weight per Foot.	Area of Section.	Distance of Center of Gravity from Back of Longer Flange.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.
	b x a	t		A	x	I	S
	Inches.	Inches.	Pounds.	Sq. In.	Inches.	Inches^4.	Inches^3.
A101	5 x 3	5/16	8.2	2.40	.68	1.75	.75
"	"	3/8	9.7	2.86	.70	2.04	.89
"	"	7/16	11.3	3.31	.73	2.32	1.02
"	"	1/2	12.8	3.75	.75	2.58	1.15
"	"	9/16	14.2	4.18	.77	2.83	1.27
"	"	5/8	15.7	4.61	.80	3.06	1.39
"	"	11/16	17.1	5.03	.82	3.29	1.51
"	"	3/4	18.5	5.44	.84	3.51	1.62
"	"	13/16	19.9	5.84	.86	3.71	1.74
A103	5 x 3½	3/8	10.4	3.05	.86	3.18	1.21
"	"	7/16	12.0	3.53	.88	3.63	1.39
"	"	1/2	13.6	4.00	.91	4.05	1.56
"	"	9/16	15.2	4.46	.93	4.45	1.73
"	"	5/8	16.7	4.92	.95	4.83	1.90
"	"	11/16	18.3	5.37	.97	5.20	2.06
"	"	3/4	19.8	5.81	1.00	5.55	2.22
"	"	13/16	21.2	6.25	1.02	5.89	2.37
"	"	7/8	22.7	6.67	1.04	6.21	2.52
A105	6 x 3½	3/8	11.6	3.42	.79	3.34	1.23
"	"	7/16	13.5	3.96	.81	3.81	1.41
"	"	1/2	15.3	4.50	.83	4.25	1.59
"	"	9/16	17.1	5.03	.86	4.67	1.77
"	"	5/8	18.9	5.55	.88	5.08	1.94
"	"	11/16	20.6	6.06	.90	5.47	2.11
"	"	3/4	22.3	6.56	.93	5.84	2.27
"	"	13/16	24.0	7.06	.95	6.20	2.43
"	"	7/8	25.7	7.55	.97	6.55	2.59
A107	6 x 4	3/8	12.3	3.61	.94	4.90	1.60
"	"	7/16	14.2	4.18	.96	5.60	1.85
"	"	1/2	16.2	4.75	.99	6.27	2.08
"	"	9/16	18.1	5.31	1.01	6.91	2.31
"	"	5/8	19.9	5.86	1.03	7.52	2.54
"	"	11/16	21.8	6.40	1.06	8.11	2.76
"	"	3/4	23.6	6.94	1.08	8.68	2.97
"	"	13/16	25.4	7.46	1.10	9.23	3.18
"	"	7/8	27.2	7.98	1.12	9.75	3.39

PROPERTIES OF STANDARD ANGLES.

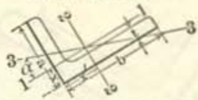
UNEQUAL LEGS



9	10	11	12	13	14	15	1
Radius of Gyration Axis 1-1.	Distance of Center of Gravity from Back of Shorter Flange.	Moment of Inertia Axis 2-2.	Section Modulus Axis 2-2.	Radius of Gyration Axis 2 2.	Tangent of Angle	Least Radius of Gyration Axis 3-3.	Section Number.
r	x'	I'	S'	r'	α	r''	
Inches.	Inches.	Inches⁴.	Inches³.	Inches.		Inches.	
.85	1.68	6.26	1.89	1.61	.368	.66	A101
.84	1.70	7.37	2.24	1.61	.364	.65	"
.84	1.73	8.43	2.58	1.60	.361	.65	"
.83	1.75	9.45	2.91	1.59	.357	.65	"
.82	1.77	10.43	3.23	1.58	.353	.65	"
.82	1.80	11.37	3.55	1.57	.349	.64	"
.81	1.82	12.28	3.86	1.56	.345	.64	"
.80	1.84	13.15	4.16	1.55	.340	.64	"
.80	1.86	13.98	4.46	1.55	.336	.64	"
1.02	1.61	7.78	2.29	1.60	.485	.76	A103
1.01	1.63	8.90	2.64	1.59	.482	.76	"
1.01	1.66	9.99	2.99	1.58	.479	.75	"
1.00	1.68	11.03	3.32	1.57	.476	.75	"
.99	1.70	12.03	3.65	1.56	.472	.75	"
.98	1.72	12.99	3.97	1.56	.468	.75	"
.98	1.75	13.92	4.28	1.55	.464	.75	"
.97	1.77	14.81	4.58	1.54	.460	.75	"
.96	1.79	15.67	4.88	1.53	.455	.75	"
.99	2.04	12.86	3.24	1.94	.350	.77	A105
.98	2.06	14.76	3.75	1.93	.347	.76	"
.97	2.08	16.59	4.24	1.92	.344	.76	"
.96	2.11	18.37	4.72	1.91	.341	.75	"
.96	2.13	20.08	5.19	1.90	.338	.75	"
.95	2.15	21.74	5.65	1.89	.334	.75	"
.94	2.18	23.34	6.10	1.89	.331	.75	"
.94	2.20	24.89	6.55	1.88	.327	.75	"
.93	2.22	26.39	6.98	1.87	.323	.75	"
1.17	1.94	13.47	3.32	1.93	.446	.88	A107
1.16	1.96	15.46	3.83	1.92	.443	.87	"
1.15	1.99	17.40	4.33	1.91	.440	.87	"
1.14	2.01	19.26	4.83	1.90	.438	.87	"
1.13	2.03	21.07	5.31	1.90	.434	.86	"
1.13	2.06	22.82	5.78	1.89	.431	.86	"
1.12	2.08	24.51	6.25	1.88	.428	.86	"
1.11	2.10	26.15	6.70	1.87	.425	.86	"
1.11	2.12	27.73	7.15	1.86	.421	.86	"

PROPERTIES OF SPECIAL ANGLES.

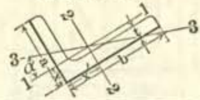
UNEQUAL LEGS.



1	2	3	4	5	6	7	8
Section Number.	Dimensions.	Thickness.	Weight per Foot.	Area of Section.	Distance of Center of Gravity from Back of Longer Flange.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.
	b x a	t		A	x	I	S
	Inches.	Inches.	Pounds.	Sq. In.	Inches.	Inches⁴.	Inches³.
A121	2 x 1 3/8	3/16	2.03	.60	.35	.10	.10
"	"	1/4	2.66	.78	.37	.12	.12
"	"	5/16	3.25	.96	.39	.14	.14
"	"	3/8	3.83	1.13	.42	.16	.17
A123	2 x 1 1/2	3/16	2.11	.62	.39	.12	.11
"	"	1/4	2.76	.81	.41	.15	.14
"	"	5/16	3.39	1.00	.44	.18	.17
"	"	3/8	3.98	1.17	.46	.21	.20
A155	2 5/16 x 1 5/16	11/64	2.02	.59	.30	.08	.08
A125	2 1/2 x 1 1/4	3/16	2.27	.67	.28	.07	.08
"	"	1/4	2.98	.88	.30	.09	.10
"	"	5/16	3.65	1.07	.33	.11	.12
"	"	3/8	4.30	1.27	.35	.13	.14
A127	2 1/2 x 1 1/2	3/16	2.43	.71	.35	.13	.11
"	"	1/4	3.19	.94	.38	.16	.14
"	"	5/16	3.92	1.15	.40	.19	.17
"	"	3/8	4.62	1.36	.42	.22	.20
A161	2 1/2 x 1 3/4	3/16	2.6	.76	.43	.20	.15
"	"	1/4	3.4	1.00	.45	.25	.20
A129	3 x 2	3/16	3.1	.90	.47	.31	.20
"	"	1/4	4.0	1.19	.49	.39	.26
"	"	5/16	5.0	1.46	.51	.47	.32
"	"	3/8	5.9	1.73	.54	.54	.37
"	"	7/16	6.8	2.00	.56	.61	.42
A131	4 x 3 1/2	5/16	7.6	2.25	.93	2.55	.99
"	"	3/8	9.1	2.67	.96	2.99	1.17
"	"	7/16	10.5	3.09	.98	3.40	1.35
"	"	1/2	11.9	3.50	1.00	3.79	1.52
"	"	9/16	13.3	3.90	1.02	4.17	1.68
"	"	5/8	14.6	4.30	1.04	4.49	1.83
A133	4 1/2 x 3	3/8	9.1	2.67	.74	1.98	.88
"	"	7/16	10.5	3.09	.76	2.25	1.01
"	"	1/2	11.9	3.50	.79	2.51	1.13
"	"	9/16	13.3	3.90	.81	2.75	1.25
"	"	5/8	14.6	4.30	.83	2.98	1.37
A135	5 x 4	3/8	11.0	3.23	1.03	4.66	1.57
"	"	7/16	12.7	3.75	1.05	5.32	1.81
"	"	1/2	14.5	4.25	1.07	5.96	2.04
"	"	9/16	16.1	4.75	1.10	6.56	2.26
"	"	5/8	17.8	5.23	1.12	7.14	2.48
A137	5 5/8 x 5	7/16	15.2	4.46	1.34	10.39	2.84
"	"	1/2	17.2	5.06	1.36	11.67	3.21
"	"	9/16	19.2	5.66	1.38	12.90	3.57
"	"	5/8	21.3	6.25	1.41	14.09	3.92
"	"	11/16	23.2	6.83	1.43	15.24	4.27

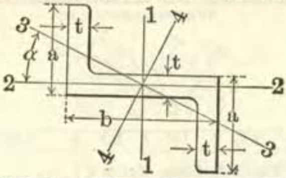
PROPERTIES OF SPECIAL ANGLES.

UNEQUAL LEGS.



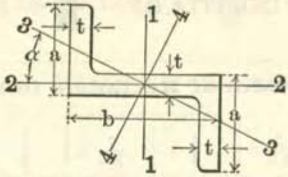
9	10	11	12	13	14	15	1
Radius of Gyration Axis 1-1.	Distance of Center of Gravity from Back of Shorter Flange.	Moment of Inertia Axis 2-2.	Section Modulus Axis 2-2.	Radius of Gyration Axis 2 2.	Tangent of Angle	Least Radius of Gyration Axis 3-3.	Section Number.
r	x′	I′	S′	r′	α	r″	
Inches.	Inches.	Inches⁴.	Inches³.	Inches.		Inches.	
.41	.66	.24	.18	.63	.475	.31	A121
.39	.68	.31	.23	.63	.455	.30	"
.38	.71	.37	.28	.62	.445	.29	"
.38	.73	.42	.33	.61	.434	.29	"
.44	.64	.25	.18	.63	.551	.32	A123
.43	.66	.32	.24	.62	.543	.32	"
.42	.69	.38	.29	.62	.534	.32	"
.42	.71	.43	.34	.61	.524	.32	"
.36	.80	.33	.22	.74	.330	.29	A155
.33	.91	.43	.27	.80	.264	.27	A125
.33	.93	.55	.35	.79	.256	.27	"
.32	.95	.66	.43	.79	.247	.26	"
.32	.97	.77	.50	.78	.238	.26	"
.42	.85	.46	.28	.80	.364	.33	A127
.41	.88	.59	.36	.79	.357	.32	"
.41	.90	.71	.44	.79	.349	.32	"
.40	.92	.82	.52	.78	.340	.32	"
.51	.81	.49	.29	.80	.486	.38	A161
.50	.83	.62	.37	.79	.479	.38	"
.58	.97	.84	.41	.97	.446	.44	A129
.57	.99	1.09	.54	.96	.440	.43	"
.57	1.02	1.32	.66	.95	.434	.43	"
.56	1.04	1.53	.78	.94	.428	.43	"
.55	1.06	1.73	.89	.93	.421	.43	"
1.07	1.18	3.56	1.26	1.26	.757	.73	A131
1.06	1.21	4.18	1.49	1.25	.755	.73	"
1.05	1.23	4.76	1.72	1.24	.753	.72	"
1.04	1.25	5.32	1.94	1.23	.750	.72	"
1.03	1.27	5.86	2.15	1.23	.747	.72	"
1.02	1.29	6.37	2.35	1.22	.742	.72	"
.86	1.49	5.50	1.83	1.44	.440	.65	A133
.85	1.51	6.29	2.10	1.43	.437	.65	"
.85	1.54	7.04	2.37	1.42	.431	.65	"
.84	1.56	7.75	2.64	1.41	.428	.64	"
.83	1.58	8.44	2.89	1.40	.424	.64	"
1.20	1.53	8.14	2.34	1.59	.631	.85	A135
1.19	1.55	9.32	2.70	1.58	.629	.85	"
1.18	1.57	10.46	3.05	1.57	.626	.85	"
1.18	1.60	11.55	3.39	1.56	.623	.85	"
1.17	1.62	12.61	3.73	1.55	.620	.84	"
1.53	1.65	13.94	3.51	1.77	.782	1.04	A137
1.52	1.67	15.67	3.97	1.76	.781	1.03	"
1.51	1.70	17.35	4.42	1.75	.779	1.03	"
1.50	1.72	18.97	4.86	1.74	.778	1.03	"
1.49	1.74	20.54	5.29	1.73	.776	1.03	"

PROPERTIES OF Z-BARS.



1	2	3	4	5	6	7	8	9	10	11	12
Section Number	Depth of Bar.	Length of Legs.	Thickness of Web and Legs.	Weight per Foot.	Area of Section.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.	Radius of Gyration Axis 1-1.	Moment of Inertia Axis 2-2.	Section Modulus Axis 2-2.	Radius of Gyration Axis 2-2.
	b	a	t		A	I	S	r	I′	S′	r′
	Inches.	Inches.	Inches.	Pounds	Sq. Ins.	Inches⁴.	Inches³.	Inches.	Inches⁴.	Inches³	Inches.
Z 5	3	2 11/16	1/4	6.7	1.97	2.87	1.92	1.21	2.81	1.10	1.19
"	3 1/16	2 3/4	5/16	8.4	2.48	3.64	2.38	1.21	3.64	1.40	1.21
Z 9	3	2 11/16	3/8	9.7	2.86	3.85	2.57	1.16	3.92	1.57	1.17
"	3 1/16	2 3/4	7/16	11.4	3.36	4.57	2.98	1.17	4.75	1.88	1.19
Z 13	3	2 11/16	1/2	12.5	3.69	4.59	3.06	1.12	4.85	1.99	1.15
"	3 1/16	2 3/4	9/16	14.2	4.18	5.26	3.43	1.12	5.68	2.30	1.17
Z 21	4	3 1/16	1/4	8.2	2.41	6.28	3.14	1.62	4.23	1.44	1.33
"	4 1/16	3 1/8	5/16	10.3	3.03	7.94	3.91	1.62	5.46	1.84	1.34
"	4 1/8	3 3/16	3/8	12.4	3.66	9.63	4.67	1.62	6.77	2.26	1.36
Z 25	4	3 1/16	7/16	13.8	4.05	9.66	4.83	1.54	6.73	2.37	1.29
"	4 1/16	3 1/8	1/2	15.8	4.66	11.18	5.50	1.55	7.96	2.77	1.31
"	4 1/8	3 3/16	9/16	17.9	5.27	12.74	6.18	1.55	9.26	3.19	1.32
Z 29	4	3 1/16	5/8	18.9	5.55	12.11	6.05	1.48	8.73	3.18	1.25
"	4 1/16	3 1/8	11/16	20.9	6.14	13.52	6.65	1.48	9.95	3.58	1.27
"	4 1/8	3 3/16	3/4	23.0	6.75	14.97	7.26	1.49	11.24	4.00	1.29
Z 37	5	3 1/4	5/16	11.6	3.40	13.36	5.34	1.98	6.18	2.00	1.35
"	5 1/16	3 5/16	3/8	13.9	4.10	16.18	6.39	1.99	7.65	2.45	1.37
"	5 1/8	3 3/8	7/16	16.4	4.81	19.07	7.44	1.99	9.20	2.92	1.38
Z 41	5	3 1/4	1/2	17.9	5.25	19.19	7.68	1.91	9.05	3.02	1.31
"	5 1/16	3 5/16	9/16	20.2	5.94	21.83	8.62	1.92	10.51	3.47	1.33
"	5 1/8	3 3/8	5/8	22.6	6.64	24.53	9.57	1.92	12.06	3.94	1.35
Z 45	5	3 1/4	11/16	23.7	6.96	23.68	9.47	1.84	11.37	3.91	1.28
"	5 1/16	3 5/16	3/4	26.0	7.64	26.16	10.34	1.85	12.83	4.37	1.30
"	5 1/8	3 3/8	13/16	28.3	8.33	28.70	11.20	1.86	14.37	4.84	1.31
Z 53	6	3 1/2	3/8	15.6	4.59	25.32	8.44	2.35	9.11	2.75	1.41
"	6 1/16	3 9/16	7/16	18.3	5.39	29.80	9.83	2.35	10.94	3.27	1.43
"	6 1/8	3 5/8	1/2	21.0	6.19	34.36	11.22	2.36	12.87	3.81	1.44
Z 57	6	3 1/2	9/16	22.7	6.68	34.64	11.55	2.28	12.59	3.91	1.37
"	6 1/16	3 9/16	5/8	25.4	7.46	38.87	12.82	2.28	14.41	4.44	1.39
"	6 1/8	3 5/8	11/16	28.1	8.25	43.18	14.10	2.29	16.34	4.98	1.41
Z 61	6	3 1/2	3/4	29.3	8.63	42.12	14.04	2.21	15.44	4.94	1.34
"	6 1/16	3 9/16	13/16	31.9	9.39	46.13	15.22	2.22	17.27	5.47	1.36
"	6 1/8	3 5/8	7/8	34.6	10.17	50.22	16.40	2.22	19.18	6.02	1.37

PROPERTIES OF Z-BARS.



13	14	15	16	17	18	1
		Coef. of Strength.		Coef. of Deflection.		
Tangent of Angle.	Least Radius of Gyration Axis 3-3.	For Fibre Stress of 16 000 Pounds per Square Inch.	For Fibre Stress of 12 500 Pounds per Square Inch	Center Load.	Uniform Load.	Section Number.
α	r″ Inches.	F	F′	N	N′	
.986	.55	20400	16000	.000432	.000270	Z 5
1.000	.55*	25400	19800	.000341	.000213	"
.990	.54*	27400	21400	.000322	.000201	Z 9
.975	.55*	31800	24800	.000272	.000170	"
.965	.53*	32600	25500	.000271	.000169	Z13
.951	.54*	36600	28600	.000236	.000148	"
.778	.67	33500	26200	.000198	.000123	Z21
.788	.68	41700	32600	.000156	.000098	"
.798	.69	49800	38900	.000129	.000081	"
.794	.66	51500	40200	.000129	.000080	Z25
.804	.67	58700	45900	.000111	.000069	"
.814	.68	65900	51500	.000097	.000061	"
.808	.65	64600	50500	.000103	.000064	Z29
.818	.67	71000	55500	.000092	.000057	"
.828	.68	77400	60500	.000083	.000052	"
.611	.75	57000	44500	.000093	.000058	Z37
.619	.76	68200	53300	.000077	.000048	"
.628	.76	79400	62000	.000065	.000041	"
.616	.74	81900	64000	.000065	.000040	Z41
.623	.75	92000	71900	.000057	.000036	"
.631	.76	102100	79800	.000051	.000032	"
.619	.73	101000	78900	.000052	.000033	Z45
.626	.74	110200	86100	.000047	.000030	"
.633	.76	119500	93300	.000043	.000027	"
.519	.83	90000	70300	.000049	.000031	Z53
.526	.83	104900	81900	.000042	.000026	"
.532	.84	119700	93500	.000036	.000023	"
.520	.81	123200	96200	.000036	.000022	Z57
.526	.82	136800	106800	.000032	.000020	"
.532	.84	150400	117500	.000029	.000018	"
.519	.81	149800	117000	.000029	.000018	Z61
.525	.82	162300	126800	.000027	.000017	"
.530	.83	174900	136700	.000025	.000015	"

* In these cases the minimum value of r″ corresponds to Neutral Axis 4-4.

MOMENTS OF INERTIA OF RECTANGLES.

Depth in Inches.	Width of Rectangle in Inches. $\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$
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	102.98	114.43
14	57.17	71.46	85.75	100.04	114.33	128.63	142.92
15	70.31	87.89	105.47	123.05	140.63	158.20	175.78
16	85.33	106.67	128.00	149.33	170.67	192.00	213.33
17	102.35	127.94	153.53	179.12	204.71	230.30	255.89
18	121.50	151.88	182.25	212.63	243.00	273.38	303.75
19	142.90	178.62	214.34	250.07	285.79	321.52	357.24
20	166.67	208.33	250.00	291.67	333.33	375.00	416.67
21	192.94	241.17	289.41	337.64	385.88	434.11	482.34
22	221.83	277.29	332.75	388.21	443.67	499.13	554.58
23	253.48	316.85	380.22	443.59	506.96	570.33	633.70
24	288.00	360.00	432.00	504.00	576.00	648.00	720.00
25	325.52	406.90	488.28	569.66	651.04	732.42	813.80
26	366.17	457.71	549.25	640.79	732.33	823.88	915.42
27	410.06	512.58	615.09	717.61	820.13	922.64	1025.16
28	457.33	571.67	686.00	800.33	914.67	1029.00	1143.33
29	508.10	635.13	762.16	889.18	1016.21	1143.23	1270.26
30	562.50	703.13	843.75	984.38	1125.00	1265.63	1406.25
32	682.67	853.33	1024.00	1194.67	1365.33	1536.00	1706.67
34	818.83	1023.54	1228.25	1432.96	1637.67	1842.38	2047.08
36	972.00	1215.00	1458.00	1701.00	1944.00	2187.00	2430.00
38	1143.17	1428.96	1714.75	2000.54	2286.33	2572.13	2857.92
40	1333.33	1666.67	2000 00	2333.33	2666.67	3000.00	3333.33
42	1543.50	1929.38	2315.25	2701.13	3087.00	3472.88	3858.75
44	1774.67	2218.33	2662.00	3105.67	3549.33	3993.00	4436.67
46	2027.83	2534.79	3041.75	3548.71	4055.67	4562.63	5069.58
48	2304.00	2880.00	3456.00	4032.00	4608.00	5184.00	5760.00
50	2604.17	3255.21	3906.25	4557.29	5208.33	5859.38	6510.42
52	2929.33	3661.67	4394.00	5126.33	5858.67	6591.00	7323.33
54	3280.50	4100.63	4920.75	5740.88	6561.00	7381.13	8201.25
56	3658.67	4573.33	5488.00	6402.67	7317.33	8232.00	9146.67
58	4064.83	5081.04	6097.25	7113.46	8129.67	9145.87	10162.08
60	4500.00	5625.00	6750.00	7875.00	9000.00	10125.00	11250.00

MOMENTS OF INERTIA OF RECTANGLES.

Width of Rectangle in Inches.						
$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1	Depth in Inches.
.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	103.98	110.92	11
99.00	108.00	117.00	126.00	135.00	144.00	12
125.87	137.31	148.75	160.20	171.64	183.08	13
157.21	171.50	185.79	200.08	214.38	228.67	14
193.36	210.94	228.52	246.09	263.67	281.25	15
234.67	256.00	277.33	298.67	320.00	341.33	16
281.47	307.06	332.65	358.24	383.83	409.42	17
334.13	364.50	394.88	425.25	455.63	486.00	18
392.96	428.69	464.41	500.14	535.86	571.58	19
458.33	500.00	541.67	583.33	625.00	666.67	20
530.58	578.81	627.05	675.28	723.52	771.75	21
610.04	665.50	720.96	776.42	831.87	887.33	22
697.07	760.44	823.81	887.18	950.55	1013.92	23
792.00	864.00	936.00	1008.00	1080.00	1152.00	24
895.18	976.56	1057.94	1139.32	1220.70	1302.08	25
1006.96	1098.50	1190.04	1281.58	1373.13	1464.67	26
1127.67	1230.19	1332.70	1435.22	1537.73	1640.25	27
1257.67	1372.00	1486.33	1600.67	1715.00	1829.33	28
1397.29	1524.31	1651.34	1778.36	1905.39	2032.42	29
1546.88	1687.50	1828.13	1968.75	2109.38	2250.00	30
1877.33	2048.00	2218.67	2389.33	2560.00	2730.67	32
2251.79	2456.50	2661.21	2865.92	3070.63	3275.33	34
2673.00	2916.00	3159.00	3402.00	3645.00	3888.00	36
3143.71	3429.50	3715.29	4001.08	4286.88	4572.67	38
3666.67	4000.00	4333.33	4666.67	5000.00	5333.33	40
4244.63	4630.50	5016.38	5402.25	5788.13	6174.00	42
4880.33	5324.00	5767.67	6211.33	6655.00	7098.67	44
5576.54	6083.50	6590.46	7097.42	7604.38	8111.33	46
6336.00	6912.00	7488.00	8064.00	8640.00	9216.00	48
7161.46	7812.50	8463.54	9114.58	9765.63	10416.67	50
8055.67	8788.00	9520.33	10252.67	10985.00	11717.33	52
9021.38	9841.50	10661.63	11481.75	12301.88	13122.00	54
10061.33	10976.00	11890.67	12805.33	13720.00	14634.67	56
11178.29	12194.50	13210.71	14226.92	15243.12	16259.33	58
12375.00	13500.00	14625.00	15750.00	16875.00	18000.00	60

STRENGTH OF STEEL COLUMNS OR STRUTS.

For various values of $\frac{L}{r}$ in which L = length in feet and r = radius of gyration in inches.

P = ultimate strength in lbs. per square inch.

FOR SOFT STEEL.

Square bearing	Pin and square bearing	Pin bearing
$P = \dfrac{45\,000}{1 + \dfrac{(12\,L)^2}{36\,000\,r^2}}$	$P = \dfrac{45\,000}{1 + \dfrac{(12\,L)^2}{24\,000\,r^2}}$	$P = \dfrac{45\,000}{1 + \dfrac{(12\,L)^2}{18\,000\,r^2}}$

To obtain safe unit stress:

For quiescent loads, as in buildings, divide by **4**.
For moving loads, as in bridges, divide by **5**.

$\frac{L}{r}$	Ultimate Strength in lbs per Square Inch.			$\frac{L}{r}$	Ultimate Strength in lbs. per Square Inch.		
	Square.	Pin and Square.	Pin.		Square.	Pin and Square.	Pin.
3.0	43437	42694	41978	7.6	36554	32419	30779
3.2	43230	42395	41593	7.8	36193	32966	30268
3.4	43011	42081	41190				
3.6	42782	41754	40773	8.0	35828	32514	29762
3.8	42543	41412	40340	8.2	35462	32064	29260
				8.4	35095	31615	28763
4.0	42294	41058	39893	8.6	34727	31169	28272
4.2	42035	40693	39435	8.8	34358	30724	27787
4.4	41765	40317	38966				
4.6	41488	39930	38485	9.0	33988	30282	27306
4.8	41203	39534	37998	9.2	33611	29844	26832
				9.4	33249	29408	26364
5.0	40910	39130	37500	9.6	32880	28977	25903
5.2	40608	38807	36997	9.8	32511	28549	25448
5.4	40299	38300	36488				
5.6	39984	37874	35975	10.0	32143	28125	25000
5.8	39663	37443	35457	10.2	31776	27706	24559
				10.4	31411	27290	24125
6.0	39335	37006	34938	10.6	31054	26879	23698
6.2	39003	36566	34416	10.8	30684	26474	23279
6.4	38665	36122	33894				
6.6	38323	35676	33371	11.0	30324	26072	22866
6.8	37976	35219	32849	11.2	29965	25675	22460
				11.4	29608	25285	22063
7.0	37616	34776	32328	11.6	29247	24899	21671
7.2	37272	34324	31809	11.8	28903	24517	21288
7.4	36914	33872	31292				

STRENGTH OF STEEL COLUMNS OR STRUTS.

For various values of $\frac{L}{r}$ in which L = length in feet and r = radius of gyration in inches.

P = ultimate strength in lbs. per square inch.

FOR SOFT STEEL.

Square bearing	Pin and square bearing	Pin bearing
$P = \dfrac{45\,000}{1+\dfrac{(12\,L)^2}{36\,000\,r^2}}$	$P = \dfrac{45\,000}{1+\dfrac{(12\,L)^2}{24\,000\,r^2}}$	$P = \dfrac{45\,000}{1+\dfrac{(12\,L)^2}{18\,000\,r^2}}$

To obtain safe unit stress:

For quiescent loads, as in buildings, divide by **4**.
For moving loads, as in bridges, divide by **5**.

$\frac{L}{r}$	Ultimate Strength in lbs. per Square Inch.		
	Square.	Pin and Square.	Pin.
12.0	28553	24142	20911
12.2	28207	23771	20542
12.4	27863	23406	20179
12.6	27522	23046	19823
12.8	27185	22693	19474
13.0	26850	22343	19133
13.2	26524	22005	18797
13.4	26189	21662	18469
13.6	25864	21329	18148
13.8	25543	21002	17833
14.0	25224	20680	17523
14.2	24909	20363	17221
14.4	24598	20052	16925
14.6	24290	19746	16634
14.8	23985	19445	16350
15.0	23684	19148	16071
15.2	23387	18858	15799
15.4	23093	18572	15532
15.6	22803	18288	15270
15.8	22516	18015	15105
16.0	22234	17744	14764
16.2	21954	17478	14518
16.4	21678	17216	14279

$\frac{L}{r}$	Ultimate Strength in lbs. per Square Inch.		
	Square.	Pin and Square.	Pin.
16.6	21406	16960	14043
16.8	21137	16708	13812
17.0	20872	16459	13584
17.2	20611	16216	13366
17.4	20353	15977	13150
17.6	20098	15742	12938
17.8	19847	15512	12731
18.0	19599	15286	12528
18.2	19351	15063	12329
18.4	19114	14845	12135
18.6	18878	14630	11944
18.8	18644	14420	11757
19.0	18418	14218	11579
19.2	18185	14010	11394
19.4	17961	13811	11219
19.6	17740	13616	11048
19.8	17519	13422	10877
20.0	17308	13235	10715
20.2	17096	13050	10553
20.4	16888	12868	10434
20.6	16682	12690	10249
20.8	16480	12515	10087

STRENGTH OF STEEL COLUMNS OR STRUTS.

For various values of $\frac{L}{r}$ in which L = length in feet and r = radius of gyration in inches.

P = ultimate strength in lbs. per square inch.

FOR MEDIUM STEEL.

Square bearing	Pin and square bearing	Pin bearing
$P = \dfrac{50\,000}{1 + \dfrac{(12\,L)^2}{36\,000\,r^2}}$	$P = \dfrac{50\,000}{1 + \dfrac{(12\,L)^2}{24\,000\,r^2}}$	$P = \dfrac{50\,000}{1 + \dfrac{(12\,L)^2}{18\,000\,r^2}}$

To obtain safe unit stress:

For quiescent loads, as in buildings, divide by 4.
For moving loads, as in bridges, divide by 5.

$\frac{L}{r}$	Ultimate Strength in lbs. per Square Inch.		
	Square.	Pin and Square.	Pin.
3.0	48263	47438	46642
3.2	48033	47106	46214
3.4	47790	46757	45767
3.6	47536	46393	45303
3.8	47270	46013	44822
4.0	46993	45620	44325
4.2	46705	45214	43817
4.4	46406	44797	43295
4.6	46098	44367	42761
4.8	45781	43927	42220
5.0	45455	43478	41667
5.2	45120	43119	41108
5.4	44777	42555	40542
5.6	44427	42082	39972
5.8	44070	41603	39397
6.0	43706	41118	38820
6.2	43337	40629	38240
6.4	42961	40136	37660
6.6	42581	39640	37079
6.8	42196	39132	36499
7.0	41796	38640	35920
7.2	41413	38138	35343
7.4	41016	37635	34769
7.6	40616	37132	34199
7.8	40214	36629	33631
8.0	39809	36127	33069
8.2	39402	35627	32511
8.4	38994	35128	31959
8.6	38585	34632	31413
8.8	38175	34138	30874
9.0	37764	33647	30340
9.2	37345	33160	29813
9.4	36943	32676	29293
9.6	36533	32197	28781
9.8	36123	31721	28275
10.0	35714	31250	27778
10.2	35307	30784	27288
10.4	34901	30322	26806
10.6	34504	29866	26331
10.8	34093	29415	25865
11.0	33693	28969	25407
11.2	33294	28528	24956
11.4	32898	28094	24514
11.6	32497	27665	24079
11.8	32114	27241	23653

STRENGTH OF STEEL COLUMNS OR STRUTS.

For various values of $\frac{L}{r}$ in which L = length in feet and r = radius of gyration in inches.

P = ultimate strength in lbs. per square inch.

FOR MEDIUM STEEL.

Square bearing	Pin and Square bearing	Pin bearing
$P = \dfrac{50\,000}{1 + \dfrac{(12\,L)^2}{36\,000\,r^2}}$	$P = \dfrac{50\,000}{1 + \dfrac{(12\,L)^2}{24\,000\,r^2}}$	$P = \dfrac{50\,000}{1 + \dfrac{(12\,L)^2}{18\,000\,r^2}}$

To obtain safe unit stress:

For quiescent loads, as in buildings, divide by **4.**
For moving loads, as in bridges, divide by **5.**

$\frac{L}{r}$	Ultimate Strength in lbs. per Square Inch.			$\frac{L}{r}$	Ultimate Strength in lbs. per Square Inch.		
	Square.	Pin and Square.	Pin.		Square.	Pin and Square.	Pin.
12.0	31726	26824	23234	16.6	23784	18844	15603
12.2	31341	26412	22824	16.8	23486	18564	15347
12.4	30959	26007	22421				
12.6	30580	25607	22026	17.0	23191	18288	15093
12.8	30205	25214	21638	17.2	22901	18018	14851
				17.4	22614	17752	14611
13.0	29833	24826	21259	17.6	22331	17491	14376
13.2	29471	24450	20886	17.8	22052	17235	14145
13.4	29099	24069	20521				
13.6	28738	23699	20164	18.0	21777	16984	13920
13.8	28381	23336	19814	18.2	21501	16737	13699
				18.4	21238	16494	13483
14.0	28027	22978	19470	18.6	20975	16256	13271
14.2	27677	22626	19134	18.8	20715	16022	13063
14.4	27331	22280	18805				
14.6	26989	21940	18482	19.0	20464	15798	12865
14.8	26650	21605	18167	19.2	20206	15567	12661
				19.4	19957	15346	12466
15.0	26316	21276	17857	19.6	19711	15129	12275
15.2	25985	20953	17554	19.8	19466	14913	12086
15.4	25659	20636	17258				
15.6	25337	20320	16967	20.0	19231	14706	11905
15.8	25018	20017	16683	20.2	18996	14500	11725
				20.4	18764	14298	11549
16.0	24704	19716	16404	20.6	18536	14100	11377
16.2	24393	19420	16131	20.8	18311	13905	11208
16.4	24087	19129	15865				

EXAMPLE OF THE USE OF THE TABLES OF STRENGTH OF STEEL COLUMNS OR STRUTS.

PAGES 180–183.

What is the size of angle and plate column of soft steel required to support a load of 140 000 pounds? Length of column 25 feet; ends square; thickness of metal not to be less than $\frac{3}{8}''$ and depth of column not to exceed 9 inches.

Assume for trial a column composed of two web plates each $9'' \times \frac{3}{8}''$ spaced $6''$ out to out, with 4 angles, $3'' \times 2\frac{1}{2}'' \times \frac{3}{8}''$ riveted to the web plates and connected by latticing. This distance between the web plates is such that the moment of inertia about the axis parallel to the web plates is slightly greater than that about the axis perpendicular thereto.

Following the method indicated on page 155, the moment of inertia of the given section about an axis through the centre of gravity, perpendicular to the web plates, will be as follows:

$$I = 2\left(\frac{9^3 \times \frac{3}{8}}{12}\right) + 4\left\{1.04 + 1.92\,(4.5 - 0.71)^2\right\} = 160.04.$$

The total area of column is 14.43 square inches and the radius of gyration r is $\sqrt{\frac{160.04}{14.43}} = 3.33$ inches.

The ratio of the length of column in feet to the least radius of gyration in inches is therefore $\frac{L}{r} = \frac{25}{3.33} = 7.50$. Referring to the "Table of Strength of Steel Columns or Struts of Soft Steel," page 180, the ultimate strength of a soft steel column in which $\frac{L}{r} = 7.50$ is 36 734 pounds per square inch. The safe unit strain for a quiescent load is one-fourth of this or 9 184 pounds per square inch, which multiplied by the area of the column, 14.43 square inches, gives a total safe load of 132 525 pounds, which is slightly less than that specified.

Assume the angles to be increased to $3'' \times 2\frac{1}{2}'' \times \frac{7}{16}''$, then a computation similar to the above gives $I = 175.92$, $A = 15.59$, $r = 3.36$, $\frac{L}{r} = 7.44$.

The safe load is equal to 9 210 pounds per square inch and the area has been increased to 15.59 square inches, which gives as the total safe load 143 584 pounds, which is slightly greater than required, showing that the latter combination is the one to be used.

STRENGTH OF HOLLOW ROUND AND HOLLOW RECTANGULAR CAST IRON COLUMNS.

For various values of $\frac{L}{d}$ in which:—

L = length of column in feet.
d = least outside diameter in inches.
P = ultimate strength in pounds per square inch.

BASED ON GORDON'S FORMULÆ FOR COLUMNS WITH SQUARE ENDS.

HOLLOW ROUND. HOLLOW RECTANGULAR.

$$P = \frac{80000}{1 + \frac{(12L)^2}{800\,d^2}} \qquad P = \frac{80000}{1 + \frac{(12L)^2}{1067\,d^2}}$$

$\frac{L}{d}$	Ultimate Strength in lbs. per sq. in. Hollow Round.	Ultimate Strength in lbs. per sq. in. Hollow Rectangular.	$\frac{L}{d}$	Ultimate Strength in lbs. per sq. in. Hollow Round.	Ultimate Strength in lbs. per sq. in. Hollow Rectangular.
1.0	67800	70487	2.5	37647	43396
1.1	65692	68770	2.6	36088	41834
1.2	63532	66983	2.7	34599	40326
1.3	61340	65142	2.8	33178	38871
1.4	59137	63265	2.9	31817	37471
1.5	56940	61366	3.0	30534	36123
1.6	54766	59458	3.1	29306	34829
1.7	52625	57553	3.2	28137	33586
1.8	50531	55660	3.3	27025	32393
1.9	48491	53792	3.4	25967	31249
2.0	46512	51954	3.5	24961	30152
2.1	44598	50151	3.6	24004	29101
2.2	42753	48391	3.7	23093	28094
2.3	40979	46676	3.8	22227	27130
2.4	39277	45011	3.9	21403	26206

Safe loads for any given hollow round or hollow rectangular columns, corresponding to any suitable factor of safety can be found from the above table as follows:—

Find from the table the ultimate strength in pounds per square inch corresponding to the given value of $\frac{L}{d}$. Multiply this by the area of the column in square inches and divide the product by the safety factor which will give as a quotient the required safe load in pounds.

EXAMPLE:—Required the safe load for a hollow round cast iron column 16 feet long, 10 inches external diameter with metal 1 inch thick with safety factor of eight. The ratio of $\frac{L}{d}$ in this case is $\frac{16}{10} = 1.6$ and the corresponding ultimate strength from the tables is 54 766 pounds per square inch.

From the table of areas of circles it is found that the net area of the column is 28.3 square inches. The safe load is therefore $\frac{54\,766 \times 28.3}{8} = 193\,735$ pounds or approximately 97 net tons, which is the required result.

SAFE LOAD IN TONS OF 2000 POUNDS FOR HOLLOW ROUND CAST IRON COLUMNS WITH SQUARE ENDS.

Based on Gordon's Formula $P = \dfrac{5}{1+\dfrac{l^2}{800d^2}}$

P = safe load in tons per square inch.
l = length of column in inches.
d = outside diameter of column in inches.
Ultimate compressive strength = 80 000 lbs. per square inch. Safety factor 8.
Safe loads for other safety factors than that of the tables may be obtained as follows:—New safe load = Safe load from table × $\dfrac{8}{\text{New factor}}$

Diameter in Inches.	Thickness in Inches.	Length of Column in Feet.										Area of Metal in Inches.	Weight per Foot of Length.
		6	8	10	12	14	16	18	20	22	24		
6	3/4	52	47	41	36	31	27	24	21	18	16	12.4	38.7
	7/8	60	53	47	41	36	31	27	23	21	18	14.1	44.0
7	3/4	65	60	54	48	43	38	34	30	27	24	14.7	46.0
	7/8	74	68	62	55	49	43	38	34	30	27	16.8	52.6
8	3/4	78	72	67	61	55	50	45	40	36	33	17.1	53.4
	7/8	89	83	76	70	63	57	51	46	41	37	19.6	61.2
	1	100	93	86	79	71	64	58	52	47	42	22.0	68.7
9	7/8	103	98	91	85	80	71	65	59	54	49	22.3	69.8
	1	117	110	103	95	90	80	73	67	61	55	25.1	78.5
	1 1/8	129	122	114	105	99	89	81	74	67	61	27.8	87.0
10	7/8	118	112	106	100	93	86	79	73	67	62	25.1	78.4
	1	133	127	120	112	105	97	89	82	76	69	28.3	88.4
	1 1/8	147	141	133	125	116	107	99	91	84	77	31.4	98.0
	1 1/4	161	154	146	136	127	118	109	100	92	84	34.4	107.4
11	1	149	143	137	129	122	114	106	98	91	85	31.4	98.2
	1 1/8	165	159	152	144	135	126	118	109	101	94	34.9	109.1
	1 1/4	182	175	167	158	148	139	129	120	111	103	38.3	119.7
	1 3/8	197	190	181	171	161	151	140	130	121	112	41.6	129.9
12	1 1/8	184	178	171	163	154	146	137	128	120	112	38.4	120.1
	1 1/4	202	195	188	179	170	160	150	141	132	123	42.2	131.9
	1 3/8	220	212	204	194	184	174	163	153	143	133	45.9	143.4
	1 1/2	237	229	220	210	199	187	176	165	154	144	49.5	154.6
13	1 1/8	202	196	190	182	174	165	156	147	138	130	42.0	131.2
	1 1/4	222	216	209	200	191	181	172	162	152	143	46.1	144.2
	1 3/8	242	235	227	218	208	197	187	176	166	156	50.2	156.9
	1 1/2	261	251	245	235	224	213	201	190	179	168	54.2	169.4
14	1 1/4	242	236	229	221	212	203	193	183	173	164	50.1	156.5
	1 3/8	264	258	250	241	231	221	210	199	189	178	54.5	170.4
	1 1/2	285	278	270	260	250	238	227	215	204	193	58.9	184.1
	1 5/8	306	298	289	279	268	256	243	231	219	207	63.2	197.4
15	1 3/8	268	280	272	264	254	244	234	223	212	203	58.9	183.9
	1 1/2	309	303	295	285	275	264	252	241	229	219	63.6	203.4
	1 5/8	332	325	316	306	295	283	271	259	246	235	68.3	213.4
	1 3/4	354	346	337	327	315	302	288	276	263	251	72.8	227.6
16	1 1/2	333	327	319	310	300	290	278	267	255	243	68.3	213.5
	1 5/8	358	351	343	333	322	311	299	286	273	261	73.4	229.3
	1 3/4	382	375	366	356	344	332	319	306	292	279	78.3	244.8
	1 7/8	455	446	435	423	410	395	380	364	347	332	93.2	291.3

SAFE LOAD IN TONS OF 2000 POUNDS FOR HOLLOW ROUND CAST IRON COLUMNS WITH SQUARE ENDS.

Based on Gordon's Formula $P = \dfrac{5}{1 + \dfrac{l^2}{800 d^2}}$

P = safe load in tons per square inch.
l = length of column in inches.
d = outside diameter of column in inches.
Ultimate compressive strength = 80 000 lbs. per square inch. Safety factor 8.
Safe loads for other safety factors than that of the tables may be obtained as follows:—New safe load = Safe load from table $\times \dfrac{8}{\text{New factor}}$

Diameter in Inches.	Thickness in Inches.	Length of Column in Feet.										Area of Metal in Inches.	Weight per Foot of Length.
		14	16	18	20	22	24	26	28	30	32		
18	1⅝	377	366	354	342	329	317	304	298	279	266	83.6	261.2
	1¾	403	391	379	365	352	338	325	318	298	285	89.3	279.2
	1⅞	428	416	402	389	374	360	345	339	317	303	95.0	296.8
	2	453	440	426	411	396	381	365	358	335	320	100.5	314.2
20	1¾	461	450	438	425	412	398	385	371	357	343	100.3	313.6
	1⅞	491	479	466	452	438	424	409	395	380	365	106.8	333.6
	2	520	507	494	479	464	449	434	418	402	387	113.1	353.4
	2⅛	548	535	521	506	490	474	457	441	425	408	119.3	372.9
22	1⅞	552	541	529	516	502	488	474	459	444	429	118.5	370.5
	2	586	574	561	547	532	517	502	486	471	455	125.7	392.7
	2⅛	619	607	593	578	563	547	531	514	498	481	132.9	415.3
	2¼	651	637	623	608	592	575	558	540	523	506	139.6	436.3
24	2	651	640	620	614	600	586	571	555	539	524	138.2	432.0
	2⅛	688	676	655	649	634	619	603	586	570	553	146.0	456.4
	2¼	724	712	690	683	668	651	635	617	600	582	153.7	480.4
	2⅜	760	747	724	717	701	684	666	648	630	611	161.4	504.2
26	2⅛	757	746	734	720	706	691	675	659	643	626	159.4	498.1
	2¼	798	786	773	759	744	728	711	694	677	660	167.9	524.6
	2⅜	838	825	811	797	781	764	747	729	711	693	176.3	550.9
	2½	877	864	850	834	817	800	782	763	744	725	184.6	576.8
28	2¼	871	860	847	834	819	804	788	771	754	737	182.0	568.8
	2⅜	915	903	890	876	860	844	828	810	792	774	191.2	597.5
	2½	958	946	932	917	901	884	867	849	830	811	200.3	625.9
	2⅝	1001	988	974	958	942	924	906	887	867	847	209.3	653.9
30	2⅜	992	980	968	954	940	924	908	891	873	855	206.1	644.1
	2½	1039	1027	1014	1000	985	968	951	934	915	896	216.0	675.0
	2⅝	1086	1074	1060	1045	1029	1012	994	976	957	937	225.8	705.5
	2¾	1133	1120	1105	1090	1074	1056	1037	1018	998	977	235.4	735.7
32	2½	1120	1109	1096	1082	1068	1052	1035	1018	1000	982	231.7	724.0
	2⅝	1171	1159	1146	1132	1116	1100	1083	1065	1046	1027	242.2	757.0
	2¾	1221	1209	1195	1181	1164	1147	1129	1111	1091	1071	252.7	789.7
	2⅞	1271	1259	1244	1229	1212	1194	1176	1156	1136	1115	263.1	822.1
34	2⅝	1255	1244	1232	1218	1203	1187	1171	1153	1136	1116	258.7	808.6
	2¾	1310	1298	1285	1271	1255	1239	1220	1203	1185	1164	270.0	843.7
	2⅞	1364	1352	1338	1323	1307	1290	1272	1253	1234	1212	281.1	878.5
	3	1418	1405	1391	1375	1358	1341	1322	1302	1283	1260	292.2	913.0
36	2¾	1398	1387	1374	1360	1346	1330	1313	1295	1277	1257	287.3	897.7
	2⅞	1456	1445	1432	1417	1402	1385	1368	1349	1330	1310	299.2	935.0
	3	1514	1502	1488	1473	1457	1440	1425	1402	1382	1361	311.0	971.9

EXTRACTS FROM BUILDING LAWS OF VARIOUS CITIES RELATING TO COLUMNS, BEAMS, GIRDERS, ETC.

BOSTON.

1895.

SEC. 19. The stresses in materials hereafter used in construction, produced by the calculated strains due to their own weight and applied loads, shall not exceed the following:

Wrought Iron and Steel.

STRESSES IN POUNDS PER SQUARE INCH.

	Wrought Iron.	Steel.
Extreme fibre stress, rolled beams and shapes..	12 000	16 000
Tension..................................	12,000	15,000
Compression in flanges of built beams	10,000	12 000
Shearing	9.000	10.000
Direct bearing, including pins and rivets.....	15,000	18.000
Bending on pins...........................	18.000	22,500

For columns and members acting as such, ten thousand for iron and twelve thousand for steel, reduced for ratio of length of column to its least radius of gyration by approved modern formulæ.

Cast Iron.

STRESSES IN POUNDS PER SQUARE INCH.

Extreme fibre stress, tension 2500
Extreme fibre stress, compression.............. 8000

For Columns.

The stresses given in the following table, in which L equals length of column in feet, D equals external diameter, or least side of rectangle in inches, and S equals stress in pounds per square inch.

NOTE:—The formulæ corresponding to the allowed unit stresses of the table are as follows, in which the notation is as stated above:

BOSTON BUILDING LAWS.

(CONTINUED.)

Round Columns.

Square Faced Bearings.	Round and Faced Bearings.	Round Bearings.
$S=\dfrac{10\,000}{1+\dfrac{L^2}{5.55D^2}}$	$S=\dfrac{10\,000}{1+\dfrac{L^2}{3.7D^2}}$	$S=\dfrac{10\,000}{1+\dfrac{L^2}{2.78\,D^2}}$

Rectangular Columns.

Square Faced Bearings.	Round and Faced Bearings.	Round Bearings.
$S=\dfrac{10\,000}{1+\dfrac{L^2}{7.41\,D^2}}$	$S=\dfrac{10\,000}{1+\dfrac{L^2}{4.93\,D^2}}$	$S=\dfrac{10\,000}{1+\dfrac{L^2}{3.7\,D^2}}$

Timber.

STRESSES IN POUNDS PER SQUARE INCH.

	On Extreme Fibre.	Shearing Along Grain.	Compression Perpendicular to Grain.
White pine and spruce.....	750	80	150
White oak...............	1000	150	250
Yellow pine (long leaved)..	1250	100	250

For Posts with Flat Ends.

The stresses given in the following table, in which L = length of post, D = least diameter of post, and S = stress per square inch.

White Pine and Spruce.		$\frac{L}{D}$	Long-leaved Yellow Pine.	White Oak.
$\frac{L}{D}$	S		S	S
0 to 10	625	0 to 15	1000	750
10 to 35	500	15 to 30	875	650
35 to 45	375	30 to 40	750	560
45 to 50	250	40 to 45	625	407
		45 to 50	500	375

CHICAGO.

1895.

SEC. 93. In all the following formulæ S represents the maximum load permitted for the kind of construction to which the formulæ apply.

SEC. 95. The maximum loads allowed upon riveted columns shall not exceed those determined by the following formulæ, to wit:

For riveted or other forms of wrought-iron columns:

$$S = 12\,000a \div \left\{ 1 + \frac{l^2}{36\,000r^2} \right\}$$

l and a as in Sec. 94, below.
r = least radius of gyration of columns in inches.

For riveted or other steel columns more than 60r in length:

$$S = 17\,000 - \left\{ \frac{60\,l}{r} \right\}$$

l and r as in Sec. 94, below.

For riveted and other steel columns less than 60r in length:

$S = 13\,500a.$ a as in Sec. 94, below.

SEC. 96. All girders, beams, corbels, brackets and trusses, if made of steel, shall be so proportioned that the maximum fibre stress will not exceed 16 000 pounds per square inch; or that if made of iron, the maximum fibre stress shall not exceed 12 000 pounds per square inch.

SEC. 97. Plate girders shall be designed and constructed of strengths at least equal to those developed by the following formulæ:

For Plate Girders:

$$\text{Flange area} = \frac{\text{Maximum Bending Moment in foot pounds}}{C\ D}$$

D = Distance between centers of gravity of flanges in feet.

$$C = \left\{ \begin{matrix} 13\,500 \text{ for steel} \\ 10\,000 \text{ for iron} \end{matrix} \right\}$$

$$\text{Web area} = \frac{\text{Maximum shear}}{C}$$

$$C = \left\{ \begin{matrix} 10\,000 \text{ for steel} \\ 6\,000 \text{ for iron} \end{matrix} \right\}$$

CHICAGO BUILDING LAWS.

(CONTINUED.)

The maximum stress per square inch of rivet area (single shear) shall not exceed:

	Steel.	Iron.
For shop-driven rivets................	9 000 pds.	7 500 pds.
For field-driven rivets................	7 500 pds.	6 000 pds.

SEC. 94. Cast iron used for pillars shall be proportioned in accordance with the following formulæ:

$$S = 10\,000a \div \left\{1 + \frac{l^2}{600d^2}\right\}$$

l = length of column in inches.
d = diameter of column in inches.
a = sectional area of column in sq. in.

For rectangular cast iron columns:

$$S = 10\,000a \div \left\{1 + \frac{l^2}{850d^2}\right\}$$

l and a as before.
d = the side of square column or the least horizontal dimension of other columns.

Cast iron used in the shape of lintels, brackets or corbels shall be so proportioned that the compression stress upon the same shall not exceed 13 500 pounds per square inch, and that the tensile stress shall not exceed 3 000 pounds per square inch.

SEC. 100. All formulæ herein given for determining the load permitted upon girders of any kind are for girders supported at both ends and uniformly loaded over their entire length. The formulæ for column loads are for columns concentrically loaded. The calculations for the allowances which must be made for other methods of loading shall be based upon the above formulæ and constants, and the rules of the best engineering practice.

SEC. 98. Where wooden pillars are used, the maximum loads to which they are to be subjected shall not exceed those determined by the following formulæ, S representing the maximum loads as intended to be fixed by this ordinance:

$$S = ac \div \left\{1 + \frac{l^2}{250d^2}\right\}$$

a = sectional area of the post in sq. inches.
d = side of square post or least side of rectangular post in inches.
l = length of post in inches.

$$c = \begin{cases} 600 \text{ for white or Norway pine.} \\ 800 \text{ for oak.} \\ 900 \text{ for long-leaf yellow pine.} \end{cases}$$

CHICAGO BUILDING LAWS.

(CONCLUDED.)

SEC. 99. The ultimate load to which timber used for girders may be subjected shall not exceed those determined by the following formulæ, to wit:

$$S = \frac{cbd^2}{l} \begin{cases} b = \text{breadth of beam in inches.} \\ d = \text{depth of beam in inches.} \\ l = \text{length of beam in feet.} \end{cases}$$

$$c = \begin{cases} 160 \text{ for long-leaf yellow pine.} \\ 120 \text{ for oak.} \\ 100 \text{ for white or Norway pine.} \end{cases}$$

The constants given in all of the foregoing formulæ are based upon the use of material and workmanship the best of their respective kinds.

NEW YORK.

1896.

The dimensions of each piece or combination of materials required shall be ascertained by computation, according to the rules given in Haswell's Mechanics' and Engineers' Pocket-Book, except as may be otherwise provided for.

The strength of all columns and posts shall be computed according to Gordon's formulæ, and the crushing weights in pounds, to the square inch of section, for the following named materials, shall be taken as the coefficients in said formulæ, namely: Cast iron, eighty thousand; wrought or rolled iron, forty thousand; rolled steel, forty-eight thousand; white pine and spruce, three thousand five hundred; pitch or Georgia pine, five thousand; American oak, six thousand. The breaking strength of wooden beams and girders shall be computed according to the formulæ in which the constants for transverse strains for central loads, shall be as follows, namely: Hemlock, four hundred; white pine, four hundred and fifty; spruce, four hundred and fifty; pitch or Georgia pine, five hundred and fifty; American oak, five hundred and fifty, and for wooden beams and girders carrying a uniformly distributed load the constants will be doubled. The factors of safety shall be as one to four for all beams, girders and other pieces subjected to a transverse strain; and as one to four for all posts, columns and other vertical supports when of wrought iron or rolled steel, and as one to five for other materials, subject to a compressive strain.

PHILADELPHIA.

1895.

SEC. 24. Before any iron column, post, beam, lintel or girder intended to support a wall built of brick or stone, or any floor or part thereof, or to span any opening eight feet or over in width in any building hereafter to be erected or altered, shall be used for that purpose, the manufacturer or founder thereof shall have a distinctive name or title properly stamped, rolled or cast in a conspicuous place thereon, and no greater weight shall be placed on any column, post, beam, lintel or girder than the published tables of said manufacturer or founder show it to be capable of sustaining with safety.

LOADS PER SQUARE FOOT FOR FLOORS IN DIFFERENT CLASSES OF BUILDINGS IN ACCORDANCE WITH THE BUILDING LAWS OF VARIOUS CITIES.

Class of Building.	Safe Live Loads per Sq. ft. Exclusive of Weight of Materials.			
	Boston. 1895.	Chicago. 1895.	New York. 1896.	Philadelphia. 1895.
Dwellings	50	70	70	70
Offices	100	70	100	..
Buildings for public assembly	150	70	120	150
Stores, warehouses, mercantile and manufacturing buildings	250*	150†	150 and up	200 and up

* Includes drill rooms and riding schools. † Includes stables.

ALLOWABLE MODULI, IN POUNDS PER SQUARE INCH, FOR TIMBER BEAMS, IN ACCORDANCE WITH THE BUILDING LAWS OF VARIOUS CITIES.

Kind of Timber.	Boston.	Chicago.	New York.
Hemlock	....	....	800
White pine	750	900	900
Spruce	750	....	900
Oak	1 000	1 080	1 100
Yellow pine	1 250	1 440	1 100

EXPLANATION OF TABLES OF RIVETS AND PINS.

Rivets.

In the design of riveted joints the total stress transmitted is assumed to be taken up by the rivets, no allowance being made for the friction between the plates riveted together, and the manner of failure of the joint will be by shearing of the rivet or crushing of the plate. This assumes that the rules given on page 202 are followed and failure by tearing off the plate caused by the rivets being too near the edge is thus prevented.

In the table of "Shearing Value of Rivets and Bearing Value of Riveted Plates," pages 196 and 197, these values are given for all customary sizes and thicknesses corresponding to various usual allowable unit stresses.

For any given size of rivet or thickness of plate to be used, an inspection of the table will show at once if the bearing value of the plate or the shearing value of the rivet is to govern the design and the amount of stress that can be transmitted by each rivet.

Pins.

In designing pin-connected joints the points which govern the design are the bending moments produced in the pin by the bars or plates connected, and the bearing value of the plates themselves. The bearing value in the case of eye-bars of proper proportions is sufficiently ample and need not be computed. Shear in pins need not ordinarily be considered, as the bending and bearing stresses usually determine the size.

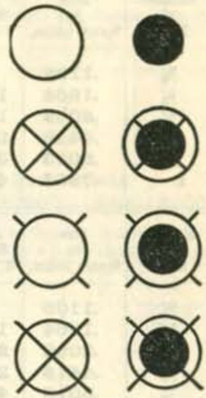
In the table of "Maximum Bending Moments on Pins," pages 198 and 199, is given the allowable bending moments on pins of various diameters for the usual allowable fibre stresses.

In the table of "Bearing Values of Pin Plates for One-Inch Thickness of Plate," on page 203, is given the allowable bearing values of plates against pins of various usual diameters, corresponding to the customary unit stresses of this character.

If the bearing value exceeds the allowable limit in any given case pin-plates must be added, thus increasing the bearing value until it is reduced to a safe limit as shown by the tables.

CONVENTIONAL SIGNS FOR RIVETING.

SHOP. FIELD.



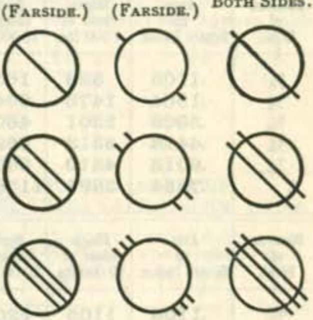
Two Full Heads.

Countersunk Inside (Farside) and Chipped.

Countersunk Outside (Nearside) and Chipped.

Countersunk both Sides and Chipped.

INSIDE. (FARSIDE.) OUTSIDE. (FARSIDE.) BOTH SIDES.



Flattened to ⅛″ high or Countersunk and not Chipped.

Flattened to ¼″ high.

Flattened to ⅜″ high.

This system, designed by F. C. Osborn, C.E., has for foundation the diagonal cross to represent a countersink, the blackened circle for a field rivet and the diagonal stroke to indicate a flattened head. The position of the cross, with respect to the circle (inside, outside or both sides), indicates the location of the countersink and similarly the number and position of the diagonal strokes indicate the height and position of the flattened heads.

Any combination of field, countersunk and flattened head rivets liable to occur may be readily indicated by the proper combination of above signs.

SHEARING VALUE OF RIVETS AND BEARING VALUE OF RIVETED PLATES.

ALL DIMENSIONS IN INCHES.

Shearing Value = Area of Rivet × Allowable Shearing Stress per Square Inch.

Diameter of Rivet.	Area in Square Inches.	Single Shear at 6 000 lbs.	Double Shear at 12 000 lbs.	Bearing Value for Different $\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$
⅜	.1105	663	1325	1125	1406	1688	
½	.1964	1178	2356	1500	1875	2250	2625
⅝	.3068	1841	3682	1875	2344	2813	3281
¾	.4418	2651	5301	2250	2813	3375	3938
⅞	.6013	3608	7216	2625	3281	3938	4594
1	.7854	4712	9425	3000	3750	4500	5250

Diameter of Rivet.	Area in Square Inches.	Single Shear at 6 750 lbs.	Double Shear at 13 500 lbs.	Bearing Value for Different $\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$
⅜	.1105	746	1491	1266	1582	1898	
½	.1964	1325	2651	1688	2109	2531	2953
⅝	.3068	2071	4142	2109	2637	3164	3691
¾	.4418	2982	5964	2531	3164	3797	4430
⅞	.6013	4059	8118	2953	3691	4430	5168
1	.7854	5301	10603	3375	4219	5063	5906

Diameter of Rivet.	Area in Square Inches.	Single Shear at 7 500 lbs.	Double Shear at 15 000 lbs.	Bearing Value for Different $\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$
⅜	.1105	828	1657	1406	1758	2109	
½	.1964	1473	2945	1875	2344	2813	3281
⅝	.3068	2301	4602	2344	2930	3516	4102
¾	.4418	3313	6627	2813	3516	4219	4922
⅞	.6013	4510	9020	3281	4102	4922	5742
1	.7854	5891	11781	3750	4688	5625	6563

Diameter of Rivet.	Area in Square Inches.	Single Shear at 10 000 lbs.	Double Shear at 20 000 lbs.	Bearing Value for Different $\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$
⅜	.1105	1105	2209	1875	2344	2813	
½	.1964	1964	3927	2500	3125	3750	4375
⅝	.3068	3068	6136	3125	3906	4688	5469
¾	.4418	4418	8836	3750	4688	5625	6563
⅞	.6013	6013	12026	4375	5469	6563	7656
1	.7854	7854	15708	5000	6250	7500	8750

In the above tables the bearing values between the lower and upper zigzag black lines are greater than single and less than double shear for the corresponding dimensions, so that in case of single shear the single shearing value governs, and in case of double shear, the bearing value governs the design.

SHEARING VALUE OF RIVETS AND BEARING VALUE OF RIVETED PLATES.

ALL DIMENSIONS IN INCHES.

Bearing Value = Diameter of Rivet × Thickness of Plate × Allowable Bearing Stress per Square Inch.

Thicknesses of Plate in Inches at 12 000 Pounds per Square Inch.

$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1
3000								
3750	4219	4688						
4500	5063	5625	6188	6750				
5250	5906	6563	7219	7875	8531	9188	9844	
6000	6750	7500	8250	9000	9750	10500	11250	12000

Thicknesses of Plate in Inches at 13 500 Pounds per Square Inch.

$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1
3375								
4219	4746	5273						
5063	5695	6328	6961	7594				
5906	6645	7383	8121	8859	9598	10336	11074	
6750	7594	8438	9281	10125	10969	11813	12656	13500

Thicknesses of Plate in Inches at 15 000 Pounds per Square Inch.

$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1
3750								
4688	5273	5859						
5625	6328	7031	7734	8438				
6563	7383	8203	9023	9844	10664	11484	12305	
7500	8438	9375	10313	11250	12188	13125	14063	15000

Thicknesses of Plate in Inches at 20 000 Pounds per Square Inch.

$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1
5000								
6250	7031	7813						
7500	8438	9375	10313	11250				
8750	9844	10938	12031	13125	14219	15313	16406	
10000	11250	12500	13750	15000	16250	17500	18750	20000

The bearing values above and to the right of the upper zigzag black lines are greater than double shear for the corresponding dimensions, so that in these cases the shearing values govern the design.

The bearing values below and to the left of the lower zigzag black lines are less than single shear, so that in these cases the bearing values govern the design.

MAXIMUM BENDING MOMENTS ON PINS WITH EXTREME FIBRE STRESSES

VARYING FROM 15 000 TO 25 000 POUNDS PER SQUARE INCH.

Diameter of Pin in Inches.	Area of Pin in Square Inches.	Moments in Inch-Pounds for Fibre Stresses of				
		15 000 Lbs. per Square Inch.	18 000 Lbs. per Square Inch.	20 000 Lbs. per Square Inch.	22 500 Lbs. per Square Inch.	25 000 Lbs. per Square Inch.
1	.785	1470	1770	1960	2210	2450
1 1/8	.994	2100	2520	2800	3150	3490
1 1/4	1.227	2900	3450	3830	4310	4790
1 3/8	1.485	3830	4590	5100	5740	6380
1 1/2	1.767	4970	5960	6630	7460	8280
1 5/8	2.074	6320	7580	8430	9480	10530
1 3/4	2.405	7890	9470	10520	11840	13150
1 7/8	2.761	9710	11650	12940	14560	16180
2	3.142	11780	14140	15710	17670	19630
2 1/8	3.547	14130	16960	18840	21200	23550
2 1/4	3.976	16770	20130	22370	25160	27960
2 3/8	4.430	19730	23670	26300	29590	32880
2 1/2	4.909	23010	27610	30680	34510	38350
2 5/8	5.412	26640	31960	35520	39960	44400
2 3/4	5.940	30630	36750	40830	45940	51040
2 7/8	6.492	34990	41990	46660	52490	58320
3	7.069	39730	47680	52970	59600	66220
3 1/8	7.670	44940	53930	59920	67410	74900
3 1/4	8.296	50550	60660	67400	75830	84250
3 3/8	8.946	56610	67940	75480	84920	94350
3 1/2	9.621	63140	75770	84180	94710	105230
3 5/8	10.321	70150	84180	93530	105220	116910
3 3/4	11.045	77660	93190	103540	116490	129430
3 7/8	11.793	85690	102820	114250	128530	142810
4	12.566	94250	113100	125660	141370	157080
4 1/8	13.364	103360	124040	137820	155040	172270
4 1/4	14.186	113050	135660	150730	169570	188410
4 3/8	15.033	123320	147980	164420	184980	205530
4 1/2	15.904	134190	161030	178920	201290	223650
4 5/8	16.800	145690	174830	194250	218510	242810
4 3/4	17.721	157820	189390	210430	236740	263040
4 7/8	18.665	170580	204740	227490	255920	284360
5	19.635	184080	220890	245440	276120	306800
5 1/8	20.629	198230	237880	264310	297350	330390
5 1/4	21.648	213090	255710	284120	319640	355160
5 3/8	22.691	228680	274420	304910	343020	381130
5 1/2	23.758	245010	294010	326680	367510	408350
5 5/8	24.850	262100	314510	349460	393140	436830
5 3/4	25.967	279960	335950	373280	419940	466600
5 7/8	27.109	298620	358340	398160	447930	497700

MAXIMUM BENDING MOMENTS ON PINS WITH EXTREME FIBRE STRESSES

VARYING FROM 15 000 TO 25 000 POUNDS PER SQUARE INCH.

Diameter of Pin in Inches.	Area of Pin in Square Inches.	Moments in Inch-Pounds for Fibre Stresses of				
		15 000 Lbs. per Square Inch.	18 000 Lbs. per Square Inch.	20 000 Lbs. per Square Inch.	22 500 Lbs. per Square Inch.	25 000 Lbs. per Square Inch.
6	28.274	318090	381700	424120	477130	530140
6⅛	29.465	338380	406060	451180	507580	563970
6¼	30.680	359530	431430	479370	539290	599210
6⅜	31.919	381530	457840	508710	572300	635890
6½	33.183	404420	485400	539230	606630	674030
6⅝	34.472	428200	513840	570940	642300	713670
6¾	35.785	452900	543480	603870	679350	754830
6⅞	37.122	478530	574240	638040	717800	797550
7	38.485	505110	606130	673480	757660	841850
7⅛	39.871	532650	639190	710210	798980	887760
7¼	41.282	561180	673420	748250	841780	935310
7⅜	42.718	590710	708860	787620	886070	984520
7½	44.179	621260	745510	828350	931890	1035440
7⅝	45.664	652850	783410	870460	979270	1088080
7¾	47.173	685480	822580	913980	1028220	1142470
7⅞	48.707	719190	863030	958920	1078780	1198650
8	50.265	753980	904780	1005310	1130970	1256640
8⅛	51.849	789880	947860	1053170	1184820	1316470
8¼	53.456	826900	992280	1102530	1240350	1378170
8⅜	55.088	865060	1038070	1153410	1297590	1441760
8½	56.745	904370	1085250	1205830	1356560	1507290
8⅝	58.426	944860	1133830	1259820	1417290	1574770
8¾	60.132	986540	1183850	1315390	1479810	1644240
8⅞	61.862	1029430	1235310	1372570	1544140	1715710
9	63.617	1073540	1288250	1431390	1610310	1789240
9⅛	65.397	1118900	1342680	1491860	1678340	1864830
9¼	67.201	1165510	1398610	1554010	1748270	1942520
9⅜	69.029	1213400	1456080	1617870	1820100	2022340
9½	70.882	1262590	1515110	1683450	1893880	2104310
9⅝	72.760	1313090	1575700	1750780	1969630	2188480
9¾	74.662	1364910	1637900	1819880	2047370	2274850
9⅞	76.590	1418090	1701700	1890780	2127130	2363480
10	78.540	1472620	1767150	1963500	2208930	2454370
10¼	82.516	1585850	1903020	2114470	2378780	2643090
10½	86.590	1704740	2045690	2272990	2557120	2841240
10¾	90.763	1829430	2195320	2439250	2744150	3049060
11	95.033	1960060	2352070	2613410	2940090	3266770
11¼	99.402	2096760	2516110	2795680	3145140	3494600
11½	103.869	2239670	2687610	2986230	3359510	3732790
12	113.098	2544690	3053630	3392920	3817040	4241150

RIVETS.

TABLES OF AREAS IN SQUARE INCHES, TO BE DEDUCTED FROM RIVETED PLATES OR SHAPES TO OBTAIN NET AREAS.

Thickness Plates in Inches.	SIZE OF HOLE. Inches. $\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1	$1\frac{1}{16}$
$\frac{1}{4}$	.06	.08	.09	.11	.13	.14	.16	.17	.19	.20	.22	.23	.25	.27
$\frac{5}{16}$	.08	.10	.12	.14	.16	.18	.20	.21	.23	.25	.27	.29	.31	.33
$\frac{3}{8}$	.09	.12	.14	.16	.19	.21	.23	.26	.28	.30	.33	.35	.38	.40
$\frac{7}{16}$	.11	.14	.16	.19	.22	.25	.27	.30	.33	.36	.38	.41	.44	.46
$\frac{1}{2}$	.13	.16	.19	.22	.25	.28	.31	.34	.38	.41	.44	.47	.50	.53
$\frac{9}{16}$	.14	.18	.21	.25	.28	.32	.35	.39	.42	.46	.49	.53	.56	.60
$\frac{5}{8}$	.16	.20	.23	.27	.31	.35	.39	.43	.47	.51	.55	.59	.63	.66
$\frac{11}{16}$	.17	.21	.26	.30	.34	.39	.43	.47	.52	.56	.60	.64	.69	.73
$\frac{3}{4}$	.19	.23	.28	.33	.38	.42	.47	.52	.56	.61	.66	.70	.75	.80
$\frac{13}{16}$	.20	.25	.30	.36	.41	.46	.51	.56	.61	.66	.71	.76	.81	.86
$\frac{7}{8}$	.22	.27	.33	.38	.44	.49	.55	.60	.66	.71	.77	.82	.88	.93
$\frac{15}{16}$	.23	.29	.35	.41	.47	.53	.59	.64	.70	.76	.82	.88	.94	1.00
1	.25	.31	.38	.44	.50	.56	.63	.69	.75	.81	.88	.94	1.00	1.06
$1\frac{1}{16}$	.27	.33	.40	.46	.53	.60	.66	.73	.80	.86	.93	1.00	1.06	1.13
$1\frac{1}{8}$	.28	.35	.42	.49	.56	.63	.70	.77	.84	.91	.98	1.05	1.13	1.20
$1\frac{3}{16}$	.30	.37	.45	.52	.59	.67	.74	.82	.89	.96	1.04	1.11	1.19	1.26
$1\frac{1}{4}$	.31	.39	.47	.55	.63	.70	.78	.86	.94	1.02	1.09	1.17	1.25	1.33
$1\frac{5}{16}$	.33	.41	.49	.57	.66	.74	.82	.90	.98	1.07	1.15	1.23	1.31	1.39
$1\frac{3}{8}$	.34	.43	.52	.60	.69	.77	.86	.95	1.03	1.12	1.20	1.29	1.38	1.46
$1\frac{7}{16}$	.36	.45	.54	.63	.72	.81	.90	.99	1.08	1.17	1.26	1.35	1.44	1.53
$1\frac{1}{2}$	.38	.47	.56	.66	.75	.84	.94	1.03	1.13	1.22	1.31	1.41	1.50	1.59
$1\frac{9}{16}$	.39	.49	.59	.68	.78	.88	.98	1.07	1.17	1.27	1.37	1.46	1.56	1.66
$1\frac{5}{8}$	.41	.51	.61	.71	.81	.91	1.02	1.12	1.22	1.32	1.42	1.52	1.63	1.73
$1\frac{11}{16}$	.42	.53	.63	.74	.84	.95	1.05	1.16	1.27	1.37	1.47	1.58	1.69	1.79
$1\frac{3}{4}$	.44	.55	.66	.77	.88	.98	1.09	1.20	1.31	1.42	1.53	1.64	1.75	1.86
$1\frac{13}{16}$	.45	.57	.68	.79	.91	1.02	1.13	1.25	1.36	1.47	1.59	1.70	1.81	1.93
$1\frac{7}{8}$	.47	.59	.70	.82	.94	1.05	1.17	1.29	1.41	1.52	1.64	1.76	1.88	1.99
$1\frac{15}{16}$	.48	.61	.73	.85	.97	1.09	1.21	1.33	1.45	1.57	1.70	1.82	1.94	2.06
2	.50	.63	.75	.88	1.00	1.13	1.25	1.38	1.50	1.63	1.75	1.88	2.00	2.13

MAXIMUM SIZE OF RIVETS IN BEAMS, CHANNELS AND ANGLES.

I-BEAMS.						CHANNELS.			ANGLES.			
Depth of Beam. Inch's	Weight per Foot. Pounds.	Size of Rivet. Inches.	Depth of Beam Inchs	Weight per Foot. Pounds.	Size of Rivet. Inches.	Depth of Channel Inches.	Weight per Foot. Pounds.	Size of Rivet. Inches.	Len'th of Leg. Inches	Size of Rivet. Inches.	Len'th of Leg. Inches	Size of Rivet. Inch's
3	5.5	$\frac{3}{8}$	15	42.0	$\frac{3}{4}$	3	4.0	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{1}{4}$	$2\frac{1}{2}$	$\frac{3}{4}$
4	7.5	$\frac{1}{2}$	15	60.0	$\frac{3}{4}$	4	5.25	$\frac{1}{2}$	1	$\frac{3}{8}$	$2\frac{3}{4}$	$\frac{3}{4}$
5	9.75	$\frac{1}{2}$	15	80.0	$\frac{7}{8}$	5	6.50	$\frac{1}{2}$	$1\frac{1}{4}$	$\frac{1}{2}$	3	$\frac{7}{8}$
6	12.25	$\frac{5}{8}$	18	55.0	$\frac{7}{8}$	6	8.0	$\frac{5}{8}$	$1\frac{5}{16}$	$\frac{1}{2}$	$3\frac{1}{2}$	1
7	15.0	$\frac{5}{8}$	20	65.0	1	7	9.75	$\frac{5}{8}$	$1\frac{3}{8}$	$\frac{1}{2}$	4	1
8	17.75	$\frac{3}{4}$	20	80.0	1	8	11.25	$\frac{3}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$	$4\frac{1}{2}$	1
9	21.0	$\frac{3}{4}$	24	80.0	1	9	13.25	$\frac{3}{4}$	$1\frac{3}{4}$	$\frac{5}{8}$	5	1
10	25.0	$\frac{3}{4}$				10	15.0	$\frac{3}{4}$	2	$\frac{5}{8}$	$5\frac{5}{8}$	1
12	31.5	$\frac{3}{4}$				12	20.50	$\frac{3}{4}$	$2\frac{1}{4}$	$\frac{3}{4}$	6	1
12	40.0	$\frac{3}{4}$				15	33.0	$\frac{3}{4}$	$2\frac{5}{16}$	$\frac{3}{4}$		

RIVETS.

TABLES OF AREAS IN SQUARE INCHES, TO BE DEDUCTED FROM RIVETED PLATES OR SHAPES TO OBTAIN NET AREAS.

SIZE OF HOLE. Inches.															Thickness Plates. in inches.
1⅛	1 3/16	1¼	1 5/16	1⅜	1 7/16	1½	1 9/16	1⅝	1 11/16	1¾	1 13/16	1⅞	1 15/16	2	
.28	.30	.31	.33	.34	.36	.38	.39	.41	.42	.44	.45	.47	.48	.50	¼
.35	.37	.39	.41	.43	.45	.47	.49	.51	.53	.55	.57	.59	.61	.63	5/16
.42	.45	.47	.49	.52	.54	.56	.59	.61	.63	.66	.68	.70	.73	.75	⅜
.49	.52	.55	.57	.60	.63	.66	.68	.71	.74	.77	.79	.82	.85	.88	7/16
.56	.59	.63	.66	.69	.72	.75	.78	.81	.84	.88	.91	.94	.97	1.00	½
.63	.67	.70	.74	.77	.81	.84	.88	.91	.95	.98	1.02	1.05	1.09	1.13	9/16
.70	.74	.78	.82	.86	.90	.94	.98	1.02	1.05	1.09	1.13	1.17	1.21	1.25	⅝
.77	.82	.86	.90	.95	.99	1.03	1.07	1.12	1.16	1.20	1.25	1.29	1.33	1.38	11/16
.84	.89	.94	.98	1.03	1.08	1.13	1.17	1.22	1.27	1.31	1.36	1.41	1.45	1.50	¾
.91	.96	1.02	1.07	1.12	1.17	1.22	1.27	1.32	1.37	1.42	1.47	1.52	1.57	1.63	13/16
.98	1.04	1.09	1.15	1.20	1.26	1.31	1.37	1.42	1.48	1.53	1.59	1.64	1.70	1.75	⅞
1.05	1.11	1.17	1.23	1.29	1.35	1.41	1.46	1.52	1.58	1.64	1.70	1.76	1.82	1.88	15/16
1.13	1.19	1.25	1.31	1.38	1.44	1.50	1.56	1.63	1.69	1.75	1.81	1.88	1.94	2.00	1
1.20	1.26	1.33	1.39	1.46	1.53	1.59	1.66	1.73	1.79	1.86	1.93	1.99	2.06	2.13	1 1/16
1.27	1.34	1.41	1.48	1.55	1.62	1.69	1.76	1.83	1.90	1.97	2.04	2.11	2.18	2.25	1⅛
1.34	1.41	1.48	1.56	1.63	1.71	1.78	1.86	1.93	2.00	2.08	2.15	2.23	2.30	2.38	1 3/16
1.41	1.48	1.56	1.64	1.72	1.80	1.88	1.95	2.03	2.11	2.19	2.27	2.34	2.42	2.50	1¼
1.48	1.56	1.64	1.72	1.80	1.89	1.97	2.05	2.13	2.21	2.30	2.38	2.46	2.54	2.63	1 5/16
1.55	1.63	1.72	1.80	1.89	1.98	2.06	2.15	2.23	2.32	2.41	2.49	2.58	2.66	2.75	1⅜
1.62	1.71	1.80	1.89	1.98	2.07	2.16	2.25	2.34	2.43	2.52	2.61	2.70	2.79	2.88	1 7/16
1.69	1.78	1.88	1.97	2.06	2.16	2.25	2.34	2.44	2.53	2.63	2.72	2.81	2.91	3.00	1½
1.76	1.86	1.95	2.05	2.15	2.25	2.34	2.44	2.54	2.64	2.73	2.83	2.93	3.03	3.13	1 9/16
1.83	1.93	2.03	2.13	2.23	2.34	2.44	2.54	2.64	2.74	2.84	2.95	3.05	3.15	3.25	1⅝
1.90	2.00	2.11	2.21	2.32	2.43	2.53	2.64	2.74	2.85	2.95	3.06	3.16	3.27	3.38	1 11/16
1.97	2.08	2.19	2.30	2.41	2.52	2.63	2.73	2.84	2.95	3.06	3.17	3.28	3.39	3.50	1¾
2.04	2.15	2.27	2.38	2.49	2.61	2.72	2.83	2.95	3.06	3.17	3.29	3.40	3.51	3.63	1 13/16
2.11	2.23	2.34	2.46	2.58	2.70	2.81	2.93	3.05	3.16	3.28	3.40	3.52	3.63	3.75	1⅞
2.18	2.30	2.42	2.54	2.66	2.79	2.91	3.03	3.15	3.27	3.39	3.51	3.63	3.75	3.88	1 15/16
2.25	2.38	2.50	2.63	2.75	2.88	3.00	3.13	3.25	3.38	3.50	3.63	3.75	3.88	4.00	2

RIVET SPACING.

ALL DIMENSIONS IN INCHES.

Size of Rivet.	Minimum Pitch.	Maximum Pitch at Ends of Compression Members.	Minimum Pitch in Flanges of Chords and Gird's.	Distance from Edge of Piece to Center of Rivet Hole.	
				Minimum.	Usual.
¼	¾	. . .	. . .	. .	. .
⅜	1⅛	. . .	. . .	. .	. .
½	1½	. . .	. . .	. .	. .
⅝	1⅞	2½	4	15/16	1¼
¾	2¼	3	4	1⅛	1½
⅞	2⅝	3½	4	1 5/16	1¾
1	3	4	4	1½	2

For General Rules for Rivet Spacing see next page.

GENERAL RULES FOR RIVET SPACING FOR BRIDGE AND STRUCTURAL WORK.

The pitch or distance from center to center of rivets should not be less than 3 diameters of the rivet. In bridge work the pitch should not exceed 6 inches or 16 times the thickness of the thinnest outside plates except in special cases hereafter noted. In the flanges of beams and girders where plates more than 12 inches wide are used, an extra line of rivets with a pitch not greater than 9 inches should be driven along each edge to draw the plates together.

At the ends of compression members the pitch should not exceed 4 diameters of the rivet for a length equal to twice the width or diameter of the member.

In the flanges of girders and chords carrying floors, the pitch should not exceed 4 inches.

For plates in compression the pitch in the direction of the line of stress should not exceed 16 times the thickness of the plate, and the pitch in a direction at right angles to the line of stress should not exceed 32 times the thickness, except for cover plates of top chords and end posts in which the pitch should not exceed 40 times their thickness.

The distance between the edge of any piece and the center of the rivet hole should not be less than $1\frac{1}{4}$ inches for $\frac{3}{4}$ inch and $\frac{7}{8}$ inch rivets except in bars less than $2\frac{1}{2}$ inches wide; when practicable it should, for all sizes, be at least 2 diameters of the rivet and should not exceed 8 times the thickness of the plate.

Minimum spacing is generally used in pin plates at ends of columns, girders, etc., etc.

In figuring clearance of rivets for special cases, allow $\frac{3}{8}$ inch in addition to diameter of head.

BEARING VALUES OF PIN PLATES.

FOR ONE INCH THICKNESS OF PLATE.

Bearing value = Diameter of Pin × 1″ × Stress per Square Inch.

Diameter of Pin.	Area of Pin.	Bearing Value at 12 000 Pounds per Square Inch.	Bearing Value at 13 500 Pounds per Square Inch.	Bearing Value at 15 000 Pounds per Square Inch.	Diameter of Pin.	Area of Pin.	Bearing Value at 12 000 Pounds per Square Inch.	Bearing Value at 13 500 Pounds per Square Inch.	Bearing Value at 15 000 Pounds per Square Inch.
Inches.	Sq. In.	Pounds.	Pounds.	Pounds.	Inches.	Sq. In.	Pounds.	Pounds.	Pounds.
1	.785	12000	13500	15000	4½	15.90	54000	60750	67500
1⅛	.994	13500	15190	16880	4⅝	16.80	55500	62440	69380
1¼	1.227	15000	16880	18750	4¾	17.72	57000	64130	71250
1⅜	1.485	16500	18560	20630	4⅞	18.67	58500	65810	73130
1½	1.767	18000	20250	22500	5	19.64	60000	67500	75000
1⅝	2.074	19500	21940	24380	5⅛	20.63	61500	69190	76880
1¾	2.405	21000	23630	26250	5¼	21.65	63000	70880	78750
1⅞	2.761	22500	25310	28130	5⅜	22.69	64500	72560	80630
2	3.142	24000	27000	30000	5½	23.76	66000	74250	82500
2⅛	3.547	25500	28690	31880	5⅝	24.85	67500	75940	84380
2¼	3.976	27000	30380	33750	5¾	25.97	69000	77630	86250
2⅜	4.430	28500	32060	35630	5⅞	27.11	70500	79310	88130
2½	4.909	30000	33750	37500	6	28.27	72000	81000	90000
2⅝	5.412	31500	35440	39380	6⅛	29.46	73500	82690	91880
2¾	5.940	33000	37130	41250	6¼	30.68	75000	84380	93750
2⅞	6.492	34500	38810	43130	6⅜	31.92	76500	86060	95630
3	7.069	36000	40500	45000	6½	33.18	78000	87750	97500
3⅛	7.670	37500	42190	46880	6⅝	34.47	79500	89440	99380
3¼	8.296	39000	43880	48750	6¾	35.79	81000	91130	101250
3⅜	8.946	40500	45560	50630	6⅞	37.12	82500	92810	103130
3½	9.621	42000	47250	52500	7	38.48	84000	94500	105000
3⅝	10.32	43500	48940	54380	7½	44.18	90000	101250	112500
3¾	11.05	45000	50630	56250	8	50.27	96000	108000	120000
3⅞	11.79	46500	52310	58130	8½	56.75	102000	114750	127500
4	12.57	48000	54000	60000	9	63.62	108000	121500	135000
4⅛	13.36	49500	55690	61880	10	78.54	120000	135000	150000
4¼	14.19	51000	57380	63750	11	95.03	132000	148500	165000
4⅜	15.03	52500	59060	65630	12	113.10	144000	162000	180000

EXAMPLE.—The stress in the end post of a bridge is 250 000 pounds and the diameter of the pin is 5⅝″. Required the total thickness of steel pin plates for a bearing value of 15 000 pounds per square inch.

From the table the bearing value of a 5⅝″ pin in a 1″ plate for 15 000 pounds unit stress is 84 375 pounds. Therefore the total thickness of metal required is $\frac{250\,000}{84\,380} = 2.97''$.

The nearest commercial size would therefore be 1½″ on each side, including web and necessary reinforcing plates.

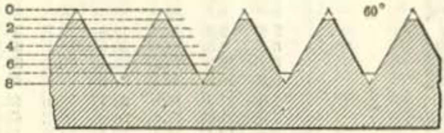
DIMENSIONS OF BOLTS AND NUTS.

FRANKLIN INSTITUTE STANDARD.

Bolts and Threads.						Rough Nuts and Heads.				
Diameter of Bolt.	Threads per Inch.	Diameter at Root of Thread.	Width of Flat.	Area of Bolt Body.	Area of Bolt at Root of Thread.	Short Diameter of Square and Hexagon.	Long Diameter of Square.	Long Diameter of Hexagon.	Thickness of Nuts.	Thickness of Heads.
Ins.	No.	Ins.	Ins.	Sq. Ins.	Sq. Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
1/4	20	.185	.0062	.049	.027	1/2	.707	.577	1/4	1/4
5/16	18	.240	.0070	.077	.045	19/32	.840	.686	5/16	19/64
3/8	16	.294	.0078	.110	.068	11/16	.972	.794	3/8	11/32
7/16	14	.344	.0089	.150	.093	25/32	1.105	.902	7/16	25/64
1/2	13	.400	.0096	.196	.126	7/8	1.238	1.010	1/2	7/16
9/16	12	.454	.0104	.249	.162	31/32	1.370	1.119	9/16	31/64
5/8	11	.507	.0113	.307	.202	1 1/16	1.503	1.227	5/8	17/32
3/4	10	.620	.0125	.442	.302	1 1/4	1.768	1.443	3/4	5/8
7/8	9	.731	.0140	.601	.420	1 7/16	2.033	1.660	7/8	23/32
1	8	.837	.0156	.785	.550	1 5/8	2.298	1.876	1	13/16
1 1/8	7	.940	.0180	.994	.694	1 13/16	2.563	2.093	1 1/8	29/32
1 1/4	7	1.065	.0180	1.227	.893	2	2.829	2.309	1 1/4	1
1 3/8	6	1.160	.0210	1.485	1.057	2 3/16	3.094	2.526	1 3/8	1 3/32
1 1/2	6	1.284	.0210	1.767	1.295	2 3/8	3.359	2.742	1 1/2	1 3/16
1 5/8	5 1/2	1.389	.0227	2.074	1.515	2 9/16	3.624	2.959	1 5/8	1 9/32
1 3/4	5	1.490	.0250	2.405	1.744	2 3/4	3.889	3.175	1 3/4	1 3/8
1 7/8	5	1.615	.0250	2.761	2.048	2 15/16	4.154	3.392	1 7/8	1 15/32
2	4 1/2	1.712	.0280	3.142	2.302	3 1/8	4.420	3.608	2	1 9/16
2 1/4	4 1/2	1.962	.0280	3.976	3.023	3 1/2	4.950	4.042	2 1/4	1 3/4
2 1/2	4	2.175	.0310	4.909	3.715	3 7/8	5.480	4.475	2 1/2	1 15/16
2 3/4	4	2.425	.0310	5.940	4.619	4 1/4	6.011	4.908	2 3/4	2 1/8
3	3 1/2	2.629	.0357	7.069	5.428	4 5/8	6.541	5.341	3	2 5/16
3 1/4	3 1/2	2.879	.0357	8.296	6.510	5	7.071	5.774	3 1/4	2 1/2
3 1/2	3 1/4	3.100	.0384	9.621	7.548	5 3/8	7.602	6.207	3 1/2	2 11/16
3 3/4	3	3.317	.0410	11.045	8.641	5 3/4	8.132	6.640	3 3/4	2 7/8
4	3	3.567	.0410	12.566	9.993	6 1/8	8.662	7.073	4	3 1/16
4 1/4	2 7/8	3.798	.0435	14.186	11.329	6 1/2	9.193	7.506	4 1/4	3 1/4
4 1/2	2 3/4	4.028	.0460	15.904	12.743	6 7/8	9.723	7.939	4 1/2	3 7/16
4 3/4	2 5/8	4.255	.0480	17.721	14.220	7 1/4	10.253	8.372	4 3/4	3 5/8
5	2 1/2	4.480	.0500	19.635	15.763	7 5/8	10.784	8.805	5	3 13/16
5 1/4	2 1/2	4.730	.0500	21.648	17.572	8	11.314	9.238	5 1/4	4
5 1/2	2 3/8	4.953	.0526	23.758	19.267	8 3/8	11.844	9.671	5 1/2	4 3/16
5 3/4	2 3/8	5.203	.0526	25.967	21.262	8 3/4	12.375	10.104	5 3/4	4 3/8
6	2 1/4	5.423	.0555	28.274	23.098	9 1/8	12.905	10.537	6	4 9/16

RULES FOR PROPORTIONS OF BOLTS AND NUTS.

FRANKLIN INSTITUTE STANDARD.



The dimensions of nuts and bolts are determined by the following rules, which apply to both square and hexagon.

Short diameter of rough nut $= 1\frac{1}{2} \times$ diameter of bolt $+ \frac{1}{8}$ in.

Short diameter of finished nut $= 1\frac{1}{2} \times$ diameter of bolt $+ \frac{1}{16}$ in.

Thickness of rough nut = diameter of bolt.

Thickness of finished nut = diameter of bolt $- \frac{1}{16}$ in.

Short diameter of rough head $= 1\frac{1}{2} \times$ diameter of bolt $+ \frac{1}{8}$ in.

Short diameter of finished head $= 1\frac{1}{2} \times$ diameter of bolt $+ \frac{1}{16}$ in.

Thickness of rough head $= \frac{1}{2}$ of short diameter of head.

Thickness of finished head = diameter of bolt $- \frac{1}{16}$ in.

In 1864, a committee of the Franklin Institute recommended the above system of screw threads and bolts which was devised by Mr. William Sellers, of Philadelphia. This system as far as it relates to screw threads is generally used in the United States, but the proportions of bolt heads and nuts are not adhered to because the sizes of bar required to make the nuts are special and extra work is necessary to make the bolt heads. Sizes of nuts and bolt heads in accordance with the *Manufacturers' Standard* are given on following pages, Nos. 211, 212, and 213.

WEIGHTS OF 100 MACHINE BOLTS WITH SQUARE HEADS AND HEXAGON NUTS.

FRANKLIN INSTITUTE STANDARD SIZES.

Basis — 1 cubic foot Iron = 480 pounds.

Length under Head to Point. Inches.	Diameter of Bolts in Inches. $\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$
1½	4.9	8.2	12.2	17.5	24.0	31.8	41.1
1¾	5.3	8.7	13.0	18.5	25.3	33.5	43.2
2	5.6	9.2	13.8	19.6	26.7	35.2	45.3
2¼	6.0	9.8	14.5	20 6	28.1	37.0	47.5
2½	6.3	10.3	15.3	21.6	29.4	38.7	49.6
2¾	6.6	10.8	16.1	22.7	30.8	40.4	51.7
3	7.0	11.4	16.8	23.7	32.1	42.1	53.9
3¼	7.3	11.9	17.6	24.8	33.5	43.9	56.0
3½	7.7	12.4	18.4	25.8	34.9	45.6	58.1
3¾	8.0	13.0	19.1	26.9	36.2	47.3	60.3
4	8.3	13.5	19.9	27.9	37.6	49.0	62.4
4½	9.0	14.6	21.4	30.0	40.3	52.5	66.6
5	9.7	15.6	23.0	32.1	43.0	55.9	70.9
5½	10.4	16.7	24.5	34.2	45.8	59.4	75.2
6	11.1	17.8	26.0	36.2	48.5	62.8	79.4
6½	11.7	18.8	27.6	38.3	51.2	66.3	83.7
7	12.4	19.9	29.1	40.4	53.9	69.7	87.9
7½	13.1	21.0	30.6	42.5	56.7	73.2	92.2
8	13.8	22.0	32.2	44.6	59.4	76.6	96.5
8½	14.5	23.1	33.7	46.7	62.1	80.1	100.7
9	15.1	24.2	35.3	48.8	64.8	83.5	105.0
9½	15.8	25.2	36.8	50.8	67.6	87.0	109.2
10	16.5	26.3	38.3	52.9	70.3	90.4	113.5
10½	17.2	27.4	39.9	55.0	73.0	93.9	117.8
11	17.9	28.4	41.4	57.1	75.7	97.3	122.0
11½	18.5	29.5	42.9	59.2	78.5	100.8	126.3
12	. . .	30.5	44.5	61.3	81.2	104.2	130.5
12½	. . .	31.6	46.0	63.3	83.9	107.7	134.8
13	. . .	32.7	47.5	65.4	86.6	111.1	139.1
13½	. . .	33.7	49.1	67.5	89.4	114.6	143.3
14	. . .	. . .	50.6	69.6	92.1	118.0	147.6
14½	. . .	. . .	52.1	71.7	94.8	121.5	151.8
15	. . .	. . .	53.7	73.8	97.5	124.9	156.1
15½	. . .	. . .	55.2	75.9	100.3	128.4	160.4
16	. . .	. . .	. . .	77.9	103.0	131.8	164.6
16½	. . .	. . .	. . .	80.0	105.7	135.3	168.9
17	. . .	. . .	. . .	82.1	108.4	138.7	173.1
17½	. . .	. . .	. . .	84.2	111.2	142.2	177.4
18	. . .	. . .	. . .	. . .	113.9	145.6	181.7
18½	. . .	. . .	. . .	. . .	116.6	149.1	185.9
19	. . .	. . .	. . .	. . .	119.3	152.5	190.2
19½	. . .	. . .	. . .	. . .	122.1	156.0	194.4
20	. . .	. . .	. . .	. . .	124.8	159.4	198.7
One inch in length of 100 Bolts.	1.36	2.13	3.07	4.18	5.45	6.90	8.52
To obtain Weights with Square Nuts per 100: Add.	.23	.41	.66	.99	1.42	1.96	2.62
Weight of one Hexagon Nut.	.0116	.020	.031	.046	.065	.088	.117
Weight of one Hexagon Head.	.0150	.025	.039	.057	.081	.109	.144
Weight of one Square Nut.	.0139	.024	.038	.056	.079	.108	.143
Weight of one Square Head.	.0173	.029	.045	.066	.093	.126	.167

All weights are approximate.

WEIGHTS OF 100 MACHINE BOLTS WITH SQUARE HEADS AND HEXAGON NUTS.

FRANKLIN INSTITUTE STANDARD SIZES.

Basis — 1 cubic foot Iron = 480 pounds.

Length under Head to Point.	Diameter of Bolts in Inches.						
Inches.	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$
1½	64.5	95.2	134	182	240	309	390
1¾	67.6	99.4	140	189	248	319	402
2	70.6	103.5	145	196	257	329	414
2¼	73.7	107.7	150	203	265	340	426
2½	76.8	111.9	156	210	274	350	439
2¾	79.8	116.1	161	216	282	360	451
3	82.9	120.2	167	223	291	371	463
3¼	86.0	124.4	172	230	300	381	475
3½	89.1	128.6	178	237	308	391	488
3¾	92.1	132.8	183	244	317	402	500
4	95.2	136.9	189	251	325	412	512
4½	101.3	145.3	199	265	342	432	537
5	107.4	153.6	210	279	359	453	561
5½	113.6	162.0	221	292	376	474	586
6	119.7	170.3	232	306	393	494	610
6½	125.9	178.7	243	320	410	515	635
7	132.0	187.0	254	334	427	536	659
7½	138.1	195.4	265	348	444	556	684
8	144 3	203.7	276	361	461	577	709
8½	150.4	212.1	287	375	478	597	733
9	156.5	220.4	298	389	495	618	758
9½	162 7	228.8	308	402	513	639	782
10	168.8	237.1	319	417	530	659	807
10½	174.9	245.5	330	430	547	680	831
11	181.1	253.8	341	444	564	701	856
11½	187.2	262.2	352	458	581	721	880
12	193.3	270.5	363	472	598	742	905
12½	199.5	278.9	374	486	615	762	929
13	205 6	287.2	385	499	632	783	954
13½	211.7	295.6	396	513	649	804	978
14	217.9	303.9	407	527	666	824	1003
14½	224.0	312.3	417	541	683	845	1027
15	230.1	320.6	428	555	700	866	1052
15½	236.3	329.0	439	568	717	886	1077
16	242.4	337.3	450	582	734	907	1101
16½	248.5	345.7	461	596	751	927	1126
17	254.7	354.0	472	610	768	948	1150
17½	260.8	362.4	483	624	785	969	1175
18	266.9	370.7	494	637	802	989	1199
18½	273.1	379.1	505	651	819	1010	1224
19	279.2	387.4	516	665	836	1031	1248
19½	285.3	395.8	526	679	853	1051	1273
20	291.5	404.1	537	693	870	1072	1297
One inch in length of 100 Bolts.	12.27	16.70	21.82	27.61	34.09	41.25	49.09
To obtain Weights with Square Nuts per 100: Add .	4.35	6.72	9.81	13.73	18.57	24.42	31.42
Weight of one Hexagon Nut .	.190	.289	.417	.579	.777	1.016	1.299
Weight of one Hexagon Head.	.235	.357	.516	.616	.962	1.259	1.611
Weight of one Square Nut . .	.234	.356	.515	.716	.963	1.260	1.614
Weight of one Square Head . .	.271	.412	.596	.827	1.111	1.453	1.860

All weights are approximate.

WEIGHTS OF 100 MACHINE BOLTS WITH SQUARE HEADS AND NUTS.

WROUGHT IRON.

MANUFACTURERS' STANDARD SIZES.

Basis — Hoopes & Townsend's List.

Length under Head to Point.	Diameter of Bolt in Inches.							
Inches.	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{3}{4}$
$1\frac{1}{2}$	3.9	6.2	9.7	14.7	20.4	26.0	37.0	58.0
2	4.6	7.2	11.3	16.5	22.4	29.0	39.9	63.2
$2\frac{1}{2}$	5.4	8.2	12.9	18.5	25.0	32.2	44.1	69.0
3	6.2	9.3	14.5	20.5	27.8	35.4	48.3	75.2
$3\frac{1}{2}$	6.9	10.4	16.1	22.6	30.6	38.7	52.5	81.4
4	7.6	11.5	17.7	24.7	33.4	42.0	56.7	87.6
$4\frac{1}{2}$	8.3	12.6	19.2	26.8	36.2	45.3	60.9	93.8
5	9.0	13.7	20.7	28.9	39.0	48.6	65.1	100.0
$5\frac{1}{2}$	9.7	14.8	22.2	31.0	41.8	51.9	69.2	106.1
6	10.4	15.9	23.7	33.1	44.6	55.2	73.4	112.2
$6\frac{1}{2}$	11.1	17.0	25.2	35.2	47.4	58.5	77.6	118.3
7	11.8	18.1	26.7	37.3	50.2	61.8	81.8	124.4
$7\frac{1}{2}$	12.5	19.2	28.2	39.4	53.1	65.1	86.0	130.5
8	13.2	20.3	29.7	41.5	56.0	68.5	90.0	136.6
9	14.6	22.5	33.1	45.7	61.5	75.2	98.0	148.8
10	. . .	. . .	36.5	49.9	67.0	81.9	106.3	161.0
11	. . .	. . .	40.0	54.1	72.5	88.7	114.6	173.2
12	. . .	. . .	43.5	58.3	78.0	95.5	122.9	184.4
13	. . .	. . .	47.0	61.5	83.5	102.3	131.2	196.6
14	. . .	. . .	. . .	. . .	89.0	109.1	139.5	208.8
15	. . .	. . .	. . .	. . .	94.5	116.0	148.0	221.0
16	. . .	. . .	. . .	. . .	100.0	123.0	156.5	233.2
17	. . .	. . .	. . .	. . .	105.5	130.0	165.0	245.4
18	. . .	. . .	. . .	. . .	111.0	137.0	173.5	257.6
19	. . .	. . .	. . .	. . .	116.5	144.0	182.0	269.8
20	. . .	. . .	. . .	. . .	122.0	151.0	190.5	282.0
21	. . .	. . .	. . .	. . .	127.5	158.0	198.0	294.0
22	. . .	. . .	. . .	. . .	. . .	. . .	206.0	306.0
23	. . .	. . .	. . .	. . .	. . .	. . .	215.0	318.0
24	. . .	. . .	. . .	. . .	. . .	. . .	224.0	330.0
25	. . .	. . .	. . .	. . .	. . .	. . .	233.0	342.0

WEIGHTS OF 100 MACHINE BOLTS WITH SQUARE HEADS AND NUTS.

WROUGHT IRON.

MANUFACTURERS' STANDARD SIZES.

Basis — Hoopes & Townsend's List.

Length under Head to Point.	Diameter of Bolt in Inches.							
Inches.	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2
	...	...	...	...	...	...	...	...
2	98	145	...	...	...	...	...	...
2½	106	153	...	...	...	...	...	...
3	114	163	240	309	350	480	...	...
3½	122	174	253	325	370	500	...	...
4	130	185	267	342	390	520	800	...
4½	138	196	281	359	410	545	833	...
5	147	207	295	376	430	570	866	1370
5½	155	218	309	394	450	595	900	1414
6	163	229	323	412	470	620	934	1458
6½	172	240	337	430	490	645	968	1502
7	180	251	351	448	510	670	1002	1546
7½	187	262	365	466	530	695	1036	1590
8	195	273	379	484	550	725	1070	1634
9	212	295	407	518	590	775	1138	1722
10	229	317	435	552	630	825	1206	1810
11	246	339	463	586	670	875	1274	1898
12	263	361	491	620	710	925	1342	1986
13	280	383	519	655	751	975	1410	2074
14	297	405	547	690	793	1025	1478	2162
15	314	427	575	725	835	1075	1548	2250
16	331	449	603	760	877	1125	1616	2338
17	348	471	631	795	919	1175	1684	2426
18	365	493	659	830	961	1225	1752	2514
19	382	515	687	865	1003	1275	1820	2602
20	399	537	715	900	1045	1325	1888	2690
21	416	559	743	935	1087	1375	1956	2778
22	437	581	771	970	1129	1425	2024	2866
23	454	603	799	1005	1171	1475	2092	2954
24	470	625	827	1040	1213	1525	2160	3042
25	487	647	855	1075	1255	1575	2228	3130

Bolts from 1⅛ inches to 2 inches, inclusive, are fitted with nuts made to U. S. Standard.

WEIGHTS OF ROUND HEADED RIVETS AND ROUND-HEADED BOLTS WITHOUT NUTS.

WROUGHT IRON.

Basis — 1 cubic foot Iron = 480 pounds.

Length under Head to Point.	Diameter of Rivet in Inches.						
Inches.	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$
1	4.7	9.3	16.0	25.2	37.2	52.6	71.3
$1\frac{1}{4}$	5.5	10.7	18.1	28.3	41.3	58.0	78.2
$1\frac{1}{2}$	6.2	12.1	20.2	31.3	45.5	63.5	85.1
$1\frac{3}{4}$	7.0	13.4	22.4	34.4	49.7	68.9	92.0
2	7.8	14.8	24.5	37.5	53.9	74.4	98.9
$2\frac{1}{4}$	8.5	16.2	26.6	40.5	58.0	79.8	105.8
$2\frac{1}{2}$	9.3	17.5	28.8	43.6	62.2	85.3	112.7
$2\frac{3}{4}$	10.1	18.9	30.9	46.7	66.4	90.7	119.6
3	10.8	20.3	33.0	49.8	70.6	96.2	126.5
$3\frac{1}{4}$	11.6	21.6	35.1	52.8	74.7	101.6	133.4
$3\frac{1}{2}$	12.4	23.0	37.3	55.9	78.9	107.1	140.3
$3\frac{3}{4}$	13.1	24.3	39.4	59.0	83.1	112.6	147.2
4	13.9	25.7	41.5	62.0	87.3	118.0	154.1
$4\frac{1}{4}$	14.7	27.1	43.7	65.1	91.4	123.5	161.0
$4\frac{1}{2}$	15.4	28.4	45.8	68.2	95.6	128.9	167.9
$4\frac{3}{4}$	16.2	29.8	47.9	71.2	99.8	134.4	174.8
5	17.0	31.2	50.1	74.3	104.0	139.8	181.7
$5\frac{1}{4}$	17.7	32.5	52.2	77.4	108.2	145.3	188.6
$5\frac{1}{2}$	18.5	33.9	54.3	80.4	112.3	150.7	195.6
$5\frac{3}{4}$	19.3	35.3	56.4	83.5	116.5	156.2	202.5
6	20.0	36.6	58.6	86.6	120.7	161.6	209.4
$6\frac{1}{4}$	20.8	38.0	60.7	89.6	124.8	167.1	216.3
$6\frac{1}{2}$	21.6	39.3	62.8	92.7	129.0	172.5	223.2
$6\frac{3}{4}$	22.3	40.7	65.0	95.8	133.2	178.0	230.1
7	23.1	42.1	67.1	98.8	137.4	183.5	237.0
$7\frac{1}{4}$	23.9	43.4	69.2	101.9	141.6	188.9	243.9
$7\frac{1}{2}$	24.6	44.8	71.4	105.0	145.7	194.4	250.8
$7\frac{3}{4}$	25.4	46.2	73.5	108.0	149.9	199.8	257.7
8	26.2	47.5	75.6	111.1	154.1	205.3	264.6
$8\frac{1}{2}$	27.7	50.2	79.9	117.2	162.4	216.2	278.4
9	29.2	53.0	84.1	123.4	170.8	227.1	292.2
$9\frac{1}{2}$	30.8	55.7	88.4	129.5	179.1	238.0	306.0
10	32.3	58.4	92.7	135.6	187.5	248.8	319.8
$10\frac{1}{2}$	33.8	61.2	96.9	141.8	195.8	259.8	333.6
11	35.4	63.9	101.2	147.9	204.2	270.7	347.4
$11\frac{1}{2}$	36.9	66.6	105.4	154.1	212.5	281.6	361.2
12	38.4	69.3	109.7	160.2	220.9	292.5	375.0
One inch in length of 100 Rivets	3.07	5.45	8.52	12.27	16.70	21.82	27.61
Weight of 100 Rivet Heads . .	1.78	4.82	9.95	16.12	24.29	34.77	47.67

WEIGHTS AND DIMENSIONS OF BOLT HEADS.

MANUFACTURERS' STANDARD SIZES.

BASIS—HOOPES & TOWNSEND'S LIST.

Diameter of Bolt.	Square.				Hexagon.			
	Short Diameter.	Long Diameter.	Thickness.	Weight per 100.	Short Diameter.	Long Diameter.	Thickness.	Weight per 100.
Inches.	Inches.	Inches.	Inches.	Pounds.	Inches.	Inches.	Inches.	Pounds.
$\frac{1}{4}$	$\frac{7}{16}$	.619	$\frac{3}{16}$	1.0	$\frac{7}{16}$	.505	$\frac{3}{16}$	.9
$\frac{5}{16}$	$\frac{1}{2}$	.707	$\frac{1}{4}$	1.7	$\frac{1}{2}$	.578	$\frac{1}{4}$	1.5
$\frac{3}{8}$	$\frac{19}{32}$	.840	$\frac{9}{32}$	2.8	$\frac{19}{32}$	.686	$\frac{9}{32}$	2.4
$\frac{7}{16}$	$\frac{11}{16}$	.972	$\frac{3}{8}$	4.9	$\frac{11}{16}$	.794	$\frac{3}{8}$	4.3
$\frac{1}{2}$	$\frac{3}{4}$	1.061	$\frac{7}{16}$	6.8	$\frac{3}{4}$	.866	$\frac{7}{16}$	5.9
$\frac{9}{16}$	$\frac{27}{32}$	1.193	$\frac{1}{2}$	9.9	$\frac{27}{32}$	.974	$\frac{1}{2}$	8.6
$\frac{5}{8}$	$\frac{15}{16}$	1.326	$\frac{17}{32}$	13.0	$\frac{15}{16}$	1.083	$\frac{17}{32}$	11.2
$\frac{3}{4}$	$1\frac{1}{8}$	1.591	$\frac{5}{8}$	22.0	$1\frac{1}{8}$	1.299	$\frac{5}{8}$	19.0
$\frac{7}{8}$	$1\frac{5}{16}$	1.856	$\frac{3}{4}$	34.8	$1\frac{5}{16}$	1.516	$\frac{3}{4}$	33.1
1	$1\frac{1}{2}$	2.122	$\frac{7}{8}$	54.7	$1\frac{1}{2}$	1.733	$\frac{7}{8}$	47.4
$1\frac{1}{8}$	$1\frac{5}{8}$	2.298	1	73.3	$1\frac{5}{8}$	1.877	1	63.5
$1\frac{1}{4}$	$1\frac{3}{4}$	2.475	$1\frac{1}{8}$	95.7	$1\frac{3}{4}$	2.021	$1\frac{1}{8}$	82.9
$1\frac{3}{8}$	$2\frac{1}{8}$	3.006	$1\frac{1}{4}$	156.8	2	2.309	$1\frac{3}{8}$	132.3
$1\frac{1}{2}$	$2\frac{3}{8}$	3.359	$1\frac{3}{8}$	215.4	$2\frac{3}{8}$	2.743	$1\frac{1}{2}$	203.5
$1\frac{5}{8}$	$2\frac{1}{2}$	3.536	$1\frac{1}{2}$	260.3	$2\frac{1}{2}$	2.888	$1\frac{5}{8}$	244.4
$1\frac{3}{4}$	$2\frac{3}{4}$	3.889	$1\frac{5}{8}$	341.3	$2\frac{3}{4}$	3.176	$1\frac{3}{4}$	318.4
$1\frac{7}{8}$	3	4.243	$1\frac{3}{4}$	437.4	3	3.464	$1\frac{7}{8}$	408.2
2	$3\frac{1}{8}$	4.420	$1\frac{7}{8}$	508.5	$3\frac{1}{8}$	3.610	2	469.9

WEIGHTS AND DIMENSIONS OF HEXAGON NUTS.

MANUFACTURERS' STANDARD SIZES.

BASIS—HOOPES & TOWNSEND'S LIST.

Diameter of Bolt.	Short Diameter.	Long Diameter.	Thickness.	Diameter of Rough Hole.	Plain. Weight per 100.	Plain. Number in 100.	Cupped. Weight per 100.	Cupped. Number in 100.
Inches.	Inches.	Inches.	Inches.	Inches.	Pounds.	Pounds.	Pounds.	Pounds.
$\frac{1}{4}$	$\frac{1}{2}$	.578	$\frac{1}{4}$	$\frac{7}{32}$	1.3	7800	1.2	8500
$\frac{5}{16}$	$\frac{5}{8}$	.722	$\frac{5}{16}$	$\frac{9}{32}$	2.3	4440	2.1	4790
$\frac{3}{8}$	$\frac{3}{4}$	.866	$\frac{3}{8}$	$\frac{11}{32}$	4.3	2330	4.0	2510
$\frac{7}{16}$	$\frac{7}{8}$	1.011	$\frac{7}{16}$	$\frac{13}{32}$	7.0	1430	6.3	1580
$\frac{1}{2}$	$\frac{7}{8}$	1.011	$\frac{1}{2}$	$\frac{7}{16}$	7.5	1330	6.9	1440
$\frac{1}{2}$	1	1.155	$\frac{1}{2}$	$\frac{7}{16}$	9.9	1010	9.2	1090
$\frac{1}{2}$	1	1.155	$\frac{9}{16}$	$\frac{7}{16}$	10.8	930	10.2	980
$\frac{9}{16}$	$1\frac{1}{8}$	1.299	$\frac{9}{16}$	$\frac{1}{2}$	13.7	730	12.5	800
$\frac{5}{8}$	$1\frac{1}{8}$	1.299	$\frac{5}{8}$	$\frac{9}{16}$	15.9	630	15.2	660
$\frac{5}{8}$	$1\frac{1}{8}$	1.299	$\frac{3}{4}$	$\frac{9}{16}$	17.9	560	17.0	588
$\frac{5}{8}$	$1\frac{1}{4}$	1.444	$\frac{5}{8}$	$\frac{9}{16}$	19.5	514	18.5	541
$\frac{5}{8}$	$1\frac{1}{4}$	1.444	$\frac{3}{4}$	$\frac{9}{16}$	23.0	435	21.7	460
$\frac{3}{4}$	$1\frac{1}{4}$	1.444	$\frac{3}{4}$	$\frac{21}{32}$	22.2	450	20.6	485
$\frac{3}{4}$	$1\frac{3}{8}$	1.588	$\frac{3}{4}$	$\frac{21}{32}$	26.6	376	25.4	394
$\frac{3}{4}$	$1\frac{3}{8}$	1.588	$\frac{7}{8}$	$\frac{21}{32}$	30.3	330	28.8	347
$\frac{3}{4}$	$1\frac{1}{2}$	1.733	$\frac{3}{4}$	$\frac{21}{32}$	34.5	290	32.3	310
$\frac{3}{4}$	$1\frac{1}{2}$	1.733	$\frac{7}{8}$	$\frac{21}{32}$	40.0	250	37.6	266
$\frac{7}{8}$	$1\frac{1}{2}$	1.733	$\frac{7}{8}$	$\frac{25}{32}$	37.7	265	35.3	283
$\frac{7}{8}$	$1\frac{1}{2}$	1.733	1	$\frac{25}{32}$	45.9	218	43.5	230
$\frac{7}{8}$	$1\frac{5}{8}$	1.877	$\frac{7}{8}$	$\frac{25}{32}$	45.3	221	42.6	235
$\frac{7}{8}$	$1\frac{5}{8}$	1.877	1	$\frac{25}{32}$	50.8	197	47.6	210
1	$1\frac{3}{4}$	2.021	1	$\frac{7}{8}$	57.5	174	53.8	186
1	$1\frac{3}{4}$	2.021	$1\frac{1}{8}$	$\frac{7}{8}$	63.7	157	59.5	168
$1\frac{1}{8}$	2	2.309	$1\frac{1}{4}$	$\frac{15}{16}$	100.0	100	90.9	110
$1\frac{1}{4}$	$2\frac{1}{4}$	2.599	$1\frac{3}{8}$	$1\frac{1}{16}$	138.9	72	126.6	79
$1\frac{3}{8}$	$2\frac{1}{2}$	2.888	$1\frac{1}{2}$	$1\frac{3}{16}$	185.2	54	169.5	59
$1\frac{1}{2}$	$2\frac{3}{4}$	3.176	$1\frac{5}{8}$	$1\frac{5}{16}$	243.9	41	222.2	45
$1\frac{5}{8}$	3	3.464	$1\frac{3}{4}$	$1\frac{7}{16}$	333.3	30	303.0	33
$1\frac{3}{4}$	$3\frac{1}{4}$	3.754	$1\frac{7}{8}$	$1\frac{9}{16}$	408.2	$24\frac{1}{2}$	370.4	27
$1\frac{7}{8}$	$3\frac{1}{2}$	4.043	2	$1\frac{11}{16}$	493.8	$20\frac{1}{4}$	459.8	$21\frac{3}{4}$
2	$3\frac{1}{2}$	4.043	2	$1\frac{13}{16}$	487.8	$20\frac{1}{2}$	454.5	22
2	$3\frac{1}{2}$	4.043	$2\frac{1}{8}$	$1\frac{13}{16}$	512.8	$19\frac{1}{2}$	487.8	$20\frac{1}{2}$

WEIGHTS AND DIMENSIONS OF SQUARE NUTS.

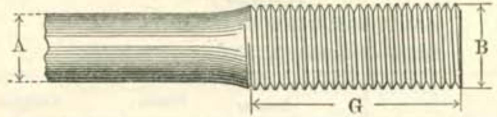
MANUFACTURERS' STANDARD SIZES.

BASIS—HOOPES & TOWNSEND'S LIST.

Diameter of Bolt.	Short Diameter.	Long Diameter.	Thickness.	Diameter of Rough Hole.	Plain.		Cupped.	
					Weight per 100.	Number in 100 Pounds.	Weight per 100.	Number in 100 Pounds.
Inches.	Inches.	Inches.	Inches.	Inches	Pounds.		Pounds.	
$\frac{1}{4}$	$\frac{1}{2}$	.707	$\frac{1}{4}$	$\frac{7}{32}$	1.5	6750	1.4	7200
$\frac{5}{16}$	$\frac{5}{8}$	.884	$\frac{5}{16}$	$\frac{9}{32}$	2.8	3540	2.5	4000
$\frac{3}{8}$	$\frac{3}{4}$	1.061	$\frac{3}{8}$	$\frac{11}{32}$	4.8	2100	4.2	2380
$\frac{7}{16}$	$\frac{7}{8}$	1.237	$\frac{7}{16}$	$\frac{13}{32}$	7.5	1330	6.8	1460
$\frac{1}{2}$	$\frac{7}{8}$	1.237	$\frac{1}{2}$	$\frac{7}{16}$	8.9	1120	8.1	1230
$\frac{1}{2}$	1	1.414	$\frac{1}{2}$	$\frac{7}{16}$	11.9	840	10.8	930
$\frac{9}{16}$	$1\frac{1}{8}$	1.591	$\frac{9}{16}$	$\frac{1}{2}$	15.4	650	14.3	700
$\frac{5}{8}$	$1\frac{1}{8}$	1.591	$\frac{5}{8}$	$\frac{9}{16}$	17.3	575	16.1	620
$\frac{5}{8}$	$1\frac{1}{4}$	1.768	$\frac{5}{8}$	$\frac{9}{16}$	23.0	435	21.1	475
$\frac{3}{4}$	$1\frac{1}{4}$	1.768	$\frac{3}{4}$	$\frac{21}{32}$	27.8	360	25.0	400
$\frac{3}{4}$	$1\frac{3}{8}$	1.945	$\frac{3}{4}$	$\frac{21}{32}$	31.7	315	29.0	345
$\frac{3}{4}$	$1\frac{1}{2}$	2.122	$\frac{3}{4}$	$\frac{21}{32}$	41.0	244	37.0	270
$\frac{7}{8}$	$1\frac{1}{2}$	2.122	$\frac{7}{8}$	$\frac{25}{32}$	46.5	215	41.7	240
$\frac{7}{8}$	$1\frac{5}{8}$	2.298	$\frac{7}{8}$	$\frac{25}{32}$	55.6	180	48.8	205
$\frac{7}{8}$	$1\frac{3}{4}$	2.475	$\frac{7}{8}$	$\frac{25}{32}$	61.3	163	54.6	183
1	$1\frac{3}{4}$	2.475	1	$\frac{7}{8}$	70.9	141	64.1	156
1	2	2.828	1	$\frac{7}{8}$	95.2	105	87.0	115
$1\frac{1}{8}$	2	2.828	$1\frac{1}{8}$	$\frac{15}{16}$	102.0	98	94.3	106
$1\frac{1}{8}$	$2\frac{1}{4}$	3.182	$1\frac{1}{8}$	$\frac{15}{16}$	135.1	74	123.5	81
$1\frac{1}{4}$	$2\frac{1}{4}$	3.182	$1\frac{1}{4}$	$1\frac{1}{16}$	156.3	64	142.9	70
$1\frac{1}{4}$	$2\frac{1}{2}$	3.536	$1\frac{1}{4}$	$1\frac{1}{16}$	192.3	52	175.4	57
$1\frac{3}{8}$	$2\frac{3}{4}$	3.889	$1\frac{3}{8}$	$1\frac{3}{16}$	250.0	40	227.3	44
$1\frac{1}{2}$	3	4.243	$1\frac{1}{2}$	$1\frac{5}{16}$	317.5	$31\frac{1}{2}$	285.7	35
$1\frac{5}{8}$	$3\frac{1}{4}$	4.597	$1\frac{5}{8}$	$1\frac{7}{16}$	454.5	22	400.0	25
$1\frac{3}{4}$	$3\frac{1}{2}$	4.950	$1\frac{3}{4}$	$1\frac{9}{16}$	555.6	18	500.0	20
$1\frac{7}{8}$	$3\frac{3}{4}$	5.303	$1\frac{7}{8}$	$1\frac{11}{16}$	666.7	15	625.0	16
2	4	5.657	2	$1\frac{13}{16}$	816.3	$12\frac{1}{4}$	784.3	$12\frac{3}{4}$

UPSET SCREW ENDS.

ROUND BARS.



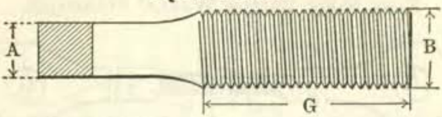
Dimensions of Upset End.				Dimensions and Proportions of Body of Bar.									
Diameter of Screw. B	Length of Upset. G	Area at Root of Thread.	Number of Threads per Inch.	Diameter of Bar. A	Area at Body of Bar.	Weight per Foot of Bar.	Add for Upset.	Excess of Area at Root of Thread over that of Body of Bar.	Diameter of Bar. A	Area of Body of Bar.	Weight per Foot of Bar.	Add for Upset.	Excess of Area at Root of Thread over that of Body of Bar.
In.	In.	Sq. In.		In.	Sq. In.	Pounds.	In.	Per Ct.	In.	Sq. In.	Pounds.	In.	Per Ct.
3/4	4 1/4	.302	10	1/2	.196	.668	6 1/2	54	9/16	.249	.845	4 1/4	21
7/8	4 1/2	.420	9	5/8	.307	1.043	5 1/2	37					
1	4 1/2	.550	8	11/16	.371	1.262	6 1/4	48	3/4	.442	1.502	4 1/2	25
1 1/8	4 3/4	.694	7	13/16	.519	1.763	5 1/2	34					
1 1/4	4 3/4	.893	7	7/8	.601	2.044	6 1/4	49	15/16	.690	2.347	4 1/2	29
1 3/8	5	1.057	6	1	.785	2.67	4 1/2	35	1 1/16	.887	3.01	4 1/4	19
1 1/2	5	1.295	6	1 1/8	.994	3.38	4 3/4	30	1 3/16	1.108	3.77	3 3/4	17
1 5/8	5 1/4	1.515	5 1/2	1 1/4	1.227	4.17	4 1/2	23					
1 3/4	5 1/4	1.744	5	1 5/16	1.353	4.60	5	29	1 3/8	1.485	5.05	4	18
1 7/8	5 1/2	2.048	5	1 7/16	1.623	5.52	4 3/4	26					
2	5 1/2	2.302	4 1/2	1 1/2	1.767	6.01	5 1/4	30	1 9/16	1.918	6.52	4 1/2	20
2 1/8	5 3/4	2.650	4 1/2	1 5/8	2.074	7.05	5	28	1 11/16	2.237	7.60	4 1/4	18
2 1/4	5 3/4	3.023	4 1/2	1 3/4	2.405	8.18	4 3/4	26	1 13/16	2.580	8.77	4	17
2 3/8	6	3.419	4 1/2	1 7/8	2.761	9.39	4 1/2	24					
2 1/2	6	3.715	4	1 15/16	2.948	10.02	5	26	2	3.142	10.68	3 1/2	18
2 5/8	6 1/4	4.155	4	2 1/16	3.341	11.36	4 3/4	24	2 1/8	3.547	12.06	4	17
2 3/4	6 1/4	4.619	4	2 3/16	3.758	12.78	4 1/2	23					
2 7/8	6 1/2	5.108	4	2 1/4	3.976	13.52	5 1/4	28	2 5/16	4.200	14.28	4 1/2	22
3	6 1/2	5.428	3 1/2	2 3/8	4.430	15.07	4 3/4	23					
3 1/8	6 3/4	5.957	3 1/2	2 7/16	4.666	15.86	5 1/2	28	2 1/2	4.909	16.69	4 3/4	21
3 1/4	6 3/4	6.510	3 1/2	2 9/16	5.157	17.53	5 1/4	26	2 5/8	5.412	18.40	4 1/2	20
3 3/8	7	7.087	3 1/2	2 11/16	5.673	19.29	5	25	2 3/4	5.940	20.20	4 1/2	19
3 1/2	7	7.548	3 1/4	2 13/16	6.213	21.12	4 3/4	22					
3 5/8	7 1/4	8.171	3 1/4	2 7/8	6.492	22.07	5 1/4	26	2 15/16	6.777	23.04	4 3/4	21
3 3/4	7 1/4	8.641	3	3	7.069	24.03	6 1/4	22					
3 7/8	7 1/2	9.305	3	3 1/8	7.670	26.08	5 1/4	21					
4	7 1/2	9.993	3	3 1/4	8.296	28.20	4 3/4	20					

Upset Ends of sizes given in first column are used with one or two sizes of bars as shown in the two columns headed "Diameter of Bar. A."

Lengths of Upset Ends above are best adapted for use with Turnbuckles of standard length, six inches between heads, as shown on page 218 Lengths of Upset Ends for use with ordinary Right and Left Nuts, shown on page 219, may be one inch shorter than above. Upset Ends 3⅛″, 3⅜″, 3⅝″ and 3⅞″ diameter are odd sizes for which Right and Left Nuts and Turnbuckles are not regularly made.

UPSET SCREW ENDS.

SQUARE BARS.



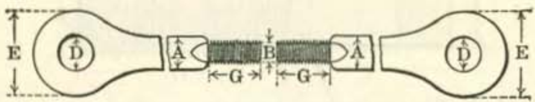
Dimensions of Upset End.				Dimensions and Proportions of Body of Bar.									
Diameter of Screw. B	Length of Upset. G	Area at Root of Thread.	Number of Threads per Inch.	Side of Square Bar. A	Area of Body of Bar.	Weight per Foot of Bar.	Add for Upset.	Excess of Area at Root of Thread over that of Body of Bar.	Side of Square Bar. A	Area of Body of Bar.	Weight per Foot of Bar.	Add for Upset.	Excess of Area at Root of Thread over that of Body of Bar.
In.	In.	Sq. In.		In.	Sq. In.	Pounds.	In.	Per Ct.	In.	Sq. In.	Pounds.	In.	Per Ct.
3/4	4 1/4	.302	10	1/2	.250	.850	4	21					
7/8	4 1/2	.420	9	9/16	.316	1.076	5	33					
1	4 1/2	.550	8	5/8	.391	1.328	5 3/4	41	11/16	.473	1.607	3 3/4	17
1 1/8	4 3/4	.694	7	3/4	.563	1.913	4 1/2	23					
1 1/4	4 3/4	.893	7	13/16	.660	2.245	5	35					
1 3/8	5	1.057	6	7/8	.766	2.60	5 3/4	38	15/16	.879	2.99	4 1/4	20
1 1/2	5	1.295	6	1	1.000	3.40	4 3/4	29					
1 5/8	5 1/4	1.515	5 1/2	1 1/16	1.129	3.84	5 1/2	34	1 1/8	1.266	4.30	4 1/4	20
1 3/4	5 1/4	1.744	5	1 3/16	1.410	4.80	4 3/4	24					
1 7/8	5 1/2	2.048	5	1 1/4	1.563	5.31	5 1/4	31	1 5/16	1.723	5.86	4 1/4	19
2	5 1/2	2.302	4 1/2	1 3/8	1.891	6.43	4 1/2	22					
2 1/8	5 3/4	2.650	4 1/2	1 7/16	2.066	7.03	5 1/4	28	1 1/2	2.250	7.65	4 1/4	18
2 1/4	5 3/4	3.023	4 1/2	1 9/16	2.441	8.30	4 1/2	24					
2 3/8	6	3.419	4 1/2	1 5/8	2.641	8.98	5	30	1 11/16	2.848	9.68	4 1/4	20
2 1/2	6	3.175	4	1 3/4	3.063	10.41	4 1/2	21					
2 5/8	6 1/4	4.155	4	1 13/16	3.285	11.17	5	26	1 7/8	3.516	11.95	4 1/4	18
2 3/4	6 1/4	4.619	4	1 15/16	3.754	12.76	4 1/2	23					
2 7/8	6 1/2	5.108	4	2	4.000	13.60	5	28	2 1/16	4.254	14.46	4 1/4	20
3	6 1/2	5.428	3 1/2	2 1/8	4.516	15.35	4 1/2	20					
3 1/8	6 3/4	5.957	3 1/2	2 3/16	4.785	16.27	5	24	2 1/4	5.063	17.22	4 1/4	18
3 1/4	6 3/4	6.510	3 1/2	2 5/16	5.348	18.19	4 3/4	22					
3 3/8	7	7.087	3 1/2	2 3/8	5.641	19.18	5 1/4	26	2 7/16	5.941	20.20	4 1/2	19
3 1/2	7	7.548	3 1/4	2 1/2	6.250	21.25	4 3/4	21					
3 5/8	7 1/4	8.171	3 1/4	2 9/16	6.566	22.33	5 1/4	24	2 5/8	6.891	23.43	4 1/2	19
3 3/4	7 1/4	8.641	3	2 11/16	7.223	24.56	4 3/4	20					
3 7/8	7 1/2	9.305	3	2 3/4	7.563	25.00	5 1/4	23	2 13/16	7.910	26.90	4 1/2	18
4	7 1/2	9.993	3	2 7/8	8.266	28.10	4 3/4	21					

Upset Ends of sizes given in first column are used with one or two sizes of bars as shown in the two columns headed "Side of Square Bar. A."

Lengths of Upset Ends above are best adapted for use with Turnbuckles of standard length, six inches between heads, as shown on page 218. Lengths of Upset Ends for use with ordinary Right and Left Nuts, shown on page 219, may be one inch shorter than above. Upset Ends 3 1/8″, 3 3/8″, 3 5/8″ and 3 7/8″ diameter are odd sizes for which Right and Left Nuts and Turnbuckles are not regularly made.

UPSET SCREW ENDS FOR FLAT BARS.

EDGE MOOR BRIDGE WORKS' STANDARD.



Width of Bar. A	Thickness of Bar. T	Diameter of Upset of Bar. B	Area of Bar.	Area at Root of Thread.	Length of Upset of Bar. G	Add for Upset of Bar.
Inches.	Inches.	Inches.	Sq. Inches.	Sq. Inches.	Inches.	Inches.
2	1	2	2.00	2.30	5½	6
3	⅞	2¼	2.63	3.023	6½	11½
3	1	2½	3.0	3.719	6½	11¼
3	1⅛	2⅝	3.38	4.159	7	11¼
3	1¼	2¾	3.75	4.62	7	11
3	1⅜	2⅞	4.13	4.92	7	10
3	1½	3	4.50	5.43	7	10
4	¾	2½	3.00	3.719	6½	12¾
4	⅞	2⅝	3.50	4.159	7	12
4	1	2¾	4.00	4.62	7	11
4	1⅛	3	4.50	5.43	7	11
4	1¼	3¼	5.00	6.51	7¼	11
4	1⅜	3¼	5.50	6.51	7¼	11
4	1½	3½	6.00	7.54	7½	10
4	1⅝	3½	6.50	7.54	7½	10
4	1¾	3¾	7.00	8.64	7½	9½
5	¾	2¾	3.75	4.62	7	11
5	⅞	3	4.38	5.43	7	11
5	1	3¼	5.00	6.51	7¼	10½
5	1⅛	3¼	5.63	6.51	7¼	10½
5	1¼	3½	6.25	7.55	7½	9½
5	1⅜	3¾	6.88	8.64	7½	9½
5	1½	3¾	7.50	8.64	7½	9¾
5	1⅝	..	8.13	9.99	..	..
5	1¾	..	8.75	9.99	..	..
6	1⅛	3¾	6.75	8.64	7½	10
6	1¼	3¾	7.50	8.64	7½	9
6	1⅜	..	8.25	9.99	..	..
6	1½	..	9.00	9.99	..	..

For dimensions of heads corresponding to different-sized pins, see table of Eye Bars on page 217.

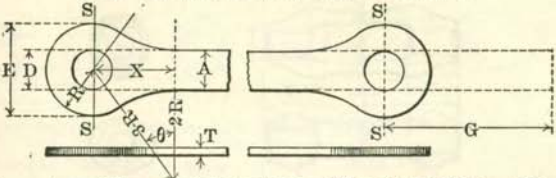
Shortest length of bar permissible on account of method of manufacture is 6′ 0″ center to end.

The above length is used only for bars having heads 12½″ diameter or less.

When possible lengths of 7′ 0″ are preferred.

STEEL EYE BARS.

EDGE MOOR BRIDGE WORKS' STANDARD.



A_x = Area of Excess to form one Head = Plane Area of Head — AX.

$$A_x = \frac{(180 + 2\theta)}{360}\,\pi\,R^2 + \left(4\,R^2 - \frac{A^2}{4}\right)\,\text{Tan.}\,\theta - .0698\,R^2\theta.$$

$$\cos\theta = \frac{2R + \frac{A}{2}}{3R}.\quad G = \frac{5A_x}{4A}.\qquad \text{Log.}\ \frac{\pi}{360} = 7.940848 - 10.$$

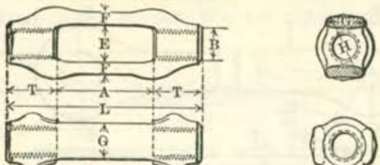
$$\text{"}\quad .0698 = 8.843855 - 10.$$

Width of Body of Bar. A Inches.	Minimum Thickness. of Bar. T Inches.	Diameter of Head of Bar. E Inches.	Diameter of Largest Pin Hole. D Inches.	Sectional Area of the Head on Line S—S in Excess of that in Body of Bar.	Additional Length of Bar Beyond Center of Eye Required to Form One Head. G Inches.
2	..	4½	1⅞	33 %	7½
2	..	5½	2⅞	"	12½
2½	..	5½	2⅛	"	9½
2½	..	6½	3⅛	"	13½
3	¾	6½	2½	"	10½
3	¾	8	4	"	17½
3	¾	9	5	"	22½
4	¾	9½	4⅛	"	17½
4	¾	10½	5⅛	"	21
4	¾	11½	6⅛	"	27½
5	¾	11½	4⅝	37 %	20
5	¾	12½	5⅝	"	24
5	1	13	6⅛	"	27½
5	1	14	7⅛	"	32
6	⅞	13½	5¼	"	21½
6	⅞	14½	6¼	"	27
6	1	15½	7¼	"	31½
7	15/16	15½	5⅝	40 %	26
7	15/16	17	7⅛	"	32
8	1	17	5¾	"	25½
8	1	18	6¾	"	30½
8	1	19	8	"	35
9	1⅛	19½	7	"	32½
9	1⅛	21½	9	"	36½
9	1¼	22½	10	..	..
10	1⅜	24½	10⅝	..	..

The size of head given is the size of die. The size of finished head will overrun this about ¼″. Eye Bars are Hydraulic Forged without the addition of extraneous metal and without buckles or welds. The heads on Eye Bars are finished of the same thickness "T" as body of bar.

TURNBUCKLES.

PRESSED WROUGHT IRON.

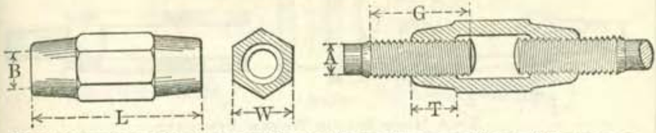


THE CLEVELAND CITY FORGE AND IRON CO.

Dimensions of Bar.									
Diameter of Screw. B	Diameter of Bar.	Side of Square Bar.	L	T	A	E	F	H	G
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
3/8			7 1/8	9/16	6	9/16	3/16	1 1/16	1/2
7/16			7 5/16	21/32	6	5/8	1/4	1 3/8	5/8
1/2			7 1/2	3/4	6	5/8	1/4	1 3/8	5/8
9/16			7 11/16	27/32	6	13/16	5/16	1 9/16	3/4
5/8			7 7/8	15/16	6	13/16	5/16	1 9/16	3/4
3/4	1/2 and 9/16	1/2	8 1/4	1 1/8	6	1 1/16	3/8	2	1
7/8	5/8	9/16	8 5/8	1 5/16	6	1 1/4	3/8	2 1/4	1 1/4
1	11/16 " 3/4	5/8 and 11/16	9	1 1/2	6	1 5/16	7/16	2 7/16	1 1/4
1 1/8	13/16	3/4	9 3/8	1 11/16	6	1 7/16	1/2	2 9/16	1 1/4
1 1/4	7/8 " 15/16	13/16	9 3/4	1 7/8	6	1 9/16	1/2	2 3/4	1 1/2
1 3/8	1 " 1 1/16	7/8 " 15/16	10 1/8	2 1/16	6	1 11/16	1/2	3 1/16	1 5/8
1 1/2	1 1/8 " 1 3/16	1	10 1/2	2 1/4	6	1 3/4	5/8	3 3/16	1 3/4
1 5/8	1 1/4	1 1/16 " 1 1/8	10 7/8	2 7/16	6	2	5/8	3 1/2	1 7/8
1 3/4	1 5/16 " 1 3/8	1 3/16	11 1/4	2 5/8	6	2 1/8	5/8	3 3/4	2
1 7/8	1 7/16	1 1/4 " 1 5/16	11 5/8	2 13/16	6	2 3/16	11/16	3 7/8	2 1/8
2	1 1/2 " 1 9/16	1 3/8	12	3	6	2 3/8	11/16	4 1/4	2 1/4
2 1/8	1 5/8 " 1 11/16	1 7/16 " 1 1/2	12 3/8	3 3/16	6	2 1/2	23/32	4 1/2	2 1/2
2 1/4	1 3/4 " 1 13/16	1 9/16	12 3/4	3 3/8	6	2 11/16	13/16	4 3/4	2 1/2
2 3/8	1 7/8	1 5/8 " 1 11/16	13 1/8	3 9/16	6	2 3/4	13/16	4 7/8	2 3/4
2 1/2	1 15/16 " 2	1 3/4	13 1/2	3 3/4	6	3 1/16	27/32	5 3/8	3
2 5/8	2 1/16 " 2 1/8	1 13/16 " 1 7/8	13 7/8	3 15/16	6	3 1/8	15/16	5 9/16	3
2 3/4	2 3/16	1 15/16	14 1/4	4 1/8	6	3 1/4	15/16	5 3/4	3 1/4
2 7/8	2 1/4 " 2 5/16	2 " 2 1/16	14 5/8	4 5/16	6	3 7/16	1 1/32	6 1/16	3 1/4
3	2 3/8	2 1/8	15	4 1/2	6	3 5/8	1 1/32	6 3/8	3 1/2
3 1/4	2 9/16 " 2 5/8	2 5/16	15 3/4	4 7/8	6	3 7/8	1 1/16	6 3/4	4
3 1/2	2 13/16	2 1/2	16 1/2	5 1/4	6	4 1/4	1 7/32	7 1/4	4
3 3/4	3	2 11/16	17 1/4	5 5/8	6	4 3/8	1 5/16	8 1/8	5
4	3 1/4	2 7/8	18	6	6	4 5/8	1 7/16	8 3/4	5

Standard Length, 6 inches between heads, (L) for all sizes.
Second " 9 " " " (L) " "
Third " 12 " " " (L) " "
Special Lengths to order.
Lengths of Upset Ends shown on pages 214 and 215 are those best adapted for use with Turnbuckles of Standard Length as above.

RIGHT AND LEFT NUTS.



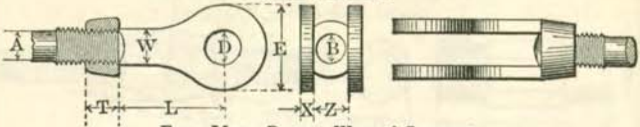
DIMENSIONS OF NUTS FROM EDGE MOOR BRIDGE WORKS' STANDARD.

Diameter of Screw. B	Length of Upset. G	Diameter of Bar. A	Side of Square Bar. A	Length of Nut. L	Length of Thread. T	Diameter of Hex. W	Weight of One Nut.	Weight of One Nut and Two Screw Ends.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Pounds.	Pounds.
				Ordinary Lengths.				
$\frac{7}{8}$	$4\frac{1}{2}$	$\frac{5}{8}$	$\frac{9}{16}$	6	$1\frac{7}{16}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$4\frac{1}{4}$
1	$4\frac{1}{2}$	$\frac{11}{16}$ and $\frac{3}{4}$	$\frac{5}{8}$ and $\frac{11}{16}$	6	$1\frac{7}{16}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$4\frac{1}{4}$
$1\frac{1}{8}$	$4\frac{3}{4}$	$\frac{13}{16}$	$\frac{3}{4}$	$6\frac{1}{2}$	$1\frac{5}{8}$	2	3	$7\frac{1}{2}$
$1\frac{1}{4}$	$4\frac{3}{4}$	$\frac{7}{8}$ " $\frac{15}{16}$	$\frac{13}{16}$	$6\frac{1}{2}$	$1\frac{5}{8}$	2	3	$7\frac{1}{2}$
$1\frac{3}{8}$	5	1 " $1\frac{1}{16}$	$\frac{7}{8}$ " $\frac{15}{16}$	7	$1\frac{7}{8}$	$2\frac{3}{8}$	$4\frac{3}{4}$	$11\frac{3}{4}$
$1\frac{1}{2}$	5	$1\frac{1}{8}$ " $1\frac{3}{16}$	1	7	$1\frac{7}{8}$	$2\frac{3}{8}$	$4\frac{3}{4}$	$11\frac{3}{4}$
$1\frac{5}{8}$	$5\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{16}$ " $1\frac{1}{8}$	$7\frac{1}{2}$	$2\frac{1}{16}$	$2\frac{3}{4}$	$6\frac{3}{4}$	$16\frac{3}{4}$
$1\frac{3}{4}$	$5\frac{1}{4}$	$1\frac{5}{16}$ " $1\frac{3}{8}$	$1\frac{3}{16}$	$7\frac{1}{2}$	$2\frac{1}{16}$	$2\frac{3}{4}$	$6\frac{3}{4}$	$16\frac{3}{4}$
$1\frac{7}{8}$	$5\frac{1}{2}$	$1\frac{7}{16}$	$1\frac{1}{4}$ " $1\frac{5}{16}$	8	$2\frac{5}{16}$	$3\frac{1}{8}$	$9\frac{1}{4}$	$23\frac{1}{4}$
2	$5\frac{1}{2}$	$1\frac{1}{2}$ " $1\frac{9}{16}$	$1\frac{3}{8}$	8	$2\frac{5}{16}$	$3\frac{1}{8}$	$9\frac{1}{4}$	$23\frac{1}{4}$
$2\frac{1}{8}$	$5\frac{3}{4}$	$1\frac{5}{8}$ " $1\frac{11}{16}$	$1\frac{7}{16}$ " $1\frac{1}{2}$	$8\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{2}$	$12\frac{1}{2}$	$31\frac{1}{2}$
$2\frac{1}{4}$	$5\frac{3}{4}$	$1\frac{3}{4}$ " $1\frac{13}{16}$	$1\frac{9}{16}$	$8\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{2}$	$12\frac{1}{2}$	$31\frac{1}{2}$
$2\frac{3}{8}$	6	$1\frac{7}{8}$	$1\frac{5}{8}$ " $1\frac{11}{16}$	9	$2\frac{3}{4}$	$3\frac{7}{8}$	$16\frac{3}{4}$	$41\frac{3}{4}$
$2\frac{1}{2}$	6	$1\frac{15}{16}$ " 2	$1\frac{3}{4}$	9	$2\frac{3}{4}$	$3\frac{7}{8}$	$16\frac{3}{4}$	$41\frac{3}{4}$
$2\frac{5}{8}$	$6\frac{1}{4}$	$2\frac{1}{16}$ " $2\frac{1}{8}$	$1\frac{13}{16}$ " $1\frac{7}{8}$	$9\frac{1}{2}$	$2\frac{15}{16}$	$4\frac{1}{4}$	$21\frac{1}{2}$	$53\frac{1}{4}$
$2\frac{3}{4}$	$6\frac{1}{4}$	$2\frac{3}{16}$	$1\frac{15}{16}$	$9\frac{1}{2}$	$2\frac{15}{16}$	$4\frac{1}{4}$	$21\frac{1}{2}$	$53\frac{1}{4}$
$2\frac{7}{8}$	$6\frac{1}{2}$	$2\frac{1}{4}$ " $2\frac{5}{16}$	2 " $2\frac{1}{16}$	10	$3\frac{3}{16}$	$4\frac{5}{8}$	$26\frac{1}{2}$	$66\frac{1}{4}$
3	$6\frac{1}{2}$	$2\frac{3}{8}$	$2\frac{1}{8}$	10	$3\frac{3}{16}$	$4\frac{5}{8}$	$26\frac{1}{2}$	$66\frac{1}{4}$
$3\frac{1}{4}$	$6\frac{3}{4}$	$2\frac{9}{16}$ " $2\frac{5}{8}$	$2\frac{5}{16}$	$10\frac{1}{2}$	$3\frac{5}{8}$	5	32	81
$3\frac{1}{2}$	7	$2\frac{13}{16}$	$2\frac{1}{2}$	11	$3\frac{5}{8}$	$5\frac{3}{8}$	$38\frac{1}{4}$	$97\frac{3}{4}$
$3\frac{3}{4}$	$7\frac{1}{4}$	3	$2\frac{11}{16}$	$11\frac{1}{2}$	$3\frac{13}{16}$	$5\frac{3}{4}$	45	116
4	$7\frac{1}{2}$	$3\frac{1}{4}$	$2\frac{7}{8}$	12	$4\frac{1}{16}$	$6\frac{1}{8}$	$53\frac{1}{2}$	138
				Extra Lengths.				
$1\frac{1}{4}$	$4\frac{3}{4}$	$\frac{7}{8}$ " $\frac{15}{16}$	$\frac{13}{16}$	12	$2\frac{1}{8}$	2		
$1\frac{1}{8}$	$4\frac{3}{4}$	$\frac{13}{16}$	$\frac{3}{4}$	$8\frac{1}{2}$	$1\frac{5}{8}$	2	4	$9\frac{3}{4}$
$1\frac{1}{4}$	$4\frac{3}{4}$	$\frac{7}{8}$ " $\frac{15}{16}$	$\frac{13}{16}$	$8\frac{1}{2}$	$1\frac{5}{8}$	2	4	$9\frac{3}{4}$
$1\frac{3}{8}$	5	1 " $1\frac{1}{16}$	$\frac{7}{8}$ " $\frac{15}{16}$	9	$1\frac{7}{8}$	$2\frac{3}{8}$	$6\frac{1}{4}$	$15\frac{1}{4}$
$1\frac{1}{2}$	5	$1\frac{1}{8}$ " $1\frac{3}{16}$	1	9	$1\frac{7}{8}$	$2\frac{3}{8}$	$6\frac{1}{4}$	$15\frac{1}{4}$
$1\frac{5}{8}$	$5\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{16}$ " $1\frac{1}{8}$	$9\frac{1}{2}$	$2\frac{1}{16}$	$2\frac{3}{4}$	$8\frac{3}{4}$	$21\frac{1}{2}$
$1\frac{3}{4}$	$5\frac{1}{4}$	$1\frac{5}{16}$ " $1\frac{3}{8}$	$1\frac{3}{16}$	$9\frac{1}{2}$	$2\frac{1}{16}$	$2\frac{3}{4}$	$8\frac{3}{4}$	$21\frac{1}{2}$
$1\frac{7}{8}$	$5\frac{1}{2}$	$1\frac{7}{16}$	$1\frac{1}{4}$ " $1\frac{5}{16}$	10	$2\frac{5}{16}$	$3\frac{1}{8}$	$12\frac{1}{4}$	$29\frac{3}{4}$
2	$5\frac{1}{2}$	$1\frac{1}{2}$ " $1\frac{9}{16}$	$1\frac{3}{8}$	10	$2\frac{5}{16}$	$3\frac{1}{8}$	$12\frac{1}{4}$	$29\frac{3}{4}$

For Details of Upset Ends, see pages 214, 215.

Length of Upset Ends for use with Right and Left Nuts may be made one inch shorter than the dimensions given in column "G" above.

CLEVISES.

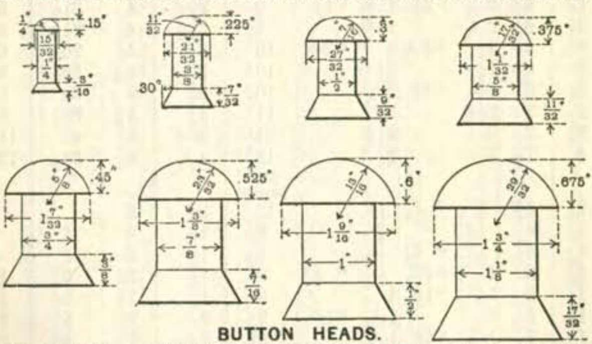


EDGE MOOR BRIDGE WORKS' STANDARD.

Diameter of Screw.	Diameter of Bar.	Side of Square Bar.	Diameter of Eye.	Length of Fork.	Diameter of Pin.	Length of Thread.	Width of Bar.	Thickness of Bar.	Width of Fork.	Weight of Clevises.	Weight of Clevis and Screw End.
B	A	A	E	L*	D*	T	W	X*	Z*		
Ins.	Inches.	Inches	Ins.	Ins.	Inches.	Ins.	Ins.	Inches.	Ins.	Pounds.	Pounds.
⅞	⅝	9/16	4	5¼	1⅛ to 2½	1½	2	½	1⅛	5½	7¼
1	11/16 & ¾	⅝ & 11/16	4	5¼	1⅛ “ 2½	1½	2	½	1⅛	5½	7¼
1⅛	13/16	¾	4	5¼	1⅜ “ 2½	1½	2	½	1⅜	6½	8¾
1¼	⅞ “ 15/16	13/16	4	5¼	1⅜ “ 2½	1½	2	½	1⅜	6½	8¾
1⅜	1 “ 1 1/16	⅞ “ 15/16	4	5¼	1⅝ “ 2	1½	2	½	1⅝	7¼	10¾
1½	1⅛ “ 1 3/16	1	4	5¼	1⅝ “ 2	1½	2	½	1⅝	7¼	10¾
1⅝	1¼	1 1/16 “ 1⅛	4	5¼	2	1¾	2	⅝ & ¾	1⅞	9	14
1¾	1 5/16 “ 1⅜	1 3/16	4	5¼	2	1¾	2	⅝ “ ¾	1⅞	9	14
1⅞	1 7/16	1¼ “ 1 5/16	4⅞	7	2¼	2	2	¾	2⅛	13¾	20¾
2	1½ “ 1 9/16	1⅜	4⅞	7	2¼	2	2	¾	2⅛	13¾	20¾
2⅛	1⅝ “ 1 11/16	1 7/16 “ 1½	5⅞	7	2½	2⅛	2½	¾	2⅜	20¼	29¾
2¼	1¾ “ 1 13/16	1 9/16	5⅞	7	2½	2⅛	2½	¾	2⅜	20¼	29¾
2⅜	1⅞	1⅝ “ 1 11/16	6⅜	7	2¾	2¼	2½	⅞	2⅝	25¼	37¾
2½	1 15/16 “ 2	1¾	6⅜	7	2¾	2¼	2½	⅞	2⅝	25¼	37¾
2⅝	2 1/16 “ 2⅛	1 13/16 “ 1⅞	6⅞	8¾	3	2¾	3	1	2⅞		
2¾	2 3/16	1 15/16	6⅞	8¾	3	2¾	3	1	2⅞		

Dimensions marked * may be varied somewhat if necessary. The minimum size is given for each with the corresponding weight. Lengths of upset ends shown on pages 214 and 215.

DIMENSIONS OF RIVET HEADS AFTER DRIVING.



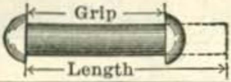
BUTTON HEADS.

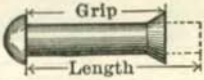
Height of Head = $\frac{6}{10}$ × Diameter of Rivet. Radius of Head = ¾ Diameter of Rivet + $\frac{1}{16}$″.

COUNTERSUNK HEADS.

Diameter of Countersunk Head same as Button Head. Angle of Countersink = 30°. In figuring Clearances for Rivet Heads allow for Heights as follows: ⅝″ for ¾″ rivets, ¾″ for ⅞″ rivets. All dimensions in inches.

LENGTH OF RIVETS REQUIRED FOR VARIOUS GRIPS INCLUDING AMOUNT NECESSARY TO FORM ONE HEAD.





Grip of Rivet in Inches.	Diameter of Rivet in Inches.							
	1/4"	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"
1/2	1	1 1/4	1 1/2	1 3/4	1 7/8	2	2 1/8	2 1/4
5/8	1 1/8	1 3/8	1 5/8	1 7/8	2	2 1/8	2 1/4	2 3/8
3/4	1 1/4	1 1/2	1 3/4	2	2 1/8	2 1/4	2 3/8	2 1/2
7/8	1 3/8	1 5/8	1 7/8	2 1/8	2 1/4	2 3/8	2 1/2	2 5/8
1	1 1/2	1 3/4	2	2 1/4	2 3/8	2 1/2	2 5/8	2 3/4
1 1/8	1 5/8	1 7/8	2 1/8	2 3/8	2 1/2	2 5/8	2 3/4	2 7/8
1 1/4	1 3/4	2	2 1/4	2 1/2	2 5/8	2 3/4	2 7/8	3
1 3/8	1 7/8	2 1/8	2 3/8	2 5/8	2 7/8	3	3	3 1/8
1 1/2	2	2 1/4	2 1/2	2 3/4	3	3 1/8	3 1/8	3 1/4
1 5/8	2 1/8	2 3/8	2 5/8	2 7/8	3 1/8	3 1/4	3 1/4	3 1/2
1 3/4	2 1/4	2 1/2	2 3/4	3	3 1/4	3 3/8	3 1/2	3 5/8
1 7/8	2 3/8	2 5/8	2 7/8	3 1/4	3 3/8	3 1/2	3 5/8	3 3/4
2	2 1/2	2 3/4	3 1/8	3 3/8	3 1/2	3 5/8	3 3/4	3 7/8
2 1/8	2 5/8	2 7/8	3 1/4	3 1/2	3 5/8	3 3/4	3 7/8	4
2 1/4	2 3/4	3	3 3/8	3 5/8	3 3/4	3 7/8	4	4 1/8
2 3/8	2 7/8	3 1/8	3 1/2	3 3/4	3 7/8	4	4 1/8	4 1/4
2 1/2	3	3 1/4	3 5/8	3 7/8	4	4 1/8	4 1/4	4 3/8
2 5/8	3 1/8	3 1/2	3 3/4	4	4 1/8	4 1/4	4 3/8	4 1/2
2 3/4	3 1/4	3 5/8	3 7/8	4 1/8	4 1/4	4 3/8	4 1/2	4 5/8
2 7/8	3 3/8	3 3/4	4	4 1/4	4 3/8	4 1/2	4 5/8	4 3/4
3	3 1/2	3 7/8	4 1/8	4 3/8	4 1/2	4 5/8	4 3/4	4 7/8
3 1/8	3 5/8	4	4 1/4	4 1/2	4 3/4	4 3/4	5	5
3 1/4	3 3/4	4 1/8	4 3/8	4 3/4	4 7/8	5	5 1/8	5 1/4
3 3/8	3 7/8	4 1/4	4 1/2	4 7/8	5	5 1/8	5 1/4	5 3/8
3 1/2	4	4 3/8	4 5/8	5	5 1/8	5 1/4	5 3/8	5 1/2
3 5/8	4 1/8	4 1/2	4 3/4	5 1/8	5 1/4	5 3/8	5 1/2	5 5/8
3 3/4	4 1/4	4 5/8	4 7/8	5 1/4	5 3/8	5 1/2	5 5/8	5 3/4
3 7/8	4 3/8	4 3/4	5	5 3/8	5 1/2	5 5/8	5 3/4	5 7/8
4	4 1/2	4 7/8	5 1/8	5 1/2	5 5/8	5 3/4	5 7/8	6
4 1/8	4 5/8	5	5 1/4	5 5/8	5 3/4	5 7/8	6	6 1/8
4 1/4	4 3/4	5 1/8	5 1/2	5 3/4	5 7/8	6	6 1/8	6 1/4
4 3/8	4 7/8	5 1/4	5 5/8	5 7/8	6	6 1/8	6 1/4	6 3/8
4 1/2	5	5 3/8	5 3/4	6	6 1/8	6 1/4	6 3/8	6 1/2
4 5/8	5 1/8	5 1/2	5 7/8	6 1/8	6 1/4	6 3/8	6 1/2	6 5/8
4 3/4	5 1/4	5 5/8	6	6 1/4	6 1/2	6 5/8	6 3/4	6 3/4
4 7/8	5 3/8	5 3/4	6 1/8	6 1/2	6 5/8	6 3/4	6 7/8	6 7/8
5	5 1/2	5 7/8	6 1/4	6 5/8	6 3/4	6 7/8	7	7
5 1/8	5 5/8	6	6 3/8	6 3/4	6 7/8	7	7 1/8	7 1/8
5 1/4	5 3/4	6 1/8	6 1/2	6 7/8	7	7 1/8	7 1/4	7 1/4
5 3/8	5 7/8	6 1/4	6 5/8	7	7 1/8	7 1/4	7 3/8	7 3/8
5 1/2	6	6 3/8	6 3/4	7 1/8	7 1/4	7 3/8	7 1/2	7 1/2
5 5/8	6 1/8	6 1/2	6 7/8	7 1/4	7 3/8	7 1/2	7 5/8	7 5/8
5 3/4	6 1/4	6 3/4	7	7 3/8	7 5/8	7 5/8	7 3/4	7 3/4
5 7/8	6 3/8	6 7/8	7 1/8	7 1/2	7 3/4	7 3/4	7 7/8	7 7/8
6	6 1/2	7	7 1/4	7 5/8	7 7/8	7 7/8	8	8 1/8

Amount in Inches to be subtracted from above lengths for Countersunk Heads.

	1/4"	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"
	1/8	1/4	1/2	1/2	5/8	3/4	7/8	7/8

BRIDGE PINS, NUTS AND PILOT NUTS.

EDGE MOOR BRIDGE WORKS' STANDARD.

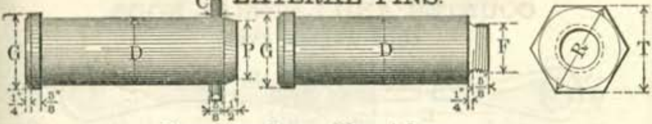
All Threads 8 per inch.

Nominal Diameter of Pin.	Turned Diameter of Pin.	Diameter of Thread.	Short Diameter of Nut.	Long Diameter of Nut.	Diameter of Holes in Eye Bars.
	D	F	A	G	
Inches.	Inches.	Inches.	Inches.	Inches.	
$1\frac{1}{2}$	$1\frac{7}{16}$	$1\frac{1}{4}$	2	$2\frac{5}{16}$	$D + \frac{1}{100}$
$1\frac{3}{4}$	$1\frac{11}{16}$	$1\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{7}{8}$	" $+ \frac{1}{100}$
2	$1\frac{15}{16}$	$1\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{7}{8}$	" $+ \frac{1}{100}$
$2\frac{1}{4}$	$2\frac{3}{16}$	$1\frac{1}{2}$	3	$3\frac{1}{2}$	" $+ \frac{1}{100}$
$2\frac{1}{2}$	$2\frac{7}{16}$	2	3	$3\frac{1}{2}$	" $+ \frac{2}{100}$
$2\frac{3}{4}$	$2\frac{11}{16}$	2	$3\frac{1}{2}$	$4\frac{1}{16}$	" $+ \frac{2}{100}$
3	$2\frac{15}{16}$	2	$3\frac{1}{2}$	$4\frac{1}{16}$	" $+ \frac{2}{100}$
$3\frac{1}{4}$	$3\frac{3}{16}$	$2\frac{1}{2}$	4	$4\frac{11}{16}$	" $+ \frac{2}{100}$
$3\frac{1}{2}$	$3\frac{7}{16}$	$2\frac{1}{2}$	4	$4\frac{11}{16}$	" $+ \frac{2}{100}$
$3\frac{3}{4}$	$3\frac{11}{16}$	$2\frac{3}{4}$	$4\frac{1}{2}$	$5\frac{3}{16}$	" $+ \frac{2}{100}$
4	$3\frac{15}{16}$	3	$4\frac{1}{2}$	$5\frac{3}{16}$	" $+ \frac{2}{100}$
$4\frac{1}{4}$	$4\frac{3}{16}$	$3\frac{1}{2}$	5	$5\frac{13}{16}$	" $+ \frac{2}{100}$
$4\frac{1}{2}$	$4\frac{7}{16}$	$3\frac{1}{2}$	5	$5\frac{13}{16}$	" $+ \frac{2}{100}$
$4\frac{3}{4}$	$4\frac{11}{16}$	4	$5\frac{1}{2}$	$6\frac{3}{8}$	" $+ \frac{2}{100}$
5	$4\frac{15}{16}$	4	$5\frac{1}{2}$	$6\frac{3}{8}$	" $+ \frac{3}{100}$
$5\frac{1}{4}$	$5\frac{3}{16}$	4	6	$6\frac{15}{16}$	" $+ \frac{3}{100}$
$5\frac{1}{2}$	$5\frac{7}{16}$	4	6	$6\frac{15}{16}$	" $+ \frac{3}{100}$
$5\frac{3}{4}$	$5\frac{11}{16}$	4	$6\frac{1}{2}$	$7\frac{1}{2}$	" $+ \frac{3}{100}$
6	$5\frac{15}{16}$	4	$6\frac{1}{2}$	$7\frac{1}{2}$	" $+ \frac{3}{100}$
$6\frac{1}{4}$	$6\frac{3}{16}$	4	7	$8\frac{1}{8}$	" $+ \frac{3}{100}$
$6\frac{1}{2}$	$6\frac{7}{16}$	4	7	$8\frac{1}{8}$	" $+ \frac{3}{100}$
$6\frac{3}{4}$	$6\frac{11}{16}$	4	$7\frac{1}{2}$	$8\frac{11}{16}$	" $+ \frac{3}{100}$
7	$6\frac{15}{16}$	4	$7\frac{1}{2}$	$8\frac{11}{16}$	" $+ \frac{3}{100}$

Allow $\frac{1}{16}''$ excess for each eye packed on the pin.

All pins turned to gauge above diameters.

LATERAL PINS.

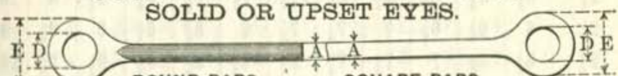


EDGE MOOR BRIDGE WORKS' STANDARD.

Rough Diameter of Pin.	Nominal Diameter of Pin.	Finished Diameter of Pin.	Reduced Point.	Short Diameter of Nut.	Long Diameter of Nut.	Diameter of Thread.	Diameter of Cotter Pin.
G	N	D	P	T	R	F	C
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
1½	1¼	1 3/16	1	1⅝	1⅞	1	5/16
1¾	1½	1 7/16	1¼	2	2 5/16	1¼	"
2	1¾	1 11/16	1½	2½	2⅞	1½	"
2¼	2	1 15/16	1¾	2½	2⅞	1½	"
2½	2¼	2 3/16	2	2½	2⅞	1½	⅜
2¾	2½	2 7/16	2¼	3½	4 1/16	2	"
3	2¾	2 11/16	2½	3½	4 1/16	2	"
3¼	3	2 15/16	2¾	3½	4 1/16	2	"
3½	3¼	3 3/16	3	4½	5 3/16	2½	"
3¾	3½	3 7/16	3¼	4½	5 3/16	2½	"
4	3¾	3 11/16	3½	4½	5 3/16	2½	"

$D = G - \frac{5}{16}''$. $P = N - \frac{1}{4}''$.

COUNTER AND LATERAL RODS.
SOLID OR UPSET EYES.



ROUND BARS. **SQUARE BARS.**

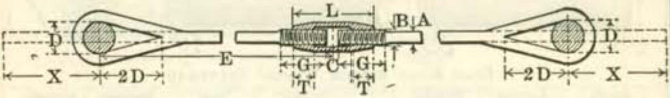
EDGE MOOR BRIDGE WORKS' STANDARD.

Diameter of Bar.	Diameter of Largest Head.	Diameter of Largest Pin.	Add for One Head.	Side of Square Bar.	Diameter of Largest Head.	Diameter of Largest Pin.	Add for One Head.
A	E	D		A	E	D	
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
⅞	2¼	1¼	9	1	4¼	2½	16
1	4¼	2½	18	1⅛	4¼	2½	14
1⅛	4¼	2½	16	1¼	5	2¾	18½
1¼	5	2¾	20½	1⅜	5	2¾	16½
1⅜	5	2¾	18½	1½	5½	3	18
1½	5½	3	20	1⅝	5½	3	16½
1⅝	5½	3	18½	1¾	6	3¼	18
1¾	6	3¼	21	1⅞	6	3¼	16½
1⅞	6	3¼	19½	2	6½	3½	18½
2	6½	3½	21½	2⅛	6½	3½	17
2⅛	6½	3½	20	2¼	7½	4	21½
2¼	7½	4	24½	2⅜	7½	4	19¾
2⅜	7½	4	22¾	2½	8	4	22½
2½	8	4	25½	2⅝	8	4	21
2⅝	8	4	24	2¾	8	4	19½
2¾	8	4	22½	1⅛	5¼	3 3/16	23
. . . . .	. . . . .		. . . .	1¼	5½	3 3/16	23
. . . . .	. . . . .	. . . . .	. . . .	1⅜	5¾	3 3/16	20
. . . . .	. . . . .	. . . . .	. . . .	1½	6	3 3/16	20
. . . . .	. . . . .	. . . . .	. . . .	⅞	3½	2¼	
. . . . .	. . . . .	. . . . .	. . . .	1 3/16	4½	2½	18

For details of upset screw ends for round and square bars see pages 214 and 215.

COUNTER AND LATERAL RODS.

LOOP WELDED EYES.



Additional length of bar beyond center of pin required to make eye for square and round bars.

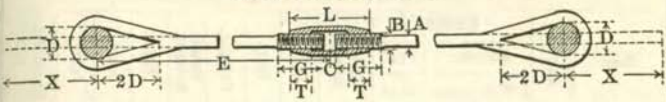
Diameter of Pin in Inches.	Diameter or Side of Bar in Inches.											
	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞
1½	4⅛	4½	4¾	5⅛	5½	5⅞	6¼	6½	6⅞	7¼	7⅝	8
1¾	4½	4⅞	5¼	5⅝	6	6¼	6⅝	7	7⅜	7¾	8	8⅜
2	5	5⅜	5¾	6	6⅛	6¾	7⅛	7½	7¾	8⅛	8½	8⅞
2¼	5½	5¾	6⅛	6½	6⅞	7¼	7½	7⅞	8¼	8⅝	9	9¼
2½	6	6¼	6⅝	7	7¼	7⅝	8	8⅜	8¾	9	9⅜	9¾
2¾	6⅜	6¾	7	7⅜	7¾	8⅛	8½	8¾	9⅛	9½	9⅞	10¼
3	6¾	7⅛	7½	7⅞	8¼	8½	8⅞	9¼	9⅝	10	10¼	10⅝
3¼	7¼	7⅝	8	8¼	8⅝	9	9⅜	9¾	10	10⅜	10¾	11⅛
3½	7¾	8	8⅜	8¾	9⅛	9½	9¾	10⅛	10½	10⅞	11¼	11½
3¾	8⅛	8½	8⅞	9¼	9½	9⅞	10¼	10⅝	11	11¼	11⅝	12
4	8⅝	9	9¼	9⅝	10	10⅜	10¾	11	11⅜	11¾	12⅛	12½
4¼	9	9⅜	9¾	10⅛	10½	10¾	11⅛	11½	11⅞	12¼	12½	12⅞
4½	9½	9⅞	10¼	10½	10⅞	11¼	11⅝	12	12¼	12⅝	13	13⅜
4¾	10	10¼	10⅝	11	11⅜	11¾	12	12⅜	12¾	13⅛	13½	13¾
5	10⅜	10¾	11⅛	11½	11¾	12⅛	12½	12⅞	13¼	13½	13⅞	14¼
5¼	10⅞	11¼	11½	11⅞	12¼	12⅝	13	13¼	13⅝	14	14⅜	14¾
5½	11¼	11⅝	12	12⅜	12¾	13	13⅜	13¾	14⅛	14½	14¾	15⅛
5¾	11¾	12⅛	12½	12¾	13⅛	13½	13⅞	14¼	14½	14⅞	15¼	15⅝
6	12¼	12½	12⅞	13¼	13⅝	14	14¼	14⅝	15	15⅜	15¾	16

FORMULÆ.—Length in inches beyond center of pin required to form one eye $= X = 3.8\ (D + A) - (2\ D + A) = 1.8\ D + 2.8\ A$.

Length of bar including amount required to form one eye $= E - \frac{1}{2}C + X$.

COUNTER AND LATERAL RODS.

LOOP WELDED EYES.



Additional length of bar beyond center of pin required to make eye for square and round bars.

Diameter of Pin in Inches.	Diameter or Side of Bar in Inches.											
	2	2⅛	2¼	2⅜	2½	2⅝	2¾	2⅞	3	3⅛	3¼	3⅜
1¾	8¾	9⅛										
2	9¼	9½	9⅞									
2¼	9⅝	10	10⅜	10¾	11	11⅜	11¾	12⅛				
2½	10⅛	10½	10¾	11⅛	11½	11⅞	12¼	12½	12⅞	13¼		
2¾	10½	10⅞	11¼	11⅝	12	12¼	12⅝	13	13⅜	13¾	14	14⅜
3	11	11⅜	11¾	12	12⅜	12¾	13⅛	13½	13¾	14⅛	14½	14⅞
3¼	11½	11¾	12⅛	12½	12⅞	13¼	13½	13⅞	14¼	14⅝	15	15¼
3½	11⅞	12¼	12⅝	13	13¼	13⅝	14	14⅜	14¾	15	15⅜	15¾
3¾	12⅜	12¾	13	13⅜	13¾	14⅛	14½	14¾	15⅛	15½	15⅞	16¼
4	12¾	13⅛	13½	13⅞	14¼	14½	14⅞	15¼	15⅝	16	16¼	16⅝
4¼	13¼	13⅝	14	14¼	14⅝	15	15⅜	15¾	16	16⅜	16¾	17⅛
4½	13¾	14	14⅜	14¾	15⅛	15½	15¾	16⅛	16½	16⅞	17¼	17½
4¾	14⅛	14½	14⅞	15¼	15½	15⅞	16¼	16⅝	17	17¼	17⅝	18
5	14⅝	15	15¼	15⅝	16	16⅜	16¾	17	17⅜	17¾	18⅛	18½
5¼	15	15⅜	15¾	16⅛	16½	16¾	17⅛	17½	17⅞	18¼	18½	18⅞
5½	15½	15⅞	16¼	16½	16⅞	17¼	17⅝	18	18¼	18⅝	19	19⅜
5¾	16	16¼	16⅝	17	17⅜	17¾	18	18⅜	18¾	19⅛	19½	19⅞
6	16⅜	16¾	17⅛	17½	17¾	18⅛	18½	18⅞	19⅛	19½	19⅞	20¼

For additional length required to form upset end and details of same see tables of Upset Ends, pages 214 and 215.

For details of Turnbuckles, see page 218.

For details of Right and Left Nuts, see page 219.

STANDARD STEEL WIRE NAILS AND SPIKES.

Sizes, Lengths and Approximate Number per Pound.

Sizes.	Length.	COMMON. Diameter. B. W. G.	COMMON. Diameter. Inches.	COMMON. No. per Pound.	Barbed Common.	Clinch.	Fence.	Finishing.	Barbed Finishing.	Fine.	Barrel.	Casing.	Smooth Box.
	3/4	...	...	...	...	..	..	..	..	..	940	..	..
	7/8	...	...	...	...	..	..	..	..	..	804	..	..
2d ...	1	15	.072	900	860	622	..	1558	1558	1440	620	1140	1000
3d Fine.	1 1/8	...	...	...	...	..	..	..	..	810	590	..	..
3d Com.	1 1/4	14	.083	615	594	412	..	884	884	..	542	675	660
	1 3/8	...	...	...	...	..	..	..	..	..	365	..	..
4d ...	1 1/2	12 1/2	.102	322	339	267	..	767	767	550	322	567	550
5d ...	1 3/4	12 1/2	.102	250	230	230	127	491	491	..	..	396	366
6d ...	2	11 1/2	.115	200	205	156	114	359	359	..	..	260	250
7d ...	2 1/4	11 1/2	.115	154	135	110	88	317	317	..	..	239	236
8d ...	2 1/2	10 1/4	.124	106	96	98	74	214	214	..	..	160	157
9d ...	2 3/4	10 1/4	.124	85	92	86	58	195	195	..	..	148	145
10d ...	3	9	.148	74	63	66	42	134	134	..	..	108	107
12d ...	3 1/4	9	.148	57	52	57	36	120	120	..	..	99	98
16d ...	3 1/2	8	.165	46	38	46	28	91	91	..	..	69	65
20d ...	4	6	.203	29	30	35	22	61	61	..	..	50	45
30d ...	4 1/2	5	.220	23	23	..	..	..	..	..	..	45	40
40d ...	5	4	.238	17	17	..	..	..	..	..	..	35	30
50d ...	5 1/2	3	.259	13 1/2	13 1/2	..	..	..	..	..	..		..
60d ...	6	2	.284	10 1/2	10 1/2	..	..	..	..	..	..	..	..

Sizes.	Length.	Barbed Box.	Flooring Brads.	Barbed Oval Head Car Nails. Light.	Barbed Oval Head Car Nails. Heavy.	Slating.	Barbed Roofing.	Shingle.	Tobacco.	Lining.	WIRE SPIKES. Diameter. B. W. G.	WIRE SPIKES. Diameter. Inches.	WIRE SPIKES. No. per Pound.
	3/4	..	..	..	...	..	648	..	..	1930	...	...	...
	7/8	..	..	..	...	..	413	..	..	1660	...	...	...
2d ...	1	1000	..	..	...	385	384	..	..	1440	...	...	...
3d Fine.	1 1/8	..	..	..	...	..	339	..	..	..	...	...	...
3d Com.	1 1/4	660	..	..	...	230	231	380	..	..	...	...	...
	1 3/8	..	..	..	...	..	..	..	..	..	...	...	...
4d ...	1 1/2	550	..	260	164	198	154	256	256	..	...	...	...
5d ...	1 3/4	366	..	134	103	125	135	226	226	..	...	...	...
6d ...	2	250	151	119	91	112	90	200	145	..	...	...	...
7d ...	2 1/4	236	136	85	73	..	..	130	130	..	...	...	...
8d ...	2 1/2	157	98	75	65	..	..	120	100	..	...	...	...
9d ...	2 3/4	145	86	58	51	..	..	115	85	..	...	...	...
10d ...	3	107	66	55	45	..	..	79	65	..	6	.203	37
12d ...	3 1/4	98	51	43	38	..	..	..	..	..	...	...	...
16d ...	3 1/2	65	40	39	34	..	..	..	..	..	5	.220	29
20d ...	4	45	29	31	26	..	..	..	..	..	4	.238	23
30d ...	4 1/2	40	..	27	23	..	..	..	..	..	3	.259	18
40d ...	5	30	..	21	17	..	..	..	..	..	2	.284	13
50d ...	5 1/2	..	..	18	14	..	..	..	..	..	1	.300	10
60d ...	6	..	..	15	13	..	..	..	..	..	1	.300	9
	6 1/2	..	..	..	...	..	..	..	..	..	...	5/16	7 1/2
	7	..	..	..	...	..	..	..	..	..	...	5/16	6 1/2
	8	..	..	..	...	..	..	..	..	..	...	3/8	4 1/4
	9	..	..	..	...	..	..	..	..	..	...	3/8	3 2/3
	10	..	..	..	...	..	..	..	..	..	...	3/8	3 1/4
	12	..	..	..	...	..	..	..	..	..	...	3/8	2 3/4

MISCELLANEOUS STEEL WIRE NAILS.

Approximate Number per Pound.

Birmingham Wire Gauge.	Diameter in Inches.	Lengths–Inches.										
		3/16	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 1/2
00	.380	...	...	...	...	...	...	...	..	..	33	27
3/8	.375	...	...	...	...	...	...	...	..	..	33	27
0	.340	...	...	...	...	...	...	...	.	..	34	29
5/16	.313	...	...	...	...	...	...	...	57	50	45	38
2	.284	...	...	...	...	...	...	...	65	58	52	44
3	.259	...	...	...	...	...	100	87	76	67	60	50
4	.238	...	...	...	...	...	120	104	90	80	72	60
5	.220	...	...	...	211	169	141	121	106	94	85	71
6	.203	...	...	...	247	197	164	141	123	111	99	82
7	.180	...	...	...	299	239	200	171	149	133	120	100
8	.165	...	...	...	345	275	229	197	172	153	137	115
9	.148	...	...	...	414	331	276	236	207	184	165	138
10	.134	...	...	663	496	397	333	283	248	220	198	165
11	.120	...	...	837	628	502	418	359	314	279	251	209
12	.109	...	...	1096	822	658	548	469	411	365	329	274
13	.095	...	..	1429	1072	857	714	613	536	476	429	357
14	.083	...	2840	1893	1420	1136	947	811	710	631	568	473
15	.072	...	3504	2336	1752	1402	1168	1001	876	778	701	584
16	.065	...	4571	3048	2280	1828	1523	1305	1143	1015	913	761
17	.058	...	6233	4156	3116	2495	2077	1781	1558	1385	1246	1038
18	.049	...	8276	5517	4138	3310	2758	2364	2069	1839	1655	1379
19	.042	...	10668	7112	5334	4267	3556	2933	2667	2370	2133	1778
20	.035	20000	15000	10000	7500	6000	5000	4400	3750	3333	3000	
21	.032	23702	17777	11850	8888	7111	5926	5079	4444			
22	.028	30476	22856	15237	11428	9143	7618					

Birmingham Wire Gauge.	Diameter in Inches.	Lengths–Inches.														
		1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/2	4	4 1/2	5	6	7	8	9	10
00	.380	23	20	18	16	15	14	12	10	9	8	7	6	5	4 1/2	4
3/8	.375	23	20	18	16	15	14	12	10	9	8	7	6	5	4 1/2	4
0	.340	25	21	19	17	16	15	13	11	10	9	8	7	5 1/2	5	4 1/3
5/16	.313	32	28	25	23	21	19	16	14	13	11	10	8	7	6	5 1/2
2	.284	37	32	29	26	24	22	19	16	14	13	11	9	8	7	6 1/2
3	.259	43	38	34	30	28	25	22	19	17	15	13	11	10	8	7 1/2
4	.238	51	45	40	36	33	30	26	23	20	18	15	13	11	10	9
5	.220	60	53	47	42	39	35	30	26	24	21	18	15			
6	.203	71	62	55	50	45	41	35	31	28	25	21	18			
7	.180	85	75	67	60	54	50	43	37	33	30	25				
8	.165	98	86	76	69	62	57	49	43	39	35	29				
9	.148	118	103	92	82	75	69	59	52	46	41					
10	.134	142	124	110	99	90	83	71	62	55	50					
11	.120	179	157	139	125	114	105	90	79	70						
12	.109	235	204	182	164	149	137	117	103							
13	.095	306	268	238	214	195	178	153								
14	.083	406	350	315	284	258	236									
15	.072	500	438	389	350											
16	.065	653	571	508												
17	.058	890	779													
18	.049	1182														

Wire Gauge.	11	12
00	3 3/4	3 1/4
3/8	3 3/4	3 1/4
0	4	3 1/2
5/16	5	4 1/2
2	6	5 1/2

These approximate numbers are an average only, and the figures given may be varied either way, by changes in the dimensions of heads or points. Brads and no-head nails will run more to the pound than table shows, and large or thick-headed nails will run less.

CUT STEEL NAILS AND SPIKES.

Sizes, Lengths and Approximate Number per Pound.

Sizes.	Length. Inches.	Common.	Clinch.	Finishing.	Casing and Box.	Fencing.	Spikes.
2d	1	740	400	1100			
3d	1¼	460	260	880			
4d	1½	280	180	530	420		
5d	1¾	210	125	350	300	100	
6d	2	160	100	300	210	80	
7d	2¼	120	80	210	180	60	
8d	2½	88	68	168	130	52	
9d	2¾	73	52	130	107	38	
10d	3	60	48	104	88	26	
12d	3¼	46	40	96	70	20	
16d	3½	33	34	86	52	18	17
20d	4	23	24	76	38	16	14
25d	4¼	20	....	....	....	....	
30d	4½	16½	....	....	30	....	
40d	5	12	....	....	26	....	9
50d	5½	10	....	....	20	....	7½
60d	6	8	....	....	16	....	6
	6½	....	....	....	....	....	5½
	7	....	....	....	....	....	5

Sizes.	Length. Inches.	Barrel.	Light Barrel.	Slating.	Sizes.	Length. Inches.	Flat Grip. Fine.	Edge Grip. Fine.	Tobacco.	Brads.	Shingle.
	⅝	750	....	....	...	¾	1462				
	¾	600	....	....	...	⅞	1300				
	⅞	500	....	....	2d	1	1100	960			
2d	1	450	....	340	3d	1⅛	800	750			
	1⅛	310	400	....	4d	1⅜	650	600			
3d	1¼	280	304	280							
	1⅜	210	....	....							
4d	1½	190	224	220							
5d	1¾	....	....	180					130		
6d	2	....	....	....					97	120	
7d	2¼	....	....	....					85	94	
8d	2½	....	....	....					68	74	90
9d	2¾	....	....	....					58	62	72
10d	3	....	....	....					48	50	60
12d	3¼	....	....	....					....	40	
16d	3½	....	....	....					....	27	

SQUARE BOAT SPIKES.

Approximate Number in a Keg of 200 Pounds.

Size. Inches.	Length of Spike—Inches. 3	4	5	6	7	8	9	10	11	12	14	16
$\frac{1}{4}$	3000	2375	2050	1825								
$\frac{5}{16}$	1660	1360	1230	1175	990	880						
$\frac{3}{8}$	1320	1140	940	800	650	600	525	475				
$\frac{7}{16}$	...	...	...	600	590	510	400	360	320	230		
$\frac{1}{2}$	...	...	...	450	375	335	300	275	260	240		
$\frac{5}{8}$	...	...	...	...	..	260	240	220	205	190	175	160

RAILROAD SPIKES.

Size Measured Under Head. Inches.	Average Number per Keg of 200 Pounds.	Quantity of Spikes per Mile of Single Track. Ties 2 feet c. to c. 4 Spikes per Tie. Pounds.	Kegs.	Rail Used. Weight per Yard. Pounds.
$5\frac{1}{2} \times \frac{5}{8}$	300	7040	$35\frac{1}{2}$	75 to 100
$5\frac{1}{2} \times \frac{9}{16}$	375	5870	$29\frac{1}{4}$	45 " 75
$5 \times \frac{9}{16}$	400	5170	26	40 " 56
$5 \times \frac{1}{2}$	450	4660	$23\frac{1}{3}$	35 " 40
$4\frac{1}{2} \times \frac{1}{2}$	530	3960	20	30 " 35
$4 \times \frac{1}{2}$	600	3520	$17\frac{5}{8}$	25 " 35
$4\frac{1}{2} \times \frac{7}{16}$	680	3110	$15\frac{1}{2}$	20 " 30
$4 \times \frac{7}{16}$	720	2910	$14\frac{3}{4}$	20 " 30
$3\frac{1}{2} \times \frac{7}{16}$	900	2350	11	16 " 25
$4 \times \frac{3}{8}$	1000	2090	$10\frac{1}{2}$	16 " 25
$3\frac{1}{2} \times \frac{3}{8}$	1190	1780	9	16 " 20
$3 \times \frac{3}{8}$	1240	1710	$8\frac{1}{2}$	16 " 20
$2\frac{1}{2} \times \frac{3}{8}$	1342	1575	$7\frac{5}{8}$	8 " 16

WROUGHT-IRON WELDED STEAM, GAS AND WATER PIPE.

TABLE OF STANDARD SIZES AND DIMENSIONS BY AMERICAN TUBE AND IRON CO.

Nominal Inside Diameter.	Actual Inside Diameter.	Actual Outside Diameter.	Thickness.	Nominal Weight per Foot.	Circumference.		Length per Square Foot of Surface.	
					Internal.	External.	Inside.	Outside.
Inches.	Inches.	Inches.	Inches.	Pounds.	Inches.	Inches.	Feet.	Feet.
1/8	.27	.405	.07	.24	.84	1.27	14.15	9.44
1/4	.36	.54	.08	.42	1.14	1.69	10.50	7.07
3/8	.49	.675	.09	.56	1.55	2.12	7.67	5.65
1/2	.62	.84	.10	.84	1.95	2.65	6.13	4.50
3/4	.82	1.05	.11	1.12	2.58	3.29	4.63	3.63
1	1.04	1.315	.13	1.67	3.29	4.13	3.67	2.90
1¼	1.38	1.66	.14	2.24	4.33	5.21	2.76	2.30
1½	1.61	1.9	.14	2.68	5.06	5.96	2.37	2.01
2	2.06	2.375	.15	3.61	6.49	7.46	1.84	1.61
2½	2.46	2.875	.20	5.74	7.75	9.03	1.54	1.32
3	3.06	3.5	.21	7.54	9.63	10.96	1.24	1.09
3½	3.56	4.	.22	9.00	11.14	12.56	1.07	.95
4	4.02	4.5	.23	10.66	12.64	14.13	.94	.84
4½	4.50	5.	.24	12.34	14.15	15.70	.84	.76
5	5.04	5.56	.25	14.50	15.84	17.47	.75	.62
6	6.06	6.625	.28	18.76	19.05	20.81	.63	.57
7	7.02	7.625	.30	23.27	22.06	23.95	.54	.50
8	7.98	8.625	.32	28.18	25.07	27.09	.47	.44
9	9.00	9.625	.34	33.70	28.27	30.43	.42	.39
10	10.01	10.75	.36	40.06	31.47	33.77	.38	.35
11	11.	11.75	.37	45.	34.55	36.91	.34	.32
12	12.	12.75	.37	49.00	37.70	40.05	.32	.30
13	13.25	14.	.37	54.00	41.62	43.98	.29	.27
14	14.25	15.	.37	58.00	44.76	47.12	.27	.25
15	15.40	16.	.28	66.00	48.48	50.26	.25	.24
16	16.40	17.	.30	70.00	51.52	53.41	.23	.23
17	17.30	18.	.34	75.00	54.41	56.55	.22	.21

Nominal Inside Diameter.	Internal Area.	External Area.	Length Containing 1 Cubic Foot.	No. of Threads per Inch.	Contents of One Foot in Length.	Sockets on Pipe.	
						Outside Diameter.	Length.
Inches.	Sq. Inches.	Sq. Inches.	Feet.		Gallons.	Inches.	Inches.
1/8	.06	.12	2500.	27	.002	.60	.81
1/4	.10	.22	1385.	18	.002	.78	1.00
3/8	.19	.35	751.5	18	.005	.91	1.10
1/2	.30	.55	472.4	14	.010	1.10	1.31
3/4	.53	.86	270.	14	.023	1.34	1.56
1	.86	1.35	166.9	11½	.040	1.66	1.75
1¼	1.49	3.16	96.25	11½	.063	2.00	1.94
1½	2.03	2.83	70.65	11½	.091	2.28	2.19
2	3.35	4.43	42.36	11½	.163	2.81	2.31
2½	4.78	6.49	30.11	8	.255	3.28	2.70
3	7.38	9.62	19.49	8	.367	4.02	3.00
3½	9.83	12.56	14.56	8	.500	4.50	3.12
4	12.73	15.90	11.31	8	.652	5.10	3.12
4½	15.93	19.63	9.03	8	.826	5.53	3.12
5	19.99	24.29	7.20	8	1.02	6.25	3.70
6	28.88	34.47	4.98	8	1.46	7.34	3.70
7	38.73	45.66	3.72	8	2.00	8.34	4.31
8	50.03	58.42	2.88	8	2.61	9.44	4.56
9	63.63	73.71	2.26	8	3.30	10.47	5.75
10	78.83	90.79	1.80	8	4.08	11.50	6.25
11	95.03	108.43	1.50	8	4.93		
12	113.09	127.67	1.27	8	5.87	13.78	6.25
13	137.88	153.94	1.04	8	6.89	. . . . .	. . . . .
14	159.48	176.71	.90	8	8.00	. . . . .	. . . . .
15	187.04	201.06	.77	8	9.18	. . . . .	. . . . .
16	211.24	226.98	.68	8	10.44	. . . . .	. . . . .
17	235.61	254.47	.61	8	11.79	. . . . .	. . . . .

MANUFACTURERS' STANDARD SPECIFICATIONS.

REVISED OCTOBER 23, 1896.

STRUCTURAL STEEL.

PROCESS OF MANUFACTURE.

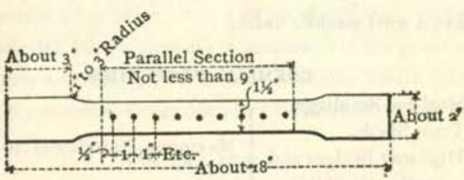
1. Steel may be made by either the Open-hearth or Bessemer process.

TESTING.

2. All tests and inspections shall be made at the place of manufacture prior to shipment.

TEST PIECES.

3. The tensile strength, limit of elasticity and ductility shall be determined from a standard test piece cut from the finished material. The standard shape of the test piece for sheared plates shall be as shown by the following sketch:



Piece to be the same thickness as the plate.

On tests cut from other material the test piece may be either the same as for plates, or it may be planed or turned parallel throughout its entire length. The elongation shall be measured on an original length of 8 inches, except when the thickness of the finished material is $\frac{5}{16}$ inch or less, in which case the elongation shall be measured in a length equal to sixteen times the thickness; and except in rounds of $\frac{5}{8}$ inch or less in diameter, in which case the elongation shall be measured in a length equal to eight times the diameter of section tested. Two test pieces shall be taken from each melt or blow of finished material, one for tension and one for bending.

ANNEALED TEST PIECES.

3 *a*. Material which is to be used without annealing or further treatment is to be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimen representing such material is to be similarly treated before testing.

MARKING.

4. Every finished piece of steel shall be stamped with the blow or melt number, and steel for pins shall have the blow or melt number stamped on the ends. Rivet and lacing steel, and small pieces for pin plates and stiffeners, may be shipped in bundles securely wired together, with the blow or melt number on a metal tag attached.

FINISH.

5. Finished bars must be free from injurious seams, flaws or cracks, and have a workmanlike finish.

CHEMICAL PROPERTIES.

6. Steel for Buildings, Train Sheds, Highway Bridges and similar structures.	Maximum Phosphorus .10 per cent.
7. Steel for Railway Bridges.	Maximum Phosphorus .08 per cent.

PHYSICAL PROPERTIES.

8. Structural steel shall be of three grades, RIVET, SOFT and MEDIUM.

RIVET STEEL.

9. Ultimate strength, 48 000 to 58 000 pounds per square inch.

Elastic limit, not less than one-half the ultimate strength.

Elongation, 26 per cent.

Bending test, 180 degrees flat on itself, without fracture on outside of bent portion.

SOFT STEEL.

10. Ultimate strength, 52 000 to 62 000 pounds per square inch.

Elastic limit, not less than one half the ultimate strength.

Elongation, 25 per cent.

Bending test, 180 degrees flat on itself, without fracture on outside of bent portion.

MEDIUM STEEL.

11. Ultimate strength, 60 000 to 70 000 pounds per square inch.

Elastic limit, not less than one half the ultimate strength.

Elongation, 22 per cent.

Bending test, 180 degrees to a diameter equal to thickness of piece tested, without fracture on outside of bent portion.

PIN STEEL.

12. Pins made from either of the above-mentioned grades of steel shall, on a specimen test piece cut at a depth of one inch from surface of finished material, fill the physical requirements of the grade of steel from which they are rolled, for ultimate strength, elastic limit, and bending, but the required elongation shall be decreased 5 per cent.

EYE-BAR STEEL.

13. Eye-bar material, $1\frac{1}{2}$ inches and less in thickness, made of either of the above-mentioned grades of steel, shall, on test pieces cut from finished material, fill the requirements of the grade of steel from which it is rolled. For thicknesses greater than $1\frac{1}{2}$ inches, there will be allowed a reduction in the percentage of elongation of 1 per cent. for each $\frac{1}{8}$ of an inch increase of thickness, to a minimum of 20 per cent. for medium steel and 22 per cent. soft for steel.

FULL SIZE TEST OF STEEL EYE-BARS.

14. Full size tests of steel eye-bars shall be required to show not less than 10 per cent. elongation in the body of the bar, and tensile strength not more than 5 000 pounds below the minimum tensile strength required in specimen tests of the grade of steel from which they are rolled. The bars will be required to break in the body, but should a bar break in the head, but develop 10 per cent. elongation and the ultimate strength specified, it shall not be cause for rejection, provided not more than one-third of the total number of bars tested break in the head; otherwise the entire lot will be rejected.

VARIATION IN WEIGHT.

15. The variation in cross-section or weight of more than 2½ per cent. from that specified will be sufficient cause for rejection, except in the case of sheared plates which will be covered by the following permissible variations:

a. Plates 12½ pounds per square foot, or heavier, when ordered to weight, shall not average more than 2½ per cent. variation above, or 2½ per cent. below the theoretical weight.

b. Plates under 12½ pounds per square foot, when ordered to weight, shall not average a greater variation than the following:

Up to 75 inches wide, 2½ per cent. above, or 2½ per cent. below the theoretical weight.

75 inches and over, 5 per cent. above, or 5 per cent. below the theoretical weight.

c. For all plates ordered to gauge, there will be permitted an average excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table:

TABLE OF ALLOWANCES FOR OVERWEIGHT FOR RECTANGULAR PLATES WHEN ORDERED TO GAUGE.

THE WEIGHT OF 1 CUBIC INCH OF ROLLED STEEL IS ASSUMED TO BE .2833 POUNDS.

PLATES $\frac{1}{4}''$ AND OVER IN THICKNESS.

THICKNESS OF PLATE.	WIDTH OF PLATE.		
	Up to 75 Inches.	75 Inches to 100 Inches.	Over 100 Inches.
$\frac{1}{4}$ inch	10 per cent.	14 per cent.	18 per cent.
$\frac{5}{16}$ "	8 "	12 "	16 "
$\frac{3}{8}$ "	7 "	10 "	13 "
$\frac{7}{16}$ "	6 "	8 "	10 "
$\frac{1}{2}$ "	5 "	7 "	9 "
$\frac{9}{16}$ "	$4\frac{1}{2}$ "	$6\frac{1}{2}$ "	$8\frac{1}{2}$ "
$\frac{5}{8}$ "	4 "	6 "	8 "
Over $\frac{5}{8}$ "	$3\frac{1}{2}$ "	5 "	$6\frac{1}{2}$ "

PLATES UNDER $\frac{1}{4}''$ IN THICKNESS.

THICKNESS OF PLATE.	WIDTH OF PLATE.	
	Up to 50 Inches.	50 Inches and Above.
$\frac{1}{8}$ up to $\frac{5}{32}$	10 per cent.	15 per cent.
$\frac{5}{32}$ " $\frac{3}{16}$	$8\frac{1}{2}$ "	$12\frac{1}{2}$ "
$\frac{3}{16}$ " $\frac{1}{4}$	7 "	10 "

STRUCTURAL CAST IRON.

1. Except when chilled iron is specified, all castings shall be tough gray iron, free from injurious cold-shuts or blow-holes, true to pattern, and of a workmanlike finish. Sample pieces, one inch square, cast from the same heat of metal in sand moulds, shall be capable of sustaining on a clear span of 4 feet 8 inches a central load of 500 pounds when tested in the rough bar.

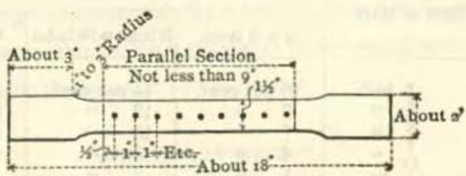
SPECIAL OPEN-HEARTH PLATE AND RIVET STEEL.

TESTING AND INSPECTION.

1. All tests and inspections shall be made at the place of manufacture prior to shipment.

TEST PIECES.

2. The tensile strength, limit of elasticity and ductility, shall be determined from a standard test piece cut from the finished material. The standard shape of the test piece for sheared plates shall be as shown by the following sketch:



Piece to be the same thickness as the plate.

On tests cut from other material the test piece may be either the same as for plates, or it may be planed or turned parallel throughout its entire length. The elongation shall be measured on an original length of 8 inches, except when the thickness of the finished material is $\frac{5}{16}$ inch or less, in which case the elongation shall be measured in a length equal to sixteen times the thickness; and except in rounds of $\frac{5}{8}$ inch or less in diameter, in which case the elongation shall be measured in a length equal to eight times the diameter of section tested. Four test pieces shall be taken from each melt of finished material; two for tension and two for bending.

ANNEALED TEST PIECES.

3. Material which is to be used without annealing or further treatment is to be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimen representing such material is to be similarly treated before testing.

MARKING.

4. Every finished piece of steel shall be stamped with the melt number. Rivet steel may be shipped in bundles securely wired together, with the melt number on a metal tag attached.

FINISH.

5 All plates shall be free from surface defects and have a workmanlike finish.

CHEMICAL PROPERTIES.

6. The maximum allowable limits of phosphorus and sulphur shall be as follows:

a. Flange or Boiler Steel.	Maximrm	Phosphorus	.06	per cent.
	"	Sulphur	.04	"
b. Extra Soft and Fire Box Steel.	"	Phosphorus	.04	"
	"	Sulphur	.04	"
c. Boiler Rivet Steel.	"	Phosphorus	.04	"
	"	Sulphur	.04	"

PHYSICAL PROPERTIES.

7. Steel shall be of four grades—EXTRA SOFT, FIRE BOX, FLANGE or BOILER, and BOILER RIVET STEEL.

EXTRA SOFT STEEL.

8. Ultimate strength, 45 000 to 55 000 pounds per square inch.

Elastic limit, not less than one-half the ultimate strength.

Elongation, 28 per cent.

Cold and quench bends, 180 degrees flat on itself, without fracture on outside of bent portion.

FIRE BOX STEEL.

9. Ultimate strength, 52 000 to 62 000 pounds per square inch.

Elastic limit, not less than one-half the ultimate strength.

Elongation, 26 per cent.

Cold and quench bends, 180 degrees flat on itself, without fracture on outside of bent portion.

FLANGE OR BOILER STEEL.

10. Ultimate strength, 52 000 to 62 000 pounds per square inch.

Elastic limit, not less than one-half the ultimate strength.

Elongation, 25 per cent.

Cold and quench bends, 180 degrees flat on itself, without fracture on outside of bent portion.

BOILER RIVET STEEL.

11. Steel for boiler rivets shall be made of the extra soft quality specified in paragraph No. 8.

VARIATION WHEN ORDERED TO WEIGHT.

12. Plates 12½ pounds per square foot, or heavier, when ordered to weight, shall not average more than 2½ per cent. variation above, or 2½ per cent. below the theoretical weight.

a. Plates under $12\frac{1}{2}$ pounds per square foot, when ordered to weight, shall not average a greater variation than the following:

Up to 75 inches wide, $2\frac{1}{2}$ per cent. above, or $2\frac{1}{2}$ per cent. below the theoretical weight.

75 inches and over, 5 per cent. above, or 5 per cent. below the theoretical weight.

VARIATION WHEN ORDERED TO GAUGE.

b. For all plates ordered to gauge, there will be permitted an average excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table, provided no plate shall be rejected for light gauge measuring .01″ or less below the ordered thickness:

TABLE OF ALLOWANCES FOR OVERWEIGHT FOR RECTANGULAR PLATES WHEN ORDERED TO GAUGE.

THE WEIGHT OF 1 CUBIC INCH OF ROLLED STEEL IS ASSUMED TO BE .2833 POUNDS.

PLATES $\frac{1}{4}$″ AND OVER IN THICKNESS.

THICKNESS OF PLATE.	WIDTH OF PLATE.		
	Up to 75 Inches.	75 Inches to 100 Inches.	Over 100 Inches.
$\frac{1}{4}$ inch	10 per cent.	14 per cent.	18 per cent.
$\frac{5}{16}$ "	8 "	12 "	16 "
$\frac{3}{8}$ "	7 "	10 "	13 "
$\frac{7}{16}$ "	6 "	8 "	10 "
$\frac{1}{2}$ "	5 "	7 "	9 "
$\frac{9}{16}$ "	$4\frac{1}{2}$ "	$6\frac{1}{2}$ "	$8\frac{1}{2}$ "
$\frac{5}{8}$ "	4 "	6 "	8 "
Over $\frac{5}{8}$ "	$3\frac{1}{2}$ "	5 "	$6\frac{1}{2}$ "

PLATES UNDER $\frac{1}{4}$″ IN THICKNESS.

THICKNESS OF PLATE.	WIDTH OF PLATE.	
Inches.	Up to 50 Inches.	50 Inches and Above.
$\frac{1}{8}$ to $\frac{5}{32}$	10 per cent.	15 per cent.
$\frac{5}{32}$ " $\frac{3}{16}$	$8\frac{1}{2}$ "	$12\frac{1}{2}$ "
$\frac{3}{16}$ " $\frac{1}{4}$	7 "	10 "

WOODEN BEAMS AND COLUMNS.

The results of the latest and most complete studies of wooden beams and columns of various kinds of American timber are contained in the Proceedings of the Fifth Annual Convention of the Association of Railway Superintendents of Bridges and Buildings, October, 1895, at which Mr. Walter Berg, Chairman of the Committee on Strength of Bridge and Trestle Timbers, presented a report, extracts and tables from which are given in the following pages.

The recent reports of the Forestry Division of the United States Department of Agriculture, Bulletins Nos. 8 and 12, and Circular No. 15, contain reports of recent tests of American woods, and deductions drawn therefrom by Prof. J. B. Johnson, and A. L. Johnson, who conducted the work under the direction of Mr. B. E. Fernow, Chief of the Forestry Division. Extracts and tables from these reports are given on the following pages.

The tables of safe loads for wooden beams and tables of strength of wooden columns given on the following pages have been specially calculated for this book, using as a basis the information regarding the properties of the various species contained in the reports above referred to.

Explanation of the Tables of Safe Loads in Pounds, Uniformly Distributed for Rectangular Wooden Beams One Inch Thick, Pages 248 to 253, Inclusive.

General.

For convenience in use, three of these tables have been prepared, each of which applies to woods having practically the same transverse strength or allowable fibre stress per square inch.

The values given in the tables are the safe loads in pounds uniformly distributed exclusive of the weight of the beam itself for rectangular beams one inch thick for spans from four to thirty-five feet and for depths from four to twenty-four inches. The safe load for a beam of any thickness may be found by multiplying the values given in the tables by the thickness of the beam in inches.

The last column of each of the three Tables of Safe Loads for Rectangular Wooden Beams gives a coefficient of deflection by means of which the deflection for any beam may be obtained, corresponding to the given span and safe load, by dividing the coefficient by the depth of the beam in inches, which will give approximately the deflection in inches under the given conditions.

In each table the deflection coefficient is given for one species of wood only as shown, but the deflections for other species may be obtained from these by proportion as explained hereafter.

For the reason that wood has no well-defined limit or modulus of elasticity the deflections obtained by the use of the coefficients are only approximate and will vary, dependent upon the moisture content of the wood and the character of the loading. The deflections thus obtained are therefore only useful as a general indication of the amount of bending to be expected under the given conditions and are not exact as in the case of materials like steel, which has a well-defined limit and modulus of elasticity.

The safe loads for other species of woods than those stated in the headings of the tables may be obtained from those given, by direct proportion, dependent upon the ratio of their allowable unit stress as compared with that for which the table is figured, as stated in the footnotes at the bottom of the tables.

EXPLANATION OF THE TABLE OF SAFE LOADS FOR RECTANGULAR BEAMS OF WHITE PINE, NORWAY PINE, SPRUCE AND EASTERN FIR.

The various species of woods the values for which are included in this table are calculated for an allowable fibre stress of 700 pounds per square inch.

The deflection coefficients are given for white pine, and are based on a modulus of elasticity of 1 000 000 pounds per square inch.

The lower dotted line crossing the table indicates the limits of spans for which the deflection will exceed $\frac{1}{360}$ of the span for the kind of wood for which the deflection coefficient is given. For spans below the line the safe loads given in the tables will produce a deflection greater than $\frac{1}{360}$ of the span, while those above the line will produce less than this, which is the usual limit of deflection in order to prevent cracking of plastered ceilings. Similarly the upper dotted line indicates the limit of deflection for the kind of wood for which the deflection coefficient is given, corresponding to a modulus of elasticity of 50 000 pounds per square inch which should be considered in cases where the deflection should be closely limited to prevent damage to decorative work or plaster on the ceilings. The coefficient of deflection for Norway pine, spruce and Eastern fir for a modulus of elasticity of 1 200 000 pounds per square inch may be obtained by multiplying those given in the tables for white pine by $\frac{5}{6}$, and for a modulus of elasticity of 600 000 by multiplying the same by $\frac{5}{3}$.

The upper full zig-zag line in the table gives the limits of the safe loads corresponding to the allowable shearing stress along the neutral axis of the beam. The safe loads above the line, which are based upon the extreme fibre strains, will produce shearing stresses along the axis or with the grain in excess of that allowable, which in the case of white pine and the other woods of this table is 100 pounds per square inch.

The position of this line which indicates the limit of safe loads for shearing along the neutral axis was determined by the aid of the following formula:

$$W = \frac{2bds}{3}$$

in which

W = safe load in pounds uniformly distributed.

d = depth of beam in inches.

b = breadth of beam in inches.

s = allowable shear in the direction of the grain in pounds per square inch.

Explanation of the Table of Safe Loads for Rectangular Beams of White Oak and Short-leaf Yellow Pine.

The table is calculated for an allowable fibre stress for flexure of 1000 pounds per square inch.

The deflection coefficients are figured for a modulus of elasticity of 1 100 000 pounds per square inch, but may be used for other, obtaining the deflections for other moduli as explained heretofore.

The lower dotted line across the table indicates the limits of spans for which the safe load will produce deflections greater than $\frac{1}{360}$ of the length of the beam. Values above the line will give less deflection than this, and those below will give greater, based on a modulus of 1 100 000 pounds per square inch. Similarly the upper dotted line indicates the limit of deflection corresponding to a modulus of elasticity of 550 000 pounds per square inch.

The lower full zig-zag line across the table indicates the limiting spans and loads based on the allowable intensity of shearing stress along the neutral axis of the beam. The values above the lower zig-zag line correspond to shearing stresses greater than the allowable stress in the direction of the grain for short-leaf yellow pine, while those below the line correspond to shearing stresses less than that allowable which in this case is assumed to be 100 pounds per square inch.

Similarly the upper full zig-zag line indicates the limits for shearing along the axis for white oak based on an allowable intensity of 200 pounds per square inch.

EXPLANATION OF TABLES OF SAFE LOADS FOR RECTANGULAR BEAMS OF LONG-LEAF YELLOW PINE.

This table is computed for an allowable fibre stress of 1 200 pounds per square inch and the deflection coefficients are calculated for a modulus of elasticity of 1 700 000 pounds per square inch.

The limit for a deflection of $\frac{1}{360}$ of the span is indicated by the lower dotted zig-zag line on the tables, the values below which correspond to greater and those above to less than the limiting deflection. The upper dotted zig-zag line indicates the limit of deflection for a modulus of elasticity of 850 000 pounds per square inch.

The full zig-zag line indicates the limit of allowable shearing stress along the axis corresponding to an allowable intensity of 150 pounds per square inch.

BEARING AT POINTS OF SUPPORT.

Care should be taken in designing to provide sufficient bearing at the points of support so that the allowable intensity of compression across the grain as given in the table on pages 244 and 245 is not exceeded.

This may be obtained where necessary by the use of corbels or bearing plates of harder wood so arranged as to give a large bearing area against the softer beam.

The following statements are made in Bulletin No. 12, U. S. Department of Agriculture, Division of Forestry:

RECOMMENDED PRACTICE.

" Since the strength of timber varies very greatly with the moisture contents (see Bulletin 8 of the Forestry Division), the economical designing of such structures will necessitate their being separated into groups according to the maximum moisture contents in use.

MOISTURE CLASSIFICATION.

" Class A (moisture contents, 18 per cent.)—Structures freely exposed to the weather, such as railway trestles, uncovered bridges, etc.

" Class B (moisture contents, 15 per cent.)—Structures under roof but without side shelter, freely exposed to outside air, but protected from rain, such as roof trusses of open shops and sheds, covered bridges over streams, etc.

" Class C (moisture contents, 12 per cent.)—Structures in buildings unheated, but more or less protected from outside air, such as roof trusses or barns, enclosed shops and sheds, etc.

" Class D (moisture contents, 10 per cent.)—Structures in buildings at all times protected from the outside air, heated in the winter, such as roof trusses in houses, halls, churches, etc.

" For long-leaf pine add to all the values given in the tables, except those for moduli of elasticity, tension and shearing, for Class B, 15 per cent.; for Class C, 40 per cent.; and for Class D, 55 per cent. For the other species add to these values, for Class B, 8 per cent.; for Class C, 18 per cent., and for Class D, 25 per cent."

Based upon the above classification of structures, the two following tables have been figured to facilitate calculations of allowable loads for wooden columns and beams.

PROPORTION OF THE VALUES GIVEN IN THE "TABLES OF SAFE LOADS FOR WOODEN BEAMS," PAGES 246 TO 251 INCLUSIVE, TO BE USED IN ORDER TO OBTAIN THE SAFE LOADS FOR THE VARIOUS CLASSES OF STRUCTURES REFERRED TO ABOVE.

Classes.	Yellow Pine.	All Others.
Class A	1.00	1.00
Class B	1.15	1.08
Class C	1.40	1.18
Class D	1.55	1.25

SAFETY FACTORS TO BE APPLIED TO THE VALUES GIVEN IN THE TABLE OF "STRENGTH OF SOLID WOODEN COLUMNS," PAGES 254 AND 255, IN ORDER TO OBTAIN THE SAFE LOADS FOR THE VARIOUS CLASSES OF STRUCTURES REFERRED TO ABOVE.

Classes.	Yellow Pine.	All Others.
Class A	0.20	0.20
Class B	0.23	0.22
Class C	0.28	0.24
Class D	0.31	0.25

SPECIFIC GRAVITY AND WEIGHT PER FOOT FOR VARIOUS KINDS OF TIMBER.

Name of Wood.	Specific Gravity.	Weight per Cubic Foot.	Weight per Foot Board Measure.
White Oak	0.80	49.94	4.16
White Pine	0.38	23.72	1.98
Southern Long-leaf or Georgia Yellow Pine	0.51	31.84	2.65
Douglas, Oregon and Washington Fir or Pine, Yellow Fir.	0.51	31.84	2.65
Douglas, Oregon and Washington Fir or Pine, Red Fir.	0.46	28.84	2.40
Northern or Short-leaf Yellow Pine	0.61	38.08	3.17
Red Pine	0.50	31.21	2.60
Norway Pine	0.50	31.21	2.60
Canadian (Ottawa) White Pine	0.60	37.46	3.15
" (Ontario) Red "	0.55	34.34	2.88
Spruce and Eastern Fir	0.40	24.97	2.08
Hemlock	0.40	24.97	2.08
Cypress	0.46	28.72	2.39
Cedar	0.37	23.10	1.93
Chestnut	0.66	41.20	3.43
California Redwood	0.39	24.16	2.01
California Spruce	0.40	24.97	2.08

The specific gravities and weights given above are the averages of a large number of determinations by various authorities, for woods containing less than 15 per cent. of moisture or such as are commercially known as dry timber. The weights of green or unseasoned woods will be from 20 to 40 per cent. greater than those given in the above table.

SAFE UNIT STRESSES FOR TIMBER.

RECOMMENDED IN BULLETIN NO. 12, U. S. DEPARTMENT OF AGRICULTURE.

Division of Forestry.

Safe Unit Stresses at 18% Moisture.

Species.	Modulus of Strength at Rupture per Square Inch. Lbs.	Modulus of Elasticity per Square Inch. Lbs.	Elastic Resilience per Cubic Inch. Lbs.	Crushing Strength Endwise per Square Inch. Lbs.	Crushing Strength Across the Grain per Square Inch. Lbs.	Tensile Strength per Square Inch. Lbs.	Shearing Strength per Square Inch. Lbs.
Long-leaf Pine (Pinus palustris) D	1550	720000	1.30	1000	215	12000	125
Short-leaf Pine (Pinus echinata) D	1300	600000	1.30	840	215	9000	100
White Pine (Pinus strobus)	880	435000	1.00	700	147	7000	75
Norway Pine (Pinus resinosa)	1090	566000	....	760	143	....	...
Colorado Pine (Pinus ponderosa)	980	444000	....	630	180	....	...
Douglas Fir (Pseudotsuga douglasii)	1320	690000	....	880	167	....	...
Redwood (Sequoia semperviseus)	1440	226000	....	650	115	....	...
Red Cedar (Juniperus virginiana)	1000	335000	....	700	250	....	...
Bald Cypress (Taxodium distichum) D	1000	450000	1.10	675	120	6000	60
White Oak (Quercus alba) D	1200	550000	1.25	800	400	10000	200
Factor of Safety	5	2	1	5	3	1	4

The values marked "D" were obtained from experiments made by the Forestry Division. The other values were obtained from various sources, chiefly the 10th Census Report, but so modified as to give results comparable with Forestry Division values. To arrive at true average values of strength multiply safe loads by factor of safety given in each column. The values for resilience and tensile strength are the ultimate values. The former is practically never used in designing. The latter is a factor impossible to develop in practice, since the piece will always fail in some other way, usually by shearing.

The crushing strength across the grain in above is based upon a crushing of 3 per cent. of the cross sectional height of the piece.

AVERAGE ULTIMATE BREAKING UNIT

Recommended by the Committee on
Association of Railway Superin
Fifth Annual Convention,

Kind of Timber.	Tension.	
	With Grain.	Across Grain.
White Oak	10000	2000
White Pine	7000	500
Southern Long-leaf or Georgia Yellow Pine	12000	600
Douglas, Oregon and Yellow Fir	12000	....
Washington Fir or Pine (Red Fir)	10000	....
Northern or Short-leaf Yellow Pine	9000	500
Red Pine	9000	500
Norway Pine	8000	....
Canadian (Ottawa) White Pine	10000	....
Canadian (Ontario) Red Pine	10000	....
Spruce and Eastern Fir	8000	500
Hemlock	6000	....
Cypress	6000	....
Cedar	8000	....
Chestnut	9000	....
California Redwood	7000	....
California Spruce	....	....

AVERAGE SAFE ALLOWABLE WORKING UNIT

Recommended by the Committee on
Association of Railway Superin
Fifth Annual Convention,

Kind of Timber.	Tension.	
	With Grain.	Across Grain.
Factor of Safety.	Ten.	Ten.
White Oak	1000	200
White Pine	700	50
Southern Long-leaf or Georgia Yellow Pine	1200	60
Douglas, Oregon and Yellow Fir	1200	....
Washington Fir or Pine (Red Fir)	1000	....
Northern or Short-leaf Yellow Pine	900	50
Red Pine	900	50
Norway Pine	800	....
Canadian (Ottawa) White Pine	1000	....
Canadian (Ontario) Red Pine	1000	....
Spruce and Eastern Fir	800	50
Hemlock	600	....
Cypress	600	....
Cedar	800	....
Chestnut	900	....
California Redwood	700	....
California Spruce	....	....

STRESSES, IN POUNDS, PER SQUARE INCH.

"Strength of Bridge and Trestle Timbers."

tendents of Bridges and Buildings.

New Orleans, October, 1895.

Compression.			Transverse.		Shearing.	
With Grain.						
End Bearing.	Columns Under 15 Diams.	Across Grain.	Extreme Fibre Stress.	Modulus of Elasticity.	With Grain.	Across Grain.
7000	4500	2000	6000	1100000	800	4000
5500	3500	800	4000	1000000	400	2000
8000	5000	1400	7000	1700000	600	5000
8000	6000	1200	6500	1400000	600	....
....	....	....	5000	....	....	....
6000	4000	1000	6000	1200000	400	4000
6000	4000	800	5000	1200000	....	....
6000	4000	800	4000	1200000	....	....
....	5000	....	....	....	350	....
....	5000	....	5000	1400000	400	....
6000	4000	700	4000	1200000	400	3000
....	4000	600	3500	900000	350	2500
6000	4000	700	5000	900000	....	....
6000	4000	700	5000	700000	....	1500
....	5000	900	5000	1000000	600	1500
....	4000	800	4500	700000	400	....
....	4000	....	5000	1200000	....	....

STRESSES, IN POUNDS, PER SQUARE INCH.

"Strength of Bridge and Trestle Timbers."

tendents of Bridges and Buildings.

New Orleans, October, 1895.

Compression.			Transverse.		Shearing.	
With Grain.						
End Bearing.	Columns Under 15 Diams.	Across Grain.	Extreme Fibre Stress.	Modulus of Elasticity.	With Grain.	Across Grain.
Five.	Five.	Four.	Six.	Two.	Four.	Four.
1400	900	500	1000	550000	200	1000
1100	700	200	700	500000	100	500
1600	1000	350	1200	850000	150	1250
1600	1200	300	1100	700000	150	....
....	....	....	800	....	....	....
1200	800	250	1000	600000	100	1000
1200	800	200	800	600000	....	....
1200	800	200	700	600000	....	....
....	1000	....	..	....	100	....
....	1000	....	800	700000	100	....
1200	800	200	700	600000	100	750
..	800	150	600	450000	100	600
1200	800	200	800	450000	....	....
1200	800	200	800	350000	....	400
....	1000	250	800	500000	150	400
....	800	200	750	350000	100	....
....	800	....	800	600000	....	....

SAFE LOAD IN POUNDS FOR RECTANGULAR OF WHITE PINE, NORWAY PINE

Allowable fibre stress 700 pounds per square inch safety factor 6.

Safe loads for other factors of safety may be obtained as follows:

Span in Feet.	Depth of Beam in Inches.											Deflection Coefficient for White Pine.
	4	5	6	7	8	9	10	11	12	13	14	V
4	311	486	700	953	1244	1575	1944	2352	2800	3286	3811	.34
5	249	389	560	762	996	1260	1556	1882	2240	2629	3049	.53
6	207	324	467	635	830	1050	1296	1569	1867	2191	2541	.76
7	178	278	400	544	711	900	1111	1344	1600	1878	2178	1.03
8	156	243	350	476	622	788	972	1176	1400	1643	1906	1.34
9	138	216	311	423	553	700	864	1046	1244	1460	1694	1.70
10	124	194	280	381	498	630	778	941	1120	1314	1524	2.10
11	113	177	255	346	453	573	707	856	1018	1195	1386	2.54
12	103	162	233	318	415	525	648	784	933	1095	1270	3.02
13	96	150	215	293	383	485	598	724	862	1011	1173	3.55
14	89	139	200	272	356	450	556	672	800	939	1089	4.12
15	83	130	187	254	332	420	519	627	747	876	1016	4.73
16	78	122	175	238	311	394	486	588	700	821	953	5.38
17	73	114	165	224	293	371	458	554	659	773	897	6.07
18	69	108	156	212	277	350	432	523	622	730	847	6.80
19	65	102	147	201	262	332	409	495	589	692	802	7.58
20		97	140	191	249	315	389	471	560	657	762	8.40
21		93	133	182	237	300	370	448	533	626	726	9.26
22		88	127	173	226	286	354	428	509	597	693	10.16
23		85	122	166	216	274	338	409	487	572	663	11.11
24			117	159	207	263	324	392	467	548	635	12.10
25			112	152	199	252	311	376	448	526	610	13.13
26			108	147	191	242	299	362	431	506	586	14.20
27			104	141	184	233	288	349	415	487	565	15.31
28			100	136	178	225	278	336	400	469	544	16.46
29			97	131	172	217	268	325	386	453	526	17.66
30			93	127	166	210	259	314	373	438	508	18.90
31			90	123	161	203	251	304	361	424	492	20.18
32			88	119	156	197	243	294	350	411	476	21.50
33			85	115	151	191	236	285	339	398	462	22.87
34				112	146	185	229	277	329	387	448	24.28
35				109	142	180	222	269	320	376	436	25.73

UNIFORMLY DISTRIBUTED
BEAMS ONE INCH THICK
AND SPRUCE OR EASTERN FIR.

Modulus of rupture 4 200 pounds per square inch.

New safe load = Safe load from table × $\frac{6}{\text{New factor}}$.

Span in Feet.	Depth of Beam in Inches.										Deflection Coefficient for White Pine.
	15	16	17	18	19	20	21	22	23	24	V
9	1944	2212	2498	2800	3120	3457	3811	4183	4571	4978	1.70
10	1750	1991	2248	2520	2808	3111	3430	3764	4114	4480	2.10
11	1601	1810	2044	2291	2552	2828	3118	3422	3740	4073	2.54
12	1458	1659	1873	2100	2340	2593	2858	3137	3428	3733	3.02
13	1346	1531	1729	1938	2160	2393	2638	2896	3165	3446	3.55
14	1250	1422	1606	1800	2056	2222	2450	2689	2939	3200	4.12
15	1167	1328	1499	1680	1872	2074	2287	2510	2743	2987	4.73
16	1094	1244	1405	1575	1755	1944	2144	2353	2571	2800	5.38
17	1029	1171	1322	1482	1652	1830	2018	2214	2420	2635	6.07
18	972	1106	1249	1400	1560	1728	1906	2091	2286	2489	6.80
19	921	1048	1183	1326	1478	1637	1805	1981	2165	2358	7.58
20	875	996	1124	1260	1404	1556	1715	1882	2057	2240	8.40
21	833	948	1070	1200	1337	1481	1633	1793	1959	2133	9.26
22	795	905	1022	1145	1276	1414	1559	1711	1870	2036	10.16
23	761	866	977	1096	1221	1353	1491	1637	1789	1948	11.11
24	729	830	937	1050	1170	1296	1429	1569	1714	1867	12.10
25	700	796	899	1008	1123	1244	1372	1506	1645	1792	13.13
26	673	766	865	969	1080	1197	1319	1448	1582	1723	14.20
27	648	737	833	933	1040	1152	1270	1394	1524	1659	15.31
28	625	711	803	900	1003	1111	1225	1344	1469	1600	16.46
29	603	687	775	869	968	1073	1183	1298	1419	1545	17.66
30	583	664	749	840	936	1037	1143	1255	1371	1493	18.90
31	565	642	725	813	906	1004	1106	1214	1327	1445	20.18
32	547	622	703	787	877	972	1072	1176	1286	1400	21.50
33	534	603	681	764	850	943	1039	1141	1247	1358	22.87
34	515	586	661	741	826	915	1009	1107	1210	1318	24.28
35	500	569	642	720	802	889	980	1076	1176	1280	25.73
36	486	553	624	700	780	864	953	1046	1143	1244	27.22
37	473	538	608	681	759	841	927	1017	1112	1211	28.75
38	460	524	592	663	739	819	903	991	1083	1179	30.32
39	449	511	576	646	720	798	880	965	1055	1149	31.94
40	438	498	562	630	702	778	858	941	1029	1120	33.60

SAFE LOAD IN POUNDS FOR RECTANGULAR WHITE OAK AND

Allowable fibre stress 1 000 pounds per square inch safety factor 6.

Safe loads for other factors of safety may be obtained as follows:

Span in Feet.	Depth of Beam in Inches. 4	5	6	7	8	9	10	11	12	13	14	Deflection Coefficient for White Oak. V
4	444	694	1000	1361	1778	2250	2778	3361	4000	4694	5444	.31
5	356	556	800	1089	1422	1800	2222	2689	3200	3756	4356	.48
6	296	463	667	907	1185	1500	1852	2241	2667	3130	3630	.69
7	254	397	571	778	1016	1286	1587	1921	2286	2683	3111	.94
8	222	347	500	681	889	1125	1389	1681	2000	2347	2722	1.22
9	198	309	444	605	790	1000	1235	1494	1778	2086	2420	1.55
10	178	278	400	544	711	900	1111	1344	1600	1878	2178	1.91
11	162	253	364	495	646	818	1010	1222	1455	1707	1980	2.31
12	148	231	333	454	593	750	926	1120	1333	1565	1815	2.75
13	137	214	308	419	547	692	855	1034	1231	1444	1675	3.23
14	127	198	286	389	508	643	794	960	1143	1341	1556	3.74
15	119	185	267	363	474	600	741	896	1067	1252	1452	4.30
16	111	174	250	340	444	563	694	840	1000	1174	1361	4.89
17	105	163	235	320	418	529	654	791	941	1105	1281	5.52
18	99	154	222	302	395	500	617	747	889	1043	1210	6.19
19	94	146	211	287	374	474	585	708	842	988	1146	6.89
20	89	139	200	272	356	450	556	672	800	939	1089	7.64
21	85	132	190	259	339	429	529	640	762	894	1037	8.42
22	81	126	182	247	323	409	505	611	727	854	990	9.24
23	77	121	174	237	309	391	483	585	696	816	947	10.10
24		116	162	227	296	375	463	560	667	782	907	11.00
25		111	160	218	284	360	444	538	640	751	871	11.93
26		107	154	209	274	346	427	517	615	722	838	12.91
27		103	148	202	263	333	412	498	593	695	807	13.92
28		99	143	194	254	321	397	480	571	671	778	14.97
29			138	188	245	310	383	464	552	648	751	16.06
30			133	181	237	300	370	448	533	626	726	17.18
31			129	176	229	290	358	434	516	606	703	18.35
32			125	170	222	281	347	420	500	587	681	19.55
33			121	165	215	273	337	407	485	569	660	20.79
34			118	160	209	265	327	395	471	552	641	22.07
35			114	156	203	257	317	384	457	537	602	23.39

Safe load for beams of Douglas and Oregon Fir or Pine $\frac{11}{10}$ of above.

UNIFORMLY DISTRIBUTED BEAMS ONE INCH THICK SHORT-LEAF YELLOW PINE.

Modulus of rupture 6 000 pounds per square inch.

New safe load = Safe load from table $\times \frac{6}{\text{New factor}}$.

Span in Feet.	Depth of Beam in Inches.										Deflection Coefficient for White Oak.
	15	16	17	18	19	20	21	22	23	24	V
9	2778	3160	3568	4000	4457	4938	5444	5975	6531	7111	1.55
10	2500	2844	3211	3600	4011	4444	4900	5378	5878	6400	1.91
11	2273	2586	2919	3273	3646	4040	4455	4889	5343	5818	2.31
12	2083	2370	2676	3000	3343	3704	4083	4481	4898	5333	2.75
13	1923	2188	2470	2769	3085	3419	3769	4137	4521	4923	3.23
14	1786	2032	2294	2571	2865	3175	3500	3841	4198	4571	3.74
15	1667	1896	2141	2400	2674	2963	3267	3585	3919	4267	4.30
16	1563	1778	2007	2250	2507	2778	3062	3361	3674	4000	4.89
17	1471	1673	1889	2118	2359	2614	2882	3163	3458	3765	5.52
18	1389	1580	1789	2000	2228	2469	2722	2988	3265	3556	6.19
19	1316	1497	1690	1895	2111	2339	2579	2830	3094	3368	6.89
20	1250	1422	1606	1800	2006	2222	2450	2689	2939	3200	7.64
21	1190	1354	1529	1714	1910	2116	2333	2561	2799	3048	8.42
22	1136	1293	1460	1636	1823	2020	2227	2444	2672	2909	9.24
23	1087	1237	1396	1565	1744	1932	2130	2338	2556	2783	10.10
24	1042	1185	1338	1500	1671	1852	2042	2241	2449	2667	11.00
25	1000	1138	1284	1440	1604	1778	1960	2131	2351	2560	11.93
26	962	1094	1235	1385	1543	1709	1885	2068	2261	2462	12.91
27	926	1053	1189	1333	1486	1646	1815	1992	2177	2370	13.92
28	893	1016	1147	1286	1433	1587	1750	1921	2099	2286	14.97
29	862	981	1107	1241	1383	1533	1690	1854	2027	2207	16.06
30	833	948	1070	1200	1337	1481	1633	1793	1959	2133	17.18
31	806	918	1036	1161	1294	1434	1581	1735	1896	2065	18.35
32	781	889	1003	1125	1253	1389	1531	1681	1837	2000	19.55
33	758	862	973	1091	1215	1347	1485	1630	1781	1939	20.79
34	735	837	944	1059	1180	1307	1441	1582	1728	1882	22.07
35	714	813	917	1029	1146	1270	1400	1537	1677	1829	23.39
36	694	780	894	1000	1114	1235	1361	1494	1633	1778	24.74
37	676	769	868	973	1084	1201	1324	1453	1589	1730	26.14
38	658	749	845	947	1056	1169	1289	1415	1547	1684	27.57
39	641	729	823	923	1028	1140	1256	1379	1507	1641	29.04
40	625	711	803	900	1003	1111	1225	1344	1469	1600	30.55

Safe load for beams of California Redwood ¾ of above.

SAFE LOAD IN POUNDS FOR RECTANGULAR LONG LEAF

Allowable fibre stress 1 200 pounds per square inch safety factor 6.

Safe loads for other factors of safety may be obtained as follows:

Span in Feet.	Depth of Beam in Inches. 4	5	6	7	8	9	10	11	12	13	14	Deflection Coefficient. V
4	533	833	1200	1633	2133	2700	3333	4033	4800	5633	6533	.20
5	427	667	960	1307	1707	2160	2667	3227	3840	4507	5227	.31
6	356	556	800	1089	1422	1800	2222	2689	3200	3756	4356	.44
7	305	476	686	933	1219	1543	1905	2305	2743	3219	3733	.61
8	267	417	600	817	1067	1350	1667	2017	2400	2817	3267	.79
9	237	370	533	726	948	1200	1481	1793	2133	2504	2904	1.00
10	213	333	480	653	853	1080	1333	1613	1920	2253	2613	1.24
11	194	303	436	594	776	982	1212	1467	1745	2048	2376	1.49
12	178	278	400	544	711	900	1111	1344	1600	1878	2178	1.78
13	164	256	369	503	656	831	1026	1241	1477	1733	2010	2.09
14	152	238	343	467	610	771	952	1152	1371	1610	1867	2.42
15	142	222	320	436	569	720	889	1076	1280	1502	1742	2.78
16	133	208	300	408	533	675	833	1008	1200	1408	1633	3.16
17	125	196	282	384	502	635	784	949	1129	1325	1537	3.57
18	119	185	267	363	474	600	741	896	1067	1252	1452	4.00
19	112	175	253	344	449	568	702	849	1011	1186	1375	4.46
20	107	167	240	327	427	540	667	807	960	1127	1307	4.91
21	102	159	229	311	406	514	635	768	914	1073	1244	5.45
22	97	157	218	297	388	491	606	733	873	1024	1188	5.98
23	93	145	209	284	371	470	580	701	835	980	1136	6.53
24	89	139	200	272	356	450	556	672	800	939	1089	7.12
25	85	133	192	261	341	432	533	645	768	901	1045	7.72
26		128	185	251	328	415	513	621	738	867	1005	8.35
27		123	178	242	316	400	494	598	711	835	968	9.01
28		119	171	233	305	386	476	576	686	805	933	9.68
29		115	166	225	294	372	460	556	662	777	901	10.39
30		111	160	218	284	360	444	538	640	751	871	11.12
31		108	155	211	275	348	430	520	619	727	843	11.87
32			150	204	267	338	417	504	600	704	817	12.65
33			145	198	259	327	404	489	582	683	792	13.45
34			141	192	251	318	392	475	565	663	769	14.28
35			137	187	244	309	381	461	549	644	747	15.13

Safe load for beams of Washington Fir or Pine, Red Pine, Canadian (Ontario) Red Pine, Cypress, Cedar, Chestnut and California Spruce, ¾ of above.

UNIFORMLY DISTRIBUTED BEAMS ONE INCH THICK YELLOW PINE.

Modulus of rupture 7 200 pounds per square inch.

New safe load = Safe load from table $\times \frac{6}{\text{New factor}}$.

Span in Feet.	Depth of Beam in Inches. 15	16	17	18	19	20	21	22	23	24	Deflection Coefficient. V
9	3333	3793	4281	4800	5348	5926	6533	7170	7837	8533	1.00
10	3000	3413	3853	4320	4813	5333	5880	6453	7053	7680	1.24
11	2727	3103	3503	3927	4376	4848	5355	5867	6412	6982	1.49
12	2500	2844	3211	3600	4011	4444	4900	5378	5878	6400	1.78
13	2308	2626	2964	3323	3703	4103	4523	4964	5426	5908	2.09
14	2143	2438	2752	3086	3438	3810	4200	4610	5038	5486	2.42
15	2000	2276	2569	2880	3209	3556	3920	4302	4702	5120	2.78
16	1875	2133	2408	2700	3008	3333	3675	4033	4433	4800	3.16
17	1765	2008	2267	2541	2831	3137	3459	3796	4149	4518	3.57
18	1667	1896	2141	2400	2674	2963	3267	3585	3819	4267	4.00
19	1579	1796	2027	2274	2533	2807	3095	3396	3712	4042	4.46
20	1500	1707	1927	2160	2407	2667	2940	3227	3527	3840	4.94
21	1429	1625	1835	2057	2292	2540	2800	3073	3359	3657	5.45
22	1364	1552	1752	1964	2188	2424	2678	2933	3206	3491	5.98
23	1304	1484	1675	1878	2093	2319	2557	2806	3067	3339	6.53
24	1250	1422	1606	1800	2006	2222	2450	2689	2939	3200	7.12
25	1200	1365	1541	1728	1925	2133	2352	2581	2821	[illegible]	7.72
26	1154	1313	1482	1662	1851	2051	2262	2482	2713	2954	8.35
27	1111	1264	1427	1600	1783	1975	2178	2390	2612	2844	9.01
28	1071	1219	1376	1543	1719	1905	2100	2305	2519	2743	9.68
29	1034	1177	1329	1490	1660	1839	2028	2225	2432	2648	10.39
30	1000	1138	1284	1440	1604	1778	1960	2151	2351	2560	11.12
31	968	1101	1243	1394	1553	1720	1897	2082	2275	2477	11.87
32	938	1067	1204	1350	1504	1667	1838	2017	2217	2400	12.65
33	909	1034	1168	1309	1459	1616	1785	1956	2137	2327	13.45
34	882	1004	1133	1271	1416	1569	1729	1898	2075	2259	14.28
35	857	975	1101	1234	1375	1524	1680	1844	2013	2194	15.13
36	833	948	1070	1200	1337	1481	1633	1793	1909	2133	16.01
37	811	923	1041	1168	1301	1441	1589	1744	1906	2076	16.91
38	789	893	1014	1137	1267	1404	1547	1698	1856	2021	17.84
39	769	875	988	1108	1234	1368	1508	1655	1809	1969	18.79
40	750	853	963	1080	1203	1333	1470	1613	1763	1920	19.76

Safe load for beams of Hemlock ½ of above.

STRENGTH OF SOLID WOODEN COLUMNS OF DIFFERENT KINDS OF TIMBER

For various values of $\frac{l}{d}$

l = length of column in inches. d = least diameter in inches.

BASED ON THE FORMULA OF A. L. JOHNSON, C. E., U. S. DEPARTMENT OF AGRICULTURE, DIVISION OF FORESTRY.

$$P = F \times \frac{700 + 15c}{700 + 15c + c^2}$$

P = ultimate strength in pounds per square inch.

F = ultimate crushing strength of timber. $c = \frac{l}{d}$.

Values of F are those given in table on pages 246 and 247 herein.

	Ultimate Strength in Pounds per Square Inch.				
	Douglas, Oregon and Washington Yellow Fir or Pine.	Southern, Long Leaf or Georgia Yellow Pine, Canadian (Ottowa) White Pine, Canadian (Ontario) Red Pine.	White Oak.	Northern or Short Leaf Yellow Pine, Red Pine, Norway Pine, Spruce and Eastern Fir, Hemlock, Cypress, Cedar, California Redwood, California Spruce.	White Pine.
F	6000	5000	4500	4000	3500
$\frac{l}{d}$					
1	5992	4993	4494	3994	3495
2	5967	4973	4475	3978	3481
3	5928	4940	4446	3952	3458
4	5876	4897	4407	3918	3428
5	5813	4844	4359	3875	3391
6	5739	4782	4304	3826	3347
7	5656	4713	4242	3770	3299
8	5566	4638	4174	3710	3247
9	5469	4558	4102	3646	3190
10	5368	4474	4026	3579	3132
11	5264	4386	3948	3509	3070
12	5156	4297	3867	3438	3008
13	5047	4206	3785	3365	2944
14	4937	4114	3703	3291	2880
15	4826	4022	3620	3217	2815
16	4716	3930	3537	3144	2751
17	4606	3838	3455	3071	2687
18	4498	3748	3373	2998	2624
19	4391	3659	3293	2927	2561

For safety factors for various classes of structures to be used in connection with the above table, see p. 244.

STRENGTH OF SOLID WOODEN COLUMNS OF DIFFERENT KINDS OF TIMBER

For various values of $\frac{l}{d}$

l = length of column in inches. d = least diameter in inches.

BASED ON THE FORMULA OF A. L. JOHNSON, C. E., U. S. DEPARTMENT OF AGRICULTURE, DIVISION OF FORESTRY.

$$P = F \times \frac{700 + 15c}{700 + 15c + c^2}$$

P = ultimate strength in pounds per square inch.

F = ultimate crushing strength of timber. $c = \frac{l}{d}$.

Values of F are those given in table on pages 246 and 247 herein.

	Ultimate Strength in Pounds per Square Inch.				
	Douglas, Oregon and Washington Yellow Fir or Pine.	Southern, Long Leaf or Georgia Yellow Pine, Canadian (Ottowa) White Pine, Canadian (Ontario) Red Pine.	White Oak.	Northern or Short Leaf Yellow Pine, Red Pine, Norway Pine, Spruce and Eastern Fir, Hemlock, Cypress, Cedar, California Redwood, California Spruce.	White Pine.
F	6000	5000	4500	4000	3500
$\frac{l}{d}$					
20	4286	3571	3214	2857	2500
21	4183	3486	3137	2788	2440
22	4082	3402	3061	2721	2381
23	3983	3320	2988	2656	2324
24	3888	3240	2916	2592	2268
25	3794	3162	2846	2529	2213
26	3703	3086	2777	2469	2160
27	3615	3013	2711	2410	2109
28	3529	2941	2647	2353	2059
29	3446	2872	2585	2298	2010
30	3366	2805	2524	2244	1963
32	3212	2677	2409	2142	1874
34	3068	2557	2301	2046	1790
36	2934	2445	2200	1956	1711
38	2808	2340	2106	1872	1638
40	2690	2241	2017	1793	1569
42	2579	2149	1934	1719	1505
44	2476	2063	1857	1650	1444
46	2379	1982	1784	1586	1388
48	2288	1907	1716	1525	1335
50	2203	1835	1652	1468	1285

For safety factors for various classes of structures to be used in connection with the above table, see p. 244.

SPECIFIC GRAVITIES AND WEIGHTS OF VARIOUS SUBSTANCES.

The Basis for Specific Gravities is Pure Water at 62 degrees Fah., Barometer 30 Inches. Weight of One Cubic Foot, 62.355 Pounds.	Average Specific Gravity. Water = 1.	Average Weight of One Cubic Foot. Pounds.
Air, atmospheric at 60 degrees F., under pressure of one atmosphere, or 14.7 pounds per square inch, weighs $\frac{1}{815}$th as much as water.	.00123	.0765
Aluminum.	2.6	162
Anthracite, 1.3 to 1.84; of Penn, 1.3 to 1.7	1.5	93.5
" broken, of any size, loose	....	52 to 56
" " moderately shaken	....	56 to 60
" " heaped bushel, loose, 77 to 83 pounds	....	....
" " a ton loose occupies 40 to 43 cubic feet	....	....
Antimony, cast	6.70	418
" native	6.67	416
Ash, perfectly dry (see note p. 259)	.752	47
" American white dry (see note p. 259)	.61	38
Ashes of soft coal, solidly packed		40 to 45
Asphaltum, 1 to 1.8	1.4	87.3
Brass (copper and zinc) cast 7.8 to 8.4	8.1	504
" rolled	8.4	524
Brick, best pressed	....	150
" common and hard	....	125
" soft inferior	....	100
Brickwork, pressed brick, fine joints	....	140
" medium quality	....	125
" coarse, inferior, soft	....	100
" at 125 pounds per cubic foot, 1 cubic yard equals 1.507 tons, and 17.92 cubic feet equal 1 ton	....	....
Bronze, copper 8, tin 1 (gun metal)	8.5	529
Cement, hydraulic. American, Rosendale, ground and loose	....	56
" hydraulic. American, Rosendale, U. S. struck bush, 70 pounds	....	....
" hydraulic. American, Rosendale, Louisville bushel 62 pounds	....	....
" hydraulic. American, Cumberland, ground, loose	....	65
" hydraulic. American, Cumberland, ground, thoroughly shaken	....	85
" hydraulic. English Portland (U. S. struck bushel 100 to 128)	....	81 to 102
" hydraulic. English Portland, a barrel 400 to 430 pounds	....	....
" hydraulic. American Portland, loose	....	88

SPECIFIC GRAVITIES AND WEIGHTS OF VARIOUS SUBSTANCES.

The Basis for Specific Gravities is Pure Water at 62 degrees Fah., Barometer 30 Inches. Weight of One Cubic Foot, 62.355 Pounds.	Average Specific Gravity. Water = 1.	Average Weight of One Cubic Foot. Pounds.
Cement, hydraulic. American Portland, thoroughly shaken	....	110
Charcoal of pines and oaks	....	15 to 30
Chalk	2.5	156
Cherry, perfectly dry (see note p. 259)	.672	42
Chestnut, perfectly dry (see note p. 259)	.660	41
Clay, potters', dry, 1.8 to 2.1	1.9	119
" dry in lump, loose	....	63
Coal, bituminous, solid, 1.2 to 1.5	1.35	84
" bituminous, solid, Cambria Co., Pa., 1.27–1.34	....	79 to 84
" bituminous, broken, of any size, loose	....	47 to 52
" bituminous, moderately shaken	....	51 to 56
" bituminous, a heaped bushel, loose, 70 to 78	....	....
" bituminous, 1 ton occupies 43 to 48 cubic feet	....	....
Coke, loose, good quality	....	23 to 32
" loose, a heaped bushel, 35 to 42	....	....
" 1 ton occupies 80 to 97 cubic feet	....	....
Corundum, pure, 3.8 to 4	3.9	....
Copper, cast, 8.6 to 8.8	8.7	542
" rolled, 8.8 to 9	8.9	555
Cork, dry (see note p. 259)	.24	15
Cypress, American (see note p. 259)	.55	64
Earth, common loam, perfectly dry, loose	....	72 to 80
" " " perfectly dry, shaken	....	82 to 92
" " " perfectly dry, rammed	....	90 to 100
" " " slightly moist, loose	....	70 to 76
" " " more moist, loose	....	66 to 68
" " " more moist, shaken	....	75 to 90
" " " more moist, packed	....	90 to 100
" " " as soft flowing mud	....	104 to 112
" " " as soft flowing mud well pressed	....	110 to 120
Elm, perfectly dry (see note p. 259)	.56	35
Flint	2.6	162
Glass, 2.5 to 3.45	2.98	186
" common window	2.52	157
Gneiss, common, 2.62 to 2.76	2.69	168
" in loose piles	....	96
Gold, cast, pure or 24 karat	19.258	1204
" pure, hammered	19.5	1217
Granite, 2.56 to 2.88	2.72	170

SPECIFIC GRAVITIES AND WEIGHTS OF VARIOUS SUBSTANCES.

The Basis for Specific Gravities is Pure Water at 62 degrees Fah., Barometer 30 Inches. Weight of One Cubic Foot, 62.355 Pounds.	Average Specific Gravity. Water = 1.	Average Weight of One Cubic Foot. Pounds.
Greenstone, trap, 2.8 to 3.2	3.00	187
Gypsum, plaster of Paris, 2.24 to 2.30	2.27	141.6
Hemlock, perfectly dry (see note p. 259)	.4	25
Hickory, " " " "	.85	53
Ice, .917 to .922	.92	57.4
Iron, cast, 6.9 to 7.4	7.15	446
" grey foundry, cold	7.21	450
" " molten	6.94	433
" wrought	7.69	480
Lead, commercial	11.38	709.6
Lignumvitæ (dry)	.65–1.33	41 to 83
Limestone and marbles	2.6	164.4
Lime, quick	1.5	95
" quick, ground, well shaken, per struck bushel 80 pounds	....	64
" quick, ground, thoroughly shaken, per struck bushel 93¾ pounds	....	75
Locust, dry (see note p. 259)	.71	44
Mahogany, Spanish, dry (see note p. 259)	.85	53
" Honduras, dry (see note p. 259)	.56	35
Maple, dry (see note p. 259)	.79	49
Marbles (see Limestone)		
Masonry of granite or limestones, well-dressed	....	165
" of granite, well-scabbled mortar rubble, about $\frac{1}{5}$ of mass will be mortar	....	154
" of granite, well-scabbled dry rubble	....	138
" of granite, roughly scabbled mortar rubble, about $\frac{1}{4}$ to $\frac{1}{3}$ of mass will be mortar	....	150
" of granite, scabbled dry rubble	....	125
" of sandstone, $\frac{1}{8}$ less than granite	....	....
Masonry of brickwork (see Brickwork)		
Mercury, at 32 degrees Fah	13.62	849
Mica, 2.75 to 3.1	2.93	183
Mortar, hardened, 1.4 to 1.9	1.65	103
Mud, dry, close	....	80 to 110
" wet, moderately pressed	....	110 to 130
" " fluid	....	104 to 120
Oak, live, perfectly dry, .88–1.02 (see note p. 259)	.95	59.3
" white, perfectly dry, .66 to .88 (see note p. 259)	.77	48
" red, black, perfectly dry	....	32 to 45
Petroleum	.878	54.8

SPECIFIC GRAVITIES AND WEIGHTS OF VARIOUS SUBSTANCES.

The Basis for Specific Gravities is Pure Water at 62 degrees Fah., Barometer 30 Inches. Weight of One Cubic Foot, 62.355 Pounds.	Average Specific Gravity. Water = 1.	Average Weight of One Cubic Foot. Pounds.
Pine, white, perfectly dry, .35 to .45 (see note p. 259)	.40	25
" yellow, Northern, perfectly dry, .48 to .62 (see note p. 259)	.55	34.3
" yellow, Southern, perfectly dry, .64 to .8, (see note p. 259)	.72	45
Pitch	1.15	71.7
Poplar, dry (see note p. 259)	.47	29
Platinum	21.5	1342
Quartz	2.65	165
Rosin.	1.10	68.6
Salt, coarse, (per struck bushel, Syracuse, N.Y., 56 pounds)	....	45
Sand, of pure quartz, perfectly dry and loose.	....	90 to 106
" " " voids full of water	....	118 to 129
" " " very large and small grains, dry	....	117
Sandstone, 2.1 to 2.73, 131 to 171	2.41	151
" quarried and piled, 1 measure solid makes $1\frac{3}{4}$ (about) piled	....	86
Snow, fresh fallen	....	5 to 12
" moistened, compacted by rain	....	15 to 50
Sycamore, perfectly dry (see note p. 259)	.59	37
Shales, red or black, 2.4 to 2.8	2.6	162
Silver	10.5	655
Slate, 2.7 to 2.9	2.8	175
Soapstone, 2.65 to 2.8	2.73	170
Spruce, perfectly dry (see note p. 259)	.4	25
Steel	7.85	490
Sulphur	2.00	125
Tallow.	.94	58.6
Tar	1	62.355
Tin, cast, 7.2 to 7.5	7.35	459
Walnut, black, perfectly dry (see note p 259).	.61	38
Water, pure rain, distilled, at 32 degrees F., Bar. 30 inches.	....	62.417
" " " at 62 degrees F., Bar. 30 inches.	1	62.355
" " " at 212 degrees F., Bar. 30 inches.	....	59.7
" sea, 1.026 to 1.030	1.028	64.08
Zinc or spelter, 6.8 to 7.2	7.00	437.5

NOTE.—Green timbers usually weigh from one-fifth to nearly one-half more than dry: ordinary building timbers, tolerably seasoned, one-sixth more.

STANDARD DECIMAL GAUGE.

Standard Decimal Gauge in Inches.	Thickness in Fractions of an Inch.	Approximate Thickness in Millimetres.	Weight per Square Foot in Pounds, Avoirdupois.	
			IRON. Basis—480 Pounds per Cubic Foot.	STEEL. Basis—489.6 Pounds per Cubic Foot.
.002	1-500	.05080010	.08	.0816
.004	1-250	.10160020	.16	.1632
.006	3-500	.15240030	.24	.2448
.008	1-125	.20320041	.32	.3264
.010	1-100	.25400051	.40	.4080
.012	3-250	.30480061	.48	.4896
.014	7-500	.35560071	.56	.5712
.016	2-125($\frac{1}{64}$+)	.40640081	.64	.6528
.018	9-500	.45720091	.72	.7344
.020	1-50	.50800102	.80	.8160
.022	11-500	.55880112	.88	.8976
.025	1-40	.63500127	1.00	1.0200
.028	7-250	.71120142	1.12	1.1424
.032	4-125($\frac{1}{32}$+)	.81280163	1.28	1.3056
.036	9-250	.91440183	1.44	1.4688
.040	1-25	1.01600203	1.60	1.6320
.045	9-200	1.14300229	1.80	1.8360
.050	1-20	1.27000254	2.00	2.0400
.055	11-200	1.39700280	2.20	2.2440
.060	3-50 ($\frac{1}{16}$—)	1.52400305	2.40	2.4480
.065	13-200	1.65100330	2.60	2.6520
.070	7-100	1.77800356	2.80	2.8560
.075	3-40	1.90500381	3.00	3.0600
.080	2-25	2.03200406	3.20	3.2640
.085	17-200	2.15900432	3.40	3.4680
.090	9-100	2.28600457	3.60	3.6720
.095	19-200	2.41300483	3.80	3.8760
.100	1-10	2.54000508	4.00	4.0800
.110	11-100	2.79400559	4.40	4.4880
.125	1-8	3.17500630	5.00	5.1000
.135	27-200	3.42900686	5.40	5.5080
.150	3-20	3.81000762	6.00	6.1200
.165	33-200	4.19100838	6.60	6.7320
.180	9-50	4.57200914	7.20	7.3440
.200	1-5	5.08001016	8.00	8.1600
.220	11-50	5.58801118	8.80	8.9760
.240	6-25	6.09601219	9.60	9.7920
.250	1-4	6.35001270	10.00	10.2000

The Standard Decimal Gauge has been recently adopted by the Association of American Steel Manufacturers, the American Railway Master Mechanics' Association and by about seventy-two of the principal railroads of the United States, Canada and Mexico. The decimal system of gauging was recommended by the American Institute of Mining Engineers in 1877 and by the American Society of Mechanical Engineers in 1895.

WIRE AND SHEET METAL GAUGES.

In Decimals of an Inch.

Number of Gauge.	Birmingham or Stubs Iron Wire Gauge.	American or Brown & Sharpe Wire Gauge.	United States Standard Gauge for Sheet and Plate Iron and Steel.	Washburn & Moen Manufacturing Co. and John A. Roebling's Sons Co. Wire Gauge.	Trenton Iron Co. Wire Gauge.	American Screw Co. Screw Wire Gauge.	British Imperial or English Legal Standard Wire Gauge.
0000000	. . .	. . . . . .	.5	. . . . . .	. . . . .	. . . . .	.500
000000	. . .	. . . . . .	.46875	.4600	. . . .	. . . . .	.464
00000	. . .	. . . .	.4375	.4300	.450	. . . . .	.432
0000	.454	.460000	.40625	.3938	.400	. . .	.400
000	.425	.409642	.375	.3625	.360	.0315	.372
00	.380	.364796	.34375	.3310	.330	.0447	.348
0	.340	.324861	.3125	.3065	.305	.0578	.324
1	.300	.289297	.28125	.2830	.285	.0710	.300
2	.284	.257627	.265625	.2625	.265	.0842	.276
3	.259	.229423	.25	.2437	.245	.0973	.252
4	.238	.204307	.234375	.2253	.225	.1105	.232
5	.220	.181940	.21875	.2070	.205	.1236	.212
6	.203	.162023	.203125	.1920	.190	.1368	.192
7	.180	.144285	.1875	.1770	.175	.1500	.176
8	.165	.128490	.171875	.1620	.160	.1631	.160
9	.148	.114423	.15625	.1483	.145	.1763	.144
10	.134	.101897	.140625	.1350	.130	.1894	.128
11	.120	.090742	.125	.1205	.1175	.2026	.116
12	.109	.080808	.109375	.1055	.105	.2158	.104
13	.095	.071962	.09375	.0915	.0925	.2289	.092
14	.083	.064084	.078125	.0800	.0806	.2421	.080
15	.072	.057068	.0703125	.0720	.070	.2552	.072
16	.065	.050821	.0625	.0625	.061	.2684	.064
17	.058	.045257	.05625	.0540	.0525	.2816	.056
18	.049	.040303	.05	.0475	.045	.2947	.048
19	.042	.035890	.04375	.0410	.040	.3079	.040
20	.035	.031961	.0375	.0348	.035	.3210	.036
21	.032	.028462	.034375	.03175	.031	.3342	.032
22	.028	.025346	.03125	.0286	.028	.3474	.028
23	.025	.022572	.028125	.0258	.025	.3605	.024
24	.022	.020101	.025	.0230	.0225	.3737	.022
25	.020	.017900	.021875	.0204	.020	.3868	.020
26	.018	.015941	.01875	.0181	.018	.4000	.018
27	.016	.014195	.0171875	.0173	.017	.4132	.0164
28	.014	.012641	.015625	.0162	.016	.4263	.0148
29	.013	.011257	.0140625	.0150	.015	.4395	.0136
30	.012	.010025	.0125	.0140	.014	.4526	.0124
31	.010	.008928	.0109375	.0132	.013	.4658	.0116
32	.009	.007950	.01015625	.0128	.012	.4790	.0108
33	.008	.007080	.009375	.0118	.011	.4921	.0100
34	.007	.006305	.00859375	.0104	.010	.5053	.0092
35	.005	.005615	.0078125	.0095	.0095	.5184	.0084
36	.004	.005000	.00703125	.0090	.009	.5316	.0076
37	. . .	.004453	.006640625	.0085	.0085	.5448	.0068
38	. . .	.003965	.00625	.0080	.008	.5579	.0060
39	. . .	.003531	. . . .	.0075	.0075	.5711	.0052
40	. .	.003144	. . . .	.0070	.007	.5842	.0048

The United States Standard Gauge was legalized by Act of Congress March 3, 1893, as a standard gauge for sheet and plate iron and steel and is used by the Custom House Department and by about forty-five sheet and tin-plate manufacturers.

WEIGHTS OF SHEETS AND PLATES OF STEEL, WROUGHT IRON, COPPER AND BRASS.

AMERICAN OR BROWNE & SHARPE GAUGE.

No. of Gauge.	Thickness in Inches.	Weight per Square Foot.			
		Steel.	Iron.	Copper.	Brass.
0000	.460000	18.7680	18.4000	20.8380	19.6880
000	.409642	16.7134	16.3857	18.5568	17.5327
00	.364796	14.8837	14.5918	16.5253	15.6133
0	.324861	13.2543	12.9944	14.7162	13.9041
1	.289297	11.8033	11.5719	13.1052	12.3819
2	.257627	10.5112	10.3051	11.6705	11.0264
3	.229423	9.3605	9.1769	10.3929	9.8193
4	.204307	8.3357	8.1723	9.2551	8.7443
5	.181940	7.4232	7.2776	8.2419	7.7870
6	.162023	6.6105	6.4809	7.3396	6.9346
7	.144285	5.8868	5.7714	6.5361	6.1754
8	.128490	5.2424	5.1396	5.8206	5.4994
9	.114423	4.6685	4.5769	5.1834	4.8973
10	.101897	4.1574	4.0759	4.6159	4.3612
11	.090742	3.7023	3.6297	4.1106	3.8838
12	.080808	3.2970	3.2323	3.6606	3.4586
13	.071962	2.9360	2.8785	3.2599	3.0800
14	.064084	2.6146	2.5634	2.9030	2.7428
15	.057068	2.3284	2.2827	2.5852	2.4425
16	.050821	2.0735	2.0328	2.3022	2.1751
17	.045257	1.8465	1.8103	2.0501	1.9370
18	.040303	1.6444	1.6121	1.8257	1.7250
19	.035890	1.4643	1.4356	1.6258	1.5361
20	·031961	1.3040	1.2784	1.4478	1.3679
21	.028462	1.1612	1.1385	1.2893	1.2182
22	.025346	1.0341	1.0138	1.1482	1.0848
23	.022572	.92094	.90288	1.0225	.96608
24	.020101	.82012	.80404	.91058	.86032
25	.017900	.73032	.71600	.81087	.76612
26	.015941	.65039	.63764	.72213	.68227
27	.014195	.57916	.56780	.64303	.60755
28	.012641	.51575	.50564	.57264	.54103
29	.011257	.45929	.45028	.50994	.48180
30	.010025	.40902	.40100	.45413	.42907
31	.008928	.36426	.35712	.40444	.38212
32	.007950	.32436	.31800	.36014	.34026
33	.007080	.28886	.28320	.32072	.30302
34	.006305	.25724	.25220	.28562	.26985
35	.005615	.22909	.22460	.25436	.24032
36	.005000	.20400	.20000	.22650	.21400
37	.004453	.18168	.17812	.20172	.19059
38	.003965	.16177	.15860	.17961	.16970
39	.003531	.14406	.14124	.15995	.15113
40	.003144	12828	.12576	.14242	.13456

For weights of steel plates from $\frac{3}{16}''$ to $2''$ thick varying by $\frac{1}{16}$ inch, see "Table of Weights of Flat Rolled Bars" herein.

WEIGHTS OF SHEETS AND PLATES OF STEEL, WROUGHT IRON, COPPER AND BRASS.

BIRMINGHAM GAUGE.

No. of Gauge.	Thickness in Inches.	Weight per Square Foot. Steel.	Iron.	Copper.	Brass.
0000	.454	18.5232	18.16	20.5662	19.4312
000	.425	17.3400	17.00	19.2525	18.1900
00	.380	15.5040	15.20	17.2140	16.2640
0	.340	13.8720	13.60	15.4020	14.5520
1	.300	12.2400	12.00	13.5900	12.8400
2	.284	11.5872	11.36	12.8652	12.1552
3	.259	10.5672	10.36	11.7327	11.0852
4	.238	9.7104	9.52	10.7814	10.1864
5	.220	8.9760	8.80	9.966	9.4160
6	.203	8.2824	8.12	9.1959	8.6884
7	.180	7.3440	7.20	8.1540	7.7040
8	.165	6.7320	6.60	7.4745	7.0620
9	.148	6.0384	5.92	6.7044	6.3344
10	.134	5.4672	5.36	6.0702	5.7352
11	.120	4.8960	4.80	5.4360	5.1360
12	.109	4.4472	4.36	4.9377	4.6652
13	.095	3.8760	3.80	4.3035	4.0660
14	.083	3.3864	3.32	3.7599	3.5524
15	.072	2.9376	2.88	3.2616	3.0816
16	.065	2.6520	2.60	2.9445	2.7820
17	.058	2.3664	2.32	2.6274	2.4824
18	.049	1.9992	1.96	2.2197	2.0972
19	.042	1.7136	1.68	1.9026	1.7976
20	.035	1.4280	1.40	1.5855	1.4980
21	.032	1.3056	1.28	1.4496	1.3696
22	.028	1.1424	1.12	1.2684	1.1984
23	.025	1.0200	1.00	1.1325	1.0700
24	.022	.8976	.88	.9966	.9416
25	.020	.8160	.80	.9060	.8560
26	.018	.7344	.72	.8154	.7704
27	.016	.6528	.64	.7248	.6848
28	.014	.5712	.56	.6342	.5992
29	.013	.5304	.52	.5889	.5564
30	.012	.4896	.48	.5436	.5136
31	.010	.4080	.40	.4530	.4280
32	.009	.3672	.36	.4077	.3852
33	.008	.3264	32	.3624	.3424
34	.007	.2856	.28	.3171	.2996
35	.005	.2040	.20	.2265	.2140
36	.004	.1632	.16	.1812	.1712
Specific Gravities		7.85	7.70	8.72	8.24
Weight of a Cubic Foot ..		489.6	480.0	543.6	513.6
" " " Inch ..		.2833	.2778	.3146	.2972

DECIMALS OF AN INCH FOR EACH $\frac{1}{64}$th.

$\frac{1}{32}$ds.	$\frac{1}{64}$ths.	Decimal.	Fraction.	$\frac{1}{32}$ds.	$\frac{1}{64}$ths.	Decimal.	Fraction.
	1	.015625			33	.515625	
1	2	.03125		17	34	.53125	
	3	.046875			35	.546875	
2	4	.0625	1-16	18	36	.5625	9-16
	5	.078125			37	.578125	
3	6	.09375		19	38	.59375	
	7	.109375			39	.609375	
4	8	.125	1-8	20	40	.625	5-8
	9	.140625			41	.640625	
5	10	.15625		21	42	.65625	
	11	.171875			43	.671875	
6	12	.1875	3-16	22	44	.6875	11-16
	13	.203125			45	.703125	
7	14	.21875		23	46	.71875	
	15	.234375			47	.734375	
8	16	.25	1-4	24	48	.75	3-4
	17	.265625			49	.765625	
9	18	.28125		25	50	.78125	
	19	.296875			51	.796875	
10	20	.3125	5-16	26	52	.8125	13-16
	21	.328125			53	.828125	
11	22	.34375		27	54	.84375	
	23	.359375			55	.859375	
12	24	.375	3-8	28	56	.875	7-8
	25	.390625			57	.890625	
13	26	.40625		29	58	.90625	
	27	.421875			59	.921875	
14	28	.4375	7-16	30	60	.9375	15-16
	29	.453125			61	.953125	
15	30	.46875		31	62	.96875	
	31	.484375			63	.984375	
16	32	.5	1-2	32	64	1.	1

DECIMALS OF A FOOT FOR EACH $\frac{1}{64}$ OF AN INCH.

Inch.	0″	1″	2″	3″	4″	5″
0	0	0.833	.1667	.2500	.3333	.4167
$\frac{1}{64}$	.0013	.0846	.1680	.2513	.3346	.4180
$\frac{1}{32}$	.0026	.0859	.1693	.2526	.3359	.4193
$\frac{3}{64}$	.0039	.0872	.1706	.2539	.3372	.4206
$\frac{1}{16}$	.0052	.0885	.1719	.2552	.3385	.4219
$\frac{5}{64}$	.0065	.0898	.1732	.2565	.3398	.4232
$\frac{3}{32}$	.0078	.0911	.1745	.2578	.3411	.4245
$\frac{7}{64}$	.0091	.0924	.1758	.2591	.3424	.4258
$\frac{1}{8}$	.0104	.0937	.1771	.2604	.3437	.4271
$\frac{9}{64}$	.0117	.0951	.1784	.2617	.3451	.4284
$\frac{5}{32}$	.0130	.0964	.1797	.2630	.3464	.4297
$\frac{11}{64}$	.0143	.0977	.1810	.2643	.3477	.4310
$\frac{3}{16}$	.0156	.0990	.1823	.2656	.3490	.4323
$\frac{13}{64}$	.0169	.1003	.1836	.2669	.3503	.4336
$\frac{7}{32}$	.0182	.1016	.1849	.2682	.3516	.4349
$\frac{15}{64}$	.0195	.1029	.1862	.2695	.3529	.4362
$\frac{1}{4}$	.0208	.1042	.1875	.2708	.3542	.4375
$\frac{17}{64}$	.0221	.1055	.1888	.2721	.3555	.4388
$\frac{9}{32}$	.0234	.1068	.1901	.2734	.3568	.4401
$\frac{19}{64}$	.0247	.1081	.1914	.2747	.3581	.4414
$\frac{5}{16}$	.0260	.1094	.1927	.2760	.3594	.4427
$\frac{21}{64}$	.0273	.1107	.1940	.2773	.3607	.4440
$\frac{11}{32}$	.0286	.1120	.1953	.2786	.3620	.4453
$\frac{23}{64}$	.0299	.1133	.1966	.2799	.3633	.4466
$\frac{3}{8}$	.0312	.1146	.1979	.2812	.3646	.4479
$\frac{25}{64}$	.0326	.1159	.1992	.2826	.3659	.4492
$\frac{13}{32}$	.0339	.1172	.2005	.2839	.3672	.4505
$\frac{27}{64}$	.0352	.1185	.2018	.2852	.3685	.4518
$\frac{7}{16}$	.0365	.1198	.2031	.2865	.3698	.4531
$\frac{29}{64}$	.0378	.1211	.2044	.2878	.3711	.4544
$\frac{15}{32}$	.0391	.1224	.2057	.2891	.3724	.4557
$\frac{31}{64}$	.0404	.1237	.2070	.2904	.3737	.4570
$\frac{1}{2}$	.0417	.1250	.2083	.2917	.3750	.4583

DECIMALS OF A FOOT FOR EACH 1/64 OF AN INCH.

Inch.	6″	7″	8″	9″	10″	11″
0	.5000	.5833	.6667	.7500	.8333	.9167
1/64	.5013	.5846	.6680	.7513	.8346	.9180
1/32	.5026	.5859	.6693	.7526	.8359	.9193
3/64	.5039	.5872	.6706	.7539	.8372	.9206
1/16	.5052	.5885	.6719	.7552	.8385	.9219
5/64	.5065	.5898	.6732	.7565	.8398	.9232
3/32	.5078	.5911	.6745	.7578	.8411	.9245
7/64	.5091	.5924	.6758	.7591	.8424	.9258
1/8	.5104	.5937	.6771	.7604	.8437	.9271
9/64	.5117	.5951	.6784	.7617	.8451	.9284
5/32	.5130	.5964	.6797	.7630	.8464	.9297
11/64	.5143	.5977	.6810	.7643	.8477	.9310
3/16	.5156	.5990	.6823	.7656	.8490	.9323
13/64	.5169	.6003	.6836	.7669	.8503	.9336
7/32	.5182	.6016	.6849	.7682	.8516	.9349
15/64	.5195	.6029	.6862	.7695	.8529	.9362
1/4	.5208	.6042	.6875	.7708	.8542	.9375
17/64	.5221	.6055	.6888	.7721	.8555	.9388
9/32	.5234	.6068	.6901	.7734	.8568	.9401
19/64	.5247	.6081	.6914	.7747	.8581	.9414
5/16	.5260	.6094	.6927	.7760	.8594	.9427
21/64	.5273	.6107	.6940	.7773	.8607	.9440
11/32	.5286	.6120	.6953	.7786	.8620	.9453
23/64	.5299	.6133	.6966	.7799	.8633	.9466
3/8	.5312	.6146	.6979	.7812	.8646	.9479
25/64	.5326	.6159	.6992	.7826	.8659	.9492
13/32	.5339	.6172	.7005	.7839	.8672	.9505
27/64	.5352	.6185	.7018	.7852	.8685	.9518
7/16	.5365	.6198	.7031	.7865	.8698	.9531
29/64	.5378	.6211	.7044	.7878	.8711	.9544
15/32	.5391	.6224	.7057	.7891	.8724	.9557
31/64	.5404	.6237	.7070	.7904	.8737	.9570
1/2	.5417	.6250	.7083	.7917	.8750	.9583

DECIMALS OF A FOOT FOR EACH $\frac{1}{64}$ OF AN INCH.

Inch.	0″	1″	2″	3″	4″	5″
$\frac{33}{64}$	.0430	.1263	.2096	.2930	.3763	.4596
$\frac{17}{32}$	.0443	.1276	.2109	.2943	.3776	.4609
$\frac{35}{64}$	.0456	.1289	.2122	.2956	.3789	.4622
$\frac{9}{16}$	.0469	.1302	.2135	.2969	.3802	.4635
$\frac{37}{64}$	.0482	.1315	.2148	.2982	.3815	.4648
$\frac{19}{32}$	.0495	.1328	.2161	.2995	.3828	.4661
$\frac{39}{64}$	.0508	.1341	.2174	.3008	.3841	.4674
$\frac{5}{8}$	.0521	.1354	.2188	.3021	.3854	.4688
$\frac{41}{64}$	.0534	.1367	.2201	.3034	.3867	.4701
$\frac{21}{32}$	.0547	.1380	.2214	.3047	.3880	.4714
$\frac{43}{64}$	.0560	.1393	.2227	.3060	.3893	.4727
$\frac{11}{16}$	.0573	.1406	.2240	.3073	.3906	.4740
$\frac{45}{64}$	.0586	.1419	.2253	.3086	.3919	.4753
$\frac{23}{32}$	.0599	.1432	.2266	.3099	.3932	.4766
$\frac{47}{64}$	.0612	.1445	.2279	.3112	.3945	.4779
$\frac{3}{4}$	.0625	.1458	.2292	.3125	.3958	.4792
$\frac{49}{64}$	.0638	.1471	.2305	.3138	.3971	.4805
$\frac{25}{32}$	.0651	.1484	.2318	.3151	.3984	.4818
$\frac{51}{64}$	.0664	.1497	.2331	.3164	.3997	.4831
$\frac{13}{16}$	.0677	.1510	.2344	.3177	.4010	.4844
$\frac{53}{64}$	.0690	.1523	.2357	.3190	.4023	.4857
$\frac{27}{32}$	.0703	.1536	.2370	.3203	.4036	.4870
$\frac{55}{64}$	.0716	.1549	.2383	.3216	.4049	.4883
$\frac{7}{8}$	.0729	.1562	.2396	.3229	.4062	.4896
$\frac{57}{64}$	.0742	.1576	.2409	.3242	.4076	.4909
$\frac{29}{32}$	.0755	.1589	.2422	.3255	.4089	.4922
$\frac{59}{64}$	.0768	.1602	.2435	.3268	.4102	.4935
$\frac{15}{16}$	.0781	.1615	.2448	.3281	.4115	.4948
$\frac{61}{64}$	.0794	.1628	.2461	.3294	.4128	.4961
$\frac{31}{32}$	.0807	.1641	.2474	.3307	.4141	.4974
$\frac{63}{64}$	.0820	.1654	.2487	.3320	.4154	.4987
1						

DECIMALS OF A FOOT FOR EACH $\frac{1}{64}$ OF AN INCH.

Inch.	6″	7″	8″	9″	10″	11″
$\frac{33}{64}$	.5430	.6263	.7096	.7930	.8763	.9596
$\frac{17}{32}$	.5443	.6276	.7109	.7943	.8776	.9609
$\frac{35}{64}$	.5456	.6289	.7122	.7956	.8789	.9622
$\frac{9}{16}$	.5469	.6302	.7135	.7969	.8802	.9635
$\frac{37}{64}$	.5482	.6315	.7148	.7982	.8815	.9648
$\frac{19}{32}$	.5495	.6328	.7161	.7995	.8828	.9661
$\frac{39}{64}$	.5508	.6341	.7174	.8008	.8841	.9674
$\frac{5}{8}$	.5521	.6354	.7188	.8021	.8854	.9688
$\frac{41}{64}$	.5534	.6367	.7201	.8034	.8867	.9701
$\frac{21}{32}$	.5547	.6380	.7214	.8047	.8880	.9714
$\frac{43}{64}$	.5560	.6393	.7227	.8060	.8893	.9727
$\frac{11}{16}$	.5573	.6406	.7240	.8073	.8906	.9740
$\frac{45}{64}$	.5586	.6419	.7253	.8086	.8919	.9753
$\frac{23}{32}$	.5599	.6432	.7266	.8099	.8932	.9766
$\frac{47}{64}$	.5612	.6445	.7279	.8112	.8945	.9779
$\frac{3}{4}$	.5625	.6458	.7292	.8125	.8958	.9792
$\frac{49}{64}$	.5638	.6471	.7305	.8138	.8971	.9805
$\frac{25}{32}$	.5651	.6484	.7318	.8151	.8984	.9818
$\frac{51}{64}$	.5664	.6497	.7331	.8164	.8997	.9831
$\frac{13}{16}$	.5677	.6510	.7344	.8177	.9010	.9844
$\frac{53}{64}$	.5690	.6523	.7357	.8190	.9023	.9857
$\frac{27}{32}$	.5703	.6536	.7370	.8203	.9036	.9870
$\frac{55}{64}$	.5716	.6549	.7383	.8216	.9049	.9883
$\frac{7}{8}$	.5729	.6562	.7396	.8229	.9062	.9896
$\frac{57}{64}$	.5742	.6576	.7409	.8242	.9076	.9909
$\frac{29}{32}$	.5755	.6589	.7422	.8255	.9089	.9922
$\frac{59}{64}$	.5768	.6602	.7435	.8268	.9102	.9935
$\frac{15}{16}$	.5781	.6615	.7448	.8281	.9115	.9948
$\frac{61}{64}$	.5794	.6628	.7461	.8294	.9128	.9961
$\frac{31}{32}$	.5807	.6641	.7474	.8307	.9141	.9974
$\frac{63}{64}$	.5820	.6654	.7487	.8320	.9154	.9987
1						1.0000

WEIGHTS AND AREAS OF SQUARE AND ROUND BARS AND CIRCUMFERENCES OF ROUND BARS.

One cubic foot of steel weighs 489.6 lbs.

Thickness or Diameter in Inches.	Weight of □ Bar One Foot Long.	Weight of ○ Bar One Foot Long.	Area of □ Bar in Sq. Inches.	Area of ○ Bar in Sq. Inches.	Circumference of ○ Bar in Inches.
1/16	.013	.010	.0039	.0031	.1963
5/64	.021	.016	.0061	.0048	.2454
3/32	.030	.023	.0088	.0069	.2945
7/64	.041	.032	.0120	.0094	.3436
1/8	.053	.042	.0156	.0123	.3927
9/64	.067	.053	.0198	.0155	.4418
5/32	.083	.065	.0244	.0192	.4909
11/64	.100	.079	.0295	.0232	.5400
3/16	.120	.094	.0352	.0276	.5890
13/64	.140	.110	.0413	.0324	.6381
7/32	.163	.128	.0479	.0376	.6872
15/64	.187	.147	.0549	.0431	.7363
1/4	.213	.167	.0625	.0491	.7854
17/64	.240	.188	.0706	.0554	.8345
9/32	.269	.211	.0791	.0621	.8836
19/64	.300	.235	.0881	.0692	.9327
5/16	.332	.261	.0977	.0767	.9817
21/64	.366	.288	.1077	.0846	1.0308
11/32	.402	.316	.1182	.0928	1.0799
23/64	.439	.345	.1292	.1014	1.1290
3/8	.478	.376	.1406	.1104	1.1781
25/64	.519	.407	.1526	.1198	1.2272
13/32	.561	.441	.1650	.1296	1.2763
27/64	.605	.475	.1780	.1398	1.3254
7/16	.651	.511	.1914	.1503	1.3744
29/64	.698	.548	.2053	.1613	1.4235
15/32	.747	.587	.2197	.1726	1.4726
31/64	.798	.627	.2346	.1843	1.5217
1/2	.850	.668	.2500	.1963	1.5708
33/64	.904	.710	.2659	.2088	1.6199
17/32	.960	.754	.2822	.2217	1.6690
35/64	1.017	.799	.2991	.2349	1.7181

SQUARE AND ROUND BARS.

(CONTINUED.)

Thickness or Diameter in Inches.	Weight of □ Bar One Foot Long.	Weight of ○ Bar One Foot Long.	Area of □ Bar in Sq. Inches.	Area of ○ Bar in Sq. Inches.	Circumference of ○ Bar in Inches.
$\frac{9}{16}$	1.076	.845	.3164	.2485	1.7671
$\frac{37}{64}$	1.136	.893	.3342	.2625	1.8162
$\frac{19}{32}$	1.199	.941	.3525	.2769	1.8653
$\frac{39}{64}$	1.263	.992	.3713	.2916	1.9144
$\frac{5}{8}$	1.328	1.043	.3906	.3068	1.9635
$\frac{41}{64}$	1.395	1.106	.4104	.3252	2.0126
$\frac{21}{32}$	1.464	1.150	.4307	.3382	2.0617
$\frac{43}{64}$	1.535	1.205	.4514	.3545	2.1108
$\frac{11}{16}$	1.607	1.262	.4727	.3712	2.1598
$\frac{45}{64}$	1.681	1.320	.4944	.3883	2.2089
$\frac{23}{32}$	1.756	1.379	.5166	.4057	2.2580
$\frac{47}{64}$	1.834	1.440	.5393	.4236	2.3071
$\frac{3}{4}$	1.913	1.502	.5625	.4418	2.3562
$\frac{13}{16}$	2.245	1.763	.6602	.5185	2.5525
$\frac{7}{8}$	2.603	2.044	.7656	.6013	2.7489
$\frac{15}{16}$	2.989	2.347	.8789	.6903	2.9452
1	3.400	2.670	1.0000	.7854	3.1416
$\frac{1}{16}$	3.838	3.014	1.1289	.8866	3.3379
$\frac{1}{8}$	4.303	3.379	1.2656	.9940	3.5343
$\frac{3}{16}$	4.795	3.766	1.4102	1.1075	3.7306
$\frac{1}{4}$	5.312	4.173	1.5625	1.2272	3.9270
$\frac{5}{16}$	5.857	4.600	1.7227	1.3530	4.1233
$\frac{3}{8}$	6.428	5.049	1.8906	1.4849	4.3197
$\frac{7}{16}$	7.026	5.518	2.0664	1.6230	4.5160
$\frac{1}{2}$	7.650	6.008	2.2500	1.7671	4.7124
$\frac{9}{16}$	8.301	6.520	2.4414	1.9175	4.9087
$\frac{5}{8}$	8.978	7.051	2.6406	2.0739	5.1051
$\frac{11}{16}$	9.682	7.604	2.8477	2.2365	5.3014
$\frac{3}{4}$	10.41	8.178	3.0625	2.4053	5.4978
$\frac{13}{16}$	11.17	8.773	3.2852	2.5802	5.6941
$\frac{7}{8}$	11.95	9.388	3.5156	2.7612	5.8905
$\frac{15}{16}$	12.76	10.02	3.7539	2.9483	6.0868

SQUARE AND ROUND BARS.

(CONTINUED.)

Thickness or Diameter in Inches.	Weight of □ Bar One Foot Long.	Weight of ○ Bar One Foot Long.	Area of □ Bar in Sq. Inches.	Area of ○ Bar in Sq. Inches.	Circumference of ○ Bar in Inches.
2	13.60	10.68	4.0000	3.1416	6.2832
$\frac{1}{16}$	14.46	11.36	4.2539	3.3410	6.4795
$\frac{1}{8}$	15.35	12.06	4.5156	3.5466	6.6759
$\frac{3}{16}$	16.27	12.78	4.7852	3.7583	6.8722
$\frac{1}{4}$	17.22	13.52	5.0625	3.9761	7.0686
$\frac{5}{16}$	18.19	14.28	5.3477	4.2000	7.2649
$\frac{3}{8}$	19.18	15.07	5.6406	4.4301	7.4613
$\frac{7}{16}$	20.20	15.86	5.9414	4.6664	7.6576
$\frac{1}{2}$	21.25	16.69	6.2500	4.9087	7.8540
$\frac{9}{16}$	22.33	17.53	6.5664	5.1572	8.0503
$\frac{5}{8}$	23.43	18.40	6.8906	5.4119	8.2467
$\frac{11}{16}$	24.56	19.29	7.2227	5.6727	8.4430
$\frac{3}{4}$	25.	20.20	7.5625	5.9396	8.6394
$\frac{13}{16}$	26.90	21.12	7.9102	6.2126	8.8357
$\frac{7}{8}$	28.10	22.07	8.2656	6.4918	9.0321
$\frac{15}{16}$	29.34	23.04	8.6289	6.7771	9.2284
3	30.60	24.03	9.0000	7.0686	9.4248
$\frac{1}{16}$	31.89	25.04	9.3789	7.3662	9.6211
$\frac{1}{8}$	33.20	26.08	9.7656	7.6699	9.8175
$\frac{3}{16}$	34.55	27.13	10.160	7.9798	10.014
$\frac{1}{4}$	35.92	28.20	10.563	8.2958	10.210
$\frac{5}{16}$	37.31	29.30	10.973	8.6179	10.407
$\frac{3}{8}$	38.73	30.42	11.391	8.9462	10.603
$\frac{7}{16}$	40.18	31.56	11.816	9.2806	10.799
$\frac{1}{2}$	41.65	32.71	12.250	9.6211	10.996
$\frac{9}{16}$	43.14	33.90	12.691	9.9678	11.192
$\frac{5}{8}$	44.68	35.09	13.141	10.321	11.388
$\frac{11}{16}$	46.24	36.31	13.598	10.680	11.585
$\frac{3}{4}$	47.82	37.56	14.063	11.045	11.781
$\frac{13}{16}$	49.42	38.81	14.535	11.416	11.977
$\frac{7}{8}$	51.05	40.10	15.016	11.793	12.174
$\frac{15}{16}$	52.71	41.40	15.504	12.177	12.370

SQUARE AND ROUND BARS.

(CONTINUED.)

Thickness or Diameter in Inches.	Weight of □ Bar One Foot Long.	Weight of ○ Bar One Foot Long.	Area of □ Bar in Sq. Inches.	Area of ○ Bar in Sq. Inches.	Circumference of ○ Bar in Inches.
4	54.40	42.73	16.000	12.566	12.566
$\frac{1}{16}$	56.11	44.07	16.504	12.962	12.763
$\frac{1}{8}$	57.85	45.44	17.016	13.364	12.959
$\frac{3}{16}$	59.62	46.83	17.535	13.772	13.155
$\frac{1}{4}$	61.41	48.24	18.063	14.186	13.352
$\frac{5}{16}$	63.23	49.66	18.598	14.607	13.548
$\frac{3}{8}$	65.08	51.11	19.141	15.033	13.744
$\frac{7}{16}$	66.95	52.58	19.691	15.466	13.941
$\frac{1}{2}$	68.85	54.07	20.250	15.904	14.137
$\frac{9}{16}$	70.78	55.59	20.816	16.349	14.334
$\frac{5}{8}$	72.73	57.12	21.391	16.800	14.530
$\frac{11}{16}$	74.70	58.67	21.973	17.257	14.726
$\frac{3}{4}$	76.71	60.25	22.563	17.721	14.923
$\frac{13}{16}$	78.74	61.84	23.160	18.190	15.119
$\frac{7}{8}$	80.81	63.46	23.766	18.665	15.315
$\frac{15}{16}$	82.89	65.10	24.379	19.147	15.512
5	85.00	66.76	25.000	19.635	15.708
$\frac{1}{16}$	87.14	68.44	25.629	20.129	15.904
$\frac{1}{8}$	89.30	70.14	26.266	20.629	16.101
$\frac{3}{16}$	91.49	71.86	26.910	21.135	16.297
$\frac{1}{4}$	93.72	73.60	27.563	21.648	16.493
$\frac{5}{16}$	95.96	75.37	28.223	22.166	16.690
$\frac{3}{8}$	98.23	77.15	28.891	22.691	16.886
$\frac{7}{16}$	100.5	78.95	29.566	23.221	17.082
$\frac{1}{2}$	102.8	80.77	30.250	23.758	17.279
$\frac{9}{16}$	105.2	82.62	30.941	24.301	17.475
$\frac{5}{8}$	107.6	84.49	31.641	24.850	17.671
$\frac{11}{16}$	110.0	86.38	32.348	25.406	17.868
$\frac{3}{4}$	112.4	88.29	33.063	25.967	18.064
$\frac{13}{16}$	114.9	90.22	33.785	26.535	18.261
$\frac{7}{8}$	117.4	92.17	34.516	27.109	18.457
$\frac{15}{16}$	119.9	94.14	35.254	27.688	18.653

SQUARE AND ROUND BARS.

(CONTINUED.)

Thickness or Diameter in Inches.	Weight of □ Bar One Foot Long.	Weight of ○ Bar One Foot Long.	Area of □ Bar in Sq. Inches.	Area of ○ Bar in Sq. Inches.	Circumference of ○ Bar in Inches.
6	122.4	96.14	36.000	28.274	18.850
$\frac{1}{16}$	125.0	98.14	36.754	28.866	19.046
$\frac{1}{8}$	127.6	100.2	37.516	29.465	19.242
$\frac{3}{16}$	130.2	102.2	38.285	30.069	19.439
$\frac{1}{4}$	132.8	104.3	39.063	30.680	19.635
$\frac{5}{16}$	135.5	106.4	39.848	31.296	19.831
$\frac{3}{8}$	138.2	108.5	40.641	31.919	20.028
$\frac{7}{16}$	140.9	110.7	41.441	32.548	20.224
$\frac{1}{2}$	143.6	112.8	42.250	33.183	20.420
$\frac{9}{16}$	146.5	114.9	43.066	33.824	20.617
$\frac{5}{8}$	149.2	117.2	43.891	34.472	20.813
$\frac{11}{16}$	152.1	119.4	44.723	35.125	21.009
$\frac{3}{4}$	154.9	121.7	45.563	35.785	21.206
$\frac{13}{16}$	157.8	123.9	46.410	36.450	21.402
$\frac{7}{8}$	160.8	126.2	47.266	37.122	21.598
$\frac{15}{16}$	163.6	128.5	48.129	37.800	21.795
7	166.6	130.9	49.000	38.485	21.991
$\frac{1}{16}$	169.6	133.2	49.879	39.175	22.187
$\frac{1}{8}$	172.6	135.6	50.766	39.871	22.384
$\frac{3}{16}$	175.6	137.9	51.660	40.574	22.580
$\frac{1}{4}$	178.7	140.4	52.563	41.282	22.777
$\frac{5}{16}$	181.8	142.8	53.473	41.997	22.973
$\frac{3}{8}$	184.9	145.3	54.391	42.718	23.169
$\frac{7}{16}$	188.1	147.7	55.316	43.445	23.366
$\frac{1}{2}$	191.3	150.2	56.250	44.179	23.562
$\frac{9}{16}$	194.4	152.7	57.191	44.918	23.758
$\frac{5}{8}$	197.7	155.2	58.141	45.664	23.955
$\frac{11}{16}$	200.9	157.8	59.098	46.415	24.151
$\frac{3}{4}$	204.2	160.3	60.063	47.173	24.347
$\frac{13}{16}$	207.6	163.0	61.035	47.937	24.544
$\frac{7}{8}$	210.8	165.6	62.016	48.707	24.740
$\frac{15}{16}$	214.2	168.2	63.004	49.483	24.936

SQUARE AND ROUND BARS.

(CONTINUED.)

Thickness or Diameter in Inches.	Weight of □ Bar One Foot Long.	Weight of ○ Bar One Foot Long.	Area of □ Bar in Sq. Inches.	Area of ○ Bar in Sq. Inches.	Circumference of ○ Bar in Inches.
8	217.6	171.0	64.000	50.265	25.133
$\frac{1}{16}$	221.0	173.6	65.004	51.054	25.329
$\frac{1}{8}$	224.5	176.3	66.016	51.849	25.525
$\frac{3}{16}$	228.0	179.0	67.035	52.649	25.722
$\frac{1}{4}$	231.4	181.8	68.063	53.456	25.918
$\frac{5}{16}$	234.9	184.5	69.098	54.269	26.114
$\frac{3}{8}$	238.5	187.3	70.141	55.088	26.311
$\frac{7}{16}$	242.0	190.1	71.191	55.914	26.507
$\frac{1}{2}$	245.6	193.0	72.250	56.745	26.704
$\frac{9}{16}$	249.3	195.7	73.316	57.583	26.900
$\frac{5}{8}$	252.9	198.7	74.391	58.426	27.096
$\frac{11}{16}$	256.6	201.6	75.473	59.276	27.293
$\frac{3}{4}$	260.3	204.4	76.563	60.132	27.489
$\frac{13}{16}$	264.1	207.4	77.660	60.994	27.685
$\frac{7}{8}$	267.9	210.3	78.766	61.862	27.882
$\frac{15}{16}$	271.6	213.3	79.879	62.737	28.078
9	275.4	216.3	81.000	63.617	28.274
$\frac{1}{16}$	279.3	219.3	82.129	64.504	28.471
$\frac{1}{8}$	283.2	222.4	83.266	65.397	28.667
$\frac{3}{16}$	287.0	225.4	84.410	66.296	28.863
$\frac{1}{4}$	290.9	228.5	85.563	67.201	29.060
$\frac{5}{16}$	294.9	231.5	86.723	68.112	29.256
$\frac{3}{8}$	298.9	234.7	87.891	69.029	29.452
$\frac{7}{16}$	302.8	237.9	89.066	69.953	29.649
$\frac{1}{2}$	306.8	241.0	90.250	70.882	29.845
$\frac{9}{16}$	310.9	244.2	91.441	71.818	30.041
$\frac{5}{8}$	315.0	247.4	92.641	72.760	30.238
$\frac{11}{16}$	319.1	250.6	93.848	73.708	30.434
$\frac{3}{4}$	323.2	253.9	95.063	74.662	30.631
$\frac{13}{16}$	327.4	257.1	96.285	75.622	30.827
$\frac{7}{8}$	331.6	260.4	97.516	76.589	31.023
$\frac{15}{16}$	335.8	263.7	98.754	77.561	31.220

SQUARE AND ROUND BARS.

(CONTINUED.)

Thickness or Diameter in Inches.	Weight of □ Bar One Foot Long.	Weight of ○ Bar One Foot Long.	Area of □ Bar in Sq. Inches.	Area of ○ Bar in Sq. Inches.	Circumference of ○ Bar in Inches.
10	340.0	267.0	100.00	78.540	31.416
$\frac{1}{16}$	344.3	270.4	101.25	79.525	31.612
$\frac{1}{8}$	348.5	273.8	102.52	80.516	31.809
$\frac{3}{16}$	352.9	277.1	103.79	81.513	32.005
$\frac{1}{4}$	357.2	280.6	105.06	82.516	32.201
$\frac{5}{16}$	361.6	284.0	106.35	83.525	32.398
$\frac{3}{8}$	366.0	287.4	107.64	84.541	32.594
$\frac{7}{16}$	370.4	290.9	108.94	85.562	32.790
$\frac{1}{2}$	374.9	294.4	110.25	86.590	32.987
$\frac{9}{16}$	379.4	297.9	111.57	87.624	33.183
$\frac{5}{8}$	383.8	301.4	112.89	88.664	33.379
$\frac{11}{16}$	388.3	305.0	114.22	89.710	33.576
$\frac{3}{4}$	392.9	308.6	115.56	90.763	33.772
$\frac{13}{16}$	397.5	312.2	116.91	91.821	33.968
$\frac{7}{8}$	402.1	315.8	118.27	92.886	34.165
$\frac{15}{16}$	406.8	319.5	119.63	93.956	34.361
11	411.4	323.1	121.00	95.033	34.558
$\frac{1}{16}$	416.1	326.8	122.38	96.116	34.754
$\frac{1}{8}$	420.9	330.5	123.77	97.205	34.950
$\frac{3}{16}$	425.5	334.3	125.16	98.301	35.147
$\frac{1}{4}$	430.3	337.9	126.56	99.402	35.343
$\frac{5}{16}$	435.1	341.7	127.97	100.51	35.539
$\frac{3}{8}$	439.9	345.5	129.39	101.62	35.736
$\frac{7}{16}$	444.8	349.4	130.82	102.74	35.932
$\frac{1}{2}$	449.6	353.1	132.25	103.87	36.128
$\frac{9}{16}$	454.5	357.0	133.69	105.00	36.325
$\frac{5}{8}$	459.5	360.9	135.14	106.14	36.521
$\frac{11}{16}$	464.4	364.8	136.60	107.28	36.717
$\frac{3}{4}$	469.4	368.6	138.06	108.43	36.914
$\frac{13}{16}$	474.4	372.6	139.54	109.59	37.110
$\frac{7}{8}$	479.5	376.6	141.02	110.75	37.306
$\frac{15}{16}$	484.5	380.6	142.50	111.92	37.503

AREAS OF FLAT ROLLED STEEL BARS.

For Thicknesses from $\frac{1}{16}$ in. to 2 in. and Widths from 1 in. to $12\frac{3}{4}$ in.

Thickness in Inches.	1″	$1\frac{1}{4}$″	$1\frac{1}{2}$″	$1\frac{3}{4}$″	2″	$2\frac{1}{4}$″	$2\frac{1}{2}$″	$2\frac{3}{4}$″	12″
$\frac{1}{16}$	.063	.078	.094	.109	.125	.141	.156	.172	.750
$\frac{1}{8}$	.125	.156	.188	.219	.250	.281	.313	.344	1.50
$\frac{3}{16}$	.188	.234	.281	.328	.375	.422	.469	.516	2.25
$\frac{1}{4}$	.250	.313	.375	.438	.500	.563	.625	.688	3.00
$\frac{5}{16}$	.313	.391	.469	.547	.625	.703	.781	.859	3.75
$\frac{3}{8}$	.375	.469	.563	.656	.750	.844	.938	1.03	4.50
$\frac{7}{16}$	.438	.547	.656	.766	.875	.984	1.09	1.20	5.25
$\frac{1}{2}$	.500	.625	.750	.875	1.00	1.13	1.25	1.38	6.00
$\frac{9}{16}$	.563	.703	.844	.984	1.13	1.27	1.41	1.55	6.75
$\frac{5}{8}$	.625	.781	.938	1.09	1.25	1.41	1.56	1.72	7.50
$\frac{11}{16}$	.688	.859	1.03	1.20	1.38	1.55	1.72	1.89	8.25
$\frac{3}{4}$	.750	.938	1.13	1.31	1.50	1.69	1.88	2.06	9.00
$\frac{13}{16}$	.813	1.02	1.22	1.42	1.63	1.83	2.03	2.23	9.75
$\frac{7}{8}$	.875	1.09	1.31	1.53	1.75	1.97	2.19	2.41	10.50
$\frac{15}{16}$	.938	1.17	1.41	1.64	1.88	2.11	2.34	2.58	11.25
1	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	12.00
$1\frac{1}{16}$	1.06	1.33	1.59	1.86	2.13	2.39	2.66	2.92	12.75
$1\frac{1}{8}$	1.13	1.41	1.69	1.97	2.25	2.53	2.81	3.09	13.50
$1\frac{3}{16}$	1.19	1.48	1.78	2.08	2.38	2.67	2.97	3.27	14.25
$1\frac{1}{4}$	1.25	1.56	1.88	2.19	2.50	2.81	3.13	3.44	15.00
$1\frac{5}{16}$	1.31	1.64	1.97	2.30	2.63	2.95	3.28	3.61	15.75
$1\frac{3}{8}$	1.38	1.72	2.06	2.41	2.75	3.09	3.44	3.78	16.50
$1\frac{7}{16}$	1.44	1.80	2.16	2.52	2.88	3.23	3.59	3.95	17.25
$1\frac{1}{2}$	1.50	1.88	2.25	2.63	3.00	3.38	3.75	4.13	18.00
$1\frac{9}{16}$	1.56	1.95	2.34	2.73	3.13	3.52	3.91	4.30	18.75
$1\frac{5}{8}$	1.63	2.03	2.44	2.84	3.25	3.66	4.06	4.47	19.50
$1\frac{11}{16}$	1.69	2.11	2.53	2.95	3.38	3.80	4.22	4.64	20.25
$1\frac{3}{4}$	1.75	2.19	2.63	3.06	3.50	3.94	4.38	4.81	21.00
$1\frac{13}{16}$	1.81	2.27	2.72	3.17	3.63	4.08	4.53	4.98	21.75
$1\frac{7}{8}$	1.88	2.34	2.81	3.28	3,75	4.22	4.69	5.16	22.50
$1\frac{15}{16}$	1.94	2.42	2.91	3.39	3.88	4.36	4.84	5.33	23.25
2	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	24.00

AREAS OF FLAT ROLLED STEEL BARS.

(CONTINUED.)

Thickness in Inches.	3″	3¼″	3½″	3¾″	4″	4¼″	4½″	4¾″	12″
$\frac{1}{16}$	.188	.203	.219	.234	.250	.266	.281	.297	.750
$\frac{1}{8}$	.375	.406	.438	.469	.500	.531	.563	.594	1.50
$\frac{3}{16}$	.563	.609	.656	.703	.750	.797	.844	.891	2.25
$\frac{1}{4}$	.750	.813	.875	.938	1.00	1.06	1.13	1.19	3.00
$\frac{5}{16}$	.938	1.02	1.09	1.17	1.25	1.33	1.41	1.48	3.75
$\frac{3}{8}$	1.13	1.22	1.31	1.41	1.50	1.59	1.69	1.78	4.50
$\frac{7}{16}$	1.31	1.42	1.53	1.64	1.75	1.86	1.97	2.08	5.25
$\frac{1}{2}$	1.50	1.63	1.75	1.88	2.00	2.13	2.25	2.38	6.00
$\frac{9}{16}$	1.69	1.83	1.97	2.11	2.25	2.39	2.53	2.67	6.75
$\frac{5}{8}$	1.88	2.03	2.19	2.34	2.50	2.66	2.81	2.97	7.50
$\frac{11}{16}$	2.06	2.23	2.41	2.58	2.75	2.92	3.09	3.27	8.25
$\frac{3}{4}$	2.25	2.44	2.63	2.81	3.00	3.19	3.38	3.56	9.00
$\frac{13}{16}$	2.44	2.64	2.84	3.05	3.25	3.45	3.66	3.86	9.75
$\frac{7}{8}$	2.63	2.84	3.06	3.28	3.50	3.72	3.94	4.16	10.50
$\frac{15}{16}$	2.81	3.05	3.28	3.52	3.75	3.98	4.22	4.45	11.25
1	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	12.00
$1\frac{1}{16}$	3.19	3.45	3.72	3.98	4.25	4.52	4.78	5.05	12.75
$1\frac{1}{8}$	3.38	3.66	3.94	4.22	4.50	4.78	5.06	5.34	13.50
$1\frac{3}{16}$	3.56	3.86	4.16	4.45	4.75	5.05	5.34	5.64	14.25
$1\frac{1}{4}$	3.75	4.06	4.38	4.69	5.00	5.31	5.63	5.94	15.00
$1\frac{5}{16}$	3.94	4.27	4.59	4.92	5.25	5.58	5.91	6.23	15.75
$1\frac{3}{8}$	4.13	4.47	4.81	5.16	5.50	5.84	6.19	6.53	16.50
$1\frac{7}{16}$	4.31	4.67	5.03	5.39	5.75	6.11	6.47	6.83	17.25
$1\frac{1}{2}$	4.50	4.88	5.25	5.63	6.00	6.38	6.75	7.13	18.00
$1\frac{9}{16}$	4.69	5.08	5.47	5.86	6.25	6.64	7.03	7.42	18.75
$1\frac{5}{8}$	4.88	5.28	5.69	6.09	6.50	6.91	7.31	7.72	19.50
$1\frac{11}{16}$	5.06	5.48	5.91	6.33	6.75	7.17	7.59	8.02	20.25
$1\frac{3}{4}$	5.25	5.69	6.13	6.56	7.00	7.44	7.88	8.31	21.00
$1\frac{13}{16}$	5.44	5.89	6.34	6.80	7.25	7.70	8.16	8.61	21.75
$1\frac{7}{8}$	5.63	6.09	6.56	7.03	7.50	7.97	8.44	8.91	22.50
$1\frac{15}{16}$	5.81	6.30	6.78	7.27	7.75	8.23	8.72	9.20	23.25
2	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	24.00

AREAS OF FLAT ROLLED STEEL BARS.

(CONTINUED.)

Thickness in Inches.	5″	5¼″	5½″	5¾″	6″	6¼″	6½″	6¾″	12″
1/16	.313	.328	.344	.359	.375	.391	.406	.422	.750
1/8	.625	.656	.688	.719	.750	.781	.813	.844	1.50
3/16	.938	.984	1.03	1.08	1.13	1.17	1.22	1.27	2.25
1/4	1.25	1.31	1.38	1.44	1.50	1.56	1.63	1.69	3.00
5/16	1.56	1.64	1.72	1.80	1.88	1.95	2.03	2.11	3.75
3/8	1.88	1.97	2.06	2.16	2.25	2.34	2.44	2.53	4.50
7/16	2.19	2.30	2.41	2.52	2.63	2.73	2.84	2.95	5.25
1/2	2.50	2.63	2.75	2.88	3.00	3.13	3.25	3.38	6.00
9/16	2.81	2.95	3.09	3.23	3.38	3.52	3.66	3.80	6.75
5/8	3.13	3.28	3.44	3.59	3.75	3.91	4.06	4.22	7.50
11/16	3.44	3.61	3.78	3.95	4.13	4.30	4.47	4.64	8.25
3/4	3.75	3.94	4.13	4.31	4.50	4.69	4.88	5.06	9.00
13/16	4.06	4.27	4.47	4.67	4.88	5.08	5.28	5.48	9.75
7/8	4.38	4.59	4.81	5.03	5.25	5.47	5.69	5.91	10.50
15/16	4.69	4.92	5.16	5.39	5.63	5.86	6.09	6.33	11.25
1	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	12.00
1 1/16	5.31	5.58	5.84	6.11	6.38	6.64	6.91	7.17	12.75
1 1/8	5.63	5.91	6.19	6.47	6.75	7.03	7.31	7.59	13.50
1 3/16	5.94	6.23	6.53	6.83	7.13	7.42	7.72	8.02	14.25
1 1/4	6.25	6.56	6.88	7.19	7.50	7.81	8.13	8.44	15.00
1 5/16	6.56	6.89	7.22	7.55	7.88	8.20	8.53	8.86	15.75
1 3/8	6.88	7.22	7.56	7.91	8.25	8.59	8.94	9.28	16.50
1 7/16	7.19	7.55	7.91	8.27	8.63	8.98	9.34	9.70	17.25
1 1/2	7.50	7.88	8.25	8.63	9.00	9.38	9.75	10.13	18.00
1 9/16	7.81	8.20	8.59	8.98	9.38	9.77	10.16	10.55	18.75
1 5/8	8.13	8.53	8.94	9.34	9.75	10.16	10.56	10.97	19.50
1 11/16	8.44	8.86	9.28	9.70	10.13	10.55	10.97	11.39	20.25
1 3/4	8.75	9.19	9.63	10.06	10.50	10.94	11.38	11.81	21.00
1 13/16	9.06	9.52	9.97	10.42	10.88	11.33	11.78	12.23	21.75
1 7/8	9.38	9.84	10.31	10.78	11.25	11.72	12.19	12.66	22.50
1 15/16	9.69	10.17	10.66	11.14	11.63	12.11	12.59	13.08	23.25
2	10.00	10.50	11.00	11.50	12.00	12.50	13.00	13.50	24.00

AREAS OF FLAT ROLLED STEEL BARS.

(CONTINUED.)

Thickness in Inches.	7″	$7\frac{1}{4}$″	$7\frac{1}{2}$″	$7\frac{3}{4}$″	8″	$8\frac{1}{4}$″	$8\frac{1}{2}$″	$8\frac{3}{4}$″	12″
$\frac{1}{16}$	.438	.453	.469	.484	.500	.516	.531	.547	.750
$\frac{1}{8}$	.875	.906	.938	.969	1.00	1.03	1.06	1.09	1.50
$\frac{3}{16}$	1.31	1.36	1.41	1.45	1.50	1.55	1.59	1.64	2.25
$\frac{1}{4}$	1.75	1.81	1.88	1.94	2.00	2.06	2.13	2.19	3.00
$\frac{5}{16}$	2.19	2.27	2.34	2.42	2.50	2.58	2.66	2.73	3.75
$\frac{3}{8}$	2.63	2.72	2.81	2.91	3.00	3.09	3.19	3.28	4.50
$\frac{7}{16}$	3.06	3.17	3.28	3.39	3.50	3.61	3.72	3.83	5.25
$\frac{1}{2}$	3.50	3.63	3.75	3.88	4.00	4.13	4.25	4.38	6.00
$\frac{9}{16}$	3.94	4.08	4.22	4.36	4.50	4.64	4.78	4.92	6.75
$\frac{5}{8}$	4.38	4.53	4.69	4.84	5.00	5.16	5.31	5.47	7.50
$\frac{11}{16}$	4.81	4.98	5.16	5.33	5.50	5.67	5.84	6.02	8.25
$\frac{3}{4}$	5.25	5.44	5.63	5.81	6.00	6.19	6.38	6.56	9.00
$\frac{13}{16}$	5.69	5.89	6.09	6.30	6.50	6.70	6.91	7.11	9.75
$\frac{7}{8}$	6.13	6.34	6.56	6.78	7.00	7.22	7.44	7.66	10.50
$\frac{15}{16}$	6.56	6.80	7.03	7.27	7.50	7.73	7.97	8.20	11.25
1	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.75	12.00
$1\frac{1}{16}$	7.44	7.70	7.97	8.23	8.50	8.77	9.03	9.30	12.75
$1\frac{1}{8}$	7.88	8.16	8.44	8.72	9.00	9.28	9.56	9.84	13.50
$1\frac{3}{16}$	8.31	8.61	8.91	9.20	9.50	9.80	10.09	10.39	14.25
$1\frac{1}{4}$	8.75	9.06	9.38	9.69	10.00	10.31	10.63	10.94	15.00
$1\frac{5}{16}$	9.19	9.52	9.84	10.17	10.50	10.83	11.16	11.48	15.75
$1\frac{3}{8}$	9.63	9.97	10.31	10.66	11.00	11.34	11.69	12.03	16.50
$1\frac{7}{16}$	10.06	10.42	10.78	11.14	11.50	11.86	12.22	12.58	17.25
$1\frac{1}{2}$	10.50	10.88	11.25	11.63	12.00	12.38	12.75	13.13	18.00
$1\frac{9}{16}$	10.94	11.33	11.72	12.11	12.50	12.89	13.28	13.67	18.75
$1\frac{5}{8}$	11.38	11.78	12.19	12.59	13.00	13.41	13.81	14.22	19.50
$1\frac{11}{16}$	11.81	12.23	12.66	13.08	13.50	13.92	14.34	14.77	20.25
$1\frac{3}{4}$	12.25	12.69	13.13	13.56	14.00	14.44	14.88	15.31	21.00
$1\frac{13}{16}$	12.69	13.14	13.59	14.05	14.50	14.95	15.41	15.86	21.75
$1\frac{7}{8}$	13.13	13.59	14.06	14.53	15.00	15.47	15.94	16.41	22.50
$1\frac{15}{16}$	13.56	14.05	14.53	15.02	15.50	15.98	16.47	16.95	23.25
2	14.00	14.50	15.00	15.50	16.00	16.50	17.00	17.50	24.00

AREAS OF FLAT ROLLED STEEL BARS.

(CONTINUED.)

Thickness in Inches.	9″	9¼″	9½″	9¾″	10″	10¼″	10½″	10¾″	12″
$\frac{1}{16}$	.563	.578	.594	.609	.625	.641	.656	.672	.750
$\frac{1}{8}$	1.13	1.16	1.19	1.22	1.25	1.28	1.31	1.34	1.50
$\frac{3}{16}$	1.69	1.73	1.78	1.83	1.88	1.92	1.97	2.02	2.25
$\frac{1}{4}$	2.25	2.31	2.38	2.44	2.50	2.56	2.63	2.69	3.00
$\frac{5}{16}$	2.81	2.89	2.97	3.05	3.13	3.20	3.28	3.36	3.75
$\frac{3}{8}$	3.38	3.47	3.56	3.66	3.75	3.84	3.94	4.03	4.50
$\frac{7}{16}$	3.94	4.05	4.16	4.27	4.38	4.48	4.59	4.70	5.25
$\frac{1}{2}$	4.50	4.63	4.75	4.88	5.00	5.13	5.25	5.38	6.00
$\frac{9}{16}$	5.06	5.20	5.34	5.48	5.63	5.77	5.91	6.05	6.75
$\frac{5}{8}$	5.63	5.78	5.94	6.09	6.25	6.41	6.56	6.72	7.50
$\frac{11}{16}$	6.19	6.36	6.53	6.70	6.88	7.05	7.22	7.39	8.25
$\frac{3}{4}$	6.75	6.94	7.13	7.31	7.50	7.69	7.88	8.06	9.00
$\frac{13}{16}$	7.31	7.52	7.72	7.92	8.13	8.33	8.53	8.73	9.75
$\frac{7}{8}$	7.88	8.09	8.31	8.53	8.75	8.97	9.19	9.41	10.50
$\frac{15}{16}$	8.44	8.67	8.91	9.14	9.38	9.61	9.84	10.08	11.25
1	9.00	9.25	9.50	9.75	10.00	10.25	10.50	10.75	12.00
$1\frac{1}{16}$	9.56	9.83	10.09	10.36	10.63	10.89	11.16	11.42	12.75
$1\frac{1}{8}$	10.13	10.41	10.69	10.97	11.25	11.53	11.81	12.09	13.50
$1\frac{3}{16}$	10.69	10.98	11.28	11.58	11.88	12.17	12.47	12.77	14.25
$1\frac{1}{4}$	11.25	11.56	11.88	12.19	12.50	12.81	13.13	13.44	15.00
$1\frac{5}{16}$	11.81	12.14	12.47	12.80	13.13	13.45	13.78	14.11	15.75
$1\frac{3}{8}$	12.38	12.72	13.06	13.41	13.75	14.09	14.44	14.78	16.50
$1\frac{7}{16}$	12.94	13.30	13.66	14.02	14.38	14.73	15.09	15.45	17.25
$1\frac{1}{2}$	13.50	13.88	14.25	14.63	15.00	15.38	15.75	16.13	18.00
$1\frac{9}{16}$	14.06	14.45	14.84	15.23	15.63	16.02	16.41	16.80	18.75
$1\frac{5}{8}$	14.63	15.03	15.44	15.84	16.25	16.66	17.06	17.47	19.50
$1\frac{11}{16}$	15.19	15.61	16.03	16.45	16.88	17.30	17.72	18.14	20.25
$1\frac{3}{4}$	15.75	16.19	16.63	17.06	17.50	17.94	18.38	18.81	21.00
$1\frac{13}{16}$	16.31	16.77	17.22	17.67	18.13	18.58	19.03	19.48	21.75
$1\frac{7}{8}$	16.88	17.34	17.81	18.28	18.75	19.22	19.69	20.16	22.50
$1\frac{15}{16}$	17.44	17.92	18.41	18.89	19.38	19.86	20.34	20.83	23.25
2	18.00	18.50	19.00	19.50	20.00	20.50	21.00	21.50	24.00

AREAS OF FLAT ROLLED STEEL BARS.

(CONTINUED.)

Thickness in Inches.	11″	11¼″	11½″	11¾″	12″	12¼″	12½″	12¾″
$\frac{1}{16}$	.688	.703	.719	.734	.750	.766	.781	.797
$\frac{1}{8}$	1.38	1.41	1.44	1.47	1.50	1.53	1.56	1.59
$\frac{3}{16}$	2.06	2.11	2.16	2.20	2.25	2.30	2.34	2.39
$\frac{1}{4}$	2.75	2.81	2.88	2.94	3.00	3.06	3.13	3.19
$\frac{5}{16}$	3.44	3.52	3.59	3.67	3.75	3.83	3.91	3.98
$\frac{3}{8}$	4.13	4.22	4.31	4.41	4.50	4.59	4.69	4.78
$\frac{7}{16}$	4.81	4.92	5.03	5.14	5.25	5.36	5.47	5.58
$\frac{1}{2}$	5.50	5.63	5.75	5.88	6.00	6.13	6.25	6.38
$\frac{9}{16}$	6.19	6.33	6.47	6.61	6.75	6.89	7.03	7.17
$\frac{5}{8}$	6.88	7.03	7.19	7.34	7.50	7.66	7.81	7.97
$\frac{11}{16}$	7.56	7.73	7.91	8.08	8.25	8.42	8.59	8.77
$\frac{3}{4}$	8.25	8.44	8.63	8.81	9.00	9.19	9.38	9.56
$\frac{13}{16}$	8.94	9.14	9.34	9.55	9.75	9.95	10.16	10.36
$\frac{7}{8}$	9.63	9.84	10.06	10.28	10.50	10.72	10.94	11.16
$\frac{15}{16}$	10.31	10.55	10.78	11.02	11.25	11.48	11.72	11.95
1	11.00	11.25	11.50	11.75	12.00	12.25	12.50	12.75
$1\frac{1}{16}$	11.69	11.95	12.22	12.48	12.75	13.02	13.28	13.55
$1\frac{1}{8}$	12.38	12.66	12.94	13.22	13.50	13.78	14.06	14.34
$1\frac{3}{16}$	13.06	13.36	13.66	13.95	14.25	14.55	14.84	15.14
$1\frac{1}{4}$	13.75	14.06	14.38	14.69	15.00	15.31	15.63	15.94
$1\frac{5}{16}$	14.44	14.77	15.09	15.42	15.75	16.08	16.41	16.73
$1\frac{3}{8}$	15.13	15.47	15.81	16.16	16.50	16.84	17.19	17.53
$1\frac{7}{16}$	15.81	16.17	16.53	16.89	17.25	17.61	17.97	18.33
$1\frac{1}{2}$	16.50	16.88	17.25	17.63	18.00	18.38	18.75	19.13
$1\frac{9}{16}$	17.19	17.58	17.97	18.36	18.75	19.14	19.53	19.92
$1\frac{5}{8}$	17.88	18.28	18.69	19.09	19.50	19.91	20.31	20.72
$1\frac{11}{16}$	18.56	18.98	19.41	19.83	20.25	20.67	21.09	21.52
$1\frac{3}{4}$	19.25	19.69	20.13	20.56	21.00	21.44	21.88	22.31
$1\frac{13}{16}$	19.94	20.39	20.84	21.30	21.75	22.20	22.66	23.11
$1\frac{7}{8}$	20.63	21.09	21.56	22.03	22.50	22.97	23.44	23.91
$1\frac{15}{16}$	21.31	21.80	22.28	22.77	23.25	23.73	24.22	24.70
2	22.00	22.50	23.00	23.50	24.00	24.50	25.00	25.50

The areas for 12″ width are repeated on each page to facilitate making the additions necessary to obtain the areas of plates of any width greater than 12″. Thus, to find the area of 15¼″ × ⅞″, add the areas to be found in the same line for 3¼ × ⅞ and 12 × ⅞ = 2.84 + 10.50 = 13.34 square inches. Area of plate 4′ 6½″ × ⅝″ = 4 × 7.50 + 4.06 = 34.06 square inches.

WEIGHTS OF FLAT ROLLED STRIPS, HOOP OR BAND STEEL.

PER LINEAL FOOT.

Thicknesses by Birmingham Wire Gauge.

One cubic foot of steel weighs 489.6 pounds.
For widths from $\frac{1}{4}$ inch to $\frac{3}{4}$ inch and thicknesses from No. 19 to No. 11 B.W.G.

Width in Inches.	No. 19. .042 In.	No. 18. .049 In.	No. 17. .058 In.	No. 16. .065 In.	No. 15. .072 In.	No. 14. .083 In.	No. 13. .095 In.	No. 12. .109 In.	No. 11. .120 In.
$\frac{1}{4}$	.036	.042	.049	.055	.061	.071	.081	.093	.102
$\frac{17}{64}$	.038	.044	.052	.059	.065	.075	.086	.098	.108
$\frac{9}{32}$	.040	.047	.055	.062	.069	.079	.091	.104	.115
$\frac{19}{64}$	.042	.049	.059	.066	.073	.084	.096	.110	.121
$\frac{5}{16}$	.045	.052	.062	.069	.077	.088	.101	.116	.128
$\frac{21}{64}$	.047	.055	.065	.073	.080	.093	.106	.122	.134
$\frac{11}{32}$	.049	.057	.068	.076	.084	.097	.111	.127	.140
$\frac{23}{64}$	.051	.060	.071	.079	.088	.101	.116	.133	.147
$\frac{3}{8}$	.054	.062	.074	.083	.092	.106	.121	.139	.153
$\frac{25}{64}$	.056	.065	.077	.086	.096	.110	.126	.145	.159
$\frac{13}{32}$	.058	.068	.080	.090	.099	.115	.131	.151	.166
$\frac{27}{64}$	.060	.070	.083	.093	.103	.119	.136	.156	.172
$\frac{7}{16}$	.062	.073	.086	.097	.107	.123	.141	.162	.179
$\frac{29}{64}$	.065	.075	.089	.100	.111	.128	.146	.168	.185
$\frac{15}{32}$	.067	.078	.092	.104	.115	.132	.151	.174	.191
$\frac{31}{64}$	.069	.081	.096	.107	.119	.137	.156	.180	.198
$\frac{1}{2}$	.071	.083	.099	.111	.122	.141	.162	.185	.204
$\frac{33}{64}$	.074	.086	.102	.114	.126	.146	.167	.191	.210
$\frac{17}{32}$	.076	.089	.105	.117	.130	.150	.172	.197	.217
$\frac{35}{64}$	.078	.091	.108	.121	.134	.154	.177	.203	.223
$\frac{9}{16}$	.080	.094	.111	.124	.138	.159	.182	.208	.230
$\frac{37}{64}$	.083	.096	.114	.128	.142	.163	.187	.214	.236
$\frac{19}{32}$	.085	.099	.117	.131	.145	.168	.192	.220	.242
$\frac{39}{64}$	.087	.102	.120	.135	.149	.172	.197	.226	.249
$\frac{5}{8}$	.089	.104	.123	.138	.153	.176	.202	.232	.255
$\frac{41}{64}$	.091	.107	.126	.142	.157	.181	.207	.237	.261
$\frac{21}{32}$	.094	.109	.139	.145	.161	.185	.212	.243	.268
$\frac{43}{64}$	.096	.112	.132	.148	.164	.190	.217	.249	.274
$\frac{11}{16}$	.098	.115	.136	.152	.168	.194	.222	.255	.281
$\frac{45}{64}$	.100	.117	.139	.155	.172	.198	.227	.261	.287
$\frac{23}{32}$	.103	.120	.142	.159	.176	.203	.232	.266	.293
$\frac{47}{64}$	.105	.122	.145	.162	.180	.207	.237	.272	.300
$\frac{3}{4}$	.107	.125	.148	.166	.184	.212	.242	.278	.306

WEIGHTS OF FLAT ROLLED STEEL BARS.

PER LINEAL FOOT.

One cubic foot of steel weighs 489.6 pounds.

For thicknesses from $\frac{1}{16}$ inch to $\frac{35}{64}$ inch and widths from $\frac{1}{4}$ inch to $\frac{3}{4}$ inch.

Thickness in Inches.	$\frac{1}{4}''$	$\frac{17}{64}''$	$\frac{9}{32}''$	$\frac{19}{64}''$	$\frac{5}{16}''$	$\frac{21}{64}''$	$\frac{11}{32}''$	$\frac{23}{64}''$	$\frac{3}{8}''$
$\frac{1}{16}$	.053	.056	.060	.063	.066	.070	.073	.076	.080
$\frac{5}{64}$	.066	.071	.075	.079	.083	.087	.091	.095	.100
$\frac{3}{32}$	.080	.085	.090	.095	.100	.105	.110	.115	.120
$\frac{7}{64}$	.093	.099	.105	.110	.116	.122	.128	.134	.139
$\frac{1}{8}$	.106	.113	.120	.126	.133	.139	.146	.153	.159
$\frac{9}{64}$	.120	.127	.134	.142	.149	.157	.164	.172	.179
$\frac{5}{32}$	.133	.141	.149	.158	.166	.174	.183	.191	.199
$\frac{11}{64}$	.146	.155	.164	.173	.183	.192	.201	.210	.219
$\frac{3}{16}$	.159	.169	.179	.189	.199	.209	.219	.229	.239
$\frac{13}{64}$	.173	.183	.194	.205	.216	.227	.237	.248	.259
$\frac{7}{32}$	.186	.198	.209	.221	.232	.244	.256	.267	.279
$\frac{15}{64}$	.199	.212	.224	.237	.249	.261	.274	.286	.299
$\frac{1}{4}$	.213	.226	.239	.252	.266	.279	.292	.305	.319
$\frac{17}{64}$	.226	.240	.254	.268	.282	.296	.310	.325	.339
$\frac{9}{32}$	.239	.254	.269	.284	.299	.314	.329	.344	.359
$\frac{19}{64}$	.252	.268	.284	.300	.315	.331	.347	.363	.379
$\frac{5}{16}$	.266	.282	.299	.315	.332	.349	.365	.382	.398
$\frac{21}{64}$	.279	.296	.314	.331	.349	.366	.383	.401	.418
$\frac{11}{32}$	.292	.310	.329	.347	.365	.383	.402	.420	.438
$\frac{23}{64}$	.305	.325	.344	.363	.382	.401	.420	.439	.458
$\frac{3}{8}$	.319	.339	.359	.379	.398	.418	.438	.458	.478
$\frac{25}{64}$	.332	.353	.374	.394	.415	.436	.457	.477	.498
$\frac{13}{32}$	.345	.367	.388	.410	.432	.453	.475	.496	.518
$\frac{27}{64}$	.359	.381	.403	.426	.448	.471	.493	.515	.538
$\frac{7}{16}$	.372	.395	.418	.442	.465	.488	.511	.535	.558
$\frac{29}{64}$	.385	.409	.433	.457	.481	.506	.530	.554	.578
$\frac{15}{32}$	.398	.423	.448	.473	.498	.523	.548	.573	.598
$\frac{31}{64}$	.412	.437	.463	.489	.515	.540	.566	.592	.618
$\frac{1}{2}$	.425	.452	.478	.505	.531	.558	.584	.611	.638
$\frac{33}{64}$	.438	.466	.493	.520	.548	.575	.603	.630	.657
$\frac{17}{32}$	.452	.480	.508	.536	.564	.593	.621	.649	.677
$\frac{35}{64}$	.465	.494	.523	.552	.581	.610	.639	.668	.697
$\frac{9}{16}$	.478	.508	.538	.567	.598	.628	.657	.687	.717

WEIGHTS OF FLAT ROLLED STEEL BARS.

PER LINEAL FOOT.

(CONTINUED.)

Thickness in Inches.	$\frac{25}{64}''$	$\frac{13}{32}''$	$\frac{27}{64}''$	$\frac{7}{16}''$	$\frac{29}{64}''$	$\frac{15}{32}''$	$\frac{31}{64}''$	$\frac{1}{2}''$	12″
$\frac{1}{16}$	.083	.086	.090	.093	.096	.100	.103	.106	2.53
$\frac{5}{64}$	.104	.108	.112	.116	.120	.125	.129	.133	3.19
$\frac{3}{32}$	.125	.129	.134	.139	.144	.149	.154	.159	3.83
$\frac{7}{64}$	.145	.151	.157	.163	.169	.174	.180	.186	4.46
$\frac{1}{8}$	.166	.173	.179	.186	.193	.199	.206	.212	5.10
$\frac{9}{64}$	.187	.194	.202	.209	.217	.224	.232	.239	5.74
$\frac{5}{32}$	.208	.216	.224	.232	.241	.249	.257	.266	6.38
$\frac{11}{64}$	.228	.237	.247	.256	.265	.274	.283	.292	7.01
$\frac{3}{16}$	.249	.259	.269	.279	.289	.299	.309	.319	7.65
$\frac{13}{64}$	.270	.281	.291	.302	.313	.324	.335	.345	8.29
$\frac{7}{32}$	.291	.302	.314	.325	.337	.349	.360	.372	8.93
$\frac{15}{64}$	.311	.324	.336	.349	.361	.374	.386	.398	9.56
$\frac{1}{4}$	.332	.345	.359	.372	.385	.398	.412	.425	10.20
$\frac{17}{64}$	.353	.367	.381	.395	.409	.423	.437	.452	10.84
$\frac{9}{32}$	.374	.388	.403	.418	.433	.448	.463	.478	11.48
$\frac{19}{64}$	.394	.410	.426	.442	.457	.473	.489	.505	12.11
$\frac{5}{16}$	.415	.432	.448	.465	.481	.498	.515	.531	12.75
$\frac{21}{64}$	.436	.453	.471	.488	.506	.523	.540	.558	13.39
$\frac{11}{32}$	.457	.475	.493	.511	.530	.548	.566	.584	14.03
$\frac{23}{64}$	.477	.496	.515	.535	.554	.573	.592	.611	14.66
$\frac{3}{8}$	.498	.518	.538	.558	.578	.598	.618	.638	15.30
$\frac{25}{64}$	.519	.540	.560	.581	.602	.623	.643	.664	15.94
$\frac{13}{32}$	.540	.561	.583	.604	.626	.647	.669	.691	16.58
$\frac{27}{64}$	.560	.583	.605	.628	.650	.672	.695	.717	17.21
$\frac{7}{16}$	.581	.604	.628	.651	.674	.697	.721	.744	17.85
$\frac{29}{64}$	.602	.626	.650	.674	.698	.722	.746	.770	18.49
$\frac{15}{32}$	.623	.647	.672	.697	.722	.747	.772	.797	19.13
$\frac{31}{64}$	.643	.669	.695	.721	.746	.772	.798	.823	19.76
$\frac{1}{2}$	.664	.691	.717	.744	.770	.797	.823	.850	20.40
$\frac{33}{64}$	.685	.712	.740	.767	.794	.822	.849	.877	21.04
$\frac{17}{32}$	.706	.734	.762	.790	.818	.847	.875	.903	21.68
$\frac{35}{64}$	.726	.755	.784	.813	.843	.872	.901	.930	22.31
$\frac{9}{16}$	.747	.777	.807	.837	.867	.896	.926	.956	22.95

WEIGHTS OF FLAT ROLLED STEEL BARS.

PER LINEAL FOOT.

(CONTINUED.)

Thickness in Inches.	$\frac{33}{64}''$	$\frac{17}{32}''$	$\frac{35}{64}''$	$\frac{9}{16}''$	$\frac{37}{64}''$	$\frac{19}{32}''$	$\frac{39}{64}''$	$\frac{5}{8}''$	12″
$\frac{1}{16}$	.110	.113	.116	.120	.123	.126	.129	.133	2.53
$\frac{5}{64}$	.137	.141	.145	.149	.154	.158	.162	.166	3.19
$\frac{3}{32}$	.164	.169	.174	.179	.184	.189	.194	.199	3.83
$\frac{7}{64}$	.192	.198	.203	.209	.215	.221	.227	.232	4.46
$\frac{1}{8}$	.219	.226	.232	.239	.246	.252	.259	.266	5.10
$\frac{9}{64}$	.247	.254	.261	.269	.276	.284	.291	.299	5.74
$\frac{5}{32}$	.274	.282	.291	.299	.307	.315	.324	.332	6.38
$\frac{11}{64}$	.301	.310	.320	.329	.338	.347	.356	.365	7.01
$\frac{3}{16}$	.329	.339	.349	.359	.369	.379	.388	.398	7.65
$\frac{13}{64}$	.356	.367	.378	.388	.399	.410	.421	.432	8.29
$\frac{7}{32}$	.383	.395	.407	.418	.430	.442	.453	.465	8.93
$\frac{15}{64}$	.411	.423	.436	.448	.461	.473	.486	.498	9.56
$\frac{1}{4}$	.438	.452	.465	.478	.491	.505	.518	.531	10.20
$\frac{17}{64}$	.466	.480	.494	.508	.522	.536	.550	.564	10.84
$\frac{9}{32}$	.493	.508	.523	.538	.553	.568	.583	.598	11.48
$\frac{19}{64}$	.520	.536	.552	.568	.584	.599	.615	.631	12.11
$\frac{5}{16}$	.548	.564	.581	.598	.614	.631	.647	.664	12.75
$\frac{21}{64}$	.575	.593	.610	.628	.645	.662	.680	.697	13.39
$\frac{11}{32}$	.603	.621	.639	.657	.676	.694	.712	.730	14.03
$\frac{23}{64}$	.630	.649	.668	.687	.706	.725	.745	.764	14.66
$\frac{3}{8}$	.657	.677	.697	.717	.737	.757	.777	.797	15.30
$\frac{25}{64}$	.685	.706	.726	.747	.768	.789	.809	.830	15.94
$\frac{13}{32}$	.712	.734	.755	.777	.799	.820	.842	.863	16.58
$\frac{27}{64}$	.740	.762	.784	.807	.829	.852	.874	.896	17.21
$\frac{7}{16}$	.767	.790	.813	.837	.860	.883	.906	.930	17.85
$\frac{29}{64}$	.794	.818	.843	.867	.891	.915	.939	.963	18.49
$\frac{15}{32}$	.822	.847	.872	.896	.921	.946	.971	.996	19.13
$\frac{31}{64}$	.849	.875	.901	.926	.952	.978	1.00	1.03	19.76
$\frac{1}{2}$	.877	.903	.930	.956	.983	1.01	1.04	1.06	20.40
$\frac{33}{64}$	.904	.931	.959	.986	1.01	1.04	1.07	1.10	21.04
$\frac{17}{32}$	.931	.960	.988	1.02	1.04	1.07	1.10	1.13	21.68
$\frac{35}{64}$	.959	.988	1.02	1.05	1.07	1.10	1.13	1.16	22.31
$\frac{9}{16}$	.986	1.02	1.05	1.08	1.11	1.14	1.17	1.20	22.95

WEIGHTS OF FLAT ROLLED STEEL BARS.

PER LINEAL FOOT.

(CONTINUED.)

Thickness in Inches.	$\frac{41}{64}''$	$\frac{21}{32}''$	$\frac{43}{64}''$	$\frac{11}{16}''$	$\frac{45}{64}''$	$\frac{23}{32}''$	$\frac{47}{64}''$	$\frac{3}{4}''$	12″
$\frac{1}{16}$	.136	.139	.143	.146	.149	.153	.156	.159	2.53
$\frac{5}{64}$	.170	.174	.178	.183	.187	.191	.195	.199	3.19
$\frac{3}{32}$	.204	.209	.214	.219	.224	.229	.234	.239	3.83
$\frac{7}{64}$	.238	.244	.250	.256	.261	.267	.273	.279	4.46
$\frac{1}{8}$	.272	.279	.286	.292	.299	.305	.312	.319	5.10
$\frac{9}{64}$	.306	.314	.321	.329	.336	.344	.351	.359	5.74
$\frac{5}{32}$	.340	.349	.357	.365	.374	.382	.390	.398	6.38
$\frac{11}{64}$	.374	.383	.393	.402	.411	.420	.429	.438	7.01
$\frac{3}{16}$	.408	.418	.428	.438	.448	.458	.468	.478	7.65
$\frac{13}{64}$	.442	.453	.464	.475	.486	.496	.507	.518	8.29
$\frac{7}{32}$	.476	.488	.500	.511	.523	.535	.546	.558	8.93
$\frac{15}{64}$	.510	.523	.535	.548	.560	.573	.585	.598	9.56
$\frac{1}{4}$	.545	.558	.571	.584	.598	.611	.624	.638	10.20
$\frac{17}{64}$	.578	.593	.607	.621	.635	.649	.663	.677	10.84
$\frac{9}{32}$	.613	.628	.642	.657	.672	.687	.702	.717	11.48
$\frac{19}{64}$	.647	.662	.678	.694	.710	.725	.741	.757	12.11
$\frac{5}{16}$	.681	.697	.714	.730	.747	.764	.780	.797	12.75
$\frac{21}{64}$	.715	.732	.750	.767	.784	.802	.819	.827	13.39
$\frac{11}{32}$	.749	.767	.785	.804	.822	.840	.858	.877	14.03
$\frac{23}{64}$	.783	.802	.821	.840	.859	.878	.897	.916	14.66
$\frac{3}{8}$	.817	.837	.857	.877	.896	.916	.936	.956	15.30
$\frac{25}{64}$	.851	.872	.892	.913	.934	.955	.975	.996	15.94
$\frac{13}{32}$	.885	.906	.928	.950	.971	.993	1.01	1.04	16.58
$\frac{27}{64}$	.919	.941	.964	.986	1.01	1.03	1.05	1.08	17.21
$\frac{7}{16}$	.953	.976	.999	1.02	1.05	1.07	1.09	1.12	17.85
$\frac{29}{64}$	.987	1.01	1.04	1.06	1.08	1.11	1.13	1.16	18.49
$\frac{15}{32}$	1.02	1.05	1.07	1.10	1.12	1.15	1.17	1.20	19.13
$\frac{31}{64}$	1.06	1.08	1.11	1.13	1.16	1.18	1.21	1.24	19.76
$\frac{1}{2}$	1.09	1.12	1.14	1.17	1.20	1.22	1.25	1.28	20.40
$\frac{33}{64}$	1.12	1.15	1.18	1.21	1.23	1.26	1.29	1.31	21.04
$\frac{17}{32}$	1.16	1.19	1.21	1.24	1.27	1.30	1.33	1.35	21.68
$\frac{35}{64}$	1.19	1.22	1.25	1.28	1.31	1.34	1.37	1.39	22.31
$\frac{9}{16}$	1.23	1.26	1.28	1.31	1.34	1.37	1.40	1.43	22.95

WEIGHTS OF FLAT ROLLED STEEL BARS.

PER LINEAL FOOT.

One cubic foot of steel weighs 489.6 pounds.
For Thicknesses from $\frac{3}{16}$ in. to 2 in. and Widths from 1 in. to $12\frac{3}{4}$ in.

Thickness in Inches.	1″	$1\frac{1}{4}$″	$1\frac{1}{2}$″	$1\frac{3}{4}$″	2″	$2\frac{1}{4}$″	$2\frac{1}{2}$″	$2\frac{3}{4}$″	12″
$\frac{3}{16}$	.638	.797	.957	1.11	1.28	1.44	1.59	1.75	7.65
$\frac{1}{4}$	.850	1.06	1.28	1.49	1.70	1.91	2.12	2.34	10.20
$\frac{5}{16}$	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	12.75
$\frac{3}{8}$	1.28	1.59	1.92	2.23	2.55	2.87	3.19	3.51	15.30
$\frac{7}{16}$	1.49	1.86	2.23	2.60	2.98	3.35	3.72	4.09	17.85
$\frac{1}{2}$	1.70	2.12	2.55	2.98	3.40	3.83	4.25	4.67	20.40
$\frac{9}{16}$	1.92	2.39	2.87	3.35	3.83	4.30	4.78	5.26	22.95
$\frac{5}{8}$	2.12	2.65	3.19	3.72	4.25	4.78	5.31	5.84	25.50
$\frac{11}{16}$	2.34	2.92	3.51	4.09	4.67	5.26	5.84	6.43	28.05
$\frac{3}{4}$	2.55	3.19	3.83	4.47	5.10	5.75	6.38	7.02	30.60
$\frac{13}{16}$	2.76	3.45	4.14	4.84	5.53	6.21	6.90	7.60	33.15
$\frac{7}{8}$	2.98	3.72	4.47	5.20	5.95	6.69	7.44	8.18	35.70
$\frac{15}{16}$	3.19	3.99	4.78	5.58	6.38	7.18	7.97	8.77	38.25
1	3.40	4.25	5.10	5.95	6.80	7.65	8.50	9.35	40.80
$1\frac{1}{16}$	3.61	4.52	5.42	6.32	7.22	8.13	9.03	9.93	43.35
$1\frac{1}{8}$	3.83	4.78	5.74	6.70	7.65	8.61	9.57	10.52	45.90
$1\frac{3}{16}$	4.04	5.05	6.06	7.07	8.08	9.09	10.10	11.11	48.45
$1\frac{1}{4}$	4.25	5.31	6.38	7.44	8.50	9.57	10.63	11.69	51.00
$1\frac{5}{16}$	4.46	5.58	6.69	7.81	8.93	10.04	11.16	12.27	53.55
$1\frac{3}{8}$	4.67	5.84	7.02	8.18	9.35	10.52	11.69	12.85	56.10
$1\frac{7}{16}$	4.89	6.11	7.34	8.56	9.78	11.00	12.22	13.44	58.65
$1\frac{1}{2}$	5.10	6.38	7.65	8.93	10.20	11.48	12.75	14.03	61.20
$1\frac{9}{16}$	5.32	6.64	7.97	9.30	10.63	11.95	13.28	14.61	63.75
$1\frac{5}{8}$	5.52	6.90	8.29	9.67	11.05	12.43	13.81	15.19	66.30
$1\frac{11}{16}$	5.74	7.17	8.61	10.04	11.47	12.91	14.34	15.78	68.85
$1\frac{3}{4}$	5.95	7.44	8.93	10.42	11.90	13.40	14.88	16.37	71.40
$1\frac{13}{16}$	6.16	7.70	9.24	10.79	12.33	13.86	15.40	16.95	73.95
$1\frac{7}{8}$	6.38	7.97	9.57	11.15	12.75	14.34	15.94	17.53	76.50
$1\frac{15}{16}$	6.59	8.24	9.88	11.53	13.18	14.83	16.47	18.12	79.05
2	6.80	8.50	10.20	11.90	13.60	15.30	17.00	18.70	81.60

WEIGHTS OF FLAT ROLLED STEEL BARS.

PER LINEAL FOOT.

(CONTINUED.)

Thickness in Inches.	3″	3¼″	3½″	3¾″	4″	4¼″	4½″	4¾″	12″
3/16	1.91	2.07	2.23	2.39	2.55	2.71	2.87	3.03	7.65
1/4	2.55	2.76	2.98	3.19	3.40	3.61	3.83	4.04	10.20
5/16	3.19	3.45	3.72	3.99	4.25	4.52	4.78	5.05	12.75
3/8	3.83	4.15	4.47	4.78	5.10	5.42	5.74	6.06	15.30
7/16	4.46	4.83	5.20	5.58	5.95	6.32	6.70	7.07	17.85
1/2	5.10	5.53	5.95	6.38	6.80	7.22	7.65	8.08	20.40
9/16	5.74	6.22	6.70	7.17	7.65	8.13	8.61	9.09	22.95
5/8	6.38	6.91	7.44	7.97	8.50	9.03	9.57	10.10	25.50
11/16	7.02	7.60	8.18	8.76	9.35	9.93	10.52	11.11	28.05
3/4	7.65	8.29	8.93	9.57	10.20	10.84	11.48	12.12	30.60
13/16	8.29	8.98	9.67	10.36	11.05	11.74	12.43	13.12	33.15
7/8	8.93	9.67	10.41	11.16	11.90	12.65	13.39	14.13	35.70
15/16	9.57	10.36	11.16	11.95	12.75	13.55	14.34	15.14	38.25
1	10.20	11.05	11.90	12.75	13.60	14.45	15.30	16.15	40.80
1 1/16	10.84	11.74	12.65	13.55	14.45	15.35	16.26	17.16	43.35
1 1/8	11.48	12.43	13.39	14.34	15.30	16.26	17.22	18.17	45.90
1 3/16	12.12	13.12	14.13	15.14	16.15	17.16	18.17	19.18	48.45
1 1/4	12.75	13.81	14.87	15.94	17.00	18.06	19.13	20.19	51.00
1 5/16	13.39	14.50	15.62	16.74	17.85	18.96	20.08	21.20	53.55
1 3/8	14.03	15.20	16.36	17.53	18.70	19.87	21.04	22.21	56.10
1 7/16	14.66	15.88	17.10	18.33	19.55	20.77	21.99	23.22	58.65
1 1/2	15.30	16.58	17.85	19.13	20.40	21.68	22.95	24.23	61.20
1 9/16	15.94	17.27	18.60	19.92	21.25	22.58	23.91	25.24	63.75
1 5/8	16.58	17.96	19.34	20.72	22.10	23.48	24.87	26.25	66.30
1 11/16	17.22	18.65	20.08	21.51	22.95	24.38	25.82	27.26	68.85
1 3/4	17.85	19.34	20.83	22.32	23.80	25.29	26.78	28.27	71.40
1 13/16	18.49	20.03	21.57	23.11	24.65	26.19	27.73	29.27	73.95
1 7/8	19.13	20.72	22.31	23.91	25.50	27.10	28.69	30.28	76.50
1 15/16	19.77	21.41	23.06	24.70	26.35	28.00	29.64	31.29	79.05
2	20.40	22.10	23.80	25.50	27.20	28.90	30.60	32.30	81.60

WEIGHTS OF FLAT ROLLED STEEL BARS.

PER LINEAL FOOT.

(CONTINUED.)

Thickness in Inches.	5″	$5\frac{1}{4}$″	$5\frac{1}{2}$″	$5\frac{3}{4}$″	6″	$6\frac{1}{4}$″	$6\frac{1}{2}$″	$6\frac{3}{4}$″	12″
$\frac{3}{16}$	3.19	3.35	3.51	3.67	3.83	3.99	4.14	4.30	7.65
$\frac{1}{4}$	4.25	4.46	4.67	4.89	5.10	5.31	5.53	5.74	10.20
$\frac{5}{16}$	5.31	5.58	5.84	6.11	6.38	6.64	6.90	7.17	12.75
$\frac{3}{8}$	6.38	6.69	7.02	7.34	7.65	7.97	8.29	8.61	15.30
$\frac{7}{16}$	7.44	7.81	8.18	8.56	8.93	9.29	9.67	10.04	17.85
$\frac{1}{2}$	8.50	8.93	9.35	9.77	10.20	10.63	11.05	11.48	20.40
$\frac{9}{16}$	9.57	10.04	10.52	11.00	11.48	11.95	12.43	12.91	22.95
$\frac{5}{8}$	10.63	11.16	11.69	12.22	12.75	13.28	13.81	14.34	25.50
$\frac{11}{16}$	11.69	12.27	12.85	13.44	14.03	14.61	15.20	15.78	28.05
$\frac{3}{4}$	12.75	13.39	14.03	14.67	15.30	15.94	16.58	17.22	30.60
$\frac{13}{16}$	13.81	14.50	15.19	15.88	16.58	17.27	17.95	18.65	33.15
$\frac{7}{8}$	14.87	15.62	16.36	17.10	17.85	18.60	19.34	20.08	35.70
$\frac{15}{16}$	15.94	16.74	17.53	18.33	19.13	19.92	20.72	21.51	38.25
1	17.00	17.85	18.70	19.55	20.40	21.25	22.10	22.95	40.80
$1\frac{1}{16}$	18.06	18.96	19.87	20.77	21.68	22.58	23.48	24.39	43.35
$1\frac{1}{8}$	19.13	20.08	21.04	21.99	22.95	23.91	24.87	25.82	45.90
$1\frac{3}{16}$	20.19	21.20	22.21	23.22	24.23	25.23	26.24	27.25	48.45
$1\frac{1}{4}$	21.25	22.32	23.38	24.44	25.50	26.56	27.62	28.69	51.00
$1\frac{5}{16}$	22.32	23.43	24.54	25.66	26.78	27.90	29.01	30.12	53.55
$1\frac{3}{8}$	23.38	24.54	25.71	26.88	28.05	29.22	30.39	31.56	56.10
$1\frac{7}{16}$	24.44	25.66	26.88	28.10	29.33	30.55	31.77	32.99	58.65
$1\frac{1}{2}$	25.50	26.78	28.05	29.33	30.60	31.88	33.15	34.43	61.20
$1\frac{9}{16}$	26.57	27.89	29.22	30.55	31.88	33.20	34.53	35.86	63.75
$1\frac{5}{8}$	27.63	29.01	30.39	31.77	33.15	34.53	35.91	37.29	66.30
$1\frac{11}{16}$	28.69	30.12	31.55	32.99	34.43	35.86	37.30	38.73	68.85
$1\frac{3}{4}$	29.75	31.24	32.73	34.22	35.70	37.19	38.68	40.17	71.40
$1\frac{13}{16}$	30.81	32.35	33.89	35.43	36.98	38.52	40.05	41.60	73.95
$1\frac{7}{8}$	31.87	33.47	35.06	36.65	38.25	39.85	41.44	43.03	76.50
$1\frac{15}{16}$	32.94	34.59	36.23	37.88	39.53	41.17	42.82	44.46	79.05
2	34.00	35.70	37.40	39.10	40.80	42.50	44.20	45.90	81.60

WEIGHTS OF FLAT ROLLED STEEL BARS.

PER LINEAL FOOT.

(CONTINUED.)

Thickness in Inches.	7″	$7\frac{1}{4}$″	$7\frac{1}{2}$″	$7\frac{3}{4}$″	8″	$8\frac{1}{4}$″	$8\frac{1}{2}$″	$8\frac{3}{4}$″	12″
$\frac{3}{16}$	4.46	4.62	4.78	4.94	5.10	5.26	5.42	5.58	7.65
$\frac{1}{4}$	5.95	6.16	6.36	6.58	6.80	7.01	7.22	7.43	10.20
$\frac{5}{16}$	7.44	7.70	7.97	8.23	8.50	8.76	9.03	9.29	12.75
$\frac{3}{8}$	8.93	9.25	9.57	9.88	10.20	10.52	10.84	11.16	15.30
$\frac{7}{16}$	10.41	10.78	11.16	11.53	11.90	12.27	12.64	13.02	17.85
$\frac{1}{2}$	11.90	12.32	12.75	13.18	13.60	14.03	14.44	14.87	20.40
$\frac{9}{16}$	13.39	13.86	14.34	14.82	15.30	15.78	16.26	16.74	22.95
$\frac{5}{8}$	14.87	15.40	15.94	16.47	17.00	17.53	18.06	18.59	25.50
$\frac{11}{16}$	16.36	16.94	17.53	18.12	18.70	19.28	19.86	20.45	28.05
$\frac{3}{4}$	17.85	18.49	19.13	19.77	20.40	21.04	21.68	22.32	30.60
$\frac{13}{16}$	19.34	20.03	20.72	21.41	22.10	22.79	23.48	24.17	33.15
$\frac{7}{8}$	20.83	21.57	22.32	23.05	23.80	24.55	25.30	26.04	35.70
$\frac{15}{16}$	22.32	23.11	23.91	24.70	25.50	26.30	27.10	27.89	38.25
1	23.80	24.65	25.50	26.35	27.20	28.05	28.90	29.75	40.80
$1\frac{1}{16}$	25.29	26.19	27.10	28.00	28.90	29.80	30.70	31.61	43.35
$1\frac{1}{8}$	26.78	27.73	28.68	29.64	30.60	31.56	32.52	33.47	45.90
$1\frac{3}{16}$	28.26	29.27	30.28	31.29	32.30	33.31	34.32	35.33	48.45
$1\frac{1}{4}$	29.75	30.81	31.88	32.94	34.00	35.06	36.12	37.20	51.00
$1\frac{5}{16}$	31.23	32.35	33.48	34.59	35.70	36.81	37.93	39.05	53.55
$1\frac{3}{8}$	32.72	33.89	35.06	36.23	37.40	38.57	39.74	40.91	56.10
$1\frac{7}{16}$	34.21	35.44	36.66	37.88	39.10	40.32	41.54	42.77	58.65
$1\frac{1}{2}$	35.70	36.98	38.26	39.53	40.80	42.08	43.35	44.63	61.20
$1\frac{9}{16}$	37.19	38.51	39.84	41.17	42.50	43.83	45.16	46.49	63.75
$1\frac{5}{8}$	38.67	40.05	41.44	42.82	44.20	45.58	46.96	48.34	66.30
$1\frac{11}{16}$	40.16	41.59	43.03	44.47	45.90	47.33	48.76	50.20	68.85
$1\frac{3}{4}$	41.65	43.14	44.63	46.12	47.60	49.09	50.58	52.07	71.40
$1\frac{13}{16}$	43.14	44.68	46.22	47.76	49.30	50.84	52.38	53.92	73.95
$1\frac{7}{8}$	44.63	46.22	47.82	49.40	51.00	52.60	54.20	55.79	76.50
$1\frac{15}{16}$	46.12	47.76	49.41	51.05	52.70	54.35	56.00	57.64	79.05
2	47.60	49.30	51.00	52.70	54.40	56.10	57.80	59.50	81.60

WEIGHTS OF FLAT ROLLED STEEL BARS.

PER LINEAL FOOT.

(CONTINUED.)

Thickness in Inches.	9″	9¼″	9½″	9¾″	10″	10¼″	10½″	10¾″	12″
$\frac{3}{16}$	5.74	5.90	6.06	6.22	6.38	6.54	6.70	6.86	7.65
$\frac{1}{4}$	7.65	7.86	8.08	8.29	8.50	8.71	8.92	9.14	10.20
$\frac{5}{16}$	9.56	9.83	10.10	10.36	10.62	10.89	11.16	11.42	12.75
$\frac{3}{8}$	11.48	11.80	12.12	12.44	12.75	13.07	13.39	13.71	15.30
$\frac{7}{16}$	13.40	13.76	14.14	14.51	14.88	15.25	15.62	15.99	17.85
$\frac{1}{2}$	15.30	15.73	16.16	16.58	17.00	17.42	17.85	18.28	20.40
$\frac{9}{16}$	17.22	17.69	18.18	18.65	19.14	19.61	20.08	20.56	22.95
$\frac{5}{8}$	19.13	19.65	20.19	20.72	21.25	21.78	22.32	22.85	25.50
$\frac{11}{16}$	21.04	21.62	22.21	22.79	23.38	23.96	24.54	25.13	28.05
$\frac{3}{4}$	22.96	23.59	24.23	24.86	25.50	26.14	26.78	27.42	30.60
$\frac{13}{16}$	24.86	25.55	26.24	26.94	27.62	28.32	29.00	29.69	33.15
$\frac{7}{8}$	26.78	27.52	28.26	29.01	29.75	30.50	31.24	31.98	35.70
$\frac{15}{16}$	28.69	29.49	30.28	31.08	31.88	32.67	33.48	34.28	38.25
1	30.60	31.45	32.30	33.15	34.00	34.85	35.70	36.55	40.80
$1\frac{1}{16}$	32.52	33.41	34.32	35.22	36.12	37.03	37.92	38.83	43.35
$1\frac{1}{8}$	34.43	35.38	36.34	37.29	38.25	39.21	40.17	41.12	45.90
$1\frac{3}{16}$	36.34	37.35	38.36	39.37	40.38	41.39	42.40	43.40	48.45
$1\frac{1}{4}$	38.26	39.31	40.37	41.44	42.50	43.56	44.63	45.69	51.00
$1\frac{5}{16}$	40.16	41.28	42.40	43.52	44.64	45.75	46.86	47.97	53.55
$1\frac{3}{8}$	42.08	43.25	44.41	45.58	46.75	47.92	49.08	50.25	56.10
$1\frac{7}{16}$	44.00	45.22	46.44	47.66	48.88	50.10	51.32	52.54	58.65
$1\frac{1}{2}$	45.90	47.18	48.45	49.73	51.00	52.28	53.55	54.83	61.20
$1\frac{9}{16}$	47.82	49.14	50.48	51.80	53.14	54.46	55.78	57.11	63.75
$1\frac{5}{8}$	49.73	51.10	52.49	53.87	55.25	56.63	58.02	59.40	66.30
$1\frac{11}{16}$	51.64	53.07	54.51	55.94	57.38	58.81	60.24	61.68	68.85
$1\frac{3}{4}$	53.56	55.04	56.53	58.01	59.50	60.99	62.48	63.97	71.40
$1\frac{13}{16}$	55.46	57.00	58.54	60.09	61.62	63.17	64.70	66.24	73.95
$1\frac{7}{8}$	57.38	58.97	60.56	62.16	63.75	65.35	66.94	68.53	76.50
$1\frac{15}{16}$	59.29	60.94	62.58	64.23	65.88	67.52	69.18	70.83	79.05
2	61.20	62.90	64.60	66.30	68.00	69.70	71.40	73.10	81.60

WEIGHTS OF FLAT ROLLED STEEL BARS.

PER LINEAL FOOT.

(CONTINUED.)

Thickness in Inches.	11″	$11\frac{1}{4}$″	$11\frac{1}{2}$″	$11\frac{3}{4}$″	12″	$12\frac{1}{4}$″	$12\frac{1}{2}$″	$12\frac{3}{4}$″
$\frac{3}{16}$	7.02	7.17	7.32	7.49	7.65	7.82	7.98	8.13
$\frac{1}{4}$	9.34	9.57	9.78	10.00	10.20	10.42	10.63	10.84
$\frac{5}{16}$	11.68	11.95	12.22	12.49	12.75	13.01	13.28	13.55
$\frac{3}{8}$	14.03	14.35	14.68	14.99	15.30	15.62	15.94	16.26
$\frac{7}{16}$	16.36	16.74	17.12	17.49	17.85	18.23	18.60	18.97
$\frac{1}{2}$	18.70	19.13	19.55	19.97	20.40	20.82	21.25	21.67
$\frac{9}{16}$	21.02	21.51	22.00	22.48	22.95	23.43	23.90	24.39
$\frac{5}{8}$	23.38	23.91	24.44	24.97	25.50	26.03	26.56	27.09
$\frac{11}{16}$	25.70	26.30	26.88	27.47	28.05	28.64	29.22	29.80
$\frac{3}{4}$	28.05	28.68	29.33	29.97	30.60	31.25	31.88	32.52
$\frac{13}{16}$	30.40	31.08	31.76	32.46	33.15	33.83	34.53	35.22
$\frac{7}{8}$	32.72	33.47	34.21	34.95	35.70	36.44	37.19	37.93
$\frac{15}{16}$	35.06	35.86	36.66	37.46	38.25	39.05	39.84	40.64
1	37.40	38.25	39.10	39.95	40.80	41.65	42.50	43.35
$1\frac{1}{16}$	39.74	40.64	41.54	42.45	43.35	44.25	45.16	46.06
$1\frac{1}{8}$	42.08	43.04	44.00	44.94	45.90	46.86	47.82	48.77
$1\frac{3}{16}$	44.42	45.42	46.44	47.45	48.45	49.46	50.46	51.48
$1\frac{1}{4}$	46.76	47.82	48.88	49.94	51.00	52.06	53.12	54.19
$1\frac{5}{16}$	49.08	50.20	51.32	52.44	53.55	54.67	55.78	56.90
$1\frac{3}{8}$	51.42	52.59	53.76	54.93	56.10	57.27	58.44	59.60
$1\frac{7}{16}$	53.76	54.99	56.21	57.43	58.65	59.87	61.10	62.32
$1\frac{1}{2}$	56.10	57.37	58.65	59.93	61.20	62.48	63.75	65.03
$1\frac{9}{16}$	58.42	59.76	61.10	62.43	63.75	65.08	66.40	67.74
$1\frac{5}{8}$	60.78	62.16	63.54	64.92	66.30	67.68	69.06	70.44
$1\frac{11}{16}$	63.10	64.55	65.98	67.42	68.85	70.29	71.72	73.15
$1\frac{3}{4}$	65.45	66.93	68.43	69.92	71.40	72.90	74.38	75.87
$1\frac{13}{16}$	67.80	69.33	70.86	72.41	73.95	75.48	77.03	78.57
$1\frac{7}{8}$	70.12	71.72	73.31	74.90	76.50	78.09	79.69	81.28
$1\frac{15}{16}$	72.46	74.11	75.76	77.41	79.05	80.70	82.34	83.99
2	74.80	76.50	78.20	79.90	81.60	83.30	85.00	86.70

The weights for 12″ width are repeated on each page to facilitate making the additions necessary to obtain the weights of plates of any width greater than 12″. Thus, to find the weight of $15\frac{1}{2}'' \times \frac{7}{8}''$, add the weights to be found in the same line for $3\frac{1}{2} \times \frac{7}{8}$ and $12 \times \frac{7}{8} = 10.41 + 35.70 = 46.11$ pounds. Weight of plate $4'\ 6\frac{1}{2}'' \times \frac{5}{8}'' = 4 \times 25.50 + 13.81 = 115.81$ pounds.

AREAS AND CIRCUMFERENCES OF CIRCLES.

For Diameters from $\frac{1}{10}$ to 100, advancing by Tenths.

Diameter.	Area.	Circumference.	Diameter.	Area.	Circumference.
0.0			4.0	12.5664	12.5664
.1	.007854	.31416	.1	13.2025	12.8805
.2	.031416	.62832	.2	13.8544	13.1947
.3	.070686	.94248	.3	14.5220	13.5088
.4	.12566	1.2566	.4	15.2053	13.8230
.5	.19635	1.5708	.5	15.9043	14.1372
.6	.28274	1.8850	.6	16.6190	14.4513
.7	.38485	2.1991	.7	17.3494	14.7655
.8	.50266	2.5133	.8	18.0956	15.0796
.9	.63617	2.8274	.9	18.8574	15.3938
1.0	.7854	3.1416	5.0	19.6350	15.7080
.1	.9503	3.4558	.1	20.4282	16.0221
.2	1.1310	3.7699	.2	21.2372	16.3363
.3	1.3273	4.0841	.3	22.0618	16.6504
.4	1.5394	4.3982	.4	22.9022	16.9646
.5	1.7671	4.7124	.5	23.7583	17.2788
.6	2.0106	5.0265	.6	24.6301	17.5929
.7	2.2698	5.3407	.7	25.5176	17.9071
.8	2.5447	5.6549	.8	26.4208	18.2212
.9	2.8353	5.9690	.9	27.3397	18.5354
2.0	3.1416	6.2832	6.0	28.2743	18.8496
.1	3.4636	6.5973	.1	29.2247	19.1637
.2	3.8013	6.9115	.2	30.1907	19.4779
.3	4.1548	7.2257	.3	31.1725	19.7920
.4	4.5239	7.5398	.4	32.1699	20.1062
.5	4.9087	7.8540	.5	33.1831	20.4204
.6	5.3093	8.1681	.6	34.2119	20.7345
.7	5.7256	8.4823	.7	35.2565	21.0487
.8	6.1575	8.7965	.8	36.3168	21.3628
.9	6.6052	9.1106	.9	37.3928	21.6770
3.0	7.0686	9.4248	7.0	38.4845	21.9911
.1	7.5477	9.7389	.1	39.5919	22.3053
.2	8.0425	10.0531	.2	40.7150	22.6195
.3	8.5530	10.3673	.3	41.8539	22.9336
.4	9.0792	10.6814	.4	43.0084	23.2478
.5	9.6211	10.9956	.5	44.1786	23.5619
.6	10.1788	11.3097	.6	45.3646	23.8761
.7	10.7521	11.6239	.7	46.5663	24.1903
.8	11.3411	11.9381	.8	47.7836	24.5044
.9	11.9459	12.2522	.9	49.0167	24.8186

AREAS AND CIRCUMFERENCES OF CIRCLES.

(CONTINUED.)

Diameter.	Area.	Circumference.	Diameter.	Area.	Circumference.
8.0	50.2655	25.1327	12.0	113.0973	37.6991
.1	51.5300	25.4469	.1	114.9901	38.0133
.2	52.8102	25.7611	.2	116.8987	38.3274
.3	54.1061	26.0752	.3	118.8229	38.6416
.4	55.4177	26.3894	.4	120.7628	38.9557
.5	56.7450	26.7035	.5	122.7185	39.2699
.6	58.0880	27.0177	.6	124.6898	39.5841
.7	59.4468	27.3319	.7	126.6769	39.8982
.8	60.8212	27.6460	.8	128.6796	40.2124
.9	62.2114	27.9602	.9	130.6981	40.5265
9.0	63.6173	28.2743	13.0	132.7323	40.8407
.1	65.0388	28.5885	.1	134.7822	41.1549
.2	66.4761	28.9027	.2	136.8478	41.4690
.3	67.9291	29.2168	.3	138.9291	41.7832
.4	69.3978	29.5310	.4	141.0261	42.0973
.5	70.8822	29.8451	.5	143.1388	42.4115
.6	72.3823	30.1593	.6	145.2672	42.7257
.7	73.8981	30.4734	.7	147.4114	43.0398
.8	75.4296	30.7876	.8	149.5712	43.3540
.9	76.9769	31.1018	.9	151.7468	43.6681
10.0	78.5398	31.4159	14.0	153.9380	43.9823
.1	80.1185	31.7301	.1	156.1450	44.2965
.2	81.7128	32.0442	.2	158.3677	44.6106
.3	83.3229	32.3584	.3	160.6061	44.9248
.4	84.9487	32.6726	.4	162.8602	45.2389
.5	86.5901	32.9867	.5	165.1300	45.5531
.6	88.2473	33.3009	.6	167.4155	45.8673
.7	89.9202	33.6150	.7	169.7167	46.1814
.8	91.6088	33.9292	.8	172.0336	46.4956
.9	93.3132	34.2434	.9	174.3662	46.8097
11.0	95.0332	34.5575	15.0	176.7146	47.1239
.1	96.7689	34.8717	.1	179.0786	47.4380
.2	98.5203	35.1858	.2	181.4584	47.7522
.3	100.2875	35.5000	.3	183.8539	48.0664
.4	102.0703	35.8142	.4	186.2650	48.3805
.5	103.8689	36.1283	.5	188.6919	48.6947
.6	105.6832	36.4425	.6	191.1345	49.0088
.7	107.5132	36.7566	.7	193.5928	49.3230
.8	109.3588	37.0708	.8	196.0668	49.6372
.9	111.2202	37.3850	.9	198.5565	49.9513

AREAS AND CIRCUMFERENCES OF CIRCLES.

(CONTINUED.)

Diameter.	Area.	Circumference.	Diameter.	Area.	Circumference.
16.0	201.0619	50.2655	20.0	314.1593	62.8319
.1	203.5831	50.5796	.1	317.3087	63.1460
.2	206.1199	50.8938	.2	320.4739	63.4602
.3	208.6724	51.2080	.3	323.6547	63.7743
.4	211.2407	51.5221	.4	326.8513	64.0885
.5	213.8246	51.8363	.5	330.0636	64.4026
.6	216.4243	52.1504	.6	333.2916	64.7168
.7	219.0397	52.4646	.7	336.5353	65.0310
.8	221.6708	52.7788	.8	339.7947	65.3451
.9	224.3176	53.0929	.9	343.0698	65.6593
17.0	226.9801	53.4071	21.0	346.3606	65.9734
.1	229.6583	53.7212	.1	349.6671	66.2876
.2	232.3522	54.0354	.2	352.9894	66.6018
.3	235.0618	54.3496	.3	356.3273	66.9159
.4	237.7871	54.6637	.4	359.6809	67.2301
.5	240.5282	54.9779	.5	363.0503	67.5442
.6	243.2849	55.2920	.6	366.4354	67.8584
.7	246.0574	55.6062	.7	369.8361	68.1726
.8	248.8456	55.9203	.8	373.2526	68.4867
.9	251.6494	56.2345	.9	376.6848	68.8009
18.0	254.4690	56.5486	22.0	380.1327	69.1150
.1	257.3043	56.8628	.1	383.5963	69.4292
.2	260.1553	57.1770	.2	387.0756	69.7434
.3	263.0220	57.4911	.3	390.5707	70.0575
.4	265.9044	57.8053	.4	394.0814	70.3717
.5	268.8025	58.1195	.5	397.6078	70.6858
.6	271.7164	58.4336	.6	401.1500	71.0000
.7	274.6459	58.7478	.7	404.7078	71.3142
.8	277.5911	59.0619	.8	408.2814	71.6283
.9	280.5521	59.3761	.9	411.8707	71.9425
19.0	283.5287	59.6903	23.0	415.4756	72.2566
.1	286.5211	60.0044	.1	419.0963	72.5708
.2	289.5292	60.3186	.2	422.7327	72.8849
.3	292.5530	60.6327	.3	426.3848	73.1991
.4	295.5925	60.9469	.4	430.0526	73.5133
.5	298.6477	61.2611	.5	433.7361	73.8274
.6	301.7186	61.5752	.6	437.4354	74.1416
.7	304.8052	61.8894	.7	441.1503	74.4557
.8	307.9075	62.2035	.8	444.8809	74.7699
.9	311.0255	62.5177	.9	448.6273	75.0841

AREAS AND CIRCUMFERENCES OF CIRCLES.

(CONTINUED.)

Diameter.	Area.	Circumference.	Diameter.	Area.	Circumference.
24.0	452.3893	75.3982	28.0	615.7522	87.9646
.1	456.1671	75.7124	.1	620.1582	88.2788
.2	459.9606	76.0265	.2	624.5800	88.5929
.3	463.7698	76.3407	.3	629.0175	88.9071
.4	467.5947	76.6549	.4	633.4707	89.2212
.5	471.4352	76.9690	.5	637.9397	89.5354
.6	475.2916	77.2832	.6	642.4243	89.8495
.7	479.1636	77.5973	.7	646.9246	90.1637
.8	483.0513	77.9115	.8	651.4407	90.4779
.9	486.9547	78.2257	.9	655.9724	90.7920
25.0	490.8739	78.5398	29.0	660.5199	91.1062
.1	494.8087	78.8540	.1	665.0830	91.4203
.2	498.7592	79.1681	.2	669.6619	91.7345
.3	502.7255	79.4823	.3	674.2565	92.0487
.4	506.7075	79.7965	.4	678.8668	92.3628
.5	510.7052	80.1106	.5	683.4928	92.6770
.6	514.7185	80.4248	.6	688.1345	92.9911
.7	518.7476	80.7389	.7	692.7919	93.3053
.8	522.7924	81.0531	.8	697.4650	93.6195
.9	526.8529	81.3672	.9	702.1538	93.9336
26.0	530.9292	81.6814	30.0	706.8583	94.2478
.1	535.0211	81.9956	.1	711.5786	94.5619
.2	539.1287	82.3097	.2	716.3145	94.8761
.3	543.2521	82.6239	.3	721.0662	95.1903
.4	547.3911	82.9380	.4	725.8336	95.5044
.5	551.5459	83.2522	.5	730.6167	95.8186
.6	555.7163	83.5664	.6	735.4154	96.1327
.7	559.9025	83.8805	.7	740.2299	96.4469
.8	564.1044	84.1947	.8	745.0601	96.7611
.9	568.3220	84.5088	.9	749.9060	97.0752
27.0	572.5553	84.8230	31.0	754.7676	97.3894
.1	576.8043	85.1372	.1	759.6450	97.7035
.2	581.0690	85.4513	.2	764.5380	98.0177
.3	585.3494	85.7655	.3	769.4467	98.3319
.4	589.6455	86.0796	.4	774.3712	98.6460
.5	593.9574	86.3938	.5	779.3113	98.9602
.6	598.2849	86.7080	.6	784.2672	99.2743
.7	602.6282	87.0221	.7	789.2388	99.5885
.8	606.9871	87.3363	.8	794.2260	99.9026
.9	611.3618	87.6504	.9	799.2290	100.2168

AREAS AND CIRCUMFERENCES OF CIRCLES.

(CONTINUED.)

Diameter.	Area.	Circumference.	Diameter.	Area.	Circumference.
32.0	804.2477	100.5310	36.0	1017.8760	113.0973
.1	809.2821	100.8451	.1	1023.5387	113.4115
.2	814.3322	101.1593	.2	1029.2172	113.7257
.3	819.3980	101.4734	.3	1034.9113	114.0398
.4	824.4796	101.7876	.4	1040.6212	114.3540
.5	829.5768	102.1018	.5	1046.3467	114.6681
.6	834.6898	102.4159	.6	1052.0880	114.9823
.7	839.8185	102.7301	.7	1057.8449	115.2965
.8	844.9628	103.0442	.8	1063.6176	115.6106
.9	850.1229	103.3584	.9	1069.4060	115.9248
33.0	855.2986	103.6726	37.0	1075.2101	116.2389
.1	860.4902	103.9867	.1	1081.0299	116.5531
.2	865.6973	104.3009	.2	1086.8654	116.8672
.3	870.9202	104.6150	.3	1092.7166	117.1814
.4	876.1588	104.9292	.4	1098.5835	117.4956
.5	881.4131	105.2434	.5	1104.4662	117.8097
.6	886.6831	105.5575	.6	1110.3645	118.1239
.7	891.9688	105.8717	.7	1116.2786	118.4380
.8	897.2703	106.1858	.8	1122.2083	118.7522
.9	902.5874	106.5000	.9	1128.1538	119.0664
34.0	907.9203	106.8142	38.0	1134.1149	119.3805
.1	913.2688	107.1283	.1	1140.0918	119.6947
.2	918.6331	107.4425	.2	1146.0844	120.0088
.3	924.0131	107.7566	.3	1152.0927	120.3230
.4	929.4088	108.0708	.4	1158.1167	120.6372
.5	934.8202	108.3849	.5	1164.1564	120.9513
.6	940.2473	108.6991	.6	1170.2118	121.2655
.7	945.6901	109.0133	.7	1176.2830	121.5796
.8	951.1486	109.3274	.8	1182.3698	121.8938
.9	956.6228	109.6416	.9	1188.4724	122.2080
35.0	962.1128	109.9557	39.0	1194.5906	122.5221
.1	967.6184	110.2699	.1	1200.7246	122.8363
.2	973.1397	110.5841	.2	1206.8742	123.1504
.3	978.6768	110.8982	.3	1213.0396	123.4646
.4	984.2296	111.2124	.4	1219.2207	123.7788
.5	989.7980	111.5265	.5	1225.4175	124.0929
.6	995.3822	111.8407	.6	1231.6300	124.4071
.7	1000.9821	112.1549	.7	1237.8582	124.7212
.8	1006.5977	112.4690	.8	1244.1021	125.0354
.9	1012.2290	112.7832	.9	1250.3617	125.3495

AREAS AND CIRCUMFERENCES OF CIRCLES.

(CONTINUED.)

Diameter.	Area.	Circumference.	Diameter.	Area.	Circumference.
40.0	1256.6371	125.6637	44.0	1520.5308	138.2301
.1	1262.9281	125.9779	.1	1527.4502	138.5442
.2	1269.2348	126.2920	.2	1534.3853	138.8584
.3	1275.5573	126.6062	.3	1541.3360	139.1726
.4	1281.8955	126.9203	.4	1548.3025	139.4867
.5	1288.2493	127.2345	.5	1555.2847	139.8009
.6	1294.6189	127.5487	.6	1562.2826	140.1153
.7	1301.0042	127.8628	.7	1569.2962	140.4292
.8	1307.4052	128.1770	.8	1576.3255	140.7434
.9	1313.8219	128.4911	.9	1583.3706	141.0575
41.0	1320.2543	128.8053	45.0	1590.4313	141.3717
.1	1326.7024	129.1195	.1	1597.5077	141.6858
.2	1333.1663	129.4336	.2	1604.5999	142.0000
.3	1339.6458	129.7478	.3	1611.7077	142.3142
.4	1346.1410	130.0619	.4	1618.8313	142.6283
.5	1352.6520	130.3761	.5	1625.9705	142.9425
.6	1359.1786	130.6903	.6	1633.1255	143.2566
.7	1365.7210	131.0044	.7	1640.2962	143.5708
.8	1372.2791	131.3186	.8	1647.4826	143.8849
.9	1378.8529	131.6327	.9	1654.6847	144.1991
42.0	1385.4424	131.9469	46.0	1661.9025	144.5133
.1	1392.0476	132.2611	.1	1669.1360	144.8274
.2	1398.6685	132.5752	.2	1676.3853	145.1416
.3	1405.3051	132.8894	.3	1683.6502	145.4557
.4	1411.9574	133.2035	.4	1690.9308	145.7699
.5	1418.6254	133.5177	.5	1698.2272	146.0841
.6	1425.3092	133.8318	.6	1705.5392	146.3982
.7	1432.0086	134.1460	.7	1712.8670	146.7124
.8	1438.7238	134.4602	.8	1720.2105	147.0265
.9	1445.4546	134.7743	.9	1727.5697	147.3407
43.0	1452.2012	135.0885	47.0	1734.9445	147.6550
.1	1458.9635	135.4026	.1	1742.3351	147.9690
.2	1465.7415	135.7168	.2	1749.7414	148.2832
.3	1472.5352	136.0310	.3	1757.1635	148.5973
.4	1479.3446	136.3451	.4	1764.6012	148.9115
.5	1486.1697	136.6593	.5	1772.0546	149.2257
.6	1493.0105	136.9734	.6	1779.5237	149.5398
.7	1499.8670	137.2876	.7	1787.0086	149.8540
.8	1506.7393	137.6018	.8	1794.5091	150.1681
.9	1513.6272	137.9159	.9	1802.0254	150.4823

AREAS AND CIRCUMFERENCES OF CIRCLES.

(CONTINUED.)

Diameter.	Area.	Circumference.	Diameter.	Area.	Circumference.
48.0	1809.5574	150.7964	52.0	2123.7166	163.3628
.1	1817.1050	151.1106	.1	2131.8926	163.6770
.2	1824.6684	151.4248	.2	2140.0843	163.9911
.3	1832.2475	151.7389	.3	2148.2917	164.3053
.4	1839.8423	152.0531	.4	2156.5149	164.6195
.5	1847.4528	152.3672	.5	2164.7537	164.9336
.6	1855.0790	152.6814	.6	2173.0082	165.2479
.7	1862.7210	152.9956	.7	2181.2785	165.5619
.8	1870.3786	153.3097	.8	2189.5644	165.8761
.9	1878.0519	153.6239	.9	2197.8661	166.1903
49.0	1885.7409	153.9380	53.0	2206.1834	166.5044
.1	1893.4457	154.2522	.1	2214.5165	166.8186
.2	1901.1662	154.5664	.2	2222.8653	167.1327
.3	1908.9024	154.8805	.3	2231.2298	167.4469
.4	1916.6543	155.1947	.4	2239.6100	167.7610
.5	1924.4218	155.5088	.5	2248.0059	168.0752
.6	1932.2051	155.8230	.6	2256.4175	168.3894
.7	1940.0042	156.1372	.7	2264.8448	168.7035
.8	1947.8189	156.4513	.8	2273.2879	169.0177
.9	1955.6493	156.7655	.9	2281.7466	169.3318
50.0	1963.4954	157.0796	54.0	2290.2210	169.6460
.1	1971.3572	157.3938	.1	2298.7112	169.9602
.2	1979.2348	157.7080	.2	2307.2171	170.2743
.3	1987.1280	158.0221	.3	2315.7386	170.5885
.4	1995.0370	158.3363	.4	2324.2759	170.9026
.5	2002.9617	158.6504	.5	2332.8289	171.2168
.6	2010.9020	158.9646	.6	2341.3976	171.5310
.7	2018.8581	159.2787	.7	2349.9820	171.8451
.8	2026.8299	159.5929	.8	2358.5821	172.1593
.9	2034.8174	159.9071	.9	2367.1979	172.4735
51.0	2042.8206	160.2212	55.0	2375.8294	172.7876
.1	2050.8395	160.5354	.1	2384.4767	173.1017
.2	2058.8742	160.8495	.2	2393.1396	173.4159
.3	2066.9245	161.1637	.3	2401.8183	173.7301
.4	2074.9905	161.4779	.4	2410.5126	174.0442
.5	2083.0723	161.7920	.5	2419.2227	174.3584
.6	2091.1697	162.1062	.6	2427.9485	174.6726
.7	2099.2829	162.4203	.7	2436.6899	174.9867
.8	2107.4118	162.7345	.8	2445.4471	175.3009
.9	2115.5563	163.0487	.9	2454.2200	175.6150

AREAS AND CIRCUMFERENCES OF CIRCLES.

(CONTINUED.)

Diameter.	Area.	Circumference.	Diameter.	Area.	Circumference.
56.0	2463.0086	175.9292	60.0	2827.4334	188.4956
.1	2471.8130	176.2433	.1	2836.8660	188.8097
.2	2480.6330	176.5575	.2	2846.3144	189.1239
.3	2489.4687	176.8717	.3	2855.7784	189.4380
.4	2498.3201	177.1858	.4	2865.2582	189.7522
.5	2507.1873	177.5000	.5	2874.7536	190.0664
.6	2516.0701	177.8141	.6	2884.2648	190.3805
.7	2524.9687	178.1283	.7	2893.7917	190.6947
.8	2533.8830	178.4425	.8	2903.3343	191.0088
.9	2542.8129	178.7566	.9	2912.8926	191.3230
57.0	2551.7586	179.0708	61.0	2922.4666	191.6372
.1	2560.7200	179.3849	.1	2932.0563	191.9513
.2	2569.6971	179.6991	.2	2941.6617	192.2655
.3	2578.6899	180.0133	.3	2951.2828	192.5796
.4	2587.6985	180.3274	.4	2960.9197	192.8938
.5	2596.7227	180.6416	.5	2970.5722	193.2079
.6	2605.7626	180.9557	.6	2980.2405	193.5221
.7	2614.8183	181.2699	.7	2989.9244	193.8363
.8	2623.8896	181.5841	.8	2999.6241	194.1504
.9	2632.9767	181.8982	.9	3009.3395	194.4646
58.0	2642.0794	182.2124	62.0	3019.0705	194.7787
.1	2651.1979	182.5265	.1	3028.8173	195.0929
.2	2660.3321	182.8407	.2	3038.5798	195.4071
.3	2669.4820	183.1549	.3	3048.3580	195.7212
.4	2678.6476	183.4690	.4	3058.1520	196.0354
.5	2687.8289	183.7832	.5	3067.9616	196.3495
.6	2697.0259	184.0973	.6	3077.7869	196.6637
.7	2706.2386	184.4115	.7	3087.6279	196.9779
.8	2715.4670	184.7256	.8	3097.4847	197.2920
.9	2724.7112	185.0398	.9	3107.3571	197.6062
59.0	2733.9710	185.3540	63.0	3117.2453	197.9203
.1	2743.2466	185.6681	.1	3127.1492	198.2345
.2	2752.5378	185.9823	.2	3137.0688	198.5487
.3	2761.8448	186.2964	.3	3147.0040	198.8628
.4	2771.1675	186.6106	.4	3156.9550	199.1770
.5	2780.5058	186.9248	.5	3166.9217	199.4911
.6	2789.8599	187.2389	.6	3176.9043	199.8053
.7	2799.2297	187.5531	.7	3186.9023	200.1195
.8	2808.6152	187.8672	.8	3196.9161	200.4336
.9	2818.0165	188.1814	.9	3206.9456	200.7478

AREAS AND CIRCUMFERENCES OF CIRCLES.

(CONTINUED.)

Diameter.	Area.	Circumference.	Diameter.	Area.	Circumference.
64.0	3216.9909	201.0620	68.0	3631.6811	213.6283
.1	3227.0518	201.3761	.1	3642.3704	213.9425
.2	3237.1285	201.6902	.2	3653.0754	214.2566
.3	3247.2222	202.0044	.3	3663.7960	214.5708
.4	3257.3289	202.3186	.4	3674.5324	214.8849
.5	3267.4527	202.6327	.5	3685.2845	215.1991
.6	3277.5922	202.9469	.6	3696.0523	215.5133
.7	3287.7474	203.2610	.7	3706.8359	215.8274
.8	3297.9183	203.5752	.8	3717.6351	216.1416
.9	3308.1049	203.8894	.9	3728.4500	216.4556
65.0	3318.3072	204.2035	69.0	3739.2807	216.7699
.1	3328.5253	204.5176	.1	3750.1270	217.0841
.2	3338.7590	204.8318	.2	3760.9891	217.3982
.3	3349.0085	205.1460	.3	3771.8668	217.7124
.4	3359.2736	205.4602	.4	3782.7603	218.0265
.5	3369.5545	205.7743	.5	3793.6695	218.3407
.6	3379.8510	206.0885	.6	3804.5944	218.6548
.7	3390.1633	206.4026	.7	3815.5350	218.9690
.8	3400.4913	206.7168	.8	3826.4913	219.2832
.9	3410.8350	207.0310	.9	3837.4633	219.5973
66.0	3421.1944	207.3451	70.0	3848.4510	219.9115
.1	3431.5695	207.6593	.1	3859.4544	220.2256
.2	3441.9603	207.9734	.2	3870.4736	220.5398
.3	3452.3669	208.2876	.3	3881.5084	220.8540
.4	3462.7891	208.6017	.4	3892.5590	221.1681
.5	3473.2270	208.9159	.5	3903.6252	221.4823
.6	3483.6807	209.2301	.6	3914.7072	221.7964
.7	3494.1500	209.5442	.7	3925.8049	222.1106
.8	3504.6351	209.8584	.8	3936.9182	222.4248
.9	3515.1359	210.1725	.9	3948.0473	222.7389
67.0	3525.6524	210.4867	71.0	3959.1921	223.0531
.1	3536.1845	210.8009	.1	3970.3526	223.3672
.2	3546.7324	211.1150	.2	3981.5289	223.6814
.3	3557.2960	211.4292	.3	3992.7208	223.9956
.4	3567.8754	211.7433	.4	4003.9284	224.3097
.5	3578.4704	212.0575	.5	4015.1518	224.6239
.6	3589.0811	212.3717	.6	4026.3908	224.9380
.7	3599.7075	212.6858	.7	4037.6456	225.2522
.8	3610.3497	213.0000	.8	4048.9160	225.5664
.9	3621.0075	213.3141	.9	4060.2022	225.8805

AREAS AND CIRCUMFERENCES OF CIRCLES.

(CONTINUED.)

Diameter.	Area.	Circumference.	Diameter.	Area.	Circumference.
72.0	4071.5041	226.1947	76.0	4536.4598	238.7610
.1	4082.8217	226.5088	.1	4548.4057	239.0752
.2	4094.1550	226.8230	.2	4560.3673	239.3894
.3	4105.5040	227.1371	.3	4572.3446	239.7035
.4	4116.8687	227.4513	.4	4584.3377	240.0177
.5	4128.2491	227.7655	.5	4596.3464	240.3318
.6	4139.6452	228.0796	.6	4608.3708	240.6460
.7	4151.0571	228.3938	.7	4620.4110	240.9602
.8	4162.4846	228.7079	.8	4632.4669	241.2743
.9	4173.9279	229.0221	.9	4644.5384	241.5885
73.0	4185.3868	229.3363	77.0	4656.6257	241.9026
.1	4196.8615	229.6504	.1	4668.7287	242.2168
.2	4208.3519	229.9646	.2	4680.8474	242.5310
.3	4219.8579	230.2787	.3	4692.9818	242.8451
.4	4231.3797	230.5929	.4	4705.1319	243.1592
.5	4242.9172	230.9071	.5	4717.2977	243.4734
.6	4254.4704	231.2212	.6	4729.4792	243.7876
.7	4266.0394	231.5354	.7	4741.6765	244.1017
.8	4277.6240	231.8495	.8	4753.8894	244.4159
.9	4289.2243	232.1637	.9	4766.1181	244.7301
74.0	4300.8403	232.4779	78.0	4778.3624	245.0442
.1	4312.4721	232.7920	.1	4790.6225	245.3584
.2	4324.1195	233.1062	.2	4802.8983	245.6725
.3	4335.7827	233.4203	.3	4815.1897	245.9867
.4	4347.4616	233.7345	.4	4827.4969	246.3009
.5	4359.1562	234.0487	.5	4839.8198	246.6150
.6	4370.8664	234.3628	.6	4852.1584	246.9292
.7	4382.5924	234.6770	.7	4864.5128	247.2433
.8	4394.3341	234.9911	.8	4876.8828	247.5575
.9	4406.0916	235.3053	.9	4889.2685	247.8717
75.0	4417.8647	235.6194	79.0	4901.6699	248.1858
.1	4429.6535	235.6336	.1	4914.0871	248.5000
.2	4441.4580	236.2478	.2	4926.5199	248.8141
.3	4453.2783	236.5619	.3	4938.9685	249.1283
.4	4465.1142	236.8761	.4	4951.4328	249.4425
.5	4476.9659	237.1902	.5	4963.9127	249.7566
.6	4488.8332	237.5044	.6	4976.4084	250.0708
.7	4500.7163	237.8186	.7	4988.9198	250.3850
.8	4512.6151	238.1327	.8	5001.4469	250.6991
.9	4524.5296	238.4469	.9	5013.9897	251.0133

AREAS AND CIRCUMFERENCES OF CIRCLES.

(CONTINUED.)

Diameter.	Area.	Circumference.	Diameter.	Area.	Circumference.
80.0	5026.5482	251.3274	84.0	5541.7694	263.8938
.1	5039.1225	251.6416	.1	5554.9720	264.2079
.2	5051.7124	251.9557	.2	5568.1902	264.5221
.3	5064.3180	252.2699	.3	5581.4242	264.8363
.4	5076.9394	252.5840	.4	5594.6739	265.1514
.5	5089.5764	252.8982	.5	5607.9392	265.4646
.6	5102.2292	253.2124	.6	5621.2203	265.7787
.7	5114.8977	253.5265	.7	5634.5171	266.0929
.8	5127.5819	253.8407	.8	5647.8296	266.4071
.9	5140.2818	254.1548	.9	5661.1578	266.7212
81.0	5152.9973	254.4690	85.0	5674.5017	267.0354
.1	5165.7287	254.7832	.1	5687.8614	267.3495
.2	5178.4757	255.0973	.2	5701.2367	267.6637
.3	5191.2384	255.4115	.3	5714.6277	267.9779
.4	5204.0168	255.7256	.4	5728.0345	268.2920
.5	5216.8110	256.0398	.5	5741.4569	268.6062
.6	5229.6208	256.3540	.6	5754.8951	268.9203
.7	5242.4463	256.6681	.7	5768.3490	269.2345
.8	5255.2876	256.9823	.8	5781.8185	269.5486
.9	5268.1446	257.2966	.9	5795.3038	269.8628
82.0	5281.0173	257.6106	86.0	5808.8048	270.1770
.1	5293.9056	257.9247	.1	5822.3215	270.4911
.2	5306.8097	258.2389	.2	5835.8539	270.8053
.3	5319.7295	258.5531	.3	5849.4020	271.1194
.4	5332.6650	258.8672	.4	5862.9659	271.4336
.5	5345.6162	259.1814	.5	5876.5454	271.7478
.6	5358.5832	259.4956	.6	5890.1407	272.0619
.7	5371.5658	259.8097	.7	5903.7516	272.3761
.8	5384.5641	260.1239	.8	5917.3783	272.6902
.9	5397.5782	260.4380	.9	5931.0206	273.0044
83.0	5410.6079	260.7522	87.0	5944.6787	273.3186
.1	5423.6534	261.0663	.1	5958.3525	273.6327
.2	5436.7146	261.3805	.2	5972.0420	273.9469
.3	5449.7915	261.6947	.3	5985.7472	274.2610
.4	5462.8840	262.0088	.4	5999.4681	274.5752
.5	5475.9923	262.3230	.5	6013.2047	274.8894
.6	5489.1163	262.6371	.6	6026.9570	275.2035
.7	5502.2561	262.9513	.7	6040.7250	275.5177
.8	5515.4115	263.2655	.8	6054.5088	275.8318
.9	5528.5826	263.5796	.9	6068.3082	276.1460

AREAS AND CIRCUMFERENCES OF CIRCLES.

(CONTINUED.)

Diameter.	Area.	Circumference.	Diameter.	Area.	Circumference.
88.0	6082.1234	276.4602	92.0	6647.6101	289.0265
.1	6095.9542	276.7743	.1	6662.0692	289.3407
.2	6109.8008	277.0885	.2	6676.5441	289.6548
.3	6123.6631	277.4026	.3	6691.0347	289.9690
.4	6137.5411	277.7168	.4	6705.5410	290.2832
.5	6151.4348	278.0309	.5	6720.0630	290.5973
.6	6165.3442	278.3451	.6	6734.6008	290.9115
.7	6179.2693	278.6593	.7	6749.1542	291.2256
.8	6193.2101	278.9740	.8	6763.7233	291.5398
.9	6207.1666	279.2876	.9	6778.3082	291.8540
89.0	6221.1389	279.6017	93.0	6792.9087	292.1681
.1	6235.1268	279.9159	.1	6807.5250	292.4823
.2	6249.1304	280.2301	.2	6822.1569	292.7964
.3	6263.1498	280.5442	.3	6836.8046	293.1106
.4	6277.1849	280.8584	.4	6851.4680	293.4248
.5	6291.2356	281.1725	.5	6866.1471	293.7389
.6	6305.3021	281.4867	.6	6880.8419	294.0531
.7	6319.3843	281.8009	.7	6895.5524	294.3672
.8	6333.4822	282.1150	.8	6910.2786	294.6814
.9	6347.5958	282.4292	.9	6925.0205	294.9956
90.0	6361.7251	282.7433	94.0	6939.7782	295.3097
.1	6375.8701	283.0575	.1	6954.5515	295.6239
.2	6390.0309	283.3717	.2	6969.3106	295.9380
.3	6404.2073	283.6858	.3	6984.1453	296.2522
.4	6418.3995	284.0000	.4	6998.9658	296.5663
.5	6432.6073	284.3141	.5	7013.8019	296.8805
.6	6446.8309	284.6283	.6	7028.6538	297.1947
.7	6461.0701	284.9425	.7	7043.5214	297.5088
.8	6475.3251	285.2566	.8	7058.4047	297.8230
.9	6489.5958	285.5708	.9	7073.3033	298.1371
91.0	6503.8822	285.8849	95.0	7088.2184	298.4513
.1	6518.1843	286.1991	.1	7103.1488	298.7655
.2	6532.5021	286.5133	.2	7118.1950	299.0796
.3	6546.8356	286.8274	.3	7133.0568	299.3938
.4	6561.1848	287.1416	.4	7148.0343	299.7079
.5	6575.5498	287.4557	.5	7163.0276	300.0221
.6	6589.9304	287.7699	.6	7178.0366	300.3363
.7	6604.3268	288.0840	.7	7193.0612	300.6504
.8	6618.7388	288.3982	.8	7208.1016	300.9646
.9	6633.1666	288.7124	.9	7223.1577	301.2787

AREAS AND CIRCUMFERENCES OF CIRCLES.

(CONTINUED.)

Diameter.	Area.	Circumference.	Diameter.	Area.	Circumference.
96.0	7238.2295	301.5929	98.0	7542.9640	307.8761
.1	7253.3170	301.9071	.1	7558.3656	308.1902
.2	7268.4202	302.2212	.2	7573.7830	308.5044
.3	7283.5391	302.5354	.3	7589.2161	308.8186
.4	7298.6737	302.8405	.4	7604.6648	309.1327
.5	7313.8240	303.1637	.5	7620.1293	309.4469
.6	7328.9901	303.4779	.6	7635.6095	309.7610
.7	7344.1718	303.7920	.7	7651.1054	310.0752
.8	7359.3693	304.1062	.8	7666.6170	310.3894
.9	7374.5824	304.4203	.9	7682.1444	310.7035
97.0	7389.8113	304.7345	99.0	7697.6893	311.0177
.1	7405.0559	305.0486	.1	7713.2461	311.3318
.2	7420.3162	305.3628	.2	7728.8206	311.6460
.3	7435.5922	305.6770	.3	7744.4107	311.9602
.4	7450.8839	305.9911	.4	7760.0166	312.2743
.5	7466.1913	306.3053	.5	7775.6382	312.5885
.6	7481.5144	306.6194	.6	7791.2754	312.9026
.7	7496.8532	306.9336	.7	7806.9284	313.2168
.8	7512.2078	307.2478	.8	7822.5971	313.5309
.9	7527.5780	307.5619	.9	7838.2815	313.8451
			100.0	7853.9816	314.1593

To find from the table areas or circumferences for larger diameters than those given.

CASE I.

For diameters greater than 100 and less than 1001:

Take from the table the area or circumference for a circle the diameter of which is one-tenth of the given diameter.

To obtain the required area or circumference, multiply the area so found by 100 and the circumference so found by 10.

For Example.—What is the area and circumference corresponding to a diameter of 459?

From the tables the area and circumference for diameter 45.9 are 1654.6847 and 144.1991. Therefore 165468.47 and 1441.991 are the area and circumference required.

CASE II.

For diameters greater than 1000:

Divide the given diameter by any convenient factor which will give as a quotient a diameter found in the table, and take from the table the area or circumference for this diameter.

To obtain the required area or circumference multiply the area so found by the square of the factor and the circumference so found by the factor.

For Example.—What is the area and circumference corresponding to a diameter of 1983?

$1983 \div 3 = 661$. From the tables and Case I the area and circumference for diameter 661 are 343156.95 and 20765.93. Therefore $343156.95 \times 9 = 3088412.55$ = area required, and $20765.93 \times 3 = 62297.79$ = circumference required.

LOGARITHMS OF NUMBERS, FROM 0 TO 1000.

No.	0	1	2	3	4	5	6	7	8	9
0	0	00000	30103	47712	60206	69897	77815	84510	90309	95424
10	00000	00432	00860	01283	01703	02118	02530	02938	03342	03742
11	04139	04532	04921	05307	05690	06069	06445	06818	07188	07554
12	07918	08278	08636	08990	09342	09691	10037	10380	10721	11059
13	11394	11727	12057	12385	12710	13033	13353	13672	13987	14301
14	14613	14921	15228	15533	15836	16136	16435	16731	17026	17318
15	17609	17897	18184	18469	18752	19033	19312	19590	19865	20139
16	20412	20682	20951	21218	21484	21748	22010	22271	22530	22788
17	23045	23299	23552	23804	24054	24303	24551	24797	25042	25285
18	25527	25767	26007	26245	26481	26717	26951	27184	27415	27646
19	27875	28103	28330	28555	28780	29003	29225	29446	29666	29885
20	30103	30319	30535	30749	30963	31175	31386	31597	31806	32014
21	32222	32428	32633	32838	33041	33243	33445	33646	33845	34044
22	34242	34439	34635	34830	35024	35218	35410	35602	35793	35983
23	36173	36361	36548	36735	36921	37106	37291	37474	37657	37839
24	38021	38201	38381	38560	38739	38916	39093	39269	39445	39619
25	39794	39967	40140	40312	40483	40654	40824	40993	41162	41330
26	41497	41664	41830	41995	42160	42324	42488	42651	42813	42975
27	43136	43296	43456	43616	43775	43933	44090	44248	44404	44560
28	44716	44870	45024	45178	45331	45484	45636	45788	45939	46089
29	46240	46389	46538	46686	46834	46982	47129	47275	47421	47567
30	47712	47856	48000	48144	48287	48430	48572	48713	48855	48995
31	49136	49276	49415	49554	49693	49831	49968	50105	50242	50379
32	50515	50650	50785	50920	51054	51188	51321	51454	51587	51719
33	51851	51982	52113	52244	52374	52504	52633	52763	52891	53020
34	53148	53275	53402	53529	53655	53781	53907	54033	54157	54282
35	54407	54530	54654	54777	54900	55022	55145	55266	55388	55509
36	55630	55750	55870	55990	56110	56229	56348	56466	56584	56702
37	56820	56937	57054	57170	57287	57403	57518	57634	57749	57863
38	57978	58092	58206	58319	58433	58546	58658	58771	58883	58995
39	59106	59217	59328	59439	59549	59659	59769	59879	59988	60097
40	60206	60314	60422	60530	60638	60745	60852	60959	61066	61172
41	61278	61384	61489	61595	61700	61804	61909	62013	62118	62221
42	62325	62428	62531	62634	62736	62838	62941	63042	63144	63245
43	63347	63447	63548	63648	63749	63848	63948	64048	64147	64246
44	64345	64443	64542	64640	64738	64836	64933	65030	65127	65224
45	65321	65417	65513	65609	65705	65801	65896	65991	66086	66181
46	66276	66370	66464	66558	66651	66745	66838	66931	67024	67117
47	67210	67302	67394	67486	67577	67669	67760	67851	67942	68033
48	68124	68214	68304	68394	68484	68574	68663	68752	68842	68930
49	69020	69108	69196	69284	69372	69460	69548	69635	69722	69810
50	69897	69983	70070	70156	70243	70329	70415	70500	70586	70671
51	70757	70842	70927	71011	71096	71180	71265	71349	71433	71516
52	71600	71683	71767	71850	71933	72015	72098	72181	72263	72345
53	72428	72509	72591	72672	72754	72835	72916	72997	73078	73158
54	73239	73319	73399	73480	73559	73639	73719	73798	73878	73957

LOGARITHMS OF NUMBERS, FROM 0 TO 1000.

(Continued.)

No.	0	1	2	3	4	5	6	7	8	9
55	74036	74115	74193	74272	74351	74429	74507	74585	74663	74741
56	74818	74896	74973	75050	75127	75204	75281	75358	75434	75511
57	75587	75663	75739	75815	75891	75966	76042	76117	76192	76267
58	76342	76417	76492	76566	76641	76715	76789	76863	76937	77011
59	77085	77158	77232	77305	77378	77451	77524	77597	77670	77742
60	77815	77887	77959	78031	78103	78175	78247	78318	78390	78461
61	78533	78604	78675	78746	78816	78887	78958	79028	79098	79169
62	79239	79309	79379	79448	79518	79588	79657	79726	79796	79865
63	79934	80002	80071	80140	80208	80277	80345	80413	80482	80550
64	80618	80685	80753	80821	80888	80956	81023	81090	81157	81224
65	81291	81358	81424	81491	81557	81624	81690	81756	81822	81888
66	81954	82020	82085	82151	82216	82282	82347	82412	82477	82542
67	82607	82672	82736	82801	82866	82930	82994	83058	83123	83187
68	83250	83314	83378	83442	83505	83569	83632	83695	83758	83821
69	83884	83947	84010	84073	84136	84198	84260	84323	84385	84447
70	84509	84571	84633	84695	84757	84818	84880	84941	85003	85064
71	85125	85187	85248	85309	85369	85430	85491	85551	85612	85672
72	85733	85793	85853	85913	85973	86033	86093	86153	86213	86272
73	86332	86391	86451	86510	86569	86628	86687	86746	86805	86864
74	86923	86981	87040	87098	87157	87215	87273	87332	87390	87448
75	87506	87564	87621	87679	87737	87794	87852	87909	87966	88024
76	88081	88138	88195	88252	88309	88366	88422	88479	88536	88592
77	88649	88705	88761	88818	88874	88930	88986	89042	89098	89153
78	89209	89265	89320	89376	89431	89487	89542	89597	89652	89707
79	89762	89817	89872	89927	89982	90036	90091	90145	90200	90254
80	90309	90363	90417	90471	90525	90579	90633	90687	90741	90794
81	90848	90902	90955	91009	91062	91115	91169	91222	91275	91328
82	91381	91434	91487	91540	91592	91645	91698	91750	91803	91855
83	91907	91960	92012	92064	92116	92168	92220	92272	92324	92376
84	92427	92479	92531	92582	92634	92685	92737	92788	92839	92890
85	92941	92993	93044	93095	93146	93196	93247	93298	93348	93399
86	93449	93500	93550	93601	93651	93701	93751	93802	93852	93902
87	93951	94001	94051	94101	94151	94200	94250	94300	94349	94398
88	94448	94497	94546	94596	94645	94694	94743	94792	94841	94890
89	94939	94987	95036	95085	95133	95182	95230	95279	95327	95376
90	95424	95472	95520	95568	95616	95664	95712	95760	95808	95856
91	95904	95951	95999	96047	96094	96142	96189	96236	96284	96331
92	96378	96426	96473	96520	96567	96614	96661	96708	96754	96801
93	96848	96895	96941	96988	97034	97081	97127	97174	97220	97266
94	97312	97359	97405	97451	97497	97543	97589	97635	97680	97726
95	97772	97818	97863	97909	97954	98000	98045	98091	98136	98181
96	98227	98272	98317	98362	98407	98452	98497	98542	98587	98632
97	98677	98721	98766	98811	98855	98900	98945	98989	99033	99078
98	99122	99166	99211	99255	99299	99343	99387	99431	99475	99519
99	99563	99607	99651	99694	99738	99782	99825	99869	99913	99956

NATURAL SINES, COSECANTS, TANGENTS, ETC.

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
0	0	.000000	Infinite.	.000000	Infinite.	1.00000	1.000000	0	90
	10	.002909	343.77516	.002909	343.77371	1.00000	.999996	50	
	20	.005818	171.88831	.005818	171.88540	1.00002	.999983	40	
	30	.008727	114.59301	.008727	114.58865	1.00004	.999962	30	
	40	.011635	85.945609	.011636	85.939791	1.00007	.999932	20	
	50	.014544	68.757360	.014545	68.750087	1.00011	.999894	10	
1	0	.017452	57.298688	.017455	57.289962	1.00015	.999848	0	89
	10	.020361	49.114062	.020365	49.103881	1.00021	.999793	50	
	20	.023269	42.975713	.023275	42.964077	1.00027	.999729	40	
	30	.026177	38.201550	.026186	38.188459	1.00034	.999657	30	
	40	.029085	34.382316	.029097	34 367771	1.00042	.999577	20	
	50	.031992	31.257577	.032009	31.241577	1.00051	.999488	10	
2	0	.034899	28.653708	.034921	28.636253	1.00061	.999391	0	88
	10	.037806	26.450510	.037834	26.431600	1.00072	.999285	50	
	20	.040713	24.562123	.040747	24.541758	1.00083	.999171	40	
	30	.043619	22.925586	.043661	22.903766	1.00095	.999048	30	
	40	.046525	21.493676	.046576	21.470401	1.00108	.998917	20	
	50	.049431	20.230284	.049491	20.205553	1.00122	.998778	10	
3	0	.052336	19.107323	.052408	19.081137	1.00137	.998630	0	87
	10	.055241	18.102619	.055325	18.074977	1.00153	.998473	50	
	20	.058145	17.198434	.058243	17.169337	1.00169	.998308	40	
	30	.061049	16.380408	.061163	16.349855	1.00187	.998135	30	
	40	.063952	15.636793	.064083	15.604784	1.00205	.997357	20	
	50	.066854	14.957882	.067004	14.924417	1.00224	.997763	10	
4	0	.069756	14.335587	.069927	14.300666	1.00244	.997564	0	86
	10	.072658	13.763115	.072851	13.726738	1.00265	.997357	50	
	20	.075559	13.234717	.075776	13.196888	1.00287	.997141	40	
	30	.078459	12.745495	.078702	12.706205	1.00309	.996917	30	
	40	.081359	12.291252	.081629	12.250505	1.00333	.996685	20	
	50	.084258	11.868370	.084558	11.826167	1.00357	.996444	10	
5	0	.087156	11.473713	.087489	11.430052	1.00382	.996195	0	85
	10	.090053	11.104549	.090421	11.059431	1.00408	.995937	50	
	20	.092950	10.758488	.093354	10.711913	1.00435	.995671	40	
	30	.095846	10.433431	.096289	10.385397	1.00463	.995396	30	
	40	.098741	10.127522	.099226	10.078031	1.00491	.995113	20	
	50	.101635	9.8391227	.102164	9.7881732	1.00521	.994822	10	
6	0	.104528	9.5667722	.105104	9.5143645	1.00551	.994522	0	84
	10	.107421	9.3091699	.108046	9 2553035	1.00582	.994214	50	
	20	.110313	9.0651512	.110990	9.0098261	1.00614	.993897	40	83
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.	′	°

For functions from 83°-40′ to 90° read from bottom of table upward.

NATURAL SINES, COSECANTS, TANGENTS, ETC.

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
6	30	.113203	8.8336715	.113936	8.7768874	1.00647	.993572	30	
	40	.116093	8.6137901	.116883	8.5555468	1.00681	.993238	20	
	50	.118982	8.4045586	.119833	8.3449558	1.00715	.992896	10	
7	0	.121869	8.2055090	.122785	8.1443464	1.00751	.992546	0	83
	10	.124756	8.0156450	.125738	7.9530224	1.00787	.992187	50	
	20	.127642	7.8344335	.128694	7.7703506	1.00825	.991820	40	
	30	.130526	7.6612976	.131653	7.5957541	1.00863	.991445	30	
	40	.133410	7.4957100	.134613	7.4287064	1.00902	.991061	20	
	50	.136292	7.3371909	.137576	7.2687255	1.00942	.990669	10	
8	0	.139173	7.1852965	.140541	7.1153697	1.00983	.990268	0	82
	10	.142053	7.0396220	.143508	6.9682335	1.01024	.989859	50	
	20	.144932	6.8997942	.146478	6.8269437	1.01067	.989442	40	
	30	.147809	6.7654691	.149451	6.6911562	1.01111	.989016	30	
	40	.150686	6.6363293	.152426	6.5605538	1.01155	.988582	20	
	50	.153561	6.5120812	.155404	6.4348428	1.01200	.988139	10	
9	0	.156434	6.3924532	.158384	6.3137515	1.01247	.987688	0	81
	10	.159307	6.2771933	.161368	6.1970279	1.01294	.987229	50	
	20	.162178	6.1660674	.164354	6.0844381	1.01432	.986762	40	
	30	.165048	6.0588980	.167343	5.9757644	1.01391	.986286	30	
	40	.167916	5.9553625	.170334	5.8708042	1.01440	.985801	20	
	50	.170783	5.8553921	.173329	5.7693688	1.01491	.985309	10	
10	0	.173648	5.7587705	.176327	5.6712818	1.01543	.984808	0	80
	10	.176512	5.6653331	.179328	5.5763786	1.01595	.984298	50	
	20	.179375	5.5749258	.182332	5.4845052	1.01649	.983781	40	
	30	.182236	5.4874043	.185339	5.3955172	1.01703	.983255	30	
	40	.185095	5.4026333	.188359	5.3092793	1.01758	.982721	20	
	50	.187953	5.3204860	.191363	5.2256647	1.01815	.982178	10	
11	0	.190809	5.2408431	.194380	5.1445540	1.01872	.981627	0	79
	10	.193664	5.1635924	.197401	5.0658352	1.01930	.981068	50	
	20	.196517	5.0886284	.200425	4.9894027	1.01989	.980500	40	
	30	.199368	5.0158317	.203452	4.9151570	1.02049	.979925	30	
	40	.202218	4.9451687	.206483	4.8430045	1.02110	.979341	20	
	50	.205065	4.8764907	.209518	4.7728568	1.02171	.978748	10	
12	0	.207912	4.8097343	.212557	4.7046301	1.02234	.978148	0	78
	10	.210756	4.7448206	.215599	4.6382457	1.02298	.977539	50	
	20	.213599	4.6816748	.218645	4.5736287	1.02362	.976921	40	
	30	.216440	4.6202263	.221695	4.5107085	1.02428	.976296	30	
	40	.219279	4.5604080	.224748	4.4494181	1.02494	.975662	20	
	50	.222116	4.5021565	.227806	4.3896940	1.02562	.975020	10	77
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.	′	°

For functions from 77°-10′ to 83°-30′ read from bottom of table upward.

NATURAL SINES, COSECANTS, TANGENTS, ETC.

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
13	0	.224951	4.4454115	.230868	4.3314759	1.02630	.974370	0	77
	10	.227784	4.3901158	.233934	4.2747066	1.02700	.973712	50	
	20	.230616	4.3362150	.237004	4.2193318	1.02770	.973045	40	
	30	.233445	4.2836576	.240079	4.1652998	1.02842	.972370	30	
	40	.236273	4.2323943	.243158	4.1125614	1.02914	.971687	20	
	50	.239098	4.1823785	.246241	4.0610700	1.02987	.970995	10	
14	0	.241922	4.1335655	.249328	4.0107809	1.03061	.970296	0	76
	10	.244743	4.0859130	.252420	3.9616518	1.03137	.969588	50	
	20	.247563	4.0393804	.255517	3.9136420	1.03213	.968872	40	
	30	.250380	3.9939292	.258618	3.8667131	1.03290	.968148	30	
	40	.253195	3.9495224	.261723	3.8208281	1.03363	.967415	20	
	50	.256008	3.9061250	.264834	3.7759519	1.03447	.966675	10	
15	0	.258819	3.8637033	.267949	3.7320508	1.03528	.965926	0	75
	10	.261628	3.8222251	.271069	3.6890927	1.03609	.965169	50	
	20	.264434	3.7816596	.274195	3.6470467	1.03691	.964404	40	
	30	.267238	3.7419775	.277325	3.6058835	1.03774	.963630	30	
	40	.270040	3.7031506	.280460	3.5655749	1.03858	.962849	20	
	50	.272840	3.6651518	.283600	3.5260938	1.03944	.962059	10	
16	0	.275637	3.6279553	.286745	3.4874144	1.04030	.961262	0	74
	10	.278432	3.5915363	.289896	3.4495120	1.04117	.960456	50	
	20	.281225	3.5558710	.293052	3.4123626	1.04206	.959642	40	
	30	.284015	3.5209365	.296214	3.3759434	1.04295	.958820	30	
	40	.286803	3.4867110	.299380	3.3402326	1.04385	.957990	20	
	50	.289589	3.4531735	.302553	3.3052091	1.04477	.957151	10	
17	0	.292372	3.4203036	.305731	3.2708526	1.04569	.956305	0	73
	10	.295152	3.3880820	.308914	3.2371438	1.04663	.955450	50	
	20	.297930	3.3564900	.312104	3.2040638	1.04757	.954588	40	
	30	.300706	3.3255095	.315299	3.1715948	1.04853	.953717	30	
	40	.303479	3.2951234	.318500	3.1397194	1.04950	.952838	20	
	50	.306249	3.2653149	.321707	3.1084210	1.05047	.951951	10	
18	0	.309017	3.2360680	.324920	3.0776835	1.05146	.951057	0	72
	10	.311782	3.2073673	.328139	3.0474915	1.05246	.950154	50	
	20	.314545	3.1791978	.331364	3.0178301	1.05347	.949243	40	
	30	.317305	3.1515453	.334595	2.9886850	1.05449	.948324	30	
	40	.320062	3.1243959	.337833	2.9600422	1.05552	.947397	20	
	50	.322816	3.0977363	.341077	2.9318885	1.05657	.946462	10	
19	0	.325568	3.0715535	.344328	2.9042109	1.05762	.945519	0	71
	10	.328317	3.0458352	.347585	2.8769970	1.05869	.944568	50	
	20	.331063	3.0205693	.350848	2.8502349	1.05976	.943609	40	70
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.	′	°

For functions from 70°-40′ to 77°-0′ read from bottom of table upward.

NATURAL SINES, COSECANTS, TANGENTS, ETC.

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
19	30	.333807	2.9957443	.354119	2.8239129	1.06085	.942641	30	
	40	.336547	2.9713490	.357396	2.7980198	1.06195	.941666	20	
	50	.339285	2.9473724	.360680	2.7725448	1.06306	.940684	10	
20	0	.342020	2.9238044	.363970	2.7474774	1.06418	.939693	0	70
	10	.344752	2.9006346	.367268	2.7228076	1.06531	.938694	50	
	20	.347481	2.8778532	.370573	2.6985254	1.06645	.937687	40	
	30	.350207	2.8554510	.373885	2.6746215	1.06761	.936672	30	
	40	.352931	2.8334185	.377204	2.6510867	1.06878	.935650	20	
	50	.355651	2.8117471	.380530	2.6279121	1.06995	.934619	10	
21	0	.358368	2.7904281	.383864	2.6050891	1.07115	.933580	0	69
	10	.361082	2.7694532	.387205	2.5826094	1.07235	.932534	50	
	20	.363793	2.7488144	.390554	2.5604649	1.07356	.931480	40	
	30	.366501	2.7285038	.393911	2.5386479	1.07479	.930418	30	
	40	.369206	2.7085139	.397275	2.5171507	1.07602	.929348	20	
	50	.371908	2.6888374	.400647	2.4959661	1.07727	.928270	10	
22	0	.374607	2.6694672	.404026	2.4750869	1.07853	.927184	0	68
	10	.377302	2.6503962	.407414	2.4545061	1.07981	.926090	50	
	20	.379994	2.6316180	.410810	2.4342172	1.08109	.924989	40	
	30	.382683	2.6131259	.414214	2.4142136	1.08239	.923880	30	
	40	.385369	2.5949137	.417626	2.3944889	1.08370	.922762	20	
	50	.388052	2.5769753	.421046	2.3750372	1.08503	.921638	10	
23	0	.390731	2.5593047	.424475	2.3558524	1.08636	.920505	0	67
	10	.393407	2.5418961	.427912	2.3369287	1.08771	.919364	50	
	20	.396080	2.5247440	.431358	2.3182606	1.08907	.918216	40	
	30	.398749	2.5078428	.434812	2.2998425	1.09044	.917060	30	
	40	.401415	2.4911874	.438276	2.2816693	1.09183	.915896	20	
	50	.404078	2.4747726	.441748	2.2637357	1.09323	.914725	10	
24	0	.406737	2.4585933	.445229	2.2460368	1.09464	.913545	0	66
	10	.409392	2.4426448	.448719	2.2285676	1.09606	.912358	50	
	20	.412045	2.4269222	.452218	2.2113234	1.09750	.911164	40	
	30	.414693	2.4114210	.455726	2.1942997	1.09895	.909961	30	
	40	.417338	2.3961367	.459244	2.1774920	1.10041	.908751	20	
	50	.419980	2.3810650	.462771	2.1608958	1.10189	.907533	10	
25	0	.422618	2.3662016	.466308	2.1445069	1.10338	.906308	0	65
	10	.425253	2.3515424	.469854	2.1283213	1.10488	.905075	50	
	20	.427884	2.3370833	.473410	2.1123348	1.10640	.903834	40	
	30	.430511	2.3228205	.476976	2.0965436	1.10793	.902585	30	
	40	.433135	2.3087501	.480551	2.0809438	1.10947	.901329	20	
	50	.435755	2.2948685	.484137	2.0655318	1.11103	.900065	10	64
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.	′	°

For functions from 64°-10′ to 70°-30′ read from bottom of table upward.

NATURAL SINES, COSECANTS, TANGENTS, ETC.

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
26	0	.438371	2.2811720	.487733	2.0503038	1.11260	.898794	0	64
	10	.440984	2.2676571	.491339	2.0352565	1.11419	.897515	50	
	20	.443593	2.2543204	.494955	2.0203862	1.11579	.896229	40	
	30	.446198	2.2411585	.498582	2.0056897	1.11740	.894934	30	
	40	.448799	2.2281681	.502219	1.9911637	1.11903	.893633	20	
	50	.451397	2.2153460	.505867	1.9768050	1.12067	.892323	10	
27	0	.453990	2.2026893	.509525	1.9626105	1.12233	.891007	0	63
	10	.456580	2.1901947	.513195	1.9485772	1.12400	.889682	50	
	20	.459166	2.1778595	.516876	1.9347020	1.12568	.888350	40	
	30	.461749	2.1656806	.520567	1.9209821	1.12738	.887011	30	
	40	.464327	2.1536553	.524270	1.9074147	1.12910	.885664	20	
	50	.466901	2.1417808	.527984	1.8939971	1.13083	.884309	10	
28	0	.469472	2.1300545	.531709	1.8807265	1.13257	.882948	0	62
	10	.472038	2.1184737	.535547	1.8676003	1.13433	.881578	50	
	20	.474600	2.1070359	.539195	1.8546159	1.13610	.880201	40	
	30	.477159	2.0957385	.542956	1.8417409	1.13789	.878817	30	
	40	.479713	2.0845792	.546728	1.8290628	1.13970	.877425	20	
	50	.482263	2.0735556	.550515	1.8164892	1.14152	.876026	10	
29	0	.484810	2.0626653	.554309	1.8040478	1.14335	.874620	0	61
	10	.487352	2.0519061	.558118	1.7917362	1.14521	.873206	50	
	20	.489890	2.0412757	.561939	1.7795524	1.14707	.871784	40	
	30	.492424	2.0307720	.565773	1.7674940	1.14896	.870356	30	
	40	.494953	2.0203929	.569619	1.7555590	1.15085	.868920	20	
	50	.497479	2.0101362	.573478	1.7437453	1.15277	.867476	10	
30	0	.500000	2.0000000	.577350	1.7320508	1.15470	.866025	0	60
	10	.502517	1.9899822	.581235	1.7204736	1.15665	.864567	50	
	20	.505030	1.9800810	.585134	1.7090116	1.15861	.863102	40	
	30	.507538	1.9702944	.589045	1.6976631	1.16059	.861629	30	
	40	.510043	1.9606206	.592970	1.6864261	1.16259	.860149	20	
	50	.512543	1.9510577	.596908	1.6752988	1.16460	.858662	10	
31	0	.515038	1.9416040	.600861	1.6642795	1.16663	.857167	0	59
	10	.517529	1.9322578	.604827	1.6533663	1.16868	.855665	50	
	20	.520016	1.9230173	.608807	1.6425576	1.17075	.854156	40	
	30	.522499	1.9138809	.612801	1.6318517	1.17283	.852640	30	
	40	.524977	1.9048469	.616809	1.6212469	1.17493	.851117	20	
	50	.527450	1.8959138	.620832	1.6107417	1.17704	.849586	10	
32	0	.529919	1.8870799	.624869	1.6003345	1.17918	.848048	0	58
	10	.532384	1.8783438	.628921	1.5900238	1.18133	.846503	50	
	20	.534844	1.8697040	.632988	1.5798079	1.18350	.844951	40	57
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.	′	°

For functions from 57°-40′ to 64°-0′ read from bottom of table upward.

NATURAL SINES, COSECANTS, TANGENTS, ETC.

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
32	30	.537300	1.8611590	.637079	1.5696856	1.18569	.843391	30	
	40	.539751	1.8527073	.641167	1.5596552	1.18790	.841825	20	
	50	.542197	1.8443476	.645280	1.5497155	1.19012	.840251	10	
33	0	.544639	1.8360785	.649408	1.5398650	1.19236	.838671	0	57
	10	.547076	1.8278985	.653531	1.5301025	1.19463	.837083	50	
	20	.549509	1.8198 65	.657710	1.5204261	1.19691	.835488	40	
	30	.551937	1.8118010	.661886	1.5108352	1.19920	.833886	30	
	40	.554360	1.8038809	.666077	1.5013282	1.20152	.832277	20	
	50	.556779	1.7960449	.670285	1.4919039	1.20386	.830661	10	
34	0	.559193	1.7882916	.674509	1.4825610	1.20622	.829038	0	56
	10	.561602	1.7806201	.678749	1.4732983	1.20859	.827407	50	
	20	.564007	1.7730290	.683007	1.4641147	1.21099	.825770	40	
	30	.566406	1.7655173	.687281	1.4550090	1.21341	.824126	30	
	40	.568801	1.7580837	.691573	1.4459801	1.21584	.822475	20	
	50	.571191	1.7507273	.695881	1.4370268	1.21830	.820817	10	
35	0	.573576	1.7434468	.700208	1.4281480	1.22077	.819152	0	55
	10	.575957	1.7362413	.704552	1.4193427	1.22327	.817480	50	
	20	.578332	1.7291096	.708913	1.4106098	1.22579	.815801	40	
	30	.580703	1.7220508	.713293	1.4019483	1.22833	.814116	30	
	40	.583069	1.7150639	.717691	1.3933571	1.23089	.812423	20	
	50	.585429	1.7081478	.722108	1.3848355	1.23347	.810723	10	
36	0	.587785	1.7013016	.726543	1.3763810	1.23607	.809017	0	54
	10	.590136	1.6945244	.730996	1.3679959	1.23869	.807304	50	
	20	.592482	1.6878151	.735469	1.3596764	1.24134	.805584	40	
	30	.594823	1.6811730	.739961	1.3514224	1.24400	.803857	30	
	40	.597159	1.6745970	.744472	1.3432331	1.24669	.802123	20	
	50	.599489	1.6680864	.749003	1.3351075	1.24940	.800383	10	
37	0	.601815	1.6616401	.753554	1.3270448	1.25214	.798636	0	53
	10	.604136	1.6552575	.758125	1.3190441	1.25489	.796882	50	
	20	.606451	1.6489376	.762716	1.3111046	1.25767	.795121	40	
	30	.608761	1.6426796	.767627	1.3032254	1.26047	.793353	30	
	40	.611067	1.6364828	.771959	1.2954057	1.26330	.791579	20	
	50	.613367	1.6303462	.776612	1.2876447	1.26615	.789798	10	
38	0	.615661	1.6242692	.781286	1.2799416	1.26902	.788011	0	52
	10	.617951	1.6182510	.785981	1.2722957	1.27191	.786217	50	
	20	.620235	1.6122908	.790698	1.2647062	1.27483	.784416	40	
	30	.622515	1.6063879	.795436	1.2571723	1.27778	.782608	30	
	40	.624789	1.6005416	.800196	1.2496933	1.28075	.780794	20	
	50	.627057	1.5947511	.804080	1.2422685	1.28374	.778973	10	51
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.	′	°

For functions from 51°-10′ to 57°-30′ read from bottom of table upward.

NATURAL SINES, COSECANTS, TANGENTS, ETC.

°	′	Sine.	Cosecant.	Tangent.	Cotangent.	Secant.	Cosine.	′	°
39	0	.629320	1.5890157	.809784	1.2348972	1.28676	.777146	0	51
	10	.631578	1.5833318	.814612	1.2275786	1.28980	.775312	50	
	20	.633831	1.5777077	.819463	1.2203121	1.29287	.773472	40	
	30	.636078	1.5721337	.824336	1.2130970	1.29597	.771625	30	
	40	.638320	1.5666121	.829234	1.2059327	1.29909	.769771	20	
	50	.640557	1.5611424	.834155	1.1988184	1.30223	.767911	10	
40	0	.642788	1.5557238	.839100	1.1917536	1.30541	.766044	0	50
	10	.645013	1.5503558	.844069	1.1847376	1.30861	.764171	50	
	20	.647233	1.5450378	.849062	1.1777698	1.31183	.762292	40	
	30	.649448	1.5397690	.854081	1.1708496	1.31509	.760406	30	
	40	.651657	1.5345491	.859124	1.1639763	1.31837	.758514	20	
	50	.653861	1.5293773	.864193	1.1571495	1.32168	.756615	10	
41	0	.656059	1.5242531	.869287	1.1503684	1.32501	.754710	0	49
	10	.658252	1.5191759	.874407	1.1436326	1.32838	.752798	50	
	20	.660439	1.5141452	.879553	1.1369414	1.33177	.750880	40	
	30	.662620	1.5091605	.884725	1.1302944	1.33519	.748956	30	
	40	.664796	1.5042211	.889924	1.1236909	1.33864	.747025	20	
	50	.666966	1.4993267	.895151	1.1171305	1.34212	.745088	10	
42	0	.669131	1.4944765	.900404	1.1106125	1.34563	.743145	0	48
	10	.671289	1.4896703	.905685	1.1041365	1.34917	.741195	50	
	20	.673443	1.4849073	.910994	1.0977020	1.35274	.739239	40	
	30	.675590	1.4801872	.916331	1.0913085	1.35634	.737277	30	
	40	.677732	1.4755095	.921697	1.0849554	1.35997	.735309	20	
	50	.679868	1.4708736	.927091	1.0786423	1.36363	.733335	10	
43	0	.681998	1.4662792	.932515	1.0723687	1.36733	.731354	0	47
	10	.684123	1.4617257	.937968	1.0661341	1.37105	.729367	50	
	20	.686242	1.4572127	.943451	1.0599381	1.37481	.727374	40	
	30	.688355	1.4527397	.948965	1.0537801	1.37860	.725374	30	
	40	.690462	1.4483063	.954508	1.0476598	1.38242	.723369	20	
	50	.692563	1.4439120	.960083	1.0415767	1.38628	.721357	10	
44	0	.694658	1.4395565	.965689	1.0355303	1.39016	.719340	0	46
	10	.696748	1.4352393	.971326	1.0295203	1.39409	.717316	50	
	20	.698832	1.4309602	.976996	1.0235461	1.39804	.715286	40	
	30	.700909	1.4267182	.982697	1.0176074	1.40203	.713251	30	
	40	.702981	1.4225134	.988432	1.0117088	1.40606	.711209	20	
	50	.705047	1.4183454	.994199	1.0058348	1.41012	.709161	10	
45	0	.707107	1.4142136	1.000000	1.0000000	1.41421	.707107	0	45
°	′	Cosine.	Secant.	Cotangent.	Tangent.	Cosecant.	Sine.	′	°

For functions from 45°-0′ to 51°-0′ read from bottom of table upward.

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
1	1	1	1.0000000	1.0000000	1.000000000
2	4	8	1.4142136	1.2599210	.500000000
3	9	27	1.7320508	1.4422496	.333333333
4	16	64	2.0000000	1.5874011	.250000000
5	25	125	2.2360680	1.7099759	.200000000
6	36	216	2.4494897	1.8171206	.166666667
7	49	343	2.6457513	1.9129312	.142857143
8	64	512	2.8284271	2.0000000	.125000000
9	81	729	3.0000000	2.0800837	.111111111
10	100	1000	3.1622777	2.1544347	.100000000
11	121	1331	3.3166248	2.2239801	.090909091
12	144	1728	3.4641016	2.2894286	.083333333
13	169	2197	3.6055513	2.3513347	.076923077
14	196	2744	3.7416574	2.4101422	.071428571
15	225	3375	3.8729833	2.4662121	.066666667
16	256	4096	4.0000000	2.5198421	.062500000
17	289	4913	4.1231056	2.5712816	.058823529
18	324	5832	4.2426407	2.6207414	.055555556
19	361	6859	4.3588989	2.6684016	.052631579
20	400	8000	4.4721360	2.7144177	.050000000
21	441	9261	4.5825757	2.7589243	.047619048
22	484	10648	4.6904158	2.8020393	.045454545
23	529	12167	4.7958315	2.8438670	.043478261
24	576	13824	4.8989795	2.8844991	.041666667
25	625	15625	5.0000000	2.9240177	.040000000
26	676	17576	5.0990195	2.9624960	.038461538
27	729	19683	5.1961524	3.0000000	.037037037
28	784	21952	5.2915026	3.0365889	.035714286
29	841	24389	5.3851648	3.0723168	.034482759
30	900	27000	5.4772256	3.1072325	.033333333
31	961	29791	5.5677644	3.1413806	.032258065
32	1024	32768	5.6568542	3.1748021	.031250000
33	1089	35937	5.7445626	3.2075343	.030303030
34	1156	39304	5.8309519	3.2396118	.029411765
35	1225	42875	5.9160798	3.2710663	.028571429
36	1296	46656	6.0000000	3.3019272	.027777778
37	1369	50653	6.0827625	3.3322218	.027027027
38	1444	54872	6.1644140	3.3619754	.026315789
39	1521	59319	6.2449980	3.3912114	.025641026
40	1600	64000	6.3245553	3.4199519	.025000000
41	1681	68921	6.4031242	3.4482172	.024390244
42	1764	74088	6.4807407	3.4760266	.023809524
43	1849	79507	6.5574385	3.5033981	.023255814
44	1936	85184	6.6332496	3.5303483	.022727273
45	2025	91125	6.7082039	3.5568933	.022222222
46	2116	97336	6.7823300	3.5830479	.021739130
47	2209	103823	6.8556546	3.6088261	.021276600
48	2304	110592	6.9282032	3.6342411	.020833333
49	2401	117649	7.0000000	3.6593057	.020408163
50	2500	125000	7.0710678	3.6840314	.020000000
51	2601	132651	7.1414284	3.7084298	.019607843
52	2704	140608	7.2111026	3.7325111	.019230769
53	2809	148877	7.2801099	3.7562858	.018867925
54	2916	157464	7.3484692	3.7797631	.018518519
55	3025	166375	7.4161985	3.8029525	.018181818
56	3136	175616	7.4833148	3.8258624	.017857143
57	3249	185193	7.5498344	3.8485011	.017543860
58	3364	195112	7.6157731	3.8708766	.017241379
59	3481	205379	7.6811457	3.8929965	.016949153

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
60	3600	216000	7.7459667	3.9148676	.016666667
61	3721	226981	7.8102497	3.9364972	.016393443
62	3844	238328	7.8740079	3.9578915	.016129032
63	3969	250047	7.9372539	3.9790571	.015873016
64	4096	262144	8.0000000	4.0000000	.015625000
65	4225	274625	8.0622577	4.0207256	.015384615
66	4356	287496	8.1240384	4.0412401	.015151515
67	4489	300763	8.1853528	4.0615480	.014925373
68	4624	314432	8.2462113	4.0816551	.014705882
69	4761	328509	8.3066239	4.1015661	.014492754
70	4900	343000	8.3666003	4.1212853	.014285714
71	5041	357911	8.4261498	4.1408178	.014084507
72	5184	373248	8.4852814	4.1601676	.013888889
73	5329	389017	8.5440037	4.1793390	.013698630
74	5476	405224	8.6023253	4.1983364	.013513514
75	5625	421875	8.6602540	4.2171633	.013333333
76	5776	438976	8.7177979	4.2358236	.013157895
77	5929	456533	8.7749644	4.2543210	.012987013
78	6084	474552	8.8317609	4.2726586	.012820513
79	6241	493039	8.8881944	4.2908404	.012658228
80	6400	512000	8.9442719	4.3088695	.012500000
81	6561	531441	9.0000000	4.3267487	.012345679
82	6724	551368	9.0553851	4.3444815	.012195122
83	6889	571787	9.1104336	4.3620707	.012048193
84	7056	592704	9.1651514	4.3795191	.011904762
85	7225	614125	9.2195445	4.3968296	.011764706
86	7396	636056	9.2736185	4.4140049	.011627907
87	7569	658503	9.3273791	4.4310476	.011494253
88	7744	681472	9.3808315	4.4479602	.011363636
89	7921	704969	9.4339811	4.4647451	.011235955
90	8100	729000	9.4868330	4.4814047	.011111111
91	8281	753571	9.5393920	4.4979414	.010989011
92	8464	778688	9.5916630	4.5143574	.010869565
93	8649	804357	9.6436508	4.5306549	.010752688
94	8836	830584	9.6953597	4.5468359	.010638298
95	9025	857375	9.7467943	4.5629026	.010526316
96	9216	884736	9.7979590	4.5788570	.010416667
97	9409	912673	9.8488578	4.5947009	.010309278
98	9604	941192	9.8994949	4.6104363	.010204082
99	9801	970299	9.9498744	4.6260650	.010101010
100	10000	1000000	10.0000000	4.6415888	.010000000
101	10201	1030301	10.0498756	4.6570095	.009900990
102	10404	1061208	10.0995049	4.6723287	.009803922
103	10609	1092727	10.1488916	4.6875482	.009708738
104	10816	1124864	10.1980390	4.7026694	.009615385
105	11025	1157625	10.2469508	4.7176940	.009523810
106	11236	1191016	10.2956301	4.7326235	.009433962
107	11449	1225043	10.3440804	4.7474594	.009345794
108	11664	1259712	10.3923048	4.7622032	.009259259
109	11881	1295029	10.4403065	4.7768562	.009174312
110	12100	1331000	10.4880885	4.7914199	.009090909
111	12321	1367631	10.5356538	4.8058955	.009009009
112	12544	1404928	10.5830052	4.8202845	.008928571
113	12769	1442897	10.6301458	4.8345881	.008849558
114	12996	1481544	10.6770783	4.8488076	.008771930
115	13225	1520875	10.7238053	4.8629442	.008695652
116	13456	1560896	10.7703296	4.8769990	.008620690
117	13689	1601613	10.8166538	4.8909732	.008547009
118	13924	1643032	10.8627805	4.9048681	.008474576
119	14161	1685159	10.9087121	4.9186847	.008403361

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
120	14400	1728000	10.9544512	4.9324242	.008333333
121	14641	1771561	11.0000000	4.9460874	.008264463
122	14884	1815848	11.0453610	4.9596757	.008196721
123	15129	1860867	11.0905365	4.9731898	.008130081
124	15376	1906624	11.1355287	4.9866310	.008064516
125	15625	1953125	11.1803399	5.0000000	.008000000
126	15876	2000376	11.2249722	5.0132979	.007936508
127	16129	2048383	11.2694277	5.0265257	.007874016
128	16384	2097152	11.3137085	5.0396842	.007812500
129	16641	2146689	11.3578167	5.0527743	.007751938
130	16900	2197000	11.4017543	5.0657970	.007692308
131	17161	2248091	11.4455231	5.0787531	.007633588
132	17424	2299968	11.4891253	5.0916434	.007575758
133	17689	2352637	11.5325626	5.1044687	.007518797
134	17956	2406104	11.5758369	5.1172299	.007462687
135	18225	2460375	11.6189500	5.1299278	.007407407
136	18496	2515456	11.6619038	5.1425632	.007352941
137	18769	2571353	11.7046999	5.1551367	.007299270
138	19044	2628072	11.7473401	5.1676493	.007246377
139	19321	2685619	11.7898261	5.1801015	.007194245
140	19600	2744000	11.8321596	5.1924941	.007142857
141	19881	2803221	11.8743421	5.2048279	.007092199
142	20164	2863288	11.9163753	5.2171034	.007042254
143	20449	2924207	11.9582607	5.2293215	.006993007
144	20736	2985984	12.0000000	5.2414828	.006944444
145	21025	3048625	12.0415946	5.2535879	.006896552
146	21316	3112136	12.0830460	5.2656374	.006849315
147	21609	3176523	12.1243557	5.2776321	.006802721
148	21904	3241792	12.1655251	5.2895725	.006756757
149	22201	3307949	12.2065556	5.3014592	.006711409
150	22500	3375000	12.2474487	5.3132928	.006666667
151	22801	3442951	12.2882057	5.3250740	.006622517
152	23104	3511808	12.3288280	5.3368033	.006578947
153	23409	3581577	12.3693169	5.3484812	.006535948
154	23716	3652264	12.4096736	5.3601084	.006493506
155	24025	3723875	12.4498996	5.3716854	.006451613
156	24336	3796416	12.4899960	5.3832126	.006410256
157	24649	3869893	12.5299641	5.3946907	.006369427
158	24964	3944312	12.5698051	5.4061202	.006329114
159	25281	4019679	12.6095202	5.4175015	.006289308
160	25600	4096000	12.6491106	5.4288352	.006250000
161	25921	4173281	12.6885775	5.4401218	.006211180
162	26244	4251528	12.7279221	5.4513618	.006172840
163	26569	4330747	12.7671453	5.4625556	.006134969
164	26896	4410944	12.8062485	5.4737037	.006097561
165	27225	4492125	12.8452326	5.4848066	.006060606
166	27556	4574296	12.8840987	5.4958647	.006024096
167	27889	4657463	12.9228480	5.5068784	.005988024
168	28224	4741632	12.9614814	5.5178484	.005952381
169	28561	4826809	13.0000000	5.5287748	.005917160
170	28900	4913000	13.0384048	5.5396583	.005882353
171	29241	5000211	13.0766968	5.5504991	.005847953
172	29584	5088448	13.1148770	5.5612978	.005813953
173	29929	5177717	13.1529464	5.5720546	.005780347
174	30276	5268024	13.1909060	5.5827702	.005747126
175	30625	5359375	13.2287566	5.5934447	.005714286
176	30976	5451776	13.2664992	5.6040787	.005681818
177	31329	5545233	13.3041347	5.6146724	.005649718
178	31684	5639752	13.3416641	5.6252263	.005617978
179	32041	5735339	13.3790882	5.6357408	.005586592

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
180	32400	5832000	13.4164079	5.6462162	.005555556
181	32761	5929741	13.4536240	5.6566528	.005524862
182	33124	6028568	13.4907376	5.6670511	.005494505
183	33489	6128487	13.5277493	5.6774114	.005464481
184	33856	6229504	13.5646600	5.6877340	.005434783
185	34225	6331625	13.6014705	5.6980192	.005405405
186	34596	6434856	13.6381817	5.7082675	.005376344
187	34969	6539203	13.6747943	5.7184791	.005347594
188	35344	6644672	13.7113092	5.7286543	.005319149
189	35721	6751269	13.7477271	5.7387936	.005291005
190	36100	6859000	13.7840488	5.7488971	.005263158
191	36481	6967871	13.8202750	5.7589652	.005235602
192	36864	7077888	13.8564065	5.7689982	.005208333
193	37249	7189057	13.8924440	5.7789966	.005181347
194	37636	7301384	13.9283883	5.7889604	.005154639
195	38025	7414875	13.9642400	5.7988900	.005128205
196	38416	7529536	14.0000000	5.8087857	.005102041
197	38809	7645373	14.0356688	5.8186479	.005076142
198	39204	7762392	14.0712473	5.8284767	.005050505
199	39601	7880599	14.1067360	5.8382725	.005025126
200	40000	8000000	14.1421356	5.8480355	.005000000
201	40401	8120601	14.1774469	5.8577660	.004975124
202	40804	8242408	14.2126704	5.8674643	.004950495
203	41209	8365427	14.2478068	5.8771307	.004926108
204	41616	8489664	14.2828569	5.8867653	.004901961
205	42025	8615125	14.3178211	5.8963685	.004878049
206	42436	8741816	14.3527001	5.9059406	.004854369
207	42849	8869743	14.3874946	5.9154817	.004830918
208	43264	8998912	14.4222051	5.9249921	.004807692
209	43681	9129329	14.4568323	5.9344721	.004784689
210	44100	9261000	14.4913767	5.9439220	.004761905
211	44521	9393931	14.5258390	5.9533418	.004739336
212	44944	9528128	14.5602198	5.9627320	.004716981
213	45369	9663597	14.5945195	5.9720926	.004694836
214	45796	9800344	14.6287388	5.9814240	.004672897
215	46225	9938375	14.6628783	5.9907264	.004651163
216	46656	10077696	14.6969385	6.0000000	.004629630
217	47089	10218313	14.7309199	6.0092450	.004608295
218	47524	10360232	14.7648231	6.0184617	.004587156
219	47961	10503459	14.7986486	6.0276502	.004566210
220	48400	10648000	14.8323970	6.0368107	.004545455
221	48841	10793861	14.8660687	6.0459435	.004524887
222	49284	10941048	14.8996644	6.0550489	.004504505
223	49729	11089567	14.9331845	6.0641270	.004484305
224	50176	11239424	14.9666295	6.0731779	.004464286
225	50625	11390625	15.0000000	6.0822020	.004444444
226	51076	11543176	15.0332964	6.0911994	.004424779
227	51529	11697083	15.0665192	6.1001702	.004405286
228	51984	11852352	15.0996689	6.1091147	.004385965
229	52441	12008989	15.1327460	6.1180332	.004366812
230	52900	12167000	15.1657509	6.1269257	.004347826
231	53361	12326391	15.1986842	6.1357924	.004329004
232	53824	12487168	15.2315462	6.1446337	.004310345
233	54289	12649337	15.2643375	6.1534495	.004291845
234	54756	12812904	15.2970585	6.1622401	.004273504
235	55225	12977875	15.3297097	6.1710058	.004255319
236	55696	13144256	15.3622915	6.1797466	.004237288
237	56169	13312053	15.3948043	6.1884628	.004219409
238	56644	13481272	15.4272486	6.1971544	.004201681
239	57121	13651919	15.4596248	6.2058218	.004184100

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
240	57600	13824000	15.4919334	6.2144650	.004166667
241	58081	13997521	15.5241747	6.2230843	.004149378
242	58564	14172488	15.5563492	6.2316797	.004132231
243	59049	14348907	15.5884573	6.2402515	.004115226
244	59536	14526784	15.6204994	6.2487998	.004098361
245	60025	14706125	15.6524758	6.2573248	.004081633
246	60516	14886936	15.6843871	6.2658266	.004065041
247	61009	15069223	15.7162336	6.2743054	.004048583
248	61504	15252992	15.7480157	6.2827613	.004032258
249	62001	15438249	15.7797338	6.2911946	.004016064
250	62500	15625000	15.8113883	6.2996053	.004000000
251	63001	15813251	15.8429795	6.3079935	.003984064
252	63504	16003008	15.8745079	6.3163596	.003968254
253	64009	16194277	15.9059737	6.3247035	.003952569
254	64516	16387064	15.9373775	6.3330256	.003937008
255	65025	16581375	15.9687194	6.3413257	.003921569
256	65536	16777216	16.0000000	6.3496042	.003906250
257	66049	16974593	16.0312195	6.3578611	.003891051
258	66564	17173512	16.0623784	6.3660968	.003875969
259	67081	17373979	16.0934769	6.3743111	.003861004
260	67600	17576000	16.1245155	6.3825043	.003846154
261	68121	17779581	16.1554944	6.3906765	.003831418
262	68644	17984728	16.1864141	6.3988279	.003816794
263	69169	18191447	16.2172747	6.4069585	.003802281
264	69696	18399744	16.2480768	6.4150687	.003787879
265	70225	18609625	16.2788206	6.4231583	.003773585
266	70756	18821096	16.3095064	6.4312276	.003759398
267	71289	19034163	16.3401346	6.4392767	.003745318
268	71824	19248832	16.3707055	6.4473057	.003731343
269	72361	19465109	16.4012195	6.4553148	.003717472
270	72900	19683000	16.4316767	6.4633041	.003703704
271	73441	19902511	16.4620776	6.4712736	.003690037
272	73984	20123648	16.4924225	6.4792236	.003676471
273	74529	20346417	16.5227116	6.4871541	.003663004
274	75076	20570824	16.5529454	6.4950653	.003649635
275	75625	20796875	16.5831240	6.5029572	.003636364
276	76176	21024576	16.6132477	6.5108300	.003623188
277	76729	21253933	16.6433170	6.5186839	.003610108
278	77284	21484952	16.6733320	6.5265189	.003597122
279	77841	21717639	16.7032931	6.5343351	.003584229
280	78400	21952000	16.7332005	6.5421326	.003571429
281	78961	22188041	16.7630546	6.5499116	.003558719
282	79524	22425768	16.7928556	6.5576722	.003546099
283	80089	22665187	16.8226038	6.5654144	.003533569
284	80656	22906304	16.8522995	6.5731385	.003521127
285	81225	23149125	16.8819430	6.5808443	.003508772
286	81796	23393656	16.9115345	6.5885323	.003496503
287	82369	23639903	16.9410743	6.5962023	.003484321
288	82944	23887872	16.9705627	6.6038545	.003472222
289	83521	24137569	17.0000000	6.6114890	.003460208
290	84100	24389000	17.0293864	6.6191060	.003448276
291	84681	24642171	17.0587221	6.6267054	.003436426
292	85264	24897088	17.0880075	6.6342874	.003424658
293	85849	25153757	17.1172428	6.6418522	.003412969
294	86436	25412184	17.1464282	6.6493998	.003401361
295	87025	25672375	17.1755640	6.6569302	.003389831
296	87616	25934336	17.2046505	6.6644437	.003378378
297	88209	26198073	17.2336879	6.6719403	.003367003
298	88804	26463592	17.2626765	6.6794200	.003355705
299	89401	26730899	17.2916165	6.6868831	.003344482

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
300	90000	27000000	17.3205081	6.6943295	.003333333
301	90601	27270901	17.3493516	6.7017593	.003322259
302	91204	27543608	17.3781472	6.7091729	.003311258
303	91809	27818127	17.4068952	6.7165700	.003300330
304	92416	28094464	17.4355958	6.7239508	.003289474
305	93025	28372625	17.4642492	6.7313155	.003278689
306	93636	28652616	17.4928557	6.7386641	.003267974
307	94249	28934443	17.5214155	6.7459967	.003257329
308	94864	29218112	17.5499288	6.7533134	.003246753
309	95481	29503629	17.5783958	6.7606143	.003236246
310	96100	29791000	17.6068169	6.7678995	.003225806
311	96721	30080231	17.6351921	6.7751690	.003215434
312	97344	30371328	17.6635217	6.7824229	.003205128
313	97969	30664297	17.6918060	6.7896613	.003194888
314	98596	30959144	17.7200451	6.7968844	.003184713
315	99225	31255875	17.7482393	6.8040921	.003174603
316	99856	31554496	17.7763888	6.8112847	.003164557
317	100489	31855013	17.8044938	6.8184620	.003154574
318	101124	32157432	17.8325545	6.8256242	.003144654
319	101761	32461759	17.8605711	6.8327714	.003134796
320	102400	32768000	17.8885438	6.8399037	.003125000
321	103041	33076161	17.9164729	6.8470213	.003115265
322	103684	33386248	17.9443584	6.8541240	.003105590
323	104329	33698267	17.9722008	6.8612120	.003095975
324	104976	34012224	18.0000000	6.8682855	.003086420
325	105625	34328125	18.0277564	6.8753443	.003076923
326	106276	34645976	18.0554701	6.8823888	.003067485
327	106929	34965783	18.0831413	6.8894188	.003058104
328	107584	35287552	18.1107703	6.8964345	.003048780
329	108241	35611289	18.1383571	6.9034359	.003039514
330	108900	35937000	18.1659021	6.9104232	.003030303
331	109561	36264691	18.1934054	6.9173964	.003021148
332	110224	36594368	18.2208672	6.9243556	.003012048
333	110889	36926037	18.2482876	6.9313008	.003003003
334	111556	37259704	18.2756669	6.9382321	.002994012
335	112225	37595375	18.3030052	6.9451496	.002985075
336	112896	37933056	18.3303028	6.9520533	.002976190
337	113569	38272753	18.3575598	6.9589434	.002967359
338	114244	38614472	18.3847763	6.9658198	.002958580
339	114921	38958219	18.4119526	6.9726826	.002949853
340	115600	39304000	18.4390889	6.9795321	.002941176
341	116281	39651821	18.4661853	6.9863681	.002932551
342	116964	40001688	18.4932420	6.9931906	.002923977
343	117649	40353607	18.5202592	7.0000000	.002915452
344	118336	40707584	18.5472370	7.0067962	.002906977
345	119025	41063625	18.5741756	7.0135791	.002898551
346	119716	41421736	18.6010752	7.0203490	.002890173
347	120409	41781923	18.6279360	7.0271058	.002881844
348	121104	42144192	18.6547581	7.0338497	.002873563
349	121801	42508549	18.6815417	7.0405806	.002865330
350	122500	42875000	18.7082869	7.0472987	.002857143
351	123201	43243551	18.7349940	7.0540041	.002849003
352	123904	43614208	18.7616630	7.0606967	.002840909
353	124609	43986977	18.7882942	7.0673767	.002832861
354	125316	44361864	18.8148877	7.0740440	.002824859
355	126025	44738875	18.8414437	7.0806988	.002816901
356	126736	45118016	18.8679623	7.0873411	.002808989
357	127449	45499293	18.8944436	7.0939709	.002801120
358	128164	45882712	18.9208879	7.1005885	.002793296
359	128881	46268279	18.9472953	7.1071937	.002785515

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
360	129600	46656000	18.9736660	7.1137866	.002777778
361	130321	47045881	19.0000000	7.1203674	.002770083
362	131044	47437928	19.0262976	7.1269360	.002762431
363	131769	47832147	19.0525589	7.1334925	.002754821
364	132496	48228544	19.0787840	7.1400370	.002747253
365	133225	48627125	19.1049732	7.1465695	.002739726
366	133956	49027896	19.1311265	7.1530901	.002732240
367	134689	49430863	19.1572441	7.1595988	.002724796
368	135424	49836032	19.1833261	7.1660957	.002717391
369	136161	50243409	19.2093727	7.1725809	.002710027
370	136900	50653000	19.2353841	7.1790544	.002702703
371	137641	51064811	19.2613603	7.1855162	.002695418
372	138384	51478848	19.2873015	7.1919663	.002688172
373	139129	51895117	19.3132079	7.1984050	.002680965
374	139876	52313624	19.3390796	7.2048322	.002673797
375	140625	52734375	19.3649167	7.2112479	.002666667
376	141376	53157376	19.3907194	7.2176522	.002659574
377	142129	53582633	19.4164878	7.2240450	.002652520
378	142884	54010152	19.4422221	7.2304268	.002645503
379	143641	54439939	19.4679223	7.2367972	.002638522
380	144400	54872000	19.4935887	7.2431565	.002631579
381	145161	55306341	19.5192213	7.2495045	.002624672
382	145924	55742968	19.5448203	7.2558415	.002617801
383	146689	56181887	19.5703858	7.2621675	.002610966
384	147456	56623104	19.5959179	7.2684824	.002604167
385	148225	57066625	19.6214169	7.2747864	.002597403
386	148996	57512456	19.6468827	7.2810794	.002590674
387	149769	57960603	19.6723156	7.2873617	.002583979
388	150544	58411072	19.6977156	7.2936330	.002577320
389	151321	58863869	19.7230829	7.2998936	.002570694
390	152100	59319000	19.7484177	7.3061436	.002564103
391	152881	59776471	19.7737199	7.3123828	.002557545
392	153664	60236288	19.7989899	7.3186114	.002551020
393	154449	60698457	19.8242276	7.3248295	.002544529
394	155236	61162984	19.8494332	7.3310369	.002538071
395	156025	61629875	19.8746069	7.3372339	.002531646
396	156816	62099136	19.8997487	7.3434205	.002525253
397	157609	62570773	19.9248588	7.3495966	.002518892
398	158404	63044792	19.9499373	7.3557624	.002512563
399	159201	63521199	19.9749844	7.3619178	.002506266
400	160000	64000000	20.0000000	7.3680630	.002500000
401	160801	64481201	20.0249844	7.3741979	.002493766
402	161604	64964808	20.0499377	7.3803227	.002487562
403	162409	65450827	20.0748599	7.3864373	.002481390
404	163216	65939264	20.0997512	7.3925418	.002475248
405	164025	66430125	20.1246118	7.3986363	.002469136
406	164836	66923416	20.1494417	7.4047206	.002463054
407	165649	67419143	20.1742410	7.4107950	.002457002
408	166464	67917312	20.1990099	7.4168595	.002450980
409	167281	68417929	20.2237484	7.4229142	.002444988
410	168100	68921000	20.2484567	7.4289589	.002439024
411	168921	69426531	20.2731349	7.4349938	.002433090
412	169744	69934528	20.2977831	7.4410189	.002427184
413	170569	70444997	20.3224014	7.4470342	.002421308
414	171396	70957944	20.3469899	7.4530399	.002415459
415	172225	71473375	20.3715488	7.4590359	.002409639
416	173056	71991296	20.3960781	7.4650223	.002403846
417	173889	72511713	20.4205779	7.4709991	.002398082
418	174724	73034632	20.4450483	7.4769664	.002392344
419	175561	73560059	20.4694895	7.4829242	.002386635

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
420	176400	74088000	20.4939015	7.4888724	.002380952
421	177241	74618461	20.5182845	7.4948113	.002375297
422	178084	75151448	20.5426386	7.5007406	.002369668
423	178929	75686967	20.5669638	7.5066607	.002364066
424	179776	76225024	20.5912603	7.5125715	.002358491
425	180625	76765625	20.6155281	7.5184730	.002352941
426	181476	77308776	20.6397674	7.5243652	.002347418
427	182329	77854483	20.6639783	7.5302482	.002341920
428	183184	78402752	20.6881609	7.5361221	.002336449
429	184041	78953589	20.7123152	7.5419867	.002331002
430	184900	79507000	20.7364414	7.5478423	.002325581
431	185761	80062991	20.7605395	7.5536888	.002320186
432	186624	80621568	20.7846097	7.5595263	.002314815
433	187489	81182737	20.8086520	7.5653548	.002309469
434	188356	81746504	20.8326667	7.5711743	.002304147
435	189225	82312875	20.8566536	7.5769849	.002298851
436	190096	82881856	20.8806130	7.5827865	.002293578
437	190969	83453453	20.9045450	7.5885793	.002288330
438	191844	84027672	20.9284495	7.5943633	.002283105
439	192721	84604519	20.9523268	7.6001385	.002277904
440	193600	85184000	20.9761770	7.6059049	.002272727
441	194481	85766121	21.0000000	7.6116626	.002267574
442	195364	86350888	21.0237960	7.6174116	.002262443
443	196249	86938307	21.0475652	7.6231519	.002257336
444	197136	87528384	21.0713075	7.6288837	.002252252
445	198025	88121125	21.0950231	7.6346067	.002247191
446	198916	88716536	21.1187121	7.6403213	.002242152
447	199809	89314623	21.1423745	7.6460272	.002237136
448	200704	89915392	21.1660105	7.6517247	.002232143
449	201601	90518849	21.1896201	7.6574138	.002227171
450	202500	91125000	21.2132034	7.6630943	.002222222
451	203401	91733851	21.2367606	7.6687665	.002217295
452	204304	92345408	21.2602916	7.6744303	.002212389
453	205209	92959677	21.2837967	7.6800857	.002207506
454	206116	93576664	21.3072758	7.6857328	.002202643
455	207025	94196375	21.3307290	7.6913717	.002197802
456	207936	94818816	21.3541565	7.6970023	.002192982
457	208849	95443993	21.3775583	7.7026246	.002188184
458	209764	96071912	21.4009346	7.7082388	.002183406
459	210681	96702579	21.4242853	7.7138448	.002178649
460	211600	97336000	21.4476106	7.7194426	.002173913
461	212521	97972181	21.4709106	7.7250325	.002169197
462	213444	98611128	21.4941853	7.7306141	.002164502
463	214369	99252847	21.5174348	7.7361877	.002159827
464	215296	99897344	21.5406592	7.7417532	.002155172
465	216225	100544625	21.5638587	7.7473109	.002150538
466	217156	101194696	21.5870331	7.7528606	.002145923
467	218089	101847563	21.6101828	7.7584023	.002141328
468	219024	102503232	21.6333077	7.7639361	.002136752
469	219961	103161709	21.6564078	7.7694620	.002132196
470	220900	103823000	21.6794834	7.7749801	.002127660
471	221841	104487111	21.7025344	7.7804904	.002123142
472	222784	105154048	21.7255610	7.7859928	.002118644
473	223729	105823817	21.7485632	7.7914875	.002114165
474	224676	106496424	21.7715411	7.7969745	.002109705
475	225625	107171875	21.7944947	7.8024538	.002105263
476	226576	107850176	21.8174242	7.8079254	.002100840
477	227529	108531333	21.8403297	7.8133892	.002096436
478	228484	109215352	21.8632111	7.8188456	.002092050
479	229441	109902239	21.8860686	7.8242942	.002087683

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
480	230400	110592000	21.9089023	7.8297353	.002083333
481	231361	111284641	21.9317122	7.8351688	.002079002
482	232324	111980168	21.9544984	7.8405949	.002074689
483	233289	112678587	21.9772610	7.8460134	.002070393
484	234256	113379904	22.0000000	7.8514244	.002066116
485	235225	114084125	22.0227155	7.8568281	.002061856
486	236196	114791256	22.0454077	7.8622242	.002057613
487	237169	115501303	22.0680765	7.8676130	.002053388
488	238144	116214272	22.0907220	7.8729944	.002049180
489	239121	116930169	22.1133444	7.8783684	.002044990
490	240100	117649000	22.1359436	7.8837352	.002040816
491	241081	118370771	22.1585198	7.8890946	.002036660
492	242064	119095488	22.1810730	7.8944468	.002032520
493	243049	119823157	22.2036033	7.8997917	.002028398
494	244036	120553784	22.2261108	7.9051294	.002024291
495	245025	121287375	22.2485955	7.9104599	.002020202
496	246016	122023936	22.2710575	7.9157832	.002016129
497	247009	122763473	22.2934968	7.9210994	.002012072
498	248004	123505992	22.3159136	7.9264085	.002008032
499	249001	124251499	22.3383079	7.9317104	.002004008
500	250000	125000000	22.3606798	7.9370053	.002000000
501	251001	125751501	22.3830293	7.9422931	.001996008
502	252004	126506008	22.4053565	7.9475739	.001992032
503	253009	127263527	22.4276615	7.9528477	.001988072
504	254016	128024064	22.4499443	7.9581144	.001984127
505	255025	128787625	22.4722051	7.9633743	.001980198
506	256036	129554216	22.4944438	7.9686271	.001976285
507	257049	130323843	22.5166605	7.9738731	.001972387
508	258064	131096512	22.5388553	7.9791122	.001968504
509	259081	131872229	22.5610283	7.9843444	.001964637
510	260100	132651000	22.5831796	7.9895697	.001960784
511	261121	133432831	22.6053091	7.9947883	.001956947
512	262144	134217728	22.6274170	8.0000000	.001953125
513	263169	135005697	22.6495033	8.0052049	.001949318
514	264196	135796744	22.6715681	8.0104032	.001945525
515	265225	136590875	22.6936114	8.0155946	.001941748
516	266256	137388096	22.7156334	8.0207794	.001937984
517	267289	138188413	22.7376340	8.0259574	.001934236
518	268324	138991832	22.7596134	8.0311287	.001930502
519	269361	139798359	22.7815715	8.0362935	.001926782
520	270400	140608000	22.8035085	8.0414515	.001923077
521	271441	141420761	22.8254244	8.0466030	.001919386
522	272484	142236648	22.8473193	8.0517479	.001915709
523	273529	143055667	22.8691933	8.0568862	.001912046
524	274576	143877824	22.8910463	8.0620180	.001908397
525	275625	144703125	22.9128785	8.0671432	.001904762
526	276676	145531576	22.9346899	8.0722620	.001901141
527	277729	146363183	22.9564806	8.0773743	.001897533
528	278784	147197952	22.9782506	8.0824800	.001893939
529	279841	148035889	23.0000000	8.0875794	.001890359
530	280900	148877000	23.0217289	8.0926723	.001886792
531	281961	149721291	23.0434372	8.0977589	.001883239
532	283024	150568768	23.0651252	8.1028390	.001879699
533	284089	151419437	23.0867928	8.1079128	.001876173
534	285156	152273304	23.1084400	8.1129803	.001872659
535	286225	153130375	23.1300670	8.1180414	.001869159
536	287296	153990656	23.1516738	8.1230962	.001865672
537	288369	154854153	23.1732605	8.1281447	.001862197
538	289444	155720872	23.1948270	8.1331870	.001858736
539	290521	156590819	23.2163735	8.1382230	.001855288

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
540	291600	157464000	23.2379001	8.1432529	.001851852
541	292681	158340421	23.2594067	8.1482765	.001848429
542	293764	159220088	23.2808935	8.1532939	.001845018
543	294849	160103007	23.3023604	8.1583051	.001841621
544	295936	160989184	23.3238076	8.1633102	.001838235
545	297025	161878625	23.3452351	8.1683092	.001834862
546	298116	162771336	23.3666429	8.1733020	.001831502
547	299209	163667323	23.3880311	8.1782888	.001828154
548	300304	164566592	23.4093998	8.1832695	.001824818
549	301401	165469149	23.4307490	8.1882441	.001821494
550	302500	166375000	23.4520788	8.1932127	.001818182
551	303601	167284151	23.4733892	8.1981753	.001814882
552	304704	168196608	23.4946802	8.2031319	.001811594
553	305809	169112377	23.5159520	8.2080825	.001808318
554	306916	170031464	23.5372046	8.2130271	.001805054
555	308025	170953875	23.5584380	8.2179657	.001801802
556	309136	171879616	23.5796522	8.2228985	.001798561
557	310249	172808693	23.6008474	8.2278254	.001795332
558	311364	173741112	23.6220236	8.2327463	.001792115
559	312481	174676879	23.6431808	8.2376614	.001788909
560	313600	175616000	23.6643191	8.2425706	.001785714
561	314721	176558481	23.6854386	8.2474740	.001782531
562	315844	177504328	23.7065392	8.2523715	.001779359
563	316969	178453547	23.7276210	8.2572633	.001776199
564	318096	179406144	23.7486842	8.2621492	.001773050
565	319225	180362125	23.7697286	8.2670294	.001769912
566	320356	181321496	23.7907545	8.2719039	.001766784
567	321489	182284263	23.8117618	8.2767726	.001763668
568	322624	183250432	23.8327506	8.2816355	.001760563
569	323761	184220009	23.8537209	8.2864928	.001757469
570	324900	185193000	23.8746728	8.2913444	.001754386
571	326041	186169411	23.8956063	8.2961903	.001751313
572	327184	187149248	23.9165215	8.3010304	.001748252
573	328329	188132517	23.9374184	8.3058651	.001745201
574	329476	189119224	23.9582971	8.3106941	.001742160
575	330625	190109375	23.9791576	8.3155175	.001739130
576	331776	191102976	24.0000000	8.3203353	.001736111
577	332929	192100033	24.0208243	8.3251475	.001733102
578	334084	193100552	24.0416306	8.3299542	.001730104
579	335241	194104539	24.0624188	8.3347553	.001727116
580	336400	195112000	24.0831891	8.3395509	.001724138
581	337561	196122941	24.1039416	8.3443410	.001721170
582	338724	197137368	24.1246762	8.3491256	.001718213
583	339889	198155287	24.1453929	8.3539047	.001715266
584	341056	199176704	24.1660919	8.3586784	.001712329
585	342225	200201625	24.1867732	8.3634466	.001709402
586	343396	201230056	24.2074369	8.3682095	.001706485
587	344569	202262003	24.2280829	8.3729668	.001703578
588	345744	203297472	24.2487113	8.3777188	.001700680
589	346921	204336469	24.2693222	8.3824653	.001697793
590	348100	205379000	24.2899156	8.3872065	.001694915
591	349281	206425071	24.3104916	8.3919423	.001692047
592	350464	207474688	24.3310501	8.3966729	.001689189
593	351649	208527857	24.3515913	8.4013981	.001686341
594	352836	209584584	24.3721152	8.4061180	.001683502
595	354025	210644875	24.3926218	8.4108326	.001680672
596	355216	211708736	24.4131112	8.4155419	.001677852
597	356409	212776173	24.4335834	8.4202460	.001675042
598	357604	213847192	24.4540385	8.4249448	.001672241
599	358801	214921799	24.4744765	8.4296383	.001669449

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
600	360000	216000000	24.4948974	8.4343267	.001666667
601	361201	217081801	24.5153013	8.4390098	.001663894
602	362404	218167208	24.5356883	8.4436877	.001661130
603	363609	219256227	24.5560583	8.4483605	.001658375
604	364816	220348864	24.5764115	8.4530281	.001655629
605	366025	221445125	24.5967478	8.4576906	.001652893
606	367236	222545016	24.6170673	8.4623479	.001650165
607	368449	223648543	24.6373700	8.4670001	.001647446
608	369664	224755712	24.6576560	8.4716471	.001644737
609	370881	225866529	24.6779254	8.4762892	.001642036
610	372100	226981000	24.6981781	8.4809261	.001639344
611	373321	228099131	24.7184142	8.4855579	.001636661
612	374544	229220928	24.7386338	8.4901848	.001633987
613	375769	230346397	24.7588368	8.4948065	.001631321
614	376996	231475544	24.7790234	8.4994233	.001628664
615	378225	232608375	24.7991935	8.5040350	.001626016
616	379456	233744896	24.8193473	8.5086417	.001623377
617	380689	234885113	24.8394847	8.5132435	.001620746
618	381924	236029032	24.8596058	8.5178403	.001618123
619	383161	237176659	24.8797106	8.5224321	.001615509
620	384400	238328000	24.8997992	8.5270189	.001612903
621	385641	239483061	24.9198716	8.5316009	.001610306
622	386884	240641848	24.9399278	8.5361780	.001607717
623	388129	241804367	24.9599679	8.5407501	.001605136
624	389376	242970624	24.9799920	8.5453173	.001602564
625	390625	244140625	25.0000000	8.5498797	.001600000
626	391876	245314376	25.0199920	8.5544372	.001597444
627	393129	246491883	25.0399681	8.5589899	.001594896
628	394384	247673152	25.0599282	8.5635377	.001592357
629	395641	248858189	25.0798724	8.5680807	.001589825
630	396900	250047000	25.0998008	8.5726189	.001587302
631	398161	251239591	25.1197134	8.5771523	.001584786
632	399424	252435968	25.1396102	8.5816809	.001582278
633	400689	253636137	25.1594913	8.5862047	.001579779
634	401956	254840104	25.1793566	8.5907238	.001577287
635	403225	256047875	25.1992063	8.5952380	.001574803
636	404496	257259456	25.2190404	8.5997476	.001572327
637	405769	258474853	25.2388589	8.6042525	.001569859
638	407044	259694072	25.2586619	8.6087526	.001567398
639	408321	260917119	25.2784493	8.6132480	.001564945
640	409600	262144000	25.2982213	8.6177388	.001562500
641	410881	263374721	25.3179778	8.6222248	.001560062
642	412164	264609288	25.3377189	8.6267063	.001557632
643	413449	265847707	25.3574447	8.6311830	.001555210
644	414736	267089984	25.3771551	8.6356551	.001552795
645	416025	268336125	25.3968502	8.6401226	.001550388
646	417316	269586136	25.4165301	8.6445855	.001547988
647	418609	270840023	25.4361947	8.6490437	.001545595
648	419904	272097792	25.4558441	8.6534974	.001543210
649	421201	273359449	25.4754784	8.6579465	.001540832
650	422500	274625000	25.4950976	8.6623911	.001538462
651	423801	275894451	25.5147016	8.6668310	.001536098
652	425104	277167808	25.5342907	8.6712665	.001533742
653	426409	278445077	25.5538647	8.6756974	.001531394
654	427716	279726264	25.5734237	8.6801237	.001529052
655	429025	281011375	25.5929678	8.6845456	.001526718
656	430336	282300416	25.6124969	8.6889630	.001524390
657	431649	283593393	25.6320112	8.6933759	.001522070
658	432964	284890312	25.6515107	8.6977843	.001519757
659	434281	286191179	25.6709953	8.7021882	.001517451

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
660	435600	287496000	25.6904652	8.7065877	.001515152
661	436921	288804781	25.7099203	8.7109827	.001512859
662	438244	290117528	25.7293607	8.7153734	.001510574
663	439569	291434247	25.7487864	8.7197590	.001508296
664	440896	292754944	25.7681975	8.7241414	.001506024
665	442225	294079625	25.7875939	8.7285187	.001503759
666	443556	295408296	25.8069758	8.7328918	.001501502
667	444889	296740963	25.8263431	8.7372604	.001499250
668	446224	298077632	25.8456960	8.7416246	.001497006
669	447561	299418309	25.8650343	8.7459846	.001494768
670	448900	300763000	25.8843582	8.7503401	.001492537
671	450241	302111711	25.9036677	8.7546913	.001490313
672	451584	303464448	25.9229628	8.7590383	.001488095
673	452929	304821217	25.9422435	8.7633809	.001485884
674	454276	306182024	25.9615100	8.7677192	.001483680
675	455625	307546875	25.9807621	8.7720532	.001481481
676	456976	308915776	26.0000000	8.7763830	.001479290
677	458329	310288733	26.0192237	8.7807084	.001477105
678	459684	311665752	26.0384331	8.7850296	.001474926
679	461041	313046839	26.0576284	8.7893466	.001472754
680	462400	314432000	26.0768096	8.7936593	.001470588
681	463761	315821241	26.0959767	8.7979679	.001468429
682	465124	317214568	26.1151297	8.8022721	.001466276
683	466489	318611987	26.1342687	8.8065722	.001464129
684	467856	320013504	26.1533937	8.8108681	.001461988
685	469225	321419125	26.1725047	8.8151598	.001459854
686	470596	322828856	26.1916017	8.8194474	.001457726
687	471969	324242703	26.2106848	8.8237307	.001455604
688	473344	325660672	26.2297541	8.8280099	.001453488
689	474721	327082769	26.2488095	8.8322850	.001451379
690	476100	328509000	26.2678511	8.8365559	.001449275
691	477481	329939371	26.2868789	8.8408227	.001447178
692	478864	331373888	26.3058929	8.8450854	.001445087
693	480249	332812557	26.3248932	8.8493440	.001443001
694	481636	334255384	26.3438797	8.8535985	.001440922
695	483025	335702375	26.3628527	8.8578489	.001438849
696	484416	337153536	26.3818119	8.8620952	.001436782
697	485809	338608873	26.4007576	8.8663375	.001434720
698	487204	340068392	26.4196896	8.8705757	.001432665
699	488601	341532099	26.4386081	8.8748099	.001430615
700	490000	343000000	26.4575131	8.8790400	.001428571
701	491401	344472101	26.4764046	8.8832661	.001426534
702	492804	345948408	26.4952826	8.8874882	.001424501
703	494209	347428927	26.5141472	8.8917063	.001422475
704	495616	348913664	26.5329983	8.8959204	.001420455
705	497025	350402625	26.5518361	8.9001304	.001418440
706	498436	351895816	26.5706605	8.9043366	.001416431
707	499849	353393243	26.5894716	8.9085387	.001414427
708	501264	354894912	26.6082694	8.9127369	.001412429
709	502681	356400829	26.6270539	8.9169311	.001410437
710	504100	357911000	26.6458252	8.9211214	.001408451
711	505521	359425431	26.6645833	8.9253078	.001406470
712	506944	360944128	26.6833281	8.9294902	.001404494
713	508369	362467097	26.7020598	8.9336687	.001402525
714	509796	363994344	26.7207784	8.9378433	.001400560
715	511225	365525875	26.7394839	8.9420140	.001398601
716	512656	367061696	26.7581763	8.9461809	.001396648
717	514089	368601813	26.7768557	8.9503438	.001394700
718	515524	370146232	26.7955220	8.9545029	.001392758
719	516961	371694959	26.8141754	8.9586581	.001390821

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
720	518400	373248000	26.8328157	8.9628095	.001388889
721	519841	374805361	26.8514432	8.9669570	.001386963
722	521284	376367048	26.8700577	8.9711007	.001385042
723	522729	377933067	26.8886593	8.9752406	.001383126
724	524176	379503424	26.9072481	8.9793766	.001381215
725	525625	381078125	26.9258240	8.9835089	.001379310
726	527076	382657176	26.9443872	8.9876373	.001377410
727	528529	384240583	26.9629375	8.9917620	.001375516
728	529984	385828352	26.9814751	8.9958829	.001373626
729	531441	387420489	27.0000000	9.0000000	.001371742
730	532900	389017000	27.0185122	9.0041134	.001369863
731	534361	390617891	27.0370117	9.0082229	.001367989
732	535824	392223168	27.0554985	9.0123288	.001366120
733	537289	393832837	27.0739727	9.0164309	.001364256
734	538756	395446904	27.0924344	9.0205293	.001362398
735	540225	397065375	27.1108834	9.0246239	.001360544
736	541696	398688256	27.1293199	9.0287149	.001358696
737	543169	400315553	27.1477439	9.0328021	.001356852
738	544644	401947272	27.1661554	9.0368857	.001355014
739	546121	403583419	27.1845544	9.0409655	.001353180
740	547600	405224000	27.2029410	9.0450417	.001351351
741	549081	406869021	27.2213152	9.0491142	.001349528
742	550564	408518488	27.2396769	9.0531831	.001347709
743	552049	410172407	27.2580263	9.0572482	.001345895
744	553536	411830784	27.2763634	9.0613098	.001344086
745	555025	413493625	27.2946881	9.0653677	.001342282
746	556516	415160936	27.3130006	9.0694220	.001340483
747	558009	416832723	27.3313007	9.0734726	.001338688
748	559504	418508992	27.3495887	9.0775197	.001336898
749	561001	420189749	27.3678644	9.0815631	.001335113
750	562500	421875000	27.3861279	9.0856030	.001333333
751	564001	423564751	27.4043792	9.0896392	.001331558
752	565504	425259008	27.4226184	9.0936719	.001329787
753	567009	426957777	27.4408455	9.0977010	.001328021
754	568516	428661064	27.4590604	9.1017265	.001326260
755	570025	430368875	27.4772633	9.1057485	.001324503
756	571536	432081216	27.4954542	9.1097669	.001322751
757	573049	433798093	27.5136330	9.1137818	.001321004
758	574564	435519512	27.5317998	9.1177931	.001319261
759	576081	437245479	27.5499546	9.1218010	.001317523
760	577600	438976000	27.5680975	9.1258053	.001315789
761	579121	440711081	27.5862284	9.1298061	.001314060
762	580644	442450728	27.6043475	9.1338034	.001312336
763	582169	444194947	27.6224546	9.1377971	.001310616
764	583696	445943744	27.6405499	9.1417874	.001308901
765	585225	447697125	27.6586334	9.1457742	.001307100
766	586756	449455096	27.6767050	9.1497576	.001305483
767	588289	451217663	27.6947648	9.1537375	.001303781
768	589824	452984832	27.7128129	9.1577139	.001302083
769	591361	454756609	27.7308492	9.1616869	.001300390
770	592900	456533000	27.7488739	9.1656565	.001298701
771	594441	458314011	27.7668868	9.1696225	.001297017
772	595984	460099648	27.7848880	9.1735852	.001295337
773	597529	461889917	27.8028775	9.1775445	.001293661
774	599076	463684824	27.8208555	9 1815003	.001291990
775	600625	465484375	27.8388218	9.1854527	.001290323
776	602176	467288576	27.8567766	9.1894018	.001288660
777	603729	469097433	27.8747197	9.1933474	.001287001
778	605284	470910952	27.8926514	9.1972897	.001285347
779	606841	472729139	27.9105715	9.2012286	.001283697

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
780	608400	474552000	27.9284801	9.2051641	.001282051
781	609961	476379541	27.9463772	9.2090962	.001280410
782	611524	478211768	27.9642629	9.2130250	.001278772
783	613089	480048687	27.9821372	9.2169505	.001277139
784	614656	481890304	28.0000000	9.2208726	.001275510
785	616225	483736625	28.0178515	9.2247914	.001273885
786	617796	485587656	28.0356915	9.2287068	.001272265
787	619369	487443403	28.0535203	9.2326189	.001270648
788	620944	489303872	28.0713377	9.2365277	.001269036
789	622521	491169069	28.0891438	9.2404333	.001267427
790	624100	493039000	28.1069386	9.2443355	.001265823
791	625681	494913671	28.1247222	9.2482344	.001264223
792	627264	496793088	28.1424946	9.2521300	.001262626
793	628849	498677257	28.1602557	9.2560224	.001261034
794	630436	500566184	28.1780056	9.2599114	.001259446
795	632025	502459875	28.1957444	9.2637973	.001257862
796	633616	504358336	28.2134720	9.2676798	.001256281
797	635209	506261573	28.2311884	9.2715592	.001254705
798	636804	508169592	28.2488938	9.2754352	.001253133
799	638401	510082399	28.2665881	9.2793081	.001251564
800	640000	512000000	28.2842712	9.2831777	.001250000
801	641601	513922401	28.3019434	9.2870440	.001248439
802	643204	515849608	28.3196045	9.2909072	.001246883
803	644809	517781627	28.3372546	9.2947671	.001245330
804	646416	519718464	28.3548938	9.2986239	.001243781
805	648025	521660125	28.3725219	9.3024775	.001242236
806	649636	523606616	28.3901391	9.3063278	.001240695
807	651249	525557943	28.4077454	9.3101750	.001239157
808	652864	527514112	28.4253408	9.3140190	.001237624
809	654481	529475129	28.4429253	9.3178599	.001236094
810	656100	531441000	28.4604989	9.3216975	.001234568
811	657721	533411731	28.4780617	9.3255320	.001233046
812	659344	535387328	28.4956137	9.3293634	.001231527
813	660969	537367797	28.5131549	9.3331916	.001230012
814	662596	539353144	28.5306852	9.3370167	.001228501
815	664225	541343375	28.5482048	9.3408386	.001226994
816	665856	543338496	28.5657137	9.3446575	.001225490
817	667489	545338513	28.5832119	9.3484731	.001223990
818	669124	547343432	28.6006993	9.3522857	.001222494
819	670761	549353259	28.6181760	9.3560952	.001221001
820	672400	551368000	28.6356421	9.3599016	.001219512
821	674041	553387661	28.6530976	9.3637049	.001218027
822	675684	555412248	28.6705424	9.3675051	.001216545
823	677329	557441767	28.6879766	9.3713022	.001215067
824	678976	559476224	28.7054002	9.3750963	.001213592
825	680625	561515625	28.7228132	9.3788873	.001212121
826	682276	563559976	28.7402157	9.3826752	.001210654
827	683929	565609283	28.7576077	9.3864600	.001209190
828	685584	567663552	28.7749891	9.3902419	.001207729
829	687241	569722789	28.7923601	9.3940206	.001206273
830	688900	571787000	28.8097206	9.3977964	.001204819
831	690561	573856191	28.8270706	9.4015691	.001203369
832	692224	575930368	28.8444102	9.4053387	.001201923
833	693889	578009537	28.8617394	9.4091054	.001200480
834	695556	580093704	28.8790582	9.4128690	.001199041
835	697225	582182875	28.8963666	9.4166297	.001197605
836	698896	584277056	28.9136646	9.4203873	.001196172
837	700569	586376253	28.9309523	9.4241420	.001194743
838	702244	588480472	28.9482297	9.4278936	.001193317
839	703921	590589719	28.9654967	9.4316423	.001191895

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
840	705600	592704000	28.9827535	9.4353880	.001190476
841	707281	594823321	29.0000000	9.4391307	.001189061
842	708964	596947688	29.0172363	9.4428704	.001187648
843	710649	599077107	29.0344623	9.4466072	.001186240
844	712336	601211584	29.0516781	9.4503410	.001184834
845	714025	603351125	29.0688837	9.4540719	.001183432
846	715716	605495736	29.0860791	9.4577999	.001182033
847	717409	607645423	29.1032644	9.4615249	.001180638
848	719104	609800192	29.1204396	9.4652470	.001179245
849	720801	611960049	29.1376046	9.4689661	.001177856
850	722500	614125000	29.1547595	9.4726824	.001176471
851	724201	616295051	29.1719043	9.4763957	.001175088
852	725904	618470208	29.1890390	9.4801061	.001173709
853	727609	620650477	29.2061637	9.4838136	.001172333
854	729316	622835864	29.2232784	9.4875182	.001170960
855	731025	625026375	29.2403830	9.4912200	.001169591
856	732736	627222016	29.2574777	9.4949188	.001168224
857	734449	629422793	29.2745623	9.4986147	.001166861
858	736164	631628712	29.2916370	9.5023078	.001165501
859	737881	633839779	29.3087018	9.5059980	.001164144
860	739600	636056000	29.3257566	9.5096854	.001162791
861	741321	638277381	29.3428015	9.5133699	.001161440
862	743044	640503928	29.3598365	9.5170515	.001160093
863	744769	642735647	29.3768616	9.5207303	.001158749
864	746496	644972544	29.3938769	9.5244063	.001157407
865	748225	647214625	29.4108823	9.5280794	.001156069
866	749956	649461896	29.4278779	9.5317497	.001154734
867	751689	651714363	29.4448637	9.5354172	.001153403
868	753424	653972032	29.4618397	9.5390818	.001152074
869	755161	656234909	29.4788059	9.5427437	.001150748
870	756900	658503000	29.4957624	9.5464027	.001149425
871	758641	660776311	29.5127091	9.5500589	.001148106
872	760384	663054848	29.5296461	9.5537123	.001146789
873	762129	665338617	29.5465734	9.5573630	.001145475
874	763876	667627624	29.5634910	9.5610108	.001144165
875	765625	669921875	29.5803989	9.5646559	.001142857
876	767376	672221376	29.5972972	9.5682982	.001141553
877	769129	674526133	29.6141858	9.5719377	.001140251
878	770884	676836152	29.6310648	9.5755745	.001138952
879	772641	679151439	29.6479342	9.5792085	.001137656
880	774400	681472000	29.6647939	9.5828397	.001136364
881	776161	683797841	29.6816442	9.5864682	.001135074
882	777924	686128968	29.6984848	9.5900939	.001133787
883	779689	688465387	29.7153159	9.5937169	.001132503
884	781456	690807104	29.7321375	9.5973373	.001131222
885	783225	693154125	29.7489496	9.6009548	.001129944
886	784996	695506456	29.7657521	9.6045696	.001128668
887	786769	697864103	29.7825452	9.6081817	.001127396
888	788544	700227072	29.7993289	9.6117911	.001126126
889	790321	702595369	29.8161030	9.6153977	.001124859
890	792100	704969000	29.8328678	9.6190017	.001123596
891	793881	707347971	29.8496231	9.6226030	.001122334
892	795664	709732288	29.8663690	9.6262016	.001121076
893	797449	712121957	29.8831056	9.6297975	.001119821
894	799236	714516984	29.8998328	9.6333907	.001118568
895	801025	716917375	29.9165506	9.6369812	.001117318
896	802816	719323136	29.9332591	9.6405690	.001116071
897	804609	721734273	29.9499583	9.6441542	.001114827
898	806404	724150792	29.9666481	9.6477367	.001113586
899	808201	726572699	29.9833287	9.6513166	.001112347

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
900	810000	729000000	30.0000000	9.6548938	.001111111
901	811801	731432701	30.0166620	9.6584684	.001109878
902	813604	733870808	30.0333148	9.6620403	.001108647
903	815409	736314327	30.0499584	9.6656096	.001107420
904	817216	738763264	30.0665928	9.6691762	.001106195
905	819025	741217625	30.0832179	9.6727403	.001104972
906	820836	743677416	30.0998339	9.6763017	.001103753
907	822649	746142643	30.1164407	9.6798604	.001102536
908	824464	748613312	30.1330383	9.6834166	.001101322
909	826281	751089429	30.1496269	9.6869701	.001100110
910	828100	753571000	30.1662063	9.6905211	.001098901
911	829921	756058031	30.1827765	9.6940694	.001097695
912	831744	758550528	30.1993377	9.6976151	.001096491
913	833569	761048497	30.2158899	9.7011583	.001095290
914	835396	763551944	30.2324329	9.7046989	.001094092
915	837225	766060875	30.2489669	9.7082369	.001092896
916	839056	768575296	30.2654919	9.7117723	.001091703
917	840889	771095213	30.2820079	9.7153051	.001090513
918	842724	773620632	30.2985148	9.7188354	.001089325
919	844561	776151559	30.3150128	9.7223631	.001088139
920	846400	778688000	30.3315018	9.7258883	.001086957
921	848241	781229961	30.3479818	9.7294109	.001085776
922	850084	783777448	30.3644529	9.7329309	.001084599
923	851929	786330467	30.3809151	9.7364484	.001083424
924	853776	788889024	30.3973683	9.7399634	.001082251
925	855625	791453125	30.4138127	9.7434758	.001081081
926	857476	794022776	30.4302481	9.7469857	.001079914
927	859329	796597983	30.4466747	9.7504930	.001078749
928	861184	799178752	30.4630924	9.7539979	.001077586
929	863041	801765089	30.4795013	9.7575002	.001076426
930	864900	804357000	30.4959014	9.7610001	.001075269
931	866761	806954491	30.5122926	9.7644974	.001074114
932	868624	809557568	30.5286750	9.7679922	.001072961
933	870489	812166237	30.5450487	9.7714845	.001071811
934	872356	814780504	30.5614136	9.7749743	.001070664
935	874225	817400375	30.5777697	9.7784616	.001069519
936	876096	820025856	30.5941171	9.7819466	.001068376
937	877969	822656953	30.6104557	9.7854288	.001067236
938	879844	825293672	30.6267857	9.7889087	.001066098
939	881721	827936019	30 6431069	9.7923861	.001064963
940	883600	830584000	30.6594194	9.7958611	.001063830
941	885481	833237621	30.6757233	9.7993336	.001062699
942	887364	835896888	30.6920185	9.8028036	.001061571
943	889249	838561807	30.7083051	9.8062711	.001060445
944	891136	841232384	30.7245830	9.8097362	.001059322
945	893025	843908625	30.7408523	9.8131989	.001058201
946	894916	846590536	30.7571130	9.8166591	.001057082
947	896809	849278123	30.7733651	9.8201169	.001055966
948	898704	851971392	30.7896086	9.8235723	.001054852
949	900601	854670349	30.8058436	9.8270252	.001053741
950	902500	857375000	30.8220700	9 8304757	.001052632
951	904401	860085351	30.8382879	9.8339238	.001051525
952	906304	862801408	30.8544972	9.8373695	.001050420
953	908209	865523177	30.8706981	9.8408127	.001049318
954	910116	868250664	30.8868904	9.8442536	.001048218
955	912025	870983875	30.9030743	9.8476920	.001047120
956	913936	873722816	30.9192497	9.8511280	.001046025
957	915849	876467493	30.9354166	9.8545617	.001044932
958	917764	879217912	30.9515751	9.8579929	.001043841
959	919681	881974079	30.9677251	9.8614218	.001042753

SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, AND RECIPROCALS.

No.	Squares.	Cubes.	Square Roots.	Cube Roots.	Reciprocals.
960	921600	884736000	30.9838668	9.8648483	.001041667
961	923521	887503681	31.0000000	9.8682724	.001040583
962	925444	890277128	31.0161248	9.8716941	.001039501
963	927369	893056347	31.0322413	9.8751135	.001038422
964	929296	895841344	31.0483494	9.8785305	.001037344
965	931225	898632125	31.0644491	9.8819451	.001036269
966	933156	901428696	31.0805405	9.8853574	.001035197
967	935089	904231063	31.0966236	9.8887673	.001034126
968	937024	907039232	31.1126984	9.8921749	.001033058
969	938961	909853209	31.1287648	9.8955801	.001031992
970	940900	912673000	31.1448230	9.8989830	.001030928
971	942841	915498611	31.1608729	9.9023835	.001029866
972	944784	918330048	31.1769145	9.9057817	.001028807
973	946729	921167317	31.1929479	9.9091776	.001027749
974	948676	924010424	31.2089731	9.9125712	.001026694
975	950625	926859375	31.2249900	9.9159624	.001025641
976	952576	929714176	31.2409987	9.9193513	.001024590
977	954529	932574833	31.2569992	9.9227379	.001023541
978	956484	935441352	31.2729915	9.9261222	.001022495
979	958441	938313739	31.2889757	9.9295042	.001021450
980	960400	941192000	31.3049517	9.9328839	.001020408
981	962361	944076141	31.3209195	9.9362613	.001019368
982	964324	946966168	31.3368792	9.9396363	.001018330
983	966289	949862087	31.3528308	9.9430092	.001017294
984	968256	952763904	31.3687743	9.9463797	.001016260
985	970225	955671625	31.3847097	9.9497479	.001015228
986	972196	958585256	31.4006369	9.9531138	.001014199
987	974169	961504803	31.4165561	9.9564775	.001013171
988	976144	964430272	31.4324673	9.9598389	.001012146
989	978121	967361669	31.4483704	9.9631981	.001011122
990	980100	970299000	31.4642654	9.9665549	.001010101
991	982081	973242271	31.4801525	9.9699095	.001009082
992	984064	976191488	31.4960315	9.9732619	.001008065
993	986049	979146657	31.5119025	9.9766120	.001007049
994	988036	982107784	31.5277655	9.9799599	.001006036
995	990025	985074875	31.5436206	9.9833055	.001005025
996	992016	988047936	31.5594677	9.9866488	.001004016
997	994009	991026973	31.5753068	9.9899900	.001003009
998	996004	994011992	31.5911380	9.9933289	.001002004
999	998001	997002999	31.6069613	9.9966656	.001001001
1000	1000000	1000000000	31.6227766	10.0000000	.001000000
1001	1002001	1003003001	31.6385840	10.0033322	.0009990010
1002	1004004	1006012008	31.6543836	10.0066622	.0009980040
1003	1006009	1009027027	31.6701752	10.0099899	.0009970090
1004	1008016	1012048064	31.6859590	10.0133155	.0009960159
1005	1010025	1015075125	31.7017349	10.0166389	.0009950249
1006	1012036	1018108216	31.7175030	10.0199601	.0009940358
1007	1014049	1021147343	31.7332633	10.0232791	.0009930487
1008	1016064	1024192512	31.7490157	10.0265958	.0009920635
1009	1018081	1027243729	31.7647603	10.0299104	.0009910803
1010	1020100	1030301000	31.7804972	10.0332228	.0009900990
1011	1022121	1033364331	31.7962262	10.0365330	.0009891197
1012	1024144	1036433728	31.8119474	10.0398410	.0009881423
1013	1026169	1039509197	31.8276609	10.0431469	.0009871668
1014	1028196	1042590744	31.8433666	10.0464506	.0009861933
1015	1030225	1045678375	31.8590646	10.0497521	.0009852217
1016	1032256	1048772096	31.8747549	10.0530514	.0009842520
1017	1034289	1051871913	31.8904374	10.0563485	.0009832842
1018	1036324	1054977832	31.9061123	10.0596435	.0009823183
1019	1038361	1058089859	31.9217794	10.0629364	.0009813543

WEIGHTS AND MEASURES.

AVOIRDUPOIS WEIGHT.

UNITED STATES AND BRITISH.

Grains.	Drams.	Ounces.	Pounds.	Hundred-weight.	Gross Tons.
1.	.03657	.002286	.000143	.00000128	.000000176
27.34375	1.	.0625	.003906	.00003488	.000001744
437.5	16.	1.	.0625	.00055804	.00002790
7000.	256.	16.	1.	.0089286	.0004464
784000.	28672.	1792.	112.	1.	.05
5680000.	573440.	35840.	2240.	20.	1.

1 pound avoirdupois = 1.215278 pounds troy.
1 net ton = 2000 pounds = .892857 gross tons.

TROY WEIGHT.

UNITED STATES AND BRITISH.

Grains.	Pennyweight.	Ounces.	Pounds.
1	.041667	.0020833	.0001736
24	1.	.05	.0041667
480	20.	1.	.0833333
5760	240.	12.	1.

1 pound troy = .822857 pounds avoirdupois.
175 ounces troy = 192 ounces avoirdupois.

APOTHECARIES' WEIGHT.

UNITED STATES AND BRITISH.

Grains.	Scruples.	Drams.	Ounces.	Pounds.
1	.05	.016667	.0020833	.000173611
20	1.	.333333	.0416667	.0034722
60	3.	1.	.125	.0104167
480	24.	8.	1.	.0833333
5760	288.	96.	12.	1.

The pound, ounce and grain are the same as in troy weights.
The avoirdupois grain = troy grain = apothecaries' grain.

WEIGHTS AND MEASURES—Continued.

LINEAR MEASURE.

UNITED STATES AND BRITISH.

Inches.	Feet.	Yards.	Rods.	Furlong.	Miles.
1	.08333	.02778	.0050505	.00012626	.00001578
12	1.	.33333	.0606061	.00151515	.00018939
36	3.	1.	.1818182	.00454545	.00056818
198	16.5	5.5	1.	.025	.003125
7920	660.	220.	40.	1.	.125
63360	5280.	1760.	320.	8.	1.

ROPE AND CABLE MEASURE.

1 inch = .111111 spans = .013889 fathoms = .0001157 cable's length.
1 span = 9 inches = .125 fathoms = .00104167 cable's length.
1 fathom = 6 feet = 8 spans = 72 inches = .008333 cable's length.
1 cable's length = 120 fathoms = 720 feet = 960 spans = 8640 inches.

NAUTICAL MEASURE.

1 nautical mile, as adopted by the United States Coast and Geodetic Survey, equals the length of one minute of arc of a great circle of a sphere whose surface equals that of the earth = 6080.204 feet = 1.1516 statute miles.

1 league = 3 nautical miles = 18240.613 feet.

GUNTER'S CHAIN.

1 link = 7.92 inches = .01 chain = .000125 miles.
1 chain = 100 links = 66 feet = 4 rods — .0125 miles.
1 mile = 80 chains = 8000 links.

SQUARE OR LAND MEASURE.

UNITED STATES AND BRITISH.

Square Inches.	Square Feet.	Square Yards.	Square Rods.	Acres.	Square Miles.
1	.006944	.0007716	. . . . . .	. . . . . .	. . . . .
144	1.	.111111	. . . . . .	. . . . . .	. . . . .
1296	9.0	1.	.03306	.0002066	. . . . .
39204	272.25	30.25	1.	.00625	.00000977
6272640	43560.	4840.	160.	1.	.0015625
	27878400.	3097600.	102400.	640.	1.

1 square rood = 40 square rods.
1 acre = 4 square roods.
1 square acre = 208.71 feet square.

WEIGHTS AND MEASURES—Continued.

CUBIC OR SOLID MEASURE.

UNITED STATES OR BRITISH.

1 cubic inch = .0005787 cubic feet = .000021433 cubic yards.

1 cubic foot = 1728 cubic inches = .03703704 cubic yards.

1 cubic yard = 27 cubic feet = 46656 cubic inches.

1 cord of wood = 128 cubic feet = 4 feet by 4 feet by 8 feet.

1 perch of masonry = 24.75 cubic feet = 16.5 feet by 1.5 feet by 1 foot. It is usually taken as 25 cubic feet.

DRY MEASURE.

UNITED STATES ONLY.

Pints.	Quarts.	Gallons.	Pecks.	Bushels.	Cubic Inches.
1	.50	.125	.0625	.015625	33.6003125
2	1.	.25	.125	.03125	67.200625
8	4.	1.	.05	.125	268.8025
16	8.	2.	1.	.25	537.605
64	32.	8.	4.	1.	2150.42

1 heaped bushel = 1.25 struck bushel, and the cone must be not less than 6 inches high.

LIQUID MEASURE.

UNITED STATES ONLY.

Gills.	Pints.	Quarts.	Gallons.	Barrels.	Cubic Inches.
1	.25	.125	.03125	.000498	7.21875
4	1.	.5	.125	.003968	28.875
8	2.	1.	.25	.007937	57.75
32	8.	4.	1.	.031746	231.
2008	252.	126.	31.5	1.	7276.5

The British imperial gallon = 277.274 cubic inches or 10 pounds avoirdupois of pure water at 62° F. and barometer at 30 inches.

The British imperial gallon = 1.20032 United States gallon.

1 fluid drachm = 60 minims = .125 fluid ounces = .0078125 pints.

1 fluid ounce = 480 minims = 8 drachms = .0625 points.

WEIGHTS AND MEASURES—Continued.

METRIC SYSTEM.

MEASURES OF LENGTH, CAPACITY AND WEIGHT.

LENGTH.	Kilometre.	Hecto-metre.	Decametre.	Metre.	Decimetre.	Centimetre.	Millimetre.
CAPACITY.	Kilolitre or Stere.	Hectolitre or Decistere.	Decalitre or Centistere.	Litre or Millistere.	Decilitre.	Centilitre.	Millilitre.
WEIGHT.	Kilo-gramme.	Hecto-gramme.	Deca-gramme.	Gramme.	Decigramme.	Centi-gramme.	Milli-gramme.
	1	10	100	1000	10000	100000	1000000
		1	10	100	1000	10000	100000
			1	10	100	1000	10000
				1	10	100	1000
				.1	1	10	100
				.01	.1	1	10
				.001	.01	.1	1

1 myriametre = 10 kilometres = 10000 metres.
1 tonne = 1000 kilogrammes = 100 quintals = 10 myriagrammes.
1 gramme = 1 cubic centimetre of distilled water at its maximum density at sea level in latitude of Paris and barometer at 760 millimetres.
1 litre = 1 cubic decimeter.

METRIC SYSTEM.

SQUARE OR SURFACE MEASURE.

Square Kilometre.	Square Hectometre or Hectare.	Square Decametre or Are.	Square Metre or Centiare.	Square Decimetre.	Square Centimetre.	Square Millimetre.
1	100	10000	1000000			
	1	100	10000	1000000		
	.01	1	100	10000	1000000	
	.0001	.01	1	100	10000	1000000
	.000001	.0001	.01	1	100	10000
		.000001	.0001	.01	1	100
			.000001	.0001	.01	1

1 square myriametre = 100 square kilometres = 100 000 000 square metres.

METRIC SYSTEM.

CUBIC MEASURE.

Cubic Decametre.	Cubic Metre.	Cubic Decimetre.	Cubic Centimetre.	Cubic Millimetre.
1	1000	1000000	1000000000	
.001	1	1000	1000000	1000000000
.000001	.001	1	1000	1000000
.000000001	.000001	.001	1	1000
	.000000001	.000001	.001	1

1 cubic metre = 1 kilolitre = 1 stere.

TABLES FOR CONVERTING UNITED STATES WEIGHTS AND MEASURES.

CUSTOMARY TO METRIC.

Weights.

No.	Grains to Milligrammes.	Troy Ounces to Grammes.	Avoirdupois Ounces to Grammes.	Avoirdupois Pounds to Kilogrammes.	Net Tons of 2000 Pounds to Tonnes.	Gross Tons of 2240 Pounds to Tonnes.
1	64.79892	31.10348	28.34953	.45359	.90718	1.01605
2	129.59784	62.20696	56.69905	.90718	1.81437	2.03209
3	194.39675	93.31044	85.04858	1.36078	2.75155	3.04814
4	259.19567	124.41392	113.39811	1.81437	3.62874	4.06419
5	323.99459	155.51740	141.74763	2.26796	4.53592	5.08024
6	388.79351	186.62088	150.09716	2.72155	5.44311	6.09628
7	453.59243	217.72437	198.44669	3.17515	6.35029	7.11233
8	518.39135	248.82785	226.79621	3.62874	7.25748	8.12838
9	583.19026	279.93133	255.14574	4.08233	8.16466	9.14442

1 Avoirdupois Pound = 453.5924277 Grammes.

Linear Measure.

No.	64ths of an Inch to Millimetres.	Inches to Centimetres.	Feet to Metres.	Yards to Metres.	Statute Miles to Kilometres.	Nautical Miles to Kilometres.
1	.39688	2.54001	.304801	.914402	1.60935	1.85325
2	.79375	5.08001	.609601	1.828804	3.21869	3.70650
3	1.19063	7.62002	.914402	2.743205	4.82804	5.55975
4	1.58750	10.16002	1.219202	3.657607	6.43739	7.41300
5	1.98438	12.70003	1.524003	4.572009	8.04674	9.26625
6	2.38125	15.24003	1.828804	5.486411	9.65608	11.11950
7	2.77813	17.78004	2.133604	6.400813	11.26543	12.97275
8	3.17501	20.32004	2.438405	7.315215	12.87478	14.82600
9	3.57188	22.86005	2.743205	8.229616	14.48412	16.67925

1 Nautical Mile = 1853.25 Metres.
1 Gunter's Chain = 20.1168 Metres.
1 Fathom = 1.829 Metres.

TABLES FOR CONVERTING UNITED STATES WEIGHTS AND MEASURES.

METRIC TO CUSTOMARY.

Weights.

No.	Milligrammes to Grains.	Grammes to Troy Ounces.	Grammes to Avoirdupois Ounces.	Kilogrammes to Avoirdupois Pounds.	Tonnes to Net Tons of 2000 Pounds.	Tonnes to Gross Tons of 2240 Pounds.
1	.01543	.03215	.03527	2.20462	1.10231	.98421
2	.03086	.06430	.07055	4.40924	2.20462	1.96841
3	.04630	.09645	.10582	6.61387	3.30693	2.95262
4	.06173	.12860	.14110	8.81849	4.40924	3.93682
5	.07716	.16075	.17637	11.02311	5.51156	4.92103
6	.09259	.19290	.21164	13.22773	6.61387	5.90524
7	.10803	.22506	.24692	15.43236	7.71618	6.88944
8	.12346	.25721	.28219	17.63698	8.81849	7.87365
9	.13889	.28936	.31747	19.84160	9.92080	8.85785

1 Kilogramme = 15432.35639 Grains.

Linear Measure.

No.	Millimetres to 64ths of an Inch.	Centimetres to Inches.	Metres to Feet.	Metres to Yards.	Kilometres to Statute Miles.	Kilometres to Nautical Miles.
1	2.51968	.39370	3.280833	1.093611	.62137	.53959
2	5.03936	.78740	6.561667	2.187222	1.24274	1.07919
3	7.55904	1.18110	9.842500	3.280833	1.86411	1.61878
4	10.07872	1.57480	13.123333	4.374444	2.48548	2.15837
5	12.59840	1.96850	16.404167	5.468056	3.10685	2.69796
6	15.11808	2.36220	19.685000	6.561667	3.72822	3.23756
7	17.63776	2.75590	22.965833	7.655278	7.34959	3.77715
8	20.15744	3.14960	26.246667	8.748889	4.97096	4.31674
9	22.67712	3.54330	29.527500	9.842500	5.59233	4.85633

TABLES FOR CONVERTING UNITED STATES WEIGHTS AND MEASURES.

CUSTOMARY TO METRIC.

Square Measure.

No.	Square Inches to Square Centimetres.	Square Feet to Square Metres.	Square Yards to Square Metres.	Acres to Hectares.	Square Miles to Square Kilometres.
1	6.45163	.09290	.83613	.40470	2.59000
2	12.90325	.18581	1.67226	.80939	5.18000
3	19.35488	.27871	2.50839	1.21409	7.77000
4	25.80650	.37161	3.34452	1.61879	10.35999
5	32.25813	.46452	4.18065	2.02349	12.94999
6	38.70975	.55742	5.01679	2.42818	15.53999
7	45.16138	.65032	5.85292	2.83288	18.12999
8	51.61300	.74323	6.68905	3.23758	20.71999
9	58.06463	.83613	7.52518	3.64228	23.30999

1 Square Statute Mile = 259.00 Hectares.

Cubic Measure.

No.	Cubic Inches to Cubic Centimetres.	Cubic Inches to Cubic Decimetres.	Cubic Feet to Cubic Metres.	Cubic Yards to Cubic Metres.
1	16.38716	.01639	.02832	.76456
2	32.77432	.03277	.05663	1.52912
3	49.16148	.04916	.08495	2.29368
4	65.54864	.06555	.11327	3.05824
5	81.93580	.08194	.14159	3.82280
6	98.32296	.09832	.16990	4.58736
7	114.71013	.11471	.19822	5.35192
8	131.09729	.13110	.22654	6.11648
9	147.48445	.14748	.25485	6.88104

TABLES FOR CONVERTING UNITED STATES WEIGHTS AND MEASURES.

METRIC TO CUSTOMARY.

Square Measure.

No.	Square Centimetres to Square Inches.	Square Metres to Square Feet.	Square Metres to Square Yards.	Hectares to Acres.	Square Kilometres to Square Miles.
1	.15500	10.76387	1.19599	2.47104	.38610
2	.31000	21.52773	2.39197	4.94209	.77220
3	.46500	32.29160	3.58796	7.41313	1.15830
4	.62000	43.05547	4.78394	9.88418	1.54440
5	.77500	53.81934	5.97993	12.35522	1.93050
6	.93000	64.58320	7.17591	14.82626	2.31660
7	1.08500	75.34707	8.37190	17.29731	2.70270
8	1.24000	86.11094	9.56788	19.76835	3.08880
9	1.39500	96.87481	10.76387	22.23940	3.47490

1 Hectare = .003861 Square Statute Miles.

Cubic Measure.

No.	Cubic Centimetres to Cubic Inches.	Cubic Decimetres to Cubic Inches.	Cubic Metres to Cubic Feet.	Cubic Metres to Cubic Yards.	
1	.06102	61.02338	35.31445	1.30794	
2	.12205	122.04676	70.62891	2.61589	
3	.18307	183.07013	105.94336	3.92383	
4	.24409	244.09351	141.25782	5.23177	
5	.30512	305.11689	176.57227	6.53971	
6	.36614	366.14027	211.88673	7.84766	
7	.42716	427.16365	247.20118	9.15560	
8	.48819	488.18702	282.51564	10.46354	
9	.54921	549.21040	317.83009	11.77149	

TABLES FOR CONVERTING UNITED STATES WEIGHTS AND MEASURES.

CUSTOMARY TO METRIC.

Capacity Measures.

No.	Liquid Quarts to Litres.	Gallons to Litres.	Gallons to Cubic Metres.	Bushels to Hectolitres.	Fluid Drachms to Millilitres or Cubic Centimetres.	Fluid Ounces to Millilitres or Cubic Centimetres.
1	.94636	3.78543	.00379	.35239	3.69671	29.57370
2	1.89272	7.57087	.00757	.70479	7.39343	59.14741
3	2.83908	11.35630	.01136	1.05718	11.09014	88.72111
4	3.78543	15.14174	.01514	1.40957	14.78685	118.29482
5	4.73179	18.92717	.01893	1.76196	18.48357	147.86852
6	5.67815	22.71260	.02271	2.11436	22.18028	177.44222
7	6.62451	26.49804	.02650	2.46675	25.87699	207.01593
8	7.57087	30.28347	.03028	2.81914	29.57370	236.58963
9	8.51723	34.06891	.03407	3.17154	33.27042	266.16334

Miscellaneous.

No.	Pounds per Lineal Foot to Kilogrammes per Lineal Metre.	Pounds per Square Inch to Kilogrammes per Square Centimetre.	Pounds per Square Foot to Kilogrammes per Square Metre.	Pounds per Cubic Foot to Kilogrammes per Cubic Metre.	Foot-Pounds to Kilogramme-Metres.	United States Horsepower to Metric Horsepower.
1	1.48816	.07031	4.88241	16.01837	.13826	1.01387
2	2.97632	.14061	9.76482	32.03674	.27651	2.02775
3	4.46448	.21092	14.64723	48.05510	.41477	3.04162
4	5.95264	.28123	19.52963	64.07348	.55302	4.05549
5	7.44081	.35153	24.41204	80.09185	.69128	5.06937
6	8.92897	.42184	29.29445	96.11021	.82953	6.08324
7	10.41713	.49215	34.17686	112.12858	.96779	7.09711
8	11.90529	.56245	39.05927	128.14695	1.10604	8.11098
9	13.39345	.63276	43.94168	144.16532	1.24430	9.12486

TABLES FOR CONVERTING UNITED STATES WEIGHTS AND MEASURES.

METRIC TO CUSTOMARY.

Capacity Measures.

No.	Litres to Fluid Quarts.	Litres to Gallons.	Cubic Metres to Gallons.	Hectolitres to Bushels	Millilitres or Cubic Centimetres to Fluid Drachms.	Millilitres or Cubic Centimetres to Fluid Ounces.
1	1.05668	.26417	264.17047	2.83774	.27051	.03381
2	2.11336	.52834	528.34093	5.67548	.54102	.06763
3	3.17005	.79251	792.51140	8.51323	.81153	.10144
4	4.22673	1.05668	1056.68187	11.35097	1.08204	.13526
5	5.28341	1.32085	1320.85234	14.18871	1.35255	.16907
6	6.34009	1.58502	1585.02280	17.02645	1.62306	.20288
7	7.39677	1.84919	1849.19327	19.86420	1.89357	.23670
8	8.45345	2.11336	2113.36374	22.70194	2.16408	.27051
9	9.51014	2.37753	2377.53420	25.53968	2.43460	.30432

Miscellaneous.

No.	Kilogrammes per Lineal Metre to Pounds per Lineal Foot.	Kilogrammes per Square Centimetre to Pounds per Square Inch.	Kilogrammes per Square Metre to Pounds per Square Foot.	Kilogrammes per Cubic Metre to Pounds per Cubic Foot.	Kilogramme-Metres to Foot-Pounds.	Metric Horsepower to United States Horsepower.
1	.67197	14.22340	.20482	.06243	7.23300	.98632
2	1.34393	28.44680	.40963	.12486	14.46600	1.97264
3	2.01590	42.67020	.61445	.18728	21.69899	2.95895
4	2.68787	56.89359	.81927	.24971	28.93199	3.94527
5	3.35984	71.11699	1.02408	.31214	36.16499	4.93159
6	4.03180	85.34039	1.22890	.37457	43.39799	5.91791
7	4.70377	99.56379	1.43372	.43700	50.63098	6.90423
8	5.37574	113.78719	1.63854	.49943	57.86398	7.89054
9	6.04770	128.01059	1.84335	.56185	65.09698	8.87686

INDEX.