Steel in Construction.

CONVENIENT RULES, FORMULÆ AND TABLES FOR
THE STRENGTH OF STEEL SHAPES USED
AS BEAMS, STRUTS, SHAFTS, ETC.

MADE BY

THE PENCOYD IRON WORKS.

A. & P. ROBERTS COMPANY.

STEEL DEPARTMENT,

MANUFACTURERS OF OPEN HEARTH STEEL SHAPES, BARS, FORGINGS, SHAFTING, HAMMERED AXLES AND STRUCTURAL MATERIAL.

BRIDGE AND CONSTRUCTION DEPARTMENT,

DESIGNERS AND MANUFACTURERS OF RAILROAD BRIDGES, VIADUCTS, TURN-TABLES, AND ALL CLASSES OF STRUCTURES OF IRON OR STEEL.

NINTH EDITION.
1896.

OFFICE:
261 SOUTH FOURTH STREET,
PHILADELPHIA, PA.

SPECIAL PREFACES.

SINCE going to press with this edition, we have added two sections of 18″ beams, which we are now prepared to roll; data explanatory of the same will be found on the following pages.

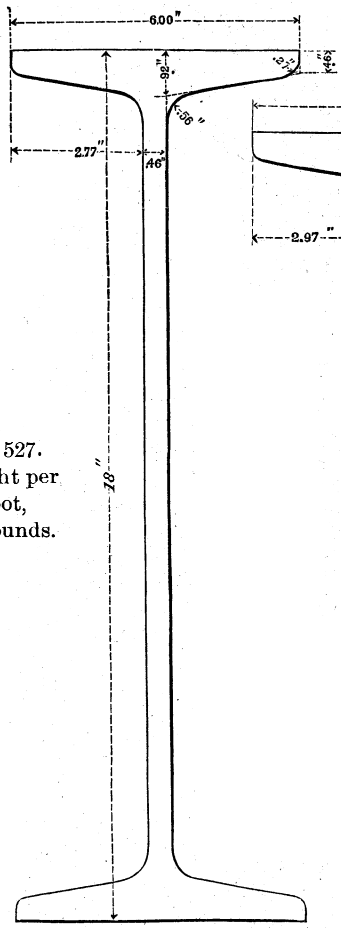
The Association of American Steel Manufacturers has adopted the sections of eye-beams and channels shown in the following tables. These sections differ but slightly from those shown in the body of the book, which will be altered from time to time to conform to the standard sections as rolls may be dressed.

Any weights ordered other than those shown in the schedule will be charged for at the next higher weight given in the schedule.

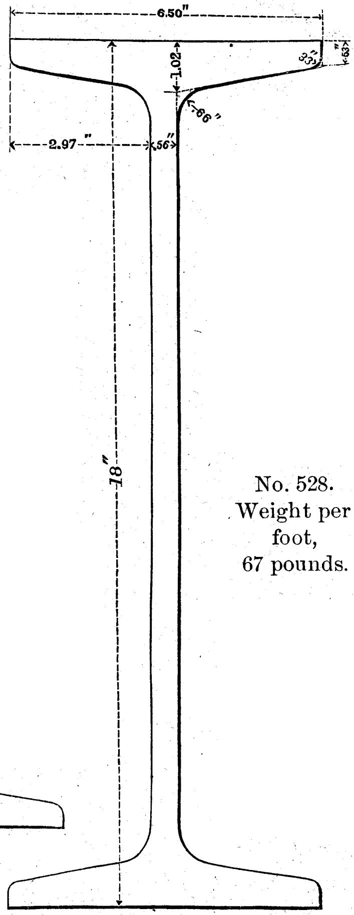
Eye-beams and channels to be cut to lengths with extreme variation not exceeding three-quarters of an inch; any cutting to less variation will be charged one-tenth cent per pound extra.

When ordering eye-beams and channels, the weight or thickness should be given, but not both.

All sections herein enumerated are steel.

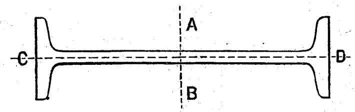


No. 527.
Weight per
foot,
55 pounds.



No. 528.
Weight per
foot,
67 pounds.

ELEMENTS OF 18″ I BEAMS.

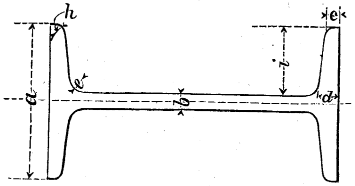


1	*Size in Inches.*		18	18
2	*Section Number.*		528	527
3	*Area in Square Inches.*		19.7	16.2
4	*Weight in Pounds per Foot.*		67.0	55.0
5	*Moments of Inertia.*	*Axis A. B.*	973.5	809.0
6		*Axis C. D.*	30.29	20.82
7	*Square of the Radius of Gyration.*	*Axis A. B.*	49.42	49.94
8		*Axis C. D.*	1.54	1.28
9	*Radius of Gyration.*	*Axis A. B.*	7.03	7.07
10		*Axis C. D.*	1.24	1.13
11	*Resistance.*		108.2	89.9
12	*Add to Resistance for Each Additional Pound per Foot.*		0.88	0.88
13	*Coefficient in Net Tons for Greatest Safe Load Distributed. 16,000 Pounds Fibre Stress.*		576.9	479.4
14	*Add to Previous Coefficient for Each Additional Pound per Foot.*		4.7	4.7
15	*Coefficient for Deflection.*	*Distributed Load.*	.00000161	.00000193
16		*Centre Load.*	.00000264	.00000317
17	*Maximum Load in Net Tons.*		47.8	32.8

PENCOYD STANDARD I BEAMS.

LIGHT SECTION.

As Adopted by the Association of American Steel Manufacturers, on January 17, 1896.



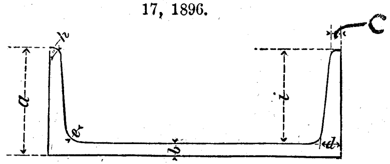
Bevel of flanges = 2″ per foot = 16⅔ p.c. = 9° 27′ 42″.

Size and Description of Beams.					*Dimensions in Inches Corresponding to Letters on Figure of Beam.*						
Size in Inches.	*Section Number.*	*Weight per Foot.*	*Area in Sq. In.*	*Coeff. in Net Tons for Safe Load Distributed.*	***a***	***b***	***c***	***d***	***e***	***h***	***i***
20	530	65.0	19.10	712	6.25	.50	.55	1.03	.60	.30	2.875
18	527	55.0	16.20	479	6.00	.46	.46	.92	.56	.27	2.77
15	521	42.4	12.48	357	5.50	.41	.41	.83	.51	.24	2.545
12	515	31.5	9.26	213	5.00	.35	.35	.74	.45	.21	2.325
10	511	25.0	7.37	143	4.66	.31	.31	.67	.41	.18	2.175
9	509	21.45	6.31	109	4.33	.29	.29	.63	.39	.17	2.02
8	507	18.0	5.33	82	4.00	.27	.27	.58	.37	.16	1.865
7	505	15.0	4.42	59	3.66	.25	.25	.53	.35	.15	1.705
6	501	12.27	3.61	41	3.33	.23	.23	.49	.33	.14	1.55
5	500	9.75	2.87	27	3.00	.21	.21	.44	.31	.13	1.395
4	20	7.50	2.21	16	2.66	.19	.19	.40	.29	.11	1.235
3	22	5.5	1.63	9	2.33	.17	.17	.35	.27	.10	1.08

PENCOYD STANDARD CHANNELS.

LIGHT SECTION.

As Adopted by the Association of American Steel Manufacturers on January 17, 1896.



Bevel of flanges = 2″ per foot = 16⅔ p.c. = 9° 27′ 42″.

Size and Description of Channels.					*Dimensions in Inches Corresponding to Letters on Figure of Channel.*						
Size in Inches.	*Section Number.*	*Weight per Foot.*	*Area in Sq. Inches.*	*Coeff. in Net Tons for Safe Load Distributed.*	***a***	***b***	***c***	***d***	***e***	***h***	***i***
. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
15	433	33.0	9.9	243	3.40	.40	.40	.90	.50	.24	3.00
12	427	20.50	6.03	124	2.94	.28	.28	.72	.38	.17	2.66
10	423	15.0	4.46	77	2.60	.24	.24	.63	.34	.14	2.36
9	421	13.25	3.89	60	2.43	.23	.23	.60	.33	.14	2.20
8	419	11.25	3.35	46	2.26	.22	.22	.56	.32	.13	2.04
7	417	9.75	2.85	34	2.09	.21	.21	.52	.31	.13	1.88
6	415	8.00	2.38	24	1.92	.20	.20	.49	.30	.12	1.72
5	413	6.50	1.95	16	1.75	.19	.19	.45	.29	.11	1.56
4	411	5.25	1.55	10	1.58	.18	.18	.41	.28	.11	1.40
3	49	4.00	1.19	6	1.41	.17	.17	.38	.27	.10	1.24

PRESS OF
EDWARD STERN & CO., INC.,
PHILADELPHIA.

PREFACE TO NINTH EDITION.

CHANGES in Engineering requirements and the substitution of steel for wrought iron in construction have rendered necessary an entire revision of the subject-matter of the following pages.

Since the eighth edition was published in 1892, the manufacture of wrought iron has been abandoned at Pencoyd, and the whole product of the plant has been changed to Open-Hearth Steel.

A number of undesirable sections have been abandoned and others substituted with an aim to standardizing wherever possible.

As heretofore, the subjects have been confined entirely to the output of our own Works, referring to the numerous Engineering Handbooks for data upon other topics.

The text and tables have been very carefully prepared under the supervision of Mr. James Christie, and we trust may be of value to all who have occasion to use the product of the Pencoyd Iron Works.

A. & P. ROBERTS COMPANY.

PENCOYD, PA., January 14, 1896.

PENCOYD I BEAMS.

Depth in Inches.	*Section Number.*	*Least Web Thickness.*	*Least Weight per Foot in Pounds.*	*Approximate Weight in Pounds per Foot for each Thickness of Web, in Inches.* 1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	*Increased Thickness in Inches for each Additional Pound per Foot.*
20	531	.60	78.0							79.7	88.2	96.7	.015
20	530	.50	64.8					64.8	69.1	73.3	81.7		
18													
18													
15	524	.60	69.2							70.8	77.2	83.6	.020
15	523	.50	57.6					57.6	60.8	64.0	70.4		
15	522	.45	49.3					51.7	54.9				
15	521	.37	41.2			41.2	44.4	47.6	50.8				
12	517	.56	55.5						55.5	58.1	63.2		.025
12	516	.40	39.4				40.7	43.2	45.8	48.3			
12	515	.34	30.6			31.9	34.4	37.1					
10	512	.35	29.8			30.7	32.8	34.9					.029
10	511	.30	23.5		24.0	26.2	28.3	30.4					
9	509	.28	20.5		21.5	23.4	25.3						.033
8	507	.26	17.4		18.8	20.5							.037
7	505	.24	14.6	15.0	16.5	17.9							.042
6	503	.63	41.0							41.0	43.6	46.1	.049
6	502	.50	32.3					32.3	33.6	34.9	37.4		
6	501	.22	11.9	12.5	13.8	15.1							
5	500	.20	9.4	10.2	11.3	12.3							.059
4	20	.16	6.2	7.5									.074
3	22	.16	5.3	6.3									.098

PENCOYD CHANNELS.

Depth in Inches.	*Section Number.*	*Least Web Thickness.*	*Least Weight per Foot.*	*Approximate Weight in Pounds per Foot for each Thickness of Web, in Inches.* 1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	*Increased Thickness in Inches for each Additional Pound per Foot.*
15	434	.62	49.8							49.8	56.4	63.0	.019
15	433	.40	32.7				34.5	37.6	40.7	44.2	50.3		
12	428	.41	31.4				32.6	35.2	37.7	40.3	45.4	50.5	.024
12	427	.28	19.8		20.7	23.5	26.1	28.5	30.9				
12	32	.28	20.6		21.8	24.4	26.9	29.5	32.1				
10	424	.33	20.9			22.6	24.7	26.9	29.0	31.1	35.3		.029
10	423	.26	16.5		18.4	20.6	22.7	24.8					
9	422	.31	17.6		17.6	19.4	21.3	23.2	25.1	27.1			.032
9	421	.24	13.4	13.7	15.6	17.5	19.5						
8	420	.28	14.6		15.4	17.1	18.8	20.6					.036
8	419	.22	10.9	11.7	13.4	15.0							
7	418	.27	12.8		13.7	15.2	16.7	18.2	19.7	21.2	24.2		.042
7	417	.20	9.1	10.3	11.8	13.1							
6	416	.25	11.0	11.0	12.3	13.5	14.8	16.1	17.4	18.6			.049
6	415	.19	7.7	8.7	10.0	11.2							
5	413	.19	6.6	7.1	8.2	9.3							.058
4	411	.18	5.4	6.2	7.1								.073
3	49	.22	5.1	5.6	6.2								.097
2¼	50	.25	3.8	3.8									.130
2	51	.22	3.0	3.2									.148
1¼	52	.09	1.1										.168

PENCOYD Z BARS.

Nominal Size in Inches.	Section Number.	Actual Size in Inches for a Variation of $\frac{1}{16}$ Inch in Thickness. Flange.	Web.	Flange.	Thickness.	Areas in Square Inches.	Weight per Foot in Pounds.	Increased Thickness in Inches for each Additional Pound per Foot.
3	220	2.62	3.00	2.62	.25	1.94	6.60	.037
3		2.69	3.06	2.69	.31	2.44	8.29	
3		2.75	3.12	2.75	.37	2.94	10.00	
3	221	2.66	3.00	2.66	.44	3.28	11.15	.039
3		2.69	3.03	2.69	.47	3.51	11.93	
3		2.72	3.06	2.72	.50	3.75	12.75	
4	222	2.87	4.00	2.87	.25	2.32	7.88	.031
4		2.94	4.06	2.94	.31	2.91	9.89	
4		3.00	4.12	3.00	.37	3.50	11.90	
4	223	2.97	4.00	2.97	.44	3.96	13.46	.030
4		3.03	4.06	3.03	.50	4.56	15.50	
4		3.09	4.12	3.09	.56	5.16	17.54	
4	224	3.06	4.00	3.06	.62	5.53	18.80	.030
4		3.19	4.12	3.19	.75	6.75	22.95	
5	225	3.19	5.00	3.19	.31	3.36	11.42	.026
5		3.25	5.06	3.25	.37	4.05	13.77	
5		3.31	5.12	3.31	.44	4.75	16.15	
5	226	3.22	5.00	3.22	.50	5.23	17.78	.027
5		3.28	5.06	3.28	.56	5.91	20.09	
5		3.34	5.12	3.34	.62	6.60	22.44	
5	227	3.25	5.00	3.25	.68	6.96	23.66	.027
5		3.31	5.06	3.31	.75	7.64	25.97	
6	228	3.50	6.00	3.50	.37	4.59	15.61	.023
6		3.56	6.06	3.56	.44	5.39	18.32	
6		3.62	6.12	3.62	.50	6.19	21.05	
6	229	3.50	6.00	3.50	.56	6.68	22.71	.023
6		3.56	6.06	3.56	.62	7.46	25.36	
6		3.62	6.12	3.62	.69	8.25	28.05	
6	230	3.50	6.00	3.50	.75	8.64	29.37	.025
6		3.56	6.06	3.56	.81	9.38	31.89	
6		3.62	6.12	3.62	.87	10.16	34.54	

For rivet spacing, see page 211.

PENCOYD DECK BEAMS.

Depth in Inches.	Section Number.	Minimum Flange Width in Inches.	Minimum Web Thickness in Inches.	Minimum Weight per Foot in Pounds.	Approximate Weight in Pounds per Foot for each Thickness of Web, in Inches. $\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	Increased Thickness in Inches for each Additional Pound per Foot.
11½	69	5.25	.406	32.2			33.4	35.8	38.2	40.7	43.1	45.6	.026
10	62	5.25	.375	28.1		28.1	30.3	32.4	34.5	36.6	38.7		.029
9	63	5.00	.375	24.7		24.7	26.6	28.5	30.4	32.3			.033
8	64	4.62	.343	21.0		21.8	23.5	25.2	26.9	28.6			.036
7	65	4.25	.343	17.9		18.6	20.1	21.6	23.1	24.6			.041
6	66	3.75	.312	14.4	14.4	15.6	16.9	18.2	19.5				.049
5	67	3.25	.312	11.5	11.5	12.5	13.6	14.7	15.8				.058

PENCOYD BULB ANGLES.

10	250	3.62	.500	25.6				25.5	28.4	31.3			.029
9	251	3.50	.484	22.4				22.9	24.7				.032
8	252	3.37	.453	19.5				21.3	23.7				.036
7	253	3.19	.406	15.9			17.0	19.1					.041
6	254	3.00	.359	12.8		13.3	15.2	17.2	19.1				.048
5	255	2.75	.312	9.6	9.6	10.6	11.6						.062

PENCOYD ANGLES.

EVEN LEGS.

Section Number.	Size in Inches.	Approximate Weight in Pounds per Foot for Various Thicknesses in Inches.												
		$\frac{1}{8}$ .125	$\frac{3}{16}$ .1875	$\frac{1}{4}$ .25	$\frac{5}{16}$ .3125	$\frac{3}{8}$ .375	$\frac{7}{16}$ .4375	$\frac{1}{2}$ .50	$\frac{9}{16}$ .5625	$\frac{5}{8}$ .625	$\frac{11}{16}$ .6875	$\frac{3}{4}$ .75	$\frac{7}{8}$ .875	1 1.00
173	8 x 8							26.4	29.8	33.2	36.7	40.2	45.8	52.8
120	6 x 6					14.8	17.3	19.9	22.4	24.9	26.5	29.1	34.2	39.3
121	5 x 5					12.2	14.3	16.4	18.5	20.7	22.8	25.0	29.2	33.4
122	4 x 4				8.2	9.8	11.4	12.9	14.5	16.1	17.7	19.3		
123	$3\frac{1}{2}$ x $3\frac{1}{2}$				7.1	8.5	10.0	11.4	12.8	14.2				
124	3 x 3			4.9	6.0	7.2	8.3	9.4	10.5	11.7				
125	$2\frac{3}{4}$ x $2\frac{3}{4}$			4.4	5.6	6.7	7.8	8.9						
126	$2\frac{1}{2}$ x $2\frac{1}{2}$		3.1	4.1	5.1	6.1	7.1	8.2						
127	$2\frac{1}{4}$ x $2\frac{1}{4}$		2.7	3.6	4.5	5.4								
128	2 x 2		2.4	3.2	4.0	4.9								
129	$1\frac{3}{4}$ x $1\frac{3}{4}$		2.1	2.8	3.6	4.4								
130	$1\frac{1}{2}$ x $1\frac{1}{2}$	1.2	1.8	2.4	3.0	3.6								
131	$1\frac{1}{4}$ x $1\frac{1}{4}$	1.0	1.5	2.0										
132	1 x 1	0.8	1.2	1.5										

For variation in length of legs, corresponding to varying thickness, see pages 12 to 17

PENCOYD ANGLES.

UNEVEN LEGS.

Section Number.	Size in Inches.	Approximate Weight in Pounds per Foot for Various Thicknesses in Inches.											
		$\frac{3}{16}$ .1875	$\frac{1}{4}$ .25	$\frac{5}{16}$ .3125	$\frac{3}{8}$ .375	$\frac{7}{16}$ .4375	$\frac{1}{2}$ .50	$\frac{9}{16}$ .5625	$\frac{5}{8}$ .625	$\frac{11}{16}$ .6875	$\frac{3}{4}$ .75	$\frac{7}{8}$ .875	1 1.00
172	8 x 5						21.3	24.1	26.9	29.7	32.5	36.9	42.6
154	7 x $3\frac{1}{2}$						17.0	18.9	20.9	22.8	24.7	28.6	32.5
152	$6\frac{1}{2}$ x 4				12.8	15.0	17.1	19.3	21.4	23.6	25.7	30.0	34.3
140	6 x 4				12.2	14.3	16.5	18.6	20.2	22.3	24.4	28.6	32.8
151	6 x $3\frac{1}{2}$				11.5	13.6	15.6	17.6	19.7	21.7	23.6	27.8	31.9
153	$5\frac{1}{2}$ x $3\frac{1}{2}$				11.0	12.8	14.6	16.4	18.2				
141	5 x 4				11.0	12.8	14.6	16.4	17.9	19.7	21.6		
142	5 x $3\frac{1}{2}$			8.7	10.3	12.0	13.6	15.2	16.9	18.5	20.1		
143	5 x 3			8.2	9.7	11.2	12.7	14.2	15.7	17.2	18.8		
144	$4\frac{1}{2}$ x 3			7.7	9.2	10.6	12.1	13.6	15.0	16.5	17.9		
145	4 x $3\frac{1}{2}$			7.7	9.2	10.6	12.1	13.6	15.0	16.5	17.9		
146	4 x 3			7.1	8.5	10.0	11.2	12.6	14.0				
147	$3\frac{1}{2}$ x 3			6.6	7.9	9.2	10.5	11.8	13.1				
150	$3\frac{1}{2}$ x $2\frac{1}{2}$		4.9	6.0	7.2	8.3	9.4						
159	$3\frac{1}{2}$ x 2		4.4	5.6	6.7								
148	3 x $2\frac{1}{2}$		4.4	5.6	6.7	7.8	8.9						
149	3 x 2		4.1	5.1	6.1	7.1	8.2						
155	$2\frac{1}{2}$ x 2	2.7	3.6	4.4	5.4	6.3	7.2						
156	$2\frac{1}{4}$ x $1\frac{1}{2}$	2.3	3.0	3.7	4.6								
139	2 x $1\frac{1}{2}$	2.1	2.9	3.6	4.5								
157	2 x $1\frac{1}{4}$	1.9	2.6	3.3	4.0								

For variation in length of legs corresponding to varying thickness, see pages 12 to 17.

PENCOYD ANGLES.

SQUARE ROOT ANGLES.

No. of Section.	Size in Inches.	Approximate Weight in Pounds per Foot for Various Thicknesses in Inches.											
		1/8 .125	3/16 .1875	1/4 .25	5/16 .3125	3/8 .375	7/16 .4375	1/2 .50	9/16 .5625	5/8 .625	11/16 .6875	3/4 .75	7/8 .875
160	4 x 4					9.8	11.4	13.0	14.6	16.2			
161	3½ x 3½				7.1	8.5	9.9	11.4					
162	3 x 3			4.9	6.1	7.2	8.3	9.4					
163	2¾ x 2¾			4.5	5.6	6.7	7.8	8.9					
164	2½ x 2½			4.1	5.1	6.1	7.1	8.2					
165	2¼ x 2¼			3.6	4.5	5.4							
166	2 x 2			3.3	4.1	4.9							
167	1¾ x 1¾			2.9	3.6	4.4							
168	1½ x 1½		1.80	2.4	3.0								
169	1¼ x 1¼		1.53	2.04	2.55								
170	1 x 1	0.82	1.16	1.53									

ANGLE COVERS.

No. of Section.	Size in Inches.	Approximate Weight in Pounds per Foot for Various Thicknesses in Inches.											
		1/8 .125	3/16 .1875	1/4 .25	5/16 .3125	3/8 .375	7/16 .4375	1/2 .50	9/16 .5625	5/8 .625	11/16 .6875	3/4 .75	7/8 .875
180	3 x 3			4.8	5.9	7.1	8.2	9.3	10.4	11.5			
181	2¾ x 2¾			4.4	5.5	6.6	7.7	8.8					
182	2½ x 2½		3.0	4.0	5.0	6.0	7.0	8.1					
183	2¼ x 2¼		2.6	3.5	4.4	5.3							
184	2 x 2		2.4	3.2	4.0	4.8							

SPECIAL ANGLES.

No. of Section.	Size in Inches.	Approximate Weight in Pounds per Foot for Various Thicknesses in Inches.											
		1/8 .125	3/16 .1875	1/4 .25	5/16 .3125	3/8 .375	7/16 .4375	1/2 .50	9/16 .5625	5/8 .625	11/16 .6875	3/4 .75	7/8 .875
158	2⅞ x 2¼			4.2	5.3	6.4							
214	4½ x 1½		3.6	4.9									

PENCOYD TEES.

For details see lithographs—Plates Nos. 19, 20, 21, 22.

EVEN TEES.			UNEVEN TEES.		
Section Number.	Size in Inches.	Weight per Foot.	Section Number.	Size in Inches.	Weight per Foot.
70	4 x 4	12.65	95	6 x 5¼	39.41
85	4 x 4	11.19	107	5 x 4	15.00
71	3½ x 3½	10.37	106	5 x 3½	16.46
86	3½ x 3½	8.97	109	4 x 4½	13.50
87	3½ x 3½	6.99	94	4 x 3	8.81
82	3 x 3	6.56	96	4 x 2	6.56
83	3 x 3	7.68	88	3½ x 3	8.57
84	2½ x 2½	4.93	89	3½ x 3	7.36
73	2½ x 2½	6.63	97	3 x 3½	9.55
74	2½ x 2½	5.85	97½	3 x 3½	8.36
75	2¼ x 2¼	3.98	98	3 x 2½	8.09
76	2¼ x 2¼	4.01	110	3 x 2½	5.98
77	2 x 2	3.54	111	3 x 2½	7.00
78	1¾ x 1¾	2.41	117	3 x 2½	5.10
79	1½ x 1½	2.04	118	2½ x 3	6.03
80	1¼ x 1¼	1.53	99	3 x 1½	3.81
81	1 x 1	1.05	119	2½ x 2¾	5.74
			105	2¾ x 2	7.28
			104	2¾ x 1¾	6.66
			100	2½ x 1¼	3.09
			108	2¼ x 9/16	2.24
			101	2 x 1½	2.96
			112	2 x 1 1/16	2.11
			102	2 x 1	2.38
			103	2 x 9/16	2.07
			116	1¾ x 1¼	3.54
			113	1¾ x 1 1/16	1.90
			114	1½ x 15/16	1.39
			115	1¼ x 15/16	1.16

MISCELLANEOUS SHAPES.

Section Number.	Section.	Size in Inches.	Weight per Foot in Pounds.
194	Half Ovals	1¼ x ½	1.6
193		1⅛ x ½	1.4
217	Heavy Rail	6	49.9
210	Floor Bars	3 1/16 x 4 x 3 1/16 x ¼ to ½	7.1 to 14.3
260		2½ x 6 x 2½ x ¼ to ⅜	9.8 to 14.7

SIZES OF PENCOYD BARS.

FLATS.

7/8	x 3/8	inches to	3/4	inches.	2 5/32	x 1 3/8	inches to	2	inches.
1	x 1/4	"	7/8	"	2 1/4	x 1/4	"	1 7/8	"
1 1/32	x 1/2	"	1	"	2 5/16	x 1 1/2	"	2	"
1 1/16	x 1/2	"	1	"	2 3/8	x 5/8	"	1 3/4	"
1 1/8	x 1/4	"	1	"	2 1/2	x 1/4	"	1 3/4	"
1 3/16	x 5/8	"	1	"	2 3/4	x 1/4	"	7/8	"
1 7/32	x 1/2	"	1	"	3	x 1/4	"	2	"
1 1/4	x 1/4	"	1	"	3 1/4	x 1/4	"	7/8	"
1 5/16	x 5/8	"	1	"	3 1/2	x 1/4	"	7/8	"
1 3/8	x 1/4	"	1 1/4	"	4	x 1/4	"	2 1/2	"
1 13/32	x 5/8	"	1	"	4 1/2	x 1/4	"	3	"
1 7/16	x 11/16	"	1 1/8	"	5	x 1/4	"	3 1/2	"
1 1/2	x 1/4	"	1 1/4	"	6	x 1/4	"	3	"
1 19/32	x 3/4	"	1 1/4	"	7	x 1/4	"	2 1/2	"
1 5/8	x 1/4	"	1 1/2	"	8	x 1/4	"	2 1/2	"
1 3/4	x 1/4	"	1 1/4	"	9	x 1/4	"	2 3/4	"
1 31/32	x 5/8	"	1 3/4	"	10	x 1/4	"	2 1/2	"
2	x 1/4	"	1 1/2	"	12	x 1/4	"	2 1/2	"

ROUNDS.

1/2, 9/16, 5/8, 11/16, 3/4, 13/16, 7/8, 15/16, 1, 1 1/16, 1 1/8, 1 3/16, 1 1/4, 1 5/16, 1 3/8, 1 7/16, 1 1/2, 1 9/16, 1 5/8, 1 3/4, 1 7/8, 2, 2 1/8, 2 1/4, 2 3/8, 2 1/2, 2 5/8, 2 3/4, 2 7/8, 3, 3 1/8, 3 1/4, 3 3/8, 3 1/2, 3 5/8, 3 3/4, 3 7/8, 4, 4 1/8, 4 1/4, 4 3/8, 4 1/2, 4 5/8, 4 3/4, 4 7/8, 5, 5 1/4, 5 1/2, 5 3/4, 6, 6 1/2, 7 inches.

HALF ROUNDS.

1/2, 9/16, 5/8, 11/16, 3/4, 13/16, 7/8, 15/16, 1, 1 1/8, 1 1/4, 1 3/8, 1 1/2, 1 5/8, 1 3/4, 2, 2 1/4, 2 1/2, 3 inches.

SQUARES.

1/2, 9/16, 5/8, 11/16, 3/4, 13/16, 7/8, 15/16, 1, 1 1/16, 1 1/8, 1 3/16, 1 1/4, 1 3/8, 1 1/2, 1 5/8 1 3/4, 1 7/8, 2, 2 1/8, 2 1/4, 2 3/8, 2 1/2, 2 5/8 2 3/4, 2 7/8, 3, 3 1/8, 3 1/4, 3 3/8, 3 1/2, 3 5/8, 3 3/4, 3 7/8, 4, 4 1/8, 4 1/4, 4 3/8, 4 1/2, 4 5/8, 4 3/4, 4 7/8, 5 inches.

RIVET SIZES.

30/64, 31/64, 33/64, 37/64, 38/64, 39/64, 41/64, 46/64, 47/64, 49/64, 53/64, 54/64, 55/64, 57/64, 61/64, 62/64, 63/64, 1 1/64, 1 5/64, 1 9/64, 1 13/64, 1 17/64 inches.

BOLT SIZES 1/64TH FULL.

1/2, 9/16, 5/8, 11/16, 3/4, 13/16, 7/8, 15/16, 1, 1 1/16, 1 1/8, 1 3/16, 1 1/4 inches.

BAR STEEL EXTRAS.

EASTERN CLASSIFICATION.

BASE SIZES.

Rounds and Squares, 3/4 to 2 in. | Flat Iron, 1 to 4 in. x 3/8 to 1 1/2

Flat Iron, . . . 4 1/8 to 6 in. x 3/8 to 1 in.

EXTRA SIZES.

Round and Square Iron.

	Extra per lb.
3/8 in., ...	.5 ct.
7/16 "	.4 "
1/2 and 9/16 in., ...	.2 "
5/8 " 11/16 "	.1 "
2 1/8 to 2 7/8 "	.1 "
3 " 3 1/2 "	.3 "
3 5/8 " 4 "	.5 "
4 1/8 " 4 1/2 "	.6 "
4 5/8 " 5 "	.8 "
5 1/8 " 5 1/2 "	1.0 "
5 5/8 " 6 "	1.5 "
6 1/4 " 6 1/2 "	2.0 "
6 3/4 " 7 "	2,5 "

Centering and Straightening, ...1 ct.

Flat Iron.

	Extra per lb.
7/8 x 3/8 in. to 3/4 in., . . .	.4 ct.
1 x 3/16 "	.4 "
1 to 6 in. x 1/4 and 5/16,	.2 "
2 " 4 " x 1 5/8 to 2 in.,	.2 "
2 " 4 " x 2 1/8 " 3 " .	.3 "
4 1/8 " 6 " x 1 1/8 " 2 " .	.2 "
4 1/8 " 6 " x 2 1/8 " 3 " .	.4 "
7 x 3/8 " to 1 in., . . .	.3 "
7 x 1 1/8 " " 2 " . . .	.4 "
8 x 3/8 " " 1 " . . .	.4 "
8 x 1 1/8 " " 2 " . . .	.6 "
9 x 3/8 " " 1 " . . .	.6 "
9 x 1 1/8 " " 2 " . . .	.8 "
10 x 3/8 " " 1 " . . .	.8 "
10 x 1 1/8 " " 2 " . . .	1.0 "
11 x 3/8 " " 1 " . . .	.9 "
11 x 1 1/8 " " 2 " . . .	1.1 "
12 x 3/8 " " 1 " . . .	.9 "
12 x 1 1/8 " " 2 " . . .	1.1 "

6 to 12 x 1/4 to 5/16 thick, .2 ct. extra above 3/8ths.

Cutting Ordinary Bars to Specified Lengths.

	Extra per lb.
Flat bars, 10 to 30 ft. long	.2 ct.
Over 30 ft. long, .1 ct. for every 10 ft. or fraction thereof.	
Round and square bars to 4 in. diameter, and from 10 to 20 ft. long, ...	.2 "
Over 4 in. diameter, ...	.3 "

PENCOYD ANGLES.

Size, area and weight per foot of various thicknesses in pounds.
Actual lengths of legs corresponding to given thicknesses.

Size.	*Area.*	*Weight per Foot.*
8 x 8 x 1/2	7.76	26.38
8 1/16 x 8 1/16 x 9/16	8.77	29.82
8 1/8 x 8 1/8 x 5/8	9.78	33.25
8 3/16 x 8 3/16 x 11/16	10.78	36.66
8 1/4 x 8 1/4 x 3/4	11.82	40.19
8 x 8 x 3/4	11.47	39.00
8 1/16 x 8 1/16 x 13/16	12.47	42.40
8 1/8 x 8 1/8 x 7/8	13.48	45.83
8 3/16 x 8 3/16 x 15/16	14.50	49.30
8 1/4 x 8 1/4 x 1	15.53	52.80
6 x 6 x 3/8	4.36	14.82
6 1/16 x 6 1/16 x 7/16	5.10	17.34
6 1/8 x 6 1/8 x 1/2	5.84	19.86
6 3/16 x 6 3/16 x 9/16	6.58	22.37
6 1/4 x 6 1/4 x 5/8	7.32	24.89
6 x 6 x 11/16	7.80	26.52
6 1/16 x 6 1/16 x 3/4	8.55	29.07
6 1/8 x 6 1/8 x 13/16	9.30	31.62
6 3/16 x 6 3/16 x 7/8	10.05	34.17
6 1/4 x 6 1/4 x 15/16	10.80	36.72
6 5/16 x 6 5/16 x 1	11.55	39.27

Size.	*Area.*	*Weight per Foot.*
5 x 5 x 3/8	3.60	12.24
5 1/16 x 5 1/16 x 7/16	4.21	14.31
5 1/8 x 5 1/8 x 1/2	4.82	16.39
5 3/16 x 5 3/16 x 9/16	5.45	18.53
5 1/4 x 5 1/4 x 5/8	6.09	20.71
5 5/16 x 5 5/16 x 11/16	6.72	22.85
5 3/8 x 5 3/8 x 3/4	7.36	25.02
5 7/16 x 5 7/16 x 13/16	7.97	27.10
5 1/2 x 5 1/2 x 7/8	8.58	29.17
5 9/16 x 5 9/16 x 15/16	9.20	31.28
5 5/8 x 5 5/8 x 1	9.83	33.43
4 x 4 x 5/16	2.40	8.16
4 1/16 x 4 1/16 x 3/8	2.87	9.76
4 1/8 x 4 1/8 x 7/16	3.34	11.36
4 3/16 x 4 3/16 x 1/2	3.81	12.95
4 1/4 x 4 1/4 x 9/16	4.28	14.55
4 5/16 x 4 5/16 x 5/8	4.75	16.15
4 3/8 x 4 3/8 x 11/16	5.22	17.75
4 7/16 x 4 7/16 x 3/4	5.69	19.35
3 1/2 x 3 1/2 x 5/16	2.09	7.11
3 9/16 x 3 9/16 x 3/8	2.51	8.53
3 5/8 x 3 5/8 x 7/16	2.93	9.96
3 11/16 x 3 11/16 x 1/2	3.35	11.39
3 3/4 x 3 3/4 x 9/16	3.77	12.82
3 13/16 x 3 13/16 x 5/8	4.19	14.24

PENCOYD ANGLES.

Size, area and weight per foot of various thicknesses in pounds.
Actual lengths of legs corresponding to given thicknesses.

Size.	*Area.*	*Weight per Foot.*
3 x 3 x 1/4	1.45	4.93
3 1/16 x 3 1/16 x 5/16	1.78	6.05
3 1/8 x 3 1/8 x 3/8	2.11	7.17
3 3/16 x 3 3/16 x 7/16	2.44	8.30
3 1/4 x 3 1/4 x 1/2	2.77	9.42
3 5/16 x 3 5/16 x 9/16	3.10	10.54
3 3/8 x 3 3/8 x 5/8	3.43	11.66
2 3/4 x 2 3/4 x 1/4	1.31	4.45
2 13/16 x 2 13/16 x 5/16	1.64	5.58
2 7/8 x 2 7/8 x 3/8	1.97	6.70
2 15/16 x 2 15/16 x 7/16	2.30	7.82
3 x 3 x 1/2	2.63	8.94
2 1/2 x 2 1/2 x 3/16	0.90	3.06
2 9/16 x 2 9/16 x 1/4	1.20	4.08
2 5/8 x 2 5/8 x 5/16	1.50	5.10
2 11/16 x 2 11/16 x 3/8	1.80	6.12
2 3/4 x 2 3/4 x 7/16	2.10	7.14
2 13/16 x 2 13/16 x 1/2	2.40	8.16
2 1/4 x 2 1/4 x 3/16	0.79	2.69
2 5/16 x 2 5/16 x 1/4	1.05	3.57
2 3/8 x 2 3/8 x 5/16	1.31	4.46
2 7/16 x 2 7/16 x 3/8	1.59	5.41

Size.	*Area.*	*Weight per Foot.*
2 x 2 x 3/16	0.72	2.45
2 1/16 x 2 1/16 x 1/4	0.95	3.23
2 1/8 x 2 1/8 x 5/16	1.19	4.05
2 3/16 x 2 3/16 x 3/8	1.45	4.93
1 3/4 x 1 3/4 x 3/16	0.63	2.14
1 13/16 x 1 13/16 x 1/4	0.83	2.82
1 7/8 x 1 7/8 x 5/16	1.05	3.57
1 15/16 x 1 15/16 x 3/8	1.29	4.39
1 1/2 x 1 1/2 x 1/8	0.34	1.16
1 9/16 x 1 9/16 x 3/16	0.53	1.80
1 5/8 x 1 5/8 x 1/4	0.70	2.38
1 11/16 x 1 11/16 x 5/16	0.88	2.99
1 3/4 x 1 3/4 x 3/8	1.05	3.57
1 1/4 x 1 1/4 x 1/8	0.30	1.02
1 5/16 x 1 5/16 x 3/16	0.45	1.53
1 3/8 x 1 3/8 x 1/4	0.59	2.01
1 x 1 x 1/8	0.23	0.78
1 1/16 x 1 1/16 x 3/16	0.34	1.16
1 1/8 x 1 1/8 x 1/4	0.45	1.53

PENCOYD ANGLES.

Size, area and weight per foot of various thicknesses in pounds.
Actual lengths of legs corresponding to given thicknesses.

Size.	Area.	Weight per Foot.
8 x 5 x 1/2	6.26	21.28
8 1/16 x 5 1/16 x 9/16	7.08	24.07
8 1/8 x 5 1/8 x 5/8	7.90	26.87
8 3/16 x 5 3/16 x 11/16	8.75	29.75
8 1/4 x 5 1/4 x 3/4	9.57	32.55
8 x 5 x 3/4	9.22	31.34
8 1/16 x 5 1/16 x 13/16	10.03	34.11
8 1/8 x 5 1/8 x 7/8	10.86	36.91
8 3/16 x 5 3/16 x 15/16	11.69	39.74
8 1/4 x 5 1/4 x 1	12.53	42.60
7 x 3 1/2 x 1/2	5.00	17.00
7 1/16 x 3 9/16 x 9/16	5.57	18.94
7 1/8 x 3 5/8 x 5/8	6.14	20.88
7 3/16 x 3 11/16 x 11/16	6.71	22.81
7 x 3 1/2 x 3/4	7.28	24.75
7 1/16 x 3 9/16 x 13/16	7.85	26.69
7 1/8 x 3 5/8 x 7/8	8.42	28.63
7 3/16 x 3 11/16 x 15/16	8.99	30.57
7 1/4 x 3 3/4 x 1	9.56	32.50
6 1/2 x 4 x 3/8	3.78	12.85
6 9/16 x 4 1/16 x 7/16	4.41	14.99
6 5/8 x 4 1/8 x 1/2	5.04	17.14
6 11/16 x 4 3/16 x 9/16	5.67	19.28
6 3/4 x 4 1/4 x 5/8	6.30	21.42
6 13/16 x 4 5/16 x 11/16	6.93	23.56
6 7/8 x 4 3/8 x 3/4	7.56	25.70
6 15/16 x 4 7/16 x 13/16	8.19	27.85

Size.	Area.	Weight per Foot.
7 x 4 1/2 x 7/8	8.82	29.99
7 1/16 x 4 9/16 x 15/16	9.45	32.13
7 1/8 x 4 5/8 x 1	10.08	34.27
6 x 4 x 3/8	3.60	12.24
6 1/16 x 4 1/16 x 7/16	4.22	14.35
6 1/8 x 4 1/8 x 1/2	4.84	16.46
6 3/16 x 4 3/16 x 9/16	5.46	18.56
6 x 4 x 9/16	5.31	18.05
6 1/16 x 4 1/16 x 5/8	5.93	20.16
6 1/8 x 4 1/8 x 11/16	6.55	22.27
6 3/16 x 4 3/16 x 3/4	7.17	24.38
6 1/4 x 4 1/4 x 13/16	7.79	26.49
6 5/16 x 4 5/16 x 7/8	8.41	28.59
6 3/8 x 4 3/8 x 15/16	9.03	30.70
6 7/16 x 4 7/16 x 1	9.65	32.81
6 x 3 1/2 x 3/8	3.39	11.53
6 1/16 x 3 9/16 x 7/16	3.99	13.57
6 1/8 x 3 5/8 x 1/2	4.59	15.61
6 3/16 x 3 11/16 x 9/16	5.19	17.65
6 1/4 x 3 3/4 x 5/8	5.79	19.69
6 5/16 x 3 13/16 x 11/16	6.39	21.73
6 3/8 x 3 7/8 x 3/4	6.99	23.57
6 7/16 x 3 15/16 x 13/16	7.59	25.81

PENCOYD ANGLES.

Size, area and weight per foot of various thicknesses in pounds.
Actual lengths of legs corresponding to given thicknesses.

Size.	Area.	Weight per Foot.
6 1/2 x 4 x 7/8	8.19	27.85
6 9/16 x 4 1/16 x 15/16	8.79	29.89
6 5/8 x 4 1/8 x 1	9.39	31.93
5 1/2 x 3 1/2 x 3/8	3.23	10.98
5 9/16 x 3 9/16 x 7/16	3.76	12.78
5 5/8 x 3 5/8 x 1/2	4.29	14.59
5 11/16 x 3 11/16 x 9/16	4.82	16.39
5 3/4 x 3 3/4 x 5/8	5.35	18.19
5 x 4 x 3/8	3.23	10.98
5 1/16 x 4 1/16 x 7/16	3.76	12.78
5 1/8 x 4 1/8 x 1/2	4.29	14.59
5 3/16 x 4 3/16 x 9/16	4.82	16.39
5 x 4 x 9/16	4.75	16.15
5 1/16 x 4 1/16 x 5/8	5.28	17.95
5 1/8 x 4 1/8 x 11/16	5.81	19.75
5 3/16 x 4 3/16 x 3/4	6.34	21.56
5 x 3 1/2 x 5/16	2.56	8.70
5 1/16 x 3 9/16 x 3/8	3.04	10.34
5 1/8 x 3 5/8 x 7/16	3.52	11.97
5 3/16 x 3 11/16 x 1/2	4.00	13.60

Size.	Area.	Weight per Foot.
5 1/4 x 3 3/4 x 9/16	4.48	15.23
5 5/16 x 3 13/16 x 5/8	4.96	16.86
5 3/8 x 3 7/8 x 11/16	5.44	18.50
5 7/16 x 3 15/16 x 3/4	5.92	20.13
5 x 3 x 5/16	2.40	8.16
5 1/16 x 3 1/16 x 3/8	2.85	9.69
5 1/8 x 3 1/8 x 7/16	3.30	11.22
5 3/16 x 3 3/16 x 1/2	3.75	12.75
5 x 3 x 1/2	3.72	12.65
5 1/16 x 3 1/16 x 9/16	4.17	14.18
5 1/8 x 3 1/8 x 5/8	4.62	15.71
5 3/16 x 3 3/16 x 11/16	5.07	17.24
5 1/4 x 3 1/4 x 3/4	5.52	18.77
4 1/2 x 3 x 5/16	2.27	7.72
4 9/16 x 3 1/16 x 3/8	2.70	9.18
4 5/8 x 3 1/8 x 7/16	3.13	10.64
4 11/16 x 3 3/16 x 1/2	3.56	12.10
4 3/4 x 3 1/4 x 9/16	3.99	13.57
4 13/16 x 3 5/16 x 5/8	4.42	15.03
4 7/8 x 3 3/8 x 11/16	4.85	16.49
4 15/16 x 3 7/16 x 3/4	5.28	17.95

PENCOYD ANGLES.

Size, area and weight per foot of various thicknesses in pounds.
Actual lengths of legs corresponding to given thicknesses.

Size.	Area.	Weight per Foot.	Size.	Area.	Weight per Foot.
$4 \times 3\frac{1}{2} \times \frac{5}{16}$	2.27	7.72	$3\frac{1}{2} \times 3 \times \frac{5}{16}$	1.93	6.56
$4\frac{1}{16} \times 3\frac{9}{16} \times \frac{3}{8}$	2.70	9.18	$3\frac{9}{16} \times 3\frac{1}{16} \times \frac{3}{8}$	2.32	7.89
$4\frac{1}{8} \times 3\frac{5}{8} \times \frac{7}{16}$	3.13	10.64	$3\frac{5}{8} \times 3\frac{1}{8} \times \frac{7}{16}$	2.70	9.18
$4\frac{3}{16} \times 3\frac{11}{16} \times \frac{1}{2}$	3.56	12.10	$3\frac{11}{16} \times 3\frac{3}{16} \times \frac{1}{2}$	3.09	10.51
$4\frac{1}{4} \times 3\frac{3}{4} \times \frac{9}{16}$	3.99	13.57	$3\frac{3}{4} \times 3\frac{1}{4} \times \frac{9}{16}$	3.48	11.83
$4\frac{5}{16} \times 3\frac{13}{16} \times \frac{5}{8}$	4.42	15.03	$3\frac{13}{16} \times 3\frac{5}{16} \times \frac{5}{8}$	3.86	13.12
$4\frac{3}{8} \times 3\frac{7}{8} \times \frac{11}{16}$	4.85	16.49			
$4\frac{7}{16} \times 3\frac{15}{16} \times \frac{3}{4}$	5.28	17.95	$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	1.45	4.93
			$3\frac{9}{16} \times 2\frac{9}{16} \times \frac{5}{16}$	1.78	6.05
$4 \times 3 \times \frac{5}{16}$	2.09	7.11	$3\frac{5}{8} \times 2\frac{5}{8} \times \frac{3}{8}$	2.11	7.17
$4\frac{1}{16} \times 3\frac{1}{16} \times \frac{3}{8}$	2.51	8.53	$3\frac{11}{16} \times 2\frac{11}{16} \times \frac{7}{16}$	2.44	8.30
$4\frac{1}{8} \times 3\frac{1}{8} \times \frac{7}{16}$	2.93	9.96	$3\frac{3}{4} \times 2\frac{3}{4} \times \frac{1}{2}$	2.77	9.42
$4 \times 3 \times \frac{7}{16}$	2.87	9.76	$3\frac{1}{2} \times 2 \times \frac{15}{64}$	1.21	4.11
$4\frac{1}{16} \times 3\frac{1}{16} \times \frac{1}{2}$	3.29	11.19	$3\frac{1}{2} \times 2 \times \frac{1}{4}$	1.31	4.45
$4\frac{1}{8} \times 3\frac{1}{8} \times \frac{9}{16}$	3.71	12.61	$3\frac{9}{16} \times 2\frac{1}{16} \times \frac{5}{16}$	1.64	5 58
$4\frac{3}{16} \times 3\frac{3}{16} \times \frac{5}{8}$	4.13	14.04	$3\frac{5}{8} \times 2\frac{1}{8} \times \frac{3}{8}$	1.97	6.70

PENCOYD ANGLES.

Size, area and weight per foot of various thicknesses in pounds.
Actual lengths of legs corresponding to given thicknesses.

Size.	Area.	Weight per Foot.	Size.	Area.	Weight per Foot.
$3 \times 2\frac{1}{2} \times \frac{1}{4}$	1.31	4.45	$2\frac{3}{4} \times 2\frac{1}{4} \times \frac{7}{16}$	1.86	6.32
$3\frac{1}{16} \times 2\frac{9}{16} \times \frac{5}{16}$	1.64	5.58	$2\frac{13}{16} \times 2\frac{5}{16} \times \frac{1}{2}$	2.12	7.21
$3\frac{1}{8} \times 2\frac{5}{8} \times \frac{3}{8}$	1.97	6.70			
$3\frac{3}{16} \times 2\frac{11}{16} \times \frac{7}{16}$	2.30	7.82	$2\frac{1}{4} \times 1\frac{1}{2} \times \frac{3}{16}$	0.67	2.28
$3\frac{1}{4} \times 2\frac{3}{4} \times \frac{1}{2}$	2.63	8.94	$2\frac{5}{16} \times 1\frac{9}{16} \times \frac{1}{4}$	0.89	3.03
			$2\frac{3}{8} \times 1\frac{5}{8} \times \frac{5}{16}$	1.11	3.74
			$2\frac{7}{16} \times 1\frac{11}{16} \times \frac{3}{8}$	1.34	4.56
$3 \times 2 \times \frac{1}{4}$	1.20	4.08			
$3\frac{1}{16} \times 2\frac{1}{16} \times \frac{5}{16}$	1.50	5.10	$2 \times 1\frac{1}{2} \times \frac{3}{16}$	0.62	2.11
$3\frac{1}{8} \times 2\frac{1}{8} \times \frac{3}{8}$	1.80	6.12	$2\frac{1}{16} \times 1\frac{9}{16} \times \frac{1}{4}$	0.84	2.87
$3\frac{3}{16} \times 2\frac{3}{16} \times \frac{7}{16}$	2.10	7.14	$2\frac{1}{8} \times 1\frac{5}{8} \times \frac{5}{16}$	1.07	3.65
$3\frac{1}{4} \times 2\frac{1}{4} \times \frac{1}{2}$	2.40	8.16	$2\frac{3}{16} \times 1\frac{11}{16} \times \frac{3}{8}$	1.31	4.46
$2\frac{1}{2} \times 2 \times \frac{3}{16}$	0.79	2.69	$2 \times 1\frac{1}{4} \times \frac{3}{16}$	0.57	1.94
$2\frac{9}{16} \times 2\frac{1}{16} \times \frac{1}{4}$	1.05	3.57	$2\frac{1}{16} \times 1\frac{5}{16} \times \frac{1}{4}$	0.78	2.65
$2\frac{5}{8} \times 2\frac{1}{8} \times \frac{5}{16}$	1.31	4.45	$2\frac{1}{8} \times 1\frac{3}{8} \times \frac{5}{16}$	0.98	3.33
$2\frac{11}{16} \times 2\frac{3}{16} \times \frac{3}{8}$	1.59	5.41	$2\frac{3}{16} \times 1\frac{7}{16} \times \frac{3}{8}$	1.17	3.98

NOTE.—In angles with uneven legs, the length of the long leg and the thickness of the short leg is a little less than that given in the tables.

ROUND AND SQUARE BARS.

Sectional area in inches × 3.4 = weight per lineal foot in pounds.

Thickness or Diameter in Inches.	*Weight per Lineal Foot in Pounds.* Round ●	*Weight per Lineal Foot in Pounds.* Square ■	*Area of ◯ in Sq. Ins.*	*Area of ▢ in Sq. Ins.*	*Circumference of ◯ in Inches.*	*Thickness or Diameter in Inches.*
0						0
1/16	**.010**	**.013**	.0031	.0039	.1963	1/16
1/8	**.042**	**.053**	.0123	.0156	.3927	1/8
3/16	**.094**	**.119**	.0276	.0352	.5890	3/16
1/4	**.167**	**.212**	.0491	.0625	.7854	1/4
5/16	**.261**	**.333**	.0767	.0977	.9817	5/16
3/8	**.375**	**.478**	.1104	.1406	1.1781	3/8
7/16	**.511**	**.651**	.1503	.1914	1.3744	7/16
1/2	**.667**	**.850**	.1963	.2500	1.5708	1/2
9/16	**.845**	**1.076**	.2485	.3164	1.7671	9/16
5/8	**1.043**	**1.328**	.3068	.3906	1.9635	5/8
11/16	**1.259**	**1.608**	.3712	.4727	2.1598	11/16
3/4	**1.502**	**1.913**	.4418	.5625	2.3562	3/4
13/16	**1.763**	**2.245**	.5185	.6602	2.5525	13/16
7/8	**2.044**	**2.603**	.6013	.7656	2.7489	7/8
15/16	**2.347**	**2.989**	.6903	.8789	2.9452	15/16
1	**2.670**	**3.400**	.7854	1.0000	3.1416	1
1/16	**3.014**	**3.838**	.8866	1.1289	3.3379	1/16
1/8	**3.379**	**4.303**	.9940	1.2656	3.5343	1/8
3/16	**3.766**	**4.795**	1.1075	1.4102	3.7306	3/16
1/4	**4.173**	**5.312**	1.2272	1.5625	3.9270	1/4
5/16	**4.600**	**5.857**	1.3530	1.7227	4.1233	5/16
3/8	**5.049**	**6.428**	1.4849	1.8906	4.3197	3/8
7/16	**5.518**	**7.026**	1.6230	2.0664	4.5160	7/16
1/2	**6.008**	**7.650**	1.7671	2.2500	4.7124	1/2
9/16	**6.520**	**8.301**	1.9175	2.4414	4.9087	9/16
5/8	**7.051**	**8.978**	2.0739	2.6406	5.1051	5/8
11/16	**7.604**	**9.682**	2.2365	2.8477	5.3014	11/16
3/4	**8.178**	**10.41**	2.4053	3.0625	5.4978	3/4
13/16	**8.773**	**11.17**	2.5802	3.2852	5.6941	13/16
7/8	**9.388**	**11.95**	2.7612	3.5156	5.8905	7/8
15/16	**10.03**	**12.76**	2.9483	3.7539	6.0868	15/16

ROUND AND SQUARE BARS.

Sectional area in inches × 3.4 = weight per lineal foot in pounds.

Thickness or Diameter in Inches.	*Weight per Lineal Foot in Pounds.* Round ●	*Weight per Lineal Foot in Pounds.* Square ■	*Area of ◯ in Sq. Ins.*	*Area of ▢ in Sq. Ins.*	*Circumference of ◯ in Inches.*	*Thickness or Diameter in Inches.*
2	**10.68**	**13.60**	3.1416	4.0000	6.2832	2
1/16	**11.36**	**14.46**	3.3410	4.2539	6.4795	1/16
1/8	**12.06**	**15.35**	3.5466	4.5156	6.6759	1/8
3/16	**12.78**	**16.27**	3.7583	4.7852	6.8722	3/16
1/4	**13.52**	**17.22**	3.9761	5.0625	7.0686	1/4
5/16	**14.28**	**18.19**	4.2000	5.3477	7.2649	5/16
3/8	**15.07**	**19.18**	4.4301	5.6406	7.4613	3/8
7/16	**15.86**	**20.20**	4.6664	5.9414	7.6576	7/16
1/2	**16.69**	**21.25**	4.9087	6.2500	7.8540	1/2
9/16	**17.53**	**22.33**	5.1572	6.5664	8.0503	9/16
5/8	**18.40**	**23.43**	5.4119	6.8906	8.2467	5/8
11/16	**19.29**	**24.56**	5.6727	7.2227	8.4430	11/16
3/4	**20.20**	**25.71**	5.9396	7.5625	8.6394	3/4
13/16	**21.12**	**26.90**	6.2126	7.9102	8.8357	13/16
7/8	**22.07**	**28.10**	6.4918	8.2656	9.0321	7/8
15/16	**23.04**	**29.34**	6.7771	8.6289	9.2284	15/16
3	**24.03**	**30.60**	7.0686	9.0000	9.4248	3
1/16	**25.04**	**31.89**	7.3662	9.3789	9.6211	1/16
1/8	**26.08**	**33.20**	7.6699	9.7656	9.8175	1/8
3/16	**27.13**	**34.55**	7.9798	10.160	10.014	3/16
1/4	**28.20**	**35.91**	8.2958	10.563	10.210	1/4
5/16	**29.00**	**37.31**	8.6179	10.973	10.407	5/16
3/8	**30.42**	**38.73**	8.9462	11.391	10.603	3/8
7/16	**31.56**	**40.18**	9.2806	11.816	10.799	7/16
1/2	**32.71**	**41.65**	9.6211	12.250	10.996	1/2
9/16	**33.89**	**43.15**	9.9678	12.691	11.192	9/16
5/8	**35.09**	**44.68**	10.321	13.141	11.388	5/8
11/16	**36.31**	**46.24**	10.680	13.598	11.585	11/16
3/4	**37.56**	**47.82**	11.045	14.063	11.781	3/4
13/16	**38.81**	**49.42**	11.416	14.535	11.977	13/16
7/8	**40.10**	**51.05**	11.793	15.016	12.174	7/8
15/16	**41.40**	**52.71**	12.177	15.504	12.370	15/16

ROUND AND SQUARE BARS.

Sectional area in inches × 3.4 = weight per lineal foot in pounds.

Thickness or Diameter in Inches.	Weight per Lineal Foot in Pounds. Round ●	Weight per Lineal Foot in Pounds. Square ■	Area of ● in Sq. Ins.	Area of ■ in Sq. Ins.	Circumference of ○ in Inches.	Thickness or Diameter in Inches.
4	**42.73**	**54.40**	12.566	16.000	12.566	4
1/16	**44.07**	**56.11**	12.962	16.504	12.763	1/16
1/8	**45.44**	**57.85**	13.364	17.016	12.959	1/8
3/16	**46.83**	**59.62**	13.772	17.535	13.155	3/16
1/4	**48.24**	**61.41**	14.186	18.063	13.352	1/4
5/16	**49.66**	**63.23**	14.607	18.598	13.548	5/16
3/8	**51.11**	**65.08**	15.033	19.141	13.744	3/8
7/16	**52.58**	**66.95**	15.466	19.691	13.941	7/16
1/2	**54.07**	**68.85**	15.904	20.250	14.137	1/2
9/16	**55.59**	**70.78**	16.349	20.816	14.334	9/16
5/8	**57.12**	**72.73**	16.800	21.391	14.530	5/8
11/16	**58.67**	**74.70**	17.257	21.973	14.726	11/16
3/4	**60.22**	**76.71**	17.721	22.563	14.923	3/4
13/16	**61.84**	**78.74**	18.190	23.160	15.119	13/16
7/8	**63.46**	**80.80**	18.665	23.766	15.315	7/8
15/16	**65.09**	**82.88**	19.147	24.379	15.512	15/16
5	**66.76**	**85.00**	19.635	25.000	15.708	5
1/16	**68.44**	**87.14**	20.129	25.629	15.904	1/16
1/8	**70.14**	**89.30**	20.629	26.266	16.101	1/8
3/16	**71.86**	**91.49**	21.135	26.910	16.297	3/16
1/4	**73.60**	**93.72**	21.648	27.563	16.493	1/4
5/16	**75.37**	**95.96**	22.166	28.223	16.690	5/16
3/8	**77.15**	**98.23**	22.691	28.891	16.886	3/8
7/16	**78.95**	**100.5**	23.221	29.566	17.082	7/16
1/2	**80.77**	**102.8**	23.758	30.250	17.279	1/2
9/16	**82.62**	**105.2**	24.301	30.941	17.475	9/16
5/8	**84.49**	**107.6**	24.850	31.641	17.671	5/8
11/16	**86.38**	**110.0**	25.406	32.348	17.868	11/16
3/4	**88.29**	**112.4**	25.967	33.063	18.064	3/4
13/16	**90.22**	**114.9**	26.535	33.785	18.261	13/16
7/8	**92.17**	**117.4**	27.109	34.516	18.457	7/8
15/16	**94.14**	**119.9**	27.688	35.254	18.653	15/16

ROUND AND SQUARE BARS.

Sectional area in inches × 3.4 = weight per lineal foot in pounds.

Thickness or Diameter in Inches.	Weight per Lineal Foot in Pounds. Round ●	Weight per Lineal Foot in Pounds. Square ■	Area of ● in Sq. Ins.	Area of ■ in Sq. Ins.	Circumference of ○ in Inches.	Thickness or Diameter in Inches.
6	**96.14**	**122.4**	28.274	36.000	18.850	6
1/16	**98.14**	**125.0**	28.866	36.754	19.046	1/16
1/8	**100.2**	**127.6**	29.465	37.516	19.242	1/8
3/16	**102.2**	**130.2**	30.069	38.285	19.439	3/16
1/4	**104.3**	**132.8**	30.680	39.063	19.635	1/4
5/16	**106.4**	**135.5**	31.296	39.848	19.831	5/16
3/8	**108.5**	**138.2**	31.919	40.641	20.028	3/8
7/16	**110.7**	**140.9**	32.548	41.441	20.224	7/16
1/2	**112.8**	**143.6**	33.183	42.250	20.420	1/2
9/16	**115.0**	**146.5**	33.824	43.066	20.617	9/16
5/8	**117.2**	**149.2**	34.472	43.891	20.813	5/8
11/16	**119.4**	**152.1**	35.125	44.723	21.009	11/16
3/4	**121.7**	**154.9**	35.785	45.563	21.206	3/4
13/16	**123.9**	**157.8**	36.450	46.410	21.402	13/16
7/8	**126.2**	**160.7**	37.122	47.266	21.598	7/8
15/16	**128.5**	**163.6**	37.800	48.129	21.795	15/16
7	**132.2**	**166.6**	38.485	49.000	21.991	7
1/16	**130.8**	**166.6**	39.175	49.879	22.187	1/16
1/8	**135.6**	**172.6**	39.871	50.766	22.384	1/8
3/16	**137.9**	**175.6**	40.574	51.660	22.580	3/16
1/4	**140.4**	**178.7**	41.282	52.563	22.777	1/4
5/16	**142.8**	**181.8**	41.997	53.473	22.973	5/16
3/8	**145.2**	**184.9**	42.718	54.391	23.169	3/8
7/16	**147.7**	**188.1**	43.445	55.316	23.366	7/16
1/2	**150.2**	**191.3**	44.179	56.250	23.562	1/2
9/16	**152.7**	**194.4**	44.918	57.191	23.758	9/16
5/8	**155.2**	**197.7**	45.664	58.141	23.955	5/8
11/16	**158.0**	**201.0**	46.415	59.098	24.151	11/16
3/4	**160.3**	**204.2**	47.173	60.063	24.347	3/4
13/16	**163.0**	**207.6**	47.937	61.035	24.544	13/16
7/8	**165.6**	**210.8**	48.707	62.016	24.740	7/8
15/16	**168.2**	**214.2**	49.483	63.004	24.936	15/16

FLAT BARS.

SECTIONAL AREAS AND WEIGHTS PER LINEAL FOOT.

Width in Inches.	$\frac{1}{16}''$ Thick.		$\frac{1}{8}''$ Thick.		$\frac{3}{16}''$ Thick.		Width in Inches.
	Lbs. per Foot.	Area in Sq. Ins.	Lbs. per Foot.	Area in Sq. Ins.	Lbs. per Foot.	Area in Sq. Ins.	
1	**.213**	.063	**.425**	.125	**.638**	.188	1
1 1/8	**.238**	.070	**.478**	.141	**.719**	.211	1 1/8
1 1/4	**.265**	.078	**.531**	.156	**.797**	.234	1 1/4
1 3/8	**.292**	.086	**.584**	.172	**.876**	.258	1 3/8
1 1/2	**.320**	.094	**.638**	.188	**.957**	.281	1 1/2
1 5/8	**.346**	.102	**.691**	.203	**1.04**	.305	1 5/8
1 3/4	**.372**	.109	**.744**	.219	**1.11**	.328	1 3/4
1 7/8	**.399**	.117	**.797**	.234	**1.19**	.352	1 7/8
2	**.425**	.125	**.850**	.250	**1.28**	.375	2
2 1/8	**.452**	.133	**.904**	.266	**1.36**	.398	2 1/8
2 1/4	**.478**	.141	**.957**	.281	**1.44**	.422	2 1/4
2 3/8	**.505**	.148	**1.01**	.297	**1.51**	.445	2 3/8
2 1/2	**.531**	.156	**1.06**	.313	**1.59**	.469	2 1/2
2 5/8	**.558**	.164	**1.11**	.328	**1.67**	.492	2 5/8
2 3/4	**.584**	.172	**1.17**	.344	**1.75**	.516	2 3/4
2 7/8	**.611**	.180	**1.22**	.359	**1.84**	.539	2 7/8
3	**.638**	.188	**1.28**	.375	**1.91**	.563	3
3 1/4	**.691**	.203	**1.38**	.406	**2.07**	.609	3 1/4
3 1/2	**.744**	.219	**1.49**	.438	**2.23**	.656	3 1/2
3 3/4	**.797**	.234	**1.59**	.469	**2.39**	.703	3 3/4
4	**.850**	.250	**1.70**	.500	**2.55**	.750	4
4 1/4	**.903**	.266	**1.81**	.531	**2.71**	.797	4 1/4
4 1/2	**.957**	.281	**1.92**	.563	**2.87**	.844	4 1/2
4 3/4	**1.01**	.297	**2.02**	.594	**3.03**	.891	4 3/4
5	**1.06**	.313	**2.12**	.625	**3.19**	.938	5
5 1/4	**1.11**	.328	**2.23**	.656	**3.35**	.984	5 1/4
5 1/2	**1.17**	.344	**2.34**	.688	**3.51**	1.03	5 1/2
5 3/4	**1.22**	.359	**2.45**	.719	**3.67**	1.08	5 3/4
6	**1.28**	.375	**2.55**	.750	**3.83**	1.13	6
6 1/2	**1.38**	.406	**2.76**	.813	**4.14**	1.22	6 1/2
7	**1.49**	.438	**2.98**	.875	**4.66**	1.31	7
8	**1.70**	.500	**3.40**	1.00	**5.10**	1.50	8
9	**1.92**	.563	**3.83**	1.13	**5.74**	1.69	9
10	**2.12**	.625	**4.25**	1.25	**6.38**	1.88	10
11	**2.34**	.688	**4.67**	1.38	**7.02**	2.06	11
12	**2.55**	.750	**5.10**	1.50	**7.65**	2.25	12

FLAT BARS.

SECTIONAL AREAS AND WEIGHTS PER LINEAL FOOT.

Width in Inches.	$\frac{1}{4}''$ Thick.		$\frac{5}{16}''$ Thick.		$\frac{3}{8}''$ Thick.		Width in Inches.
	Lbs. per Foot.	Area in Sq. Ins.	Lbs. per Foot.	Area in Sq. Ins.	Lbs. per Foot.	Area in Sq. Ins.	
1	**.850**	.250	**1.06**	.313	**1.28**	.375	1
1 1/8	**.957**	.281	**1.19**	.352	**1.44**	.422	1 1/8
1 1/4	**1.06**	.313	**1.33**	.391	**1.59**	.469	1 1/4
1 3/8	**1.17**	.344	**1.46**	.430	**1.75**	.516	1 3/8
1 1/2	**1.28**	.375	**1.59**	.469	**1.92**	.563	1 1/2
1 5/8	**1.39**	.406	**1.72**	.508	**2.07**	.609	1 5/8
1 3/4	**1.49**	.438	**1.86**	.547	**2.23**	.656	1 3/4
1 7/8	**1.59**	.469	**1.99**	.586	**2.39**	.703	1 7/8
2	**1.70**	.500	**2.12**	.625	**2.55**	.750	2
2 1/8	**1.81**	.531	**2.25**	.664	**2.70**	.797	2 1/8
2 1/4	**1.92**	.563	**2.39**	.703	**2.87**	.844	2 1/4
2 3/8	**2.02**	.594	**2.52**	.742	**3.03**	.891	2 3/8
2 1/2	**2.12**	.625	**2.65**	.781	**3.19**	.938	2 1/2
2 5/8	**2.23**	.656	**2.78**	.820	**3.35**	.984	2 5/8
2 3/4	**2.34**	.688	**2.92**	.859	**3.51**	1.03	2 3/4
2 7/8	**2.45**	.719	**3.06**	.898	**3.67**	1.08	2 7/8
3	**2.55**	.750	**3.19**	.938	**3.83**	1.13	3
3 1/4	**2.76**	.813	**3.45**	1.02	**4.15**	1.22	3 1/4
3 1/2	**2.98**	.875	**3.72**	1.09	**4.47**	1.31	3 1/2
3 3/4	**3.19**	.938	**3.99**	1.17	**4.78**	1.41	3 3/4
4	**3.40**	1.00	**4.25**	1.25	**5.10**	1.50	4
4 1/4	**3.61**	1.06	**4.52**	1.33	**5.42**	1.59	4 1/4
4 1/2	**3.83**	1.13	**4.78**	1.41	**5.74**	1.69	4 1/2
4 3/4	**4.04**	1.19	**5.05**	1.48	**6.06**	1.78	4 3/4
5	**4.25**	1.25	**5.31**	1.56	**6.38**	1.88	5
5 1/4	**4.46**	1.31	**5.58**	1.64	**6.69**	1.97	5 1/4
5 1/2	**4.67**	1.38	**5.84**	1.72	**7.02**	2.06	5 1/2
5 3/4	**4.89**	1.44	**6.11**	1.80	**7.34**	2.16	5 3/4
6	**5.10**	1.50	**6.38**	1.88	**7.65**	2.25	6
6 1/2	**5.53**	1.63	**6.90**	2.03	**8.29**	2.44	6 1/2
7	**5.95**	1.75	**7.44**	2.19	**8.93**	2.63	7
8	**6.80**	2.00	**8.50**	2.50	**10.2**	3.00	8
9	**7.65**	2.25	**9.56**	2.81	**11.48**	3.38	9
10	**8.50**	2.50	**10.64**	3.13	**12.75**	3.75	10
11	**9.35**	2.75	**11.70**	3.44	**14.03**	4.13	11
12	**10.2**	3.00	**12.75**	3.75	**15.30**	4.50	12

FLAT BARS.

SECTIONAL AREAS AND WEIGHTS PER LINEAL FOOT.

Width in Inches.	7/16" Thick. Lbs. per Foot.	7/16" Thick. Area in Sq. Ins.	1/2" Thick. Lbs. per Foot.	1/2" Thick. Area in Sq. Ins.	9/16" Thick. Lbs. per Foot.	9/16" Thick. Area in Sq. Ins.	Width in Inches.
1	**1.49**	.438	**1.70**	.500	**1.92**	.563	1
1 1/8	**1.67**	.481	**1.91**	.563	**2.10**	.618	1 1/8
1 1/4	**1.86**	.547	**2.12**	.625	**2.39**	.703	1 1/4
1 3/8	**2.05**	.602	**2.34**	.688	**2.63**	.773	1 3/8
1 1/2	**2.23**	.656	**2.55**	.750	**2.87**	.844	1 1/2
1 5/8	**2.42**	.711	**2.76**	.813	**3.11**	.914	1 5/8
1 3/4	**2.60**	.766	**2.98**	.875	**3.35**	.984	1 3/4
1 7/8	**2.78**	.820	**3.18**	.938	**3.57**	1.05	1 7/8
2	**2.98**	.875	**3.40**	1.00	**3.83**	1.13	2
2 1/8	**3.16**	.930	**3.61**	1.06	**4.08**	1.20	2 1/8
2 1/4	**3.35**	.984	**3.83**	1.13	**4.30**	1.27	2 1/4
2 3/8	**3.53**	1.04	**4.04**	1.19	**4.55**	1.34	2 3/8
2 1/2	**3.72**	1.09	**4.25**	1.25	**4.78**	1.41	2 1/2
2 5/8	**3.91**	1.15	**4.47**	1.31	**5.02**	1.48	2 5/8
2 3/4	**4.09**	1.20	**4.67**	1.38	**5.26**	1.55	2 3/4
2 7/8	**4.28**	1.26	**4.89**	1.44	**5.50**	1.62	2 7/8
3	**4.46**	1.31	**5.10**	1.50	**5.74**	1.69	3
3 1/4	**4.83**	1.42	**5.53**	1.63	**6.22**	1.83	3 1/4
3 1/2	**5.20**	1.53	**5.95**	1.75	**6.70**	1.97	3 1/2
3 3/4	**5.58**	1.64	**6.38**	1.88	**7.17**	2.11	3 3/4
4	**5.95**	1.75	**6.80**	2.00	**7.65**	2.25	4
4 1/4	**6.32**	1.86	**7.22**	2.13	**8.13**	2.39	4 1/4
4 1/2	**6.70**	1.97	**7.65**	2.25	**8.61**	2.53	4 1/2
4 3/4	**7.07**	2.08	**8.08**	2.38	**9.09**	2.67	4 3/4
5	**7.44**	2.19	**8.50**	2.50	**9.57**	2.81	5
5 1/4	**7.81**	2.30	**8.93**	2.63	**10.04**	2.95	5 1/4
5 1/2	**8.18**	2.41	**9.35**	2.75	**10.52**	3.09	5 1/2
5 3/4	**8.56**	2.52	**9.77**	2.88	**11.00**	3.23	5 3/4
6	**8.93**	2.63	**10.20**	3.00	**11.48**	3.38	6
6 1/2	**9.67**	2.84	**11.05**	3.25	**12.43**	3.66	6 1/2
7	**10.41**	3.06	**11.90**	3.50	**13.39**	3.94	7
8	**11.90**	3.50	**13.60**	4.00	**15.30**	4.50	8
9	**13.40**	3.94	**15.30**	4.50	**17.22**	5.06	9
10	**14.88**	4.38	**17.00**	5.00	**19.14**	5.63	10
11	**16.36**	4.81	**18.70**	5.50	**21.05**	6.19	11
12	**17.85**	5.25	**20.40**	6.00	**22.95**	6.75	12

FLAT BARS.

SECTIONAL AREAS AND WEIGHTS PER LINEAL FOOT.

Width in Inches.	5/8" Thick. Lbs. per Foot.	5/8" Thick. Area in Sq. Ins.	11/16" Thick. Lbs. per Foot.	11/16" Thick. Area in Sq. Ins.	3/4" Thick. Lbs. per Foot.	3/4" Thick. Area in Sq. Ins.	Width in Inches.
1	**2.12**	.625	**2.34**	.688	**2.55**	.750	1
1 1/8	**2.39**	.687	**2.57**	.756	**2.86**	.825	1 1/8
1 1/4	**2.65**	.781	**2.92**	.859	**3.19**	.938	1 1/4
1 3/8	**2.92**	.859	**3.21**	.945	**3.51**	1.03	1 3/8
1 1/2	**3.19**	.938	**3.51**	1.03	**3.83**	1.13	1 1/2
1 5/8	**3.46**	1.02	**3.80**	1.12	**4.14**	1.22	1 5/8
1 3/4	**3.72**	1.09	**4.09**	1.20	**4.47**	1.31	1 3/4
1 7/8	**3.99**	1.17	**4.39**	1.29	**4.78**	1.41	1 7/8
2	**4.25**	1.25	**4.67**	1.38	**5.10**	1.50	2
2 1/8	**4.52**	1.33	**4.97**	1.46	**5.42**	1.59	2 1/8
2 1/4	**4.78**	1.41	**5.26**	1.55	**5.74**	1.69	2 1/4
2 3/8	**5.05**	1.48	**5.55**	1.63	**6.06**	1.78	2 3/8
2 1/2	**5.31**	1.56	**5.84**	1.72	**6.38**	1.88	2 1/2
2 5/8	**5.58**	1.64	**6.13**	1.80	**6.69**	1.97	2 5/8
2 3/4	**5.84**	1.72	**6.43**	1.89	**7.02**	2.06	2 3/4
2 7/8	**6.11**	1.80	**6.72**	1.98	**7.33**	2.16	2 7/8
3	**6.38**	1.88	**7.02**	2.06	**7.65**	2.25	3
3 1/4	**6.91**	2.03	**7.60**	2.23	**8.29**	2.44	3 1/4
3 1/2	**7.44**	2.19	**8.18**	2.41	**8.93**	2.63	3 1/2
3 3/4	**7.97**	2.34	**8.76**	2.58	**9.57**	2.81	3 3/4
4	**8.50**	2.50	**9.35**	2.75	**10.20**	3.00	4
4 1/4	**9.03**	2.66	**9.93**	2.92	**10.84**	3.19	4 1/4
4 1/2	**9.57**	2.81	**10.52**	3.09	**11.48**	3.38	4 1/2
4 3/4	**10.10**	2.97	**11.11**	3.27	**12.12**	3.56	4 3/4
5	**10.63**	3.13	**11.69**	3.44	**12.75**	3.75	5
5 1/4	**11.16**	3.28	**12.27**	3.61	**13.39**	3.94	5 1/4
5 1/2	**11.69**	3.44	**12.85**	3.78	**14.03**	4.13	5 1/2
5 3/4	**12.22**	3.59	**13.44**	3.95	**14.67**	4.31	5 3/4
6	**12.75**	3.75	**14.03**	4.13	**15.30**	4.50	6
6 1/2	**13.81**	4.06	**15.20**	4.47	**16.58**	4.88	6 1/2
7	**14.87**	4.38	**16.36**	4.81	**17.85**	5.25	7
8	**17.00**	5.00	**18.70**	5.50	**20.40**	6.00	8
9	**19.13**	5.63	**21.04**	6.19	**22.95**	6.75	9
10	**21.25**	6.25	**23.38**	6.88	**25.50**	7.50	10
11	**23.38**	6.88	**25.71**	7.56	**28.05**	8.25	11
12	**25.50**	7.50	**28.05**	8.25	**30.60**	9.00	12

FLAT BARS.

SECTIONAL AREAS AND WEIGHTS PER LINEAL FOOT.

Width in Inches.	13/16″ Thick.		7/8″ Thick.		15/16″ Thick.		Width in Inches.
	Lbs. per Foot.	Area in Sq. Ins.	Lbs. per Foot.	Area in Sq. Ins.	Lbs. per Foot.	Area in Sq. Ins.	
1	**2.76**	.813	**2.98**	.875	**3.19**	.938	1
1⅛	**3.03**	.893	**3.35**	.962	**3.51**	1.03	1⅛
1¼	**3.45**	1.02	**3.72**	1.09	**3.99**	1.17	1¼
1⅜	**3.80**	1.12	**4.09**	1.20	**4.39**	1.29	1⅜
1½	**4.14**	1.22	**4.47**	1.31	**4.78**	1.41	1½
1⅝	**4.49**	1.32	**4.83**	1.42	**5.18**	1.52	1⅝
1¾	**4.83**	1.42	**5.20**	1.53	**5.58**	1.64	1¾
1⅞	**5.18**	1.52	**5.58**	1.64	**5.98**	1.76	1⅞
2	**5.53**	1.63	**5.95**	1.75	**6.38**	1.88	2
2⅛	**5.88**	1.73	**6.32**	1.86	**6.77**	1.99	2⅛
2¼	**6.21**	1.83	**6.69**	1.97	**7.17**	2.11	2¼
2⅜	**6.56**	1.93	**7.07**	2.08	**7.57**	2.23	2⅜
2½	**6.91**	2.03	**7.44**	2.19	**7.97**	2.34	2½
2⅝	**7.25**	2.13	**7.81**	2.30	**8.36**	2.46	2⅝
2¾	**7.60**	2.23	**8.18**	2.41	**8.77**	2.58	2¾
2⅞	**7.95**	2.34	**8.56**	2.52	**9.17**	2.70	2⅞
3	**8.29**	2.44	**8.93**	2.63	**9.57**	2.81	3
3¼	**8.98**	2.64	**9.67**	2.84	**10.36**	3.05	3¼
3½	**9.67**	2.84	**10.41**	3.06	**11.16**	3.28	3½
3¾	**10.36**	3.05	**11.16**	3.28	**11.95**	3.52	3¾
4	**11.05**	3.25	**11.90**	3.50	**12.75**	3.75	4
4¼	**11.74**	3.45	**12.65**	3.72	**13.55**	3.98	4¼
4½	**12.43**	3.66	**13.39**	3.94	**14.34**	4.22	4½
4¾	**13.12**	3.86	**14.13**	4.16	**15.14**	4.45	4¾
5	**13.81**	4.06	**14.87**	4.38	**15.94**	4.69	5
5¼	**14.50**	4.27	**15.62**	4.59	**16.74**	4.92	5¼
5½	**15.20**	4.47	**16.36**	4.81	**17.53**	5.16	5½
5¾	**15.88**	4.67	**17.11**	5.03	**18.33**	5.39	5¾
6	**16.58**	4.88	**17.85**	5.25	**19.13**	5.63	6
6½	**17.95**	5.28	**19.34**	5.69	**20.72**	6.09	6½
7	**19.34**	5.69	**20.83**	6.13	**22.32**	6.56	7
8	**22.10**	6.50	**23.80**	7.00	**25.50**	7.50	8
9	**24.86**	7.31	**26.78**	7.88	**28.69**	8.44	9
10	**27.62**	8.13	**29.75**	8.75	**31.88**	9.38	10
11	**30.39**	8.94	**32.72**	9.63	**35.06**	10.31	11
12	**33.15**	9.75	**35.70**	10.50	**38.25**	11.25	12

FLAT BARS.

SECTIONAL AREAS AND WEIGHTS PER LINEAL FOOT.

Width in Inches.	1″ Thick.		1 1/16″ Thick.		1 3/16″ Thick.		Width in Inches.
	Lbs. per Foot.	Area in Sq. Ins.	Lbs. per Foot.	Area in Sq. Ins.	Lbs. per Foot.	Area in Sq. Ins.	
1	**3.40**	1.00	**3.61**	1.06	**4.04**	1.19	1
1⅛	**3.83**	1.13	**3.97**	1.17	**4.44**	1.31	1⅛
1¼	**4.25**	1.25	**4.52**	1.33	**5.05**	1.48	1¼
1⅜	**4.67**	1.38	**4.97**	1.46	**5.55**	1.63	1⅜
1½	**5.10**	1.50	**5.42**	1.59	**6.06**	1.78	1½
1⅝	**5.53**	1.63	**5.87**	1.73	**6.56**	1.93	1⅝
1¾	**5.95**	1.75	**6.32**	1.86	**7.07**	2.08	1¾
1⅞	**6.38**	1.88	**6.77**	1.99	**7.57**	2.23	1⅞
2	**6.80**	2.00	**7.22**	2.13	**8.08**	2.38	2
2⅛	**7.22**	2.13	**7.68**	2.26	**8.58**	2.52	2⅛
2¼	**7.65**	2.25	**8.13**	2.39	**9.09**	2.67	2¼
2⅜	**8.08**	2.38	**8.58**	2.52	**9.59**	2.82	2⅜
2½	**8.50**	2.50	**9.03**	2.66	**10.10**	2.97	2½
2⅝	**8.93**	2.63	**9.49**	2.79	**10.60**	3.12	2⅝
2¾	**9.35**	2.75	**9.93**	2.92	**11.11**	3.27	2¾
2⅞	**9.77**	2.88	**10.38**	3.05	**11.61**	3.41	2⅞
3	**10.20**	3.00	**10.84**	3.19	**12.12**	3.56	3
3¼	**11.05**	3.25	**11.74**	3.45	**13.12**	3.86	3¼
3½	**11.90**	3.50	**12.65**	3.72	**14.13**	4.16	3½
3¾	**12.75**	3.75	**13.55**	3.98	**15.14**	4.45	3¾
4	**13.60**	4.00	**14.45**	4.25	**16.15**	4.75	4
4¼	**14.45**	4.25	**15.35**	4.52	**17.16**	5.05	4¼
4½	**15.30**	4.50	**16.26**	4.78	**18.17**	5.34	4½
4¾	**16.15**	4.75	**17.16**	5.05	**19.18**	5.64	4¾
5	**17.00**	5.00	**18.06**	5.31	**20.19**	5.94	5
5¼	**17.85**	5.25	**18.96**	5.58	**21.20**	6.23	5¼
5½	**18.70**	5.50	**19.87**	5.84	**22.21**	6.53	5½
5¾	**19.55**	5.75	**20.77**	6.11	**23.22**	6.83	5¾
6	**20.40**	6.00	**21.68**	6.38	**24.23**	7.13	6
6½	**22.10**	6.50	**23.48**	6.91	**26.24**	7.72	6½
7	**23.80**	7.00	**25.29**	7.44	**28.26**	8.31	7
8	**27.20**	8.00	**28.90**	8.50	**32.30**	9.50	8
9	**30.60**	9.00	**32.52**	9.56	**36.34**	10.69	9
10	**34.00**	10.00	**36.13**	10.63	**40.38**	11.88	10
11	**37.40**	11.00	**39.74**	11.69	**44.41**	13.06	11
12	**40.80**	12.00	**43.35**	12.75	**48.45**	14.25	12

WEIGHT OF STEEL PLATE, PER LINEAL FOOT, IN POUNDS.

Width in Inches.	Thickness in Inches. 1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
12	2.55	5.10	7.65	10.20	12.75	15.30	17.85	20.40	22.95	25.50	28.05	30.60	33.15	35.70	38.25	40.80
13	2.76	5.52	8.29	11.05	13.81	16.57	19.34	22.10	24.87	27.62	30.38	33.15	35.91	38.68	41.44	44.20
14	2.98	5.95	8.92	11.90	14.87	17.85	20.83	23.80	26.77	29.75	32.72	35.70	38.68	41.65	44.62	47.60
15	3.19	6.37	9.57	12.75	15.94	19.12	22.32	25.50	28.69	31.87	35.07	38.25	41.44	44.62	47.82	51.00
16	3.40	6.80	10.20	13.60	17.00	20.40	23.80	27.20	30.60	34.00	37.40	40.80	44.20	47.60	51.00	54.40
17	3.61	7.22	10.84	14.45	18.06	21.67	25.28	28.91	32.52	36.13	39.74	43.35	46.97	50.59	54.19	57.80
18	3.82	7.65	11.47	15.30	19.12	22.95	26.77	30.60	34.42	38.25	42.07	45.90	49.72	53.55	57.37	61.20
19	4.04	8.08	12.11	16.15	20.18	24.22	28.26	32.29	36.38	40.37	44.41	48.45	52.48	56.52	60.56	64.60
20	4.25	8.50	12.75	17.00	21.25	25.50	29.75	34.00	38.25	42.50	46.75	51.00	55.25	59.50	63.75	68.00
21	4.47	8.92	13.39	17.85	22.32	26.77	31.24	35.70	40.17	44.62	49.09	53.55	58.02	62.47	66.94	71.40
22	4.67	9.35	14.02	18.70	23.38	28.05	32.72	37.40	42.07	46.75	51.43	56.10	60.77	65.45	70.12	74.80
23	4.88	9.77	14.67	19.55	24.44	29.32	34.21	39.11	43.89	48.88	53.76	58.65	63.55	68.43	73.32	78.20
24	5.10	10.20	15.30	20.40	25.50	30.60	35.70	40.80	45.90	51.00	56.10	61.20	66.30	71.40	76.50	81.60
25	5.31	10.63	15.93	21.25	26.56	31.87	37.19	42.49	47.71	53.12	58.43	63.75	69.05	74.37	79.68	85.00
26	5.53	11.05	16.57	22.10	27.62	33.15	38.68	44.20	49.72	55.25	60.77	66.30	71.83	77.35	82.87	88.40
27	5.74	11.47	17.22	22.95	28.69	34.42	40.17	45.90	51.64	57.37	63.12	68.85	74.59	80.32	86.07	91.80
28	5.95	11.90	17.85	23.80	29.75	35.70	41.65	47.60	53.55	59.50	65.45	71.40	77.36	83.29	89.25	95.20

WEIGHT OF STEEL PLATE, PER LINEAL FOOT, IN POUNDS.—Continued.

Width in Inches.	Thickness in Inches. 1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
29	6.16	12.32	18.49	24.65	30.81	36.97	43.13	49.31	55.47	61.63	67.79	73.95	80.12	86.28	92.44	98.60
30	6.37	12.75	19.12	25.50	31.87	38.25	44.62	51.00	57.37	63.75	70.12	76.50	82.87	89.25	95.62	102.00
32	6.80	13.60	20.40	27.20	34.00	40.80	47.60	54.40	61.20	68.00	74.80	81.60	88.40	95.20	102.00	108.83
34	7.22	14.45	21.67	28.90	36.13	43.35	50.57	57.79	65.02	72.25	79.47	86.70	93.92	101.14	108.32	115.57
36	7.65	15.30	22.95	30.60	38.25	45.90	53.55	61.20	68.85	76.50	84.15	91.80	99.45	107.10	114.75	122.40
38	8.08	16.15	24.22	32.30	40.38	48.45	56.53	64.61	72.67	80.75	88.83	96.90	104.96	113.02	121.18	129.23
40	8.50	17.00	25.50	34.00	42.50	51.00	59.50	67.99	76.50	85.00	93.49	102.00	110.47	119.03	127.50	135.97
42	8.92	17.85	26.77	35.70	44.62	53.55	62.47	71.40	80.32	89.25	98.17	107.10	115.97	124.95	133.82	142.80
44	9.35	18.70	28.05	37.40	46.76	56.10	65.45	74.81	84.15	93.50	102.82	112.20	121.58	130.87	140.25	149.63
46	9.77	19.55	29.32	39.10	48.88	58.65	68.42	78.19	87.97	97.75	107.51	117.30	127.09	136.88	146.57	156.37
48	10.20	20.40	30.60	40.80	51.00	61.20	71.40	81.60	91.80	102.00	112.20	122.40	132.60	142.80	153.00	163.20
50	10.63	21.25	31.87	42.49	53.12	63.75	74.37	85.00	95.61	106.28	116.89	127.50	138.11	148.72	159.32	170.03
52	11.05	22.10	33.15	44.20	55.25	66.30	77.35	88.39	99.45	110.47	121.58	132.60	143.62	154.73	165.75	176.77
54	11.47	22.95	34.42	45.90	57.37	68.85	8[illegible].32	91.80	103.33	114.75	126.28	137.70	149.23	160.65	172.18	183.60
56	14.00	23.80	35.70	47.59	59.50	71.40	83.29	95.20	107.10	119.03	130.87	142.80	154.73	166.57	178.50	190.43
58	12.32	24.65	36.97	49.30	61.63	73.95	86.27	98.59	110.87	123.22	135.56	147.90	160.24	172.58	184.82	197.17
60	12.75	25.50	38.25	51.00	63.75	76.50	89.25	102.00	114.75	127.50	140.25	153.00	165.55	178.50	191.25	204.00

WEIGHT OF ROLLED SHEETS.

CALCULATIONS BASED ON SPECIFIC GRAVITY OF 7.85.

Number of Gauge.	*Birmingham Wire Gauge.*		*American (B. & S.) Wire Gauge.*	
	Thickness in Inches.	*Weight per Square Foot.*	*Thickness in Inches.*	*Weight per Square Foot.*
0000	.454	18.52	.46	18.76
000	.425	17.34	.4096	16.72
00	.38	15.50	.3648	14.88
0	.34	13.87	.3249	13.26
1	.3	12.24	.2893	11.80
2	.284	11.59	.2576	10.52
3	.259	10.56	.2294	9.36
4	.238	9.71	.2043	8.33
5	.22	8.98	.1819	7.42
6	.203	8.28	.1620	6.61
7	.18	7.34	.1443	5.88
8	.165	6.73	.1285	5.24
9	.148	6.04	.1144	4.66
10	.134	5.47	.1019	4.15
11	.12	4.89	.0907	3.70
12	.109	4.44	.0808	3.29
13	.095	3.87	.0720	2.93
14	.083	3.38	.0641	2.61
15	.072	2.94	.0571	2.32
16	.065	2.65	.0508	2.07
17	.058	2.37	.0453	1.84
18	.049	1.99	.0403	1.64
19	.042	1.71	.0359	1.46
20	.035	1.42	.0320	1.30
21	.032	1.30	.0285	1.16
22	.028	1.14	.0253	1.03
23	.025	1.02	.0226	.921
24	.022	.898	.0201	.821
25	.02	.816	.0179	.729
26	.018	.734	.0159	.651
27	.016	.653	.0142	.581
28	.014	.571	.0126	.515
29	.013	.531	.0113	.459
30	.012	.489	.0100	.409
31	.01	.408	.0089	.364
32	.009	.367	.0080	.324
33	.008	.326	.0071	.288
34	.007	.286	.0063	.257
35	.005	.204	.0056	.228
36	.004	.162	.0050	.204

OPEN-HEARTH STEEL AXLES.

Axles for locomotive and car service are made at Pencoyd of open-hearth steel, to conform to either the drop or mechanical test, as may be required.

The results below, taken as an average of a number of tests, represent the quality of material used for this purpose.

TRANSVERSE TEST.

Number of Axles.	*Diameter of Hub Seat.*	*Diameter of Centre.*	*Weight of Ram.*	*Height of Fall.*	*Number of Blows.*
14	$5\frac{1}{2}$	$4\frac{5}{8}$	1640	29	36
26	$5\frac{3}{16}$	$4\frac{3}{8}$	1640	25	37

TENSILE TEST.

	Elastic Limit.	*Ultimate Strength.*	*Elongation.*	*Reduction of Area.*
Average of 12 tests.	45320	79230	In 2″. 22.7 %	38 %

The blooms are worked at a single uniform heat, under heavy hammers, to the finished forging. Locomotive and passenger car-axles are furnished rough-turned throughout; those for freight service, with journals forged and rough-turned.

The process of manufacture thus indicated produces axles of the highest standard of excellence.

STRUCTURAL STEEL.

The strength of structural steel depends largely on the amount of the constituent elements that are associated with the iron, and each of which affect more or less the hardness and strength of the metal.

The principal of these are carbon, manganese, silicon, phosphorus and sulphur, the first-named being purposely retained as useful or necessary, the others being rejected, as far as practicable, as objectionable when in excess of certain minute proportions.

The grade and character of the steel is usually known by the percentage of contained carbon. Steel used in structures usually varies in tensile strength from 55,000 to 70,000 lbs. per square inch of section, or from .10 to .25 per cent. of carbon.

The following table exhibits the physical characteristics of Open-Hearth Basic Steel of the various grades, the results derived from an extensive series of tests indicating the tendency of a total average of the composition hereafter described to approximate to the figures given in table.

The predominant elements other than carbon averaged throughout the following series as follows: manganese, .54; phosphorus, .05; sulphur, .05 per cent. Any increase of any of these elements is attended with an increase of tensile strength and reduced ductility, and vice versa. The tensile strength of the steel is also affected to some extent by the temperature at which it is finished, and the rate of cooling, these influences being more apparent in the grades containing highest carbon. Therefore the values given have only a general significance, and individual tests may vary widely above or below the figures in the table.

For Bessemer or open-hearth acid process steel, the tensile strength will ordinarily be greater for the same percentage of carbon given in this table, for the reason that the proportions of phosphorus and sulphur, and sometimes manganese, are usually higher than in open-hearth basic steel, each of these elements contributing to strength and hardness in the steel.

OPEN-HEARTH BASIC STEEL.

Percentage of Carbon.	*Tensile Strength in Pounds per Square Inch.*		*Ductility.*	
	Ultimate Strength.	*Elastic Limit.*	*Stretch in 8 Inches.*	*Reduction of Fractured Area.*
.08	54000	32500	32 per cent.	60 per cent.
.09	54800	33000	31 "	58 "
.10	55700	33500	31 "	57 "
.11	56500	34000	30 "	56 "
.12	57400	34500	30 "	55 "
	58200	35000	29 "	54 "
.13				
.14	59100	35500	29 "	53 "
.15	60000	36000	28 "	52 "
.16	60800	36500	28 "	51 "
.17	61600	37000	27 "	50 "
.18	62500	37500	27 "	49 "
	63300	38000	26 "	48 "
.19				
.20	64200	38500	26 "	47 "
.21	65000	39000	25 "	46 "
.22	65800	39500	25 "	45 "
.23	66600	40000	24 "	44 "
.24	67400	40500	24 "	43 "
.25	68200	41000	23 "	42 "

For convenient distinguishing terms, it is customary to classify steel in three grades: "mild or soft," "medium" and "hard," and although the different grades blend into each other, so that no line of distinction exists, in a general sense the grades below .15 carbon may be considered as "soft" steel, from .15 to .30 carbon as "medium," and above that "hard" steel. Each grade has its own advantages for the particular purpose to which it is adapted. The soft steel is well adapted for boiler plate and similar uses, where its high ductility is advantageous. The medium grades are used for general structural purposes, while harder steel is especially adapted for axles and shafts, and any service where good wearing surfaces are desired. Mild steel has superior welding property as compared to hard steel, and will endure higher heat without injury. Steel below .10 carbon should be capable of doubling flat without fracture, after being chilled from a red heat in cold water. Steel of

.15 carbon will occasionally submit to the same treatment, but will usually bend around a curve whose radius is equal to the thickness of the specimen; about 90 per cent. of specimens stand the latter bending test without fracture. As the steel becomes harder, its ability to endure this bending test becomes more exceptional, and when the carbon ratio becomes .20, little over twenty-five per cent. of specimens will stand the last-described bending test. Steel having about .40 per cent. carbon will usually harden sufficiently to cut soft iron and maintain an edge.

ELASTICITY.

As the material elongates or shortens under stress, the change of length is directly proportionate to the stress, and the material recovers its original length after removal of the stress, until the elastic limit is reached, when changes of length are no longer regular and permanent set takes place, or the destruction of the material has begun.

In good material the stress at elastic limit, for either tension or compression, is usually about six-tenths of the ultimate tenacity.

The ductility, under tensile stress, is usually measured by the total elongation in a given length, or by the percentage of reduction of the fractured area, or by both.

The elasticity is measured by the change of length under stress below the elastic limit of the material. The elasticity of the various grades of steel are practically uniform, that is, each material will exhibit a uniform change of length under uniform stress below the elastic limit; but, as the elastic limit of the higher grades is greater than that of the lower or softer grades, the former will elongate or shorten to a greater extent than the latter before its elasticity is injured. This property is expressed by a modulus, which for either material will average about 29,000,000 lbs. That is, if the change of length could be extended sufficiently, it would require 29,000,000 lbs. per square inch of section to double the original length under tensile strain, or to shorten the length one-half under compression. Therefore, steel will extend or shorten $\frac{1}{29000000}$ part of its normal length, for every pound per sectional inch in change of load.

EXPANSION BY HEAT.

Soft steel or iron will extend about $\frac{1}{150000}$ part of its length for each degree F. of elevation of temperature. For a variation in temperature of 100 degrees F., the change in length will be about one inch in 125 feet.

SPECIFIC GRAVITY.

The specific gravity of steel varies according to the purity of the metal, and also according to the degree of condensation imparted by the process of rolling or forging.

As a rule, mild steel has a higher specific gravity than hard steel, and both are lower than perfectly pure iron, but about two per cent. higher than ordinary commercial iron. Structural steel in comparatively small sections having the composition denoted in the previous table of tensile strength, has the following specific gravity, corresponding to given carbon ratio:

Carbon, Per cent.	*Specific Gravity.*	*Weight per Cubic Foot in Pounds.*
.10	7.860	489.92
.20	7.858	489.80
.30	7.856	489.67

In the form of rolled beams and largest commercial sections the weight will be slightly less than this.

The tables in this book are all calculated on a basis of 489.6 lbs. per cubic foot, or the sectional area in square inches multiplied by 3.4 equals the weight in pounds per foot.

Tables for Pencoyd Beams.

THE following tables for beams give the greatest safe loads in net tons, evenly distributed, including the weight of the beam. The results are obtained by the methods described on pages 113 to 127, and correspond to an extreme fibre stress of 16,000 lbs. per square inch of section, or approximately about one-half the elastic limit of the material, presuming that very soft steel may be used.

LIMITS FOR THE SAFE LOAD.

These loads are given as the greatest safe loads, and the beams are entirely reliable for them under ordinary conditions.

As there is great diversity in published tables of safe loads for beams, everyone must judge for himself what proportion of the elastic strength of the beam will best suit his purpose.

The character of the load must be considered, and the mode of application of the same. If the load is suddenly applied, especially if accompanied by impact, the resulting dynamic stresses will not be expressed by formulæ which are derived from static consideration alone. Freedom from vibration, or excessive deflection has usually to be provided for, or the beam may be of considerable length without lateral support. In many such cases it may be necessary to take smaller loads for beams than those given in tables. In general, the following limitations of the tabulated safe loads will be proper for the specified conditions:

Character of Service.	*Greatest Safe Loads.*
Quiescent load, subject to little vibration, as in ordinary floors, etc., especially where beams are short.	As in tables.
Fluctuating loads, causing vibration, especially if the beams are long as compared to their depth.	One-fifth ($\frac{1}{5}$) less than the table.

Character of Service.	*Greatest Safe Loads.*
When loads are suddenly applied with some impact, or exposed to vibration from machinery or rapidly moving loads.	One-third ($\frac{1}{3}$) less than the table.

The beams, if of considerable length, are supposed to be braced horizontally, and it is safest to limit the application of the tabular loads to beams whose length between lateral supports does not exceed twenty times the flange width.

Our experience has been that a beam without lateral support is more stable than is commonly supposed. In an open-webbed beam, the top flange acts as a simple strut, and is liable to lateral flexure when the unsupported length is considerable. But in a solid beam the parts in tension sustain the parts in compression, and prevent the buckling which would otherwise occur.

Experiments have shown a reduction of about one-third of the normal modulus of rupture when the length of the beam becomes 80 times its flange width. But as the long beam may suffer if exposed to accidental cross strains, we recommend the greatest safe load to be reduced in such a ratio for long beams that when the length is seventy times the flange width the greatest safe loads will be reduced one-half. This will give safe loads, corresponding to given lengths, as follows :

BEAMS WITHOUT LATERAL SUPPORT.

Length of Beam.	*Proportion of Tabular Load Forming Greatest Safe Load.*
20 times flange width.	Whole tabular load.
30 " " "	$\frac{9}{10}$ " "
40 " " "	$\frac{8}{10}$ " "
50 " " "	$\frac{7}{10}$ " "
60 " " "	$\frac{6}{10}$ " "
70 " " "	$\frac{5}{10}$ " "

In the case of very short beams, unless the web is stiffened at the points of support, it will be necessary to limit the safe load to that denoted "maximum load in tons," col. xvii, pages 115 to 121, for reasons given on page 113.

DEFLECTION.

The tabular deflections are derived from the coefficients on pages 114 to 121, as described on page 113. If the load on the beam is reduced below that of the tables, the deflection will be less than that given in the tables, in the direct ratio of the loads.

The greatest safe load in the middle of the beam is exactly one-half ($\frac{1}{2}$) of the distributed load, and the deflection for the former will be eight-tenths ($\frac{8}{10}$) of the deflection corresponding to the distributed load as given in the tables. If the load is placed out of centre on the beam, it will bear the same ratio to the load at the centre that the square of half the span bears to the product of the segments of the beam formed by the position of the load.

Example.—A 15-inch No. 524 **I** beam, 16 feet between supports, will safely carry an evenly distributed load (by the tables) of 30.7 tons, and deflect under same .30 inches. The greatest safe load in the middle will be one-half the above, viz., 15.3 tons, and the resulting deflection $\frac{8}{10}$ of the former, or .24 inches.

If the weight is concentrated 3 feet out of centre, or 5 feet and 11 feet from the ends, then the square of half the span being 64, and the product of the segments being 55, the greatest safe load will be $\frac{15.3 \times 64}{55} = 17.9$ tons.

If a beam of above size and length is used without any lateral support, reduce the safe load in the ratio aforesaid. Thus the flange is 6.4 inches wide, and the length 30 times this; therefore the greatest safe load will be $\frac{9}{10}$ of the results in the example.

If beams are supported as described below, the greatest safe loads and corresponding deflections will bear the given ratios to the tabulated loads and deflections, for the same length and section of beams.

Character of Beam.	*Greatest Safe Load.*	*Deflection.*
Fixed at one end, with the load concentrated at the other end.	One-eighth ($\frac{1}{8}$) part of the tabular load.	Three and one-fifth ($3\frac{1}{5}$) times the tabular deflection.
Fixed at one end, with the load uniformly distributed.	One-fourth ($\frac{1}{4}$) part of the tabular load.	Two and two-fifths ($2\frac{2}{5}$) times the tabular deflection.
Rigidly fixed at both ends, with a load in the middle of beam.	Same as the tabular load.	Four-tenths ($\frac{4}{10}$) of the tabular deflection.
Rigidly fixed at both ends, with the load uniformly distributed.	One and one-half ($1\frac{1}{2}$) times the tabular load.	Three-tenths ($\frac{3}{10}$) of the tabular deflection.
Continuous beam loaded in middle.	Same as the tabular load.	Four-tenths ($\frac{4}{10}$) of the tabular deflection.
Continuous beam load uniformly distributed.	One and one-half ($1\frac{1}{2}$) times the tabular load.	Three-tenths ($\frac{3}{10}$) of the tabular deflection.

BEAMS WITH FIXED ENDS.

By beams "rigidly fixed," as denoted in the previous table, we mean that the beam must be so securely fastened at both ends, by being built into solid masonry, or so firmly attached to an adjacent structure, that the connection would not be severed if the beam was exposed to its ultimate load. In this case the beam is of the same character as if continuous over several supports, or as if consisting of two cantilevers, the space between whose ends was spanned by a separate beam.

CONTINUOUS BEAMS.

If a beam is continuous over several supports, and is equally loaded on each span, the greatest safe loads and the resulting deflections on any intermediate span will be as given in the preceding table. But the end spans of such a beam, being only semi-continuous, must be either of a shorter span than the intermediates, or, if of the same length, the load must be diminished.

LIMIT FOR DEFLECTION.

It is considered good practice in the case of plastered ceilings, or in other circumstances where undue deflection may be prejudicial, to proportion beams so that their deflection will not exceed $\frac{1}{30}$ of an inch per foot of span, or $\frac{1}{360}$ part of the span.

On each table the figures under the dark line (and in small type) denote cases where the deflection exceeds $\frac{1}{360}$ part of the span.

The spacing or distance transversely between centres of floor beams is given in the tables as the "greatest" that should be used for the standard minimum section. If a thicker beam than the least section is used, an addition to the greatest spacing is given in the final column. This column is derived from the basis that the resistance of any rectangular section weighing 1 lb. per lineal foot is as follows the fibre stress for either metal, as in the tables.

$\frac{5 \times \text{depth}}{102} =$ the resistance for each unit of area equivalent to 1 lb. weight per lineal foot.

Example.—A 12″ **I** beam, No. 517, is thickened to a weight of 65.5 lbs. per foot, and is used in a floor of 20 feet span, for a distributed load of 150 lbs. per square foot of floor. The addition in third column for each pound per foot is .17; $.17 \times 10$ (increased weight) $= 1.7$ tons, making greatest safe load 17.8 tons. The deflection remains .59 in. as in table. The tabular spacing of 10.75 ft. may be increased by correction in final column: $\frac{16.2 \times 10}{150} = 1.08 + 10.75 = 11.83$ ft. between beam centres. If this beam is loaded in the centre the greatest safe load will be one-half the foregoing, or 8.9 tons, and the deflection under this load will be $\frac{8}{10}$ lbs. of that for the greatest distributed load, or .47 in. If the load is reduced the deflection will be reduced in proportion.

20″ I BEAMS.—No. 531.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	6.75	Flange width,	7.05
Web Thickness,	.60	Web Thickness,	.90
Area in square inches,	22.94	Area in square inches,	28.94
Resistance,	136.74	Resistance,	156.74
Pounds per foot,	78.00	Pounds per foot,	98.4

Greatest safe load in net tons evenly distributed, including beam itself.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centre of Beam of Least Section for Distributed Load as Below.*				*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
				100 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	200 *Pounds per Sq. Foot.*	250 *Pounds per Sq. Foot.*	
10	72.93	.52	.08	145.86	97.24	72.93	58.34	108.00
11	66.30	.48	.10	120.55	80.36	60.27	48.22	89.30
12	60.77	.44	.12	101.28	67.52	50.64	40.51	75.00
13	56.11	.40	.14	86.32	57.55	43.16	34.53	63.91
14	52.09	.37	.16	74.41	49.61	37.21	29.77	55.10
15	48.62	.35	.19	64.83	43.22	32.42	25.93	48.00
16	45.58	.33	.21	56.98	37.98	28.49	22.79	42.19
17	42.90	.31	.24	50.47	33.65	25.23	20.19	37.37
18	40.51	.29	.27	45.00	30.00	22.50	18.00	33.33
19	38.38	.27	.30	40.40	26.93	20.20	16.16	29.92
20	36.46	.26	.33	36.46	24.31	18.23	14.59	27.00
21	34.72	.25	.37	33.03	22.04	16.53	13.23	24.49
22	33.15	.24	.41	30.14	20.09	15.07	12.06	22.31
23	31.71	.23	.44	27.57	18.30	13.78	11.03	20.42
24	30.39	.22	.48	25.32	16.88	12.66	10.13	18.75
25	29.17	.21	.52	23.34	15.56	11.67	9.33	17.28
26	28.05	.20	.57	21.58	14.38	10.79	8.63	15.98
27	27.01	.19	.61	20.00	13.34	10.00	8.00	14.81
28	26.05	.18	.66	18.60	12.40	9.30	7.44	13.78
29	25.15	.18	.71	17.34	11.56	8.67	6.94	12.84
30	24.31	.17	.75	16.21	10.80	8.10	6.48	12.00
31	23.52	.17	.80	15.17	10.12	7.58	6.07	11.24
32	22.79	.16	.86	14.24	9.50	7.12	5.57	10.55
33	22.10	.16	.91	13.39	8.93	6.69	5.34	9.92

20″ I BEAMS.—No. 530.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	6.25	Flange width,	6.50
Web Thickness,	.50	Web Thickness,	.75
Area in square inches,	19.04	Area in square inches,	24.04
Resistance,	114.58	Resistance,	131.24
Pounds per foot,	64.8	Pounds per foot,	81.7

Greatest safe load in net tons evenly distributed, including beam itself.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centre of Beams of Least Section for Distributed Load as Below.*				*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
				100 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	200 *Pounds per Sq. Foot.*	250 *Pounds per Sq. Foot.*	
10	61.10	.52	.08	122.20	81.47	61.10	48.88	108.00
11	55.55	.48	.10	101.00	67.33	50.50	40.40	89.30
12	50.92	.44	.12	84.86	56.58	42.43	33.95	75.00
13	47.00	.40	.14	72.30	48.21	36.15	28.92	63.91
14	43.65	.37	.16	62.36	41.57	31.18	24.94	55.10
15	40.74	.35	.19	54.32	36.21	27.16	21.73	48.00
16	38.19	.33	.21	47.74	31.83	23.87	19.09	42.19
17	35.95	.31	.24	42.29	28.20	21.15	16.92	37.37
18	33.95	.29	.27	37.72	25.15	18.86	15.09	33.33
19	32.16	.27	.30	33.85	22.57	16.92	13.54	29.92
20	30.55	.26	.33	30.55	20.37	15.27	12.22	27.00
21	29.10	.25	.37	27.71	18.48	13.85	11.08	24.49
22	27.78	.24	.41	25.25	16.84	12.63	10.10	22.31
23	26.57	.23	.44	23.14	15.40	11.57	9.24	20.42
24	25.46	.22	.48	21.22	14.14	10.61	8.49	18.75
25	24.44	.21	.52	19.55	13.03	9.77	7.82	17.28
26	23.50	.20	.57	18.08	12.05	9.04	7.23	15.98
27	22.63	.19	.61	16.76	11.17	8.38	6.71	14.81
28	21.82	.18	.66	15.57	10.39	7.78	6.23	13.78
29	21.07	.18	.71	14.53	9.69	7.26	5.81	12.84
30	20.37	.17	.75	13.58	9.05	6.79	5.43	12.00
31	19.71	.17	.80	12.72	8.48	6.36	5.09	11.24
32	19.10	.16	.86	11.94	7.96	5.97	4.78	10.55
33	18.52	.16	.91	11.22	7.48	5.61	4.37	9.92

15″ I BEAMS.—No. 524.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	6.4	Flange width,	6.70
Web thickness,	.60	Web thickness,	.90
Area in square inches,	20.38	Area in square inches,	25.03
Resistance,	94.67	Resistance,	105.23
Pounds per foot,	69.2	Pounds per foot,	85.1

Greatest safe load in net tons evenly distributed, including beam itself.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.*				*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
				100 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	200 *Pounds per Sq. Foot.*	250 *Pounds per Sq. Foot.*	
10	48.60	.42	.10	102.04	68.02	51.08	40.82	81.00
11	44.73	.38	.13	85.38	56.92	42.69	34.15	66.94
12	41.00	.35	.16	71.75	47.83	35.87	28.7	56.25
13	37.85	.32	.19	61.13	40.75	30.56	24.45	47.92
14	35.14	.30	.23	52.71	35.14	26.35	21.08	41.33
15	33.40	.28	.26	45.92	30.61	22.96	18.37	36.00
16	30.74	.25	.30	43.50	29.00	21.75	17.40	31.64
17	28.93	.24	.34	35.74	23.82	17.87	14.30	28.03
18	27.33	.23	.38	31.98	21.32	15.99	12.79	25.00
19	25.34	.22	.42	28.01	15.34	14.00	11.20	22.24
20	24.60	.22	.47	25.83	17.22	12.91	10.33	20.25
21	23.43	.20	.51	22.31	14.87	11.15	8.92	18.37
22	22.37	.19	.56	21.34	14.22	10.67	8.54	16.74
23	21.40	.18	.61	19.53	13.02	9.76	7.81	15.31
24	20.50	.18	.67	17.92	11.74	8.96	7.17	14.06
25	19.68	.16	.72	16.52	11.01	8.26	6.60	12.96
26	18.92	.16	.78	15.28	10.18	7.64	6.11	11.98
27	18.22	.16	.84	14.17	9.44	7.08	5.67	11.11
28	17.57	.16	.90	13.17	8.78	6.58	5.27	10.33
29	16.96	.14	.97	12.28	8.18	6.14	4.91	9.63
30	16.40	.14	1.04	11.48	7.65	5.74	4.59	9.00
31	15.87	.13	1.11	10.74	7.16	5.38	4.30	8.43
32	15.37	.13	1.18	10.08	6.72	5.04	4.03	7.91
33	14.90	.13	1.25	9.48	6.32	4.74	3.79	7.44

15″ I BEAMS.—No. 523.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	6.10	Flange width,	6.35
Web thickness,	.50	Web thickness,	.75
Area in square inches,	16.95	Area in square inches,	20.70
Resistance,	77.84	Resistance,	87.21
Pounds per foot,	57.6	Pounds per foot,	70.4

Greatest safe load in net tons evenly distributed, including beam itself.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.* 100 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	200 *Pounds per Sq. Foot.*	250 *Pounds per Sq. Foot.*	*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
10	36.83	.42	.10	77.34	51.56	38.67	30.94	81.00
11	36.83	.38	.13	70.30	46.86	35.15	28.12	66.94
12	33.97	.35	.16	59.45	39.63	29.73	23.78	56.25
13	30.62	.32	.19	49.46	32.97	24.73	19.78	47.92
14	29.11	.30	.23	43.67	29.11	21.84	17.47	41.33
15	27.17	.28	.26	38.04	25.36	19.02	15.22	36.00
16	25.48	.25	.30	33.43	22.28	16.72	13.37	31.64
17	23.98	.24	.34	29.62	19.74	14.81	11.85	28.03
18	22.65	.23	.38	26.42	17.61	13.21	10.57	25.00
19	21.46	.22	.42	23.87	15.91	11.92	9.55	22.24
20	20.39	.22	.47	21.40	14.26	10.70	8.56	20.25
21	19.41	.20	.51	19.45	12.96	9.72	7.78	18.37
22	18.52	.19	.56	17.68	11.78	8.84	7.07	16.74
23	17.72	.18	.61	16.18	10.78	8.09	6.47	15.31
24	16.98	.18	.67	14.85	9.90	7.42	5.94	14.06
25	16.30	.16	.72	13.69	9.12	6.84	5.48	12.96
26	15.68	.16	.78	12.66	8.44	6.33	5.06	11.98
27	15.10	.16	.84	11.74	7.82	5.82	4.70	11.11
28	14.45	.16	.90	10.91	7.27	5.43	4.36	10.33
29	14.06	.14	.97	10.17	6.78	5.08	4.07	9.63
30	13.58	.14	1.04	9.51	6.34	4.75	3.80	9.00
31	13.14	.13	1.11	8.90	5.93	4.45	3.56	8.43
32	12.73	.13	1.18	8.65	5.76	4.32	3.46	7.91
33	12.35	.13	1.26	7.86	5.24	3.93	3.14	7.44

15″ I BEAMS.—No. 522.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	5.8	Flange width,	5.95
Web thickness,	.45	Web thickness,	.60
Area in square inches,	14.49	Area in square inches,	16.74
Resistance,	69.15	Resistance,	74.77
Pounds per foot,	49.3	Pounds per foot,	56.9

Greatest safe load in net tons evenly distributed, including beam itself.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.* 100 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	200 *Pounds per Sq. Foot.*	250 *Pounds per Sq. Foot.*	*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
10	30.46	.42	.10	63.96	41.60	31.98	25.58	81.00
11	30.46	.38	.13	58.14	38.76	29.07	23.26	66.94
12	28.92	.35	.16	50.61	33.74	25.30	20.24	56.25
13	26.71	.32	.19	43.13	28.75	21.67	17.25	47.92
14	24.79	.30	.23	37.18	24.78	18.59	14.87	41.33
15	23.14	.28	.26	32.40	21.60	16.20	12.96	36.00
16	21.70	.25	.30	28.47	18.98	14.23	11.39	31.64
17	20.42	.24	.34	25.22	16.81	12.61	10.09	28.03
18	19.29	.23	.38	22.50	15.00	11.25	9.00	25.00
19	18.27	.22	.42	20.18	13.45	10.09	8.07	22.24
20	17.35	.22	.47	18.22	12.14	9.11	7.29	20.25
21	16.53	.20	.51	16.53	11.02	8.26	6.61	18.37
22	15.77	.19	.56	15.05	10.03	7.52	6.02	16.74
23	15.10	.18	.61	13.78	9.18	6.89	5.51	15.31
24	14.46	.18	.67	12.65	8.43	6.32	5.06	14.06
25	13.89	.16	.72	11.64	7.76	5.82	4.65	12.96
26	13.35	.16	.78	10.78	7.18	5.39	4.31	11.98
27	12.86	.16	.84	10.00	6.66	5.00	4.00	11.11
28	12.39	.16	.90	9.25	6.16	4.63	3.80	10.33
29	11.97	.14	.97	8.66	5.77	4.33	3.46	9.63
30	11.57	.14	1.04	8.10	5.40	4.05	3.24	9.00
31	11.19	.13	1.11	7.58	5.05	3.79	3.03	8.43
32	10.85	.13	1.18	7.12	4.74	3.56	2.84	7.91
33	10.51	.13	1.26	6.60	4.45	3.34	2.67	7.44

15″ I BEAMS.—No. 521.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	5.56	Flange width,	5.80
Web thickness,	.37	Web thickness,	.60
Area in square inches,	12.11	Area in square inches,	15.56
Resistance,	57.73	Resistance,	66.36
Pounds per foot,	41.2	Pounds per foot,	52.9

Greatest safe load in net tons evenly distributed, including beam itself.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.* 100 Pounds per Sq. Foot.	150 Pounds per Sq. Foot.	200 Pounds per Sq. Foot.	250 Pounds per Sq. Foot.	*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
10	25.56	.42	.10	54.65	36.43	27.32	21.86	81.00
11	25.56	.38	.13	49.68	33.12	24.84	19.87	66.94
12	25.56	.35	.16	45.54	30.36	22.78	18.22	56.25
13	24.27	.32	.19	39.19	26.12	19.60	15.67	47.92
14	22.52	.30	.23	33.79	22.52	16.90	13.51	41.33
15	21.03	.28	.26	29.44	19.63	14.72	11.77	36.00
16	19.71	.25	.30	25.87	17.26	12.94	10.36	31.64
17	18.55	.24	.34	22.91	15.28	11.46	9.17	28.03
18	17.52	.23	.38	20.44	13.63	10.22	8.17	25.00
19	16.59	.22	.42	18.34	12.23	9.17	7.33	22.44
20	15.77	.22	.47	16.56	11.04	8.28	6.62	20.25
21	15.02	.20	.51	15.01	10.01	7.51	6.01	18.37
22	14.33	.19	.56	13.68	9.12	6.84	5.47	16.74
23	13.71	.18	.61	12.52	8.35	6.26	5.00	15.31
24	13.14	.18	.67	11.50	7.67	5.75	4.60	14.06
25	12.62	.16	.72	10.20	7.07	5.30	4.24	12.96
26	12.12	.16	.78	9.79	6.53	4.90	3.91	11.98
27	11.68	.16	.84	9.08	6.06	4.55	3.64	11.11
28	11.27	.16	.90	8.45	5.64	4.22	3.38	10.33
29	10.88	.14	.97	7.88	5.26	3.94	3.16	9.63
30	10.51	.14	1.04	7.36	4.91	3.68	2.94	9.00
31	10.17	.13	1.11	6.89	4.60	3.44	2.76	8.43
32	9.85	.13	1.18	6.47	4.31	3.23	2.59	7.91
33	9.55	.13	1.26	6.08	4.06	3.04	2.44	7.44

12″ I BEAMS.—No. 517.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	5.75	Flange width,	6.03
Web thickness,	.56	Web thickness,	.84
Area in square inches,	16.32	Area in square inches,	19.68
Resistance,	60.5	Resistance,	67.2
Pounds per foot,	55.5	Pounds per foot,	66.9

Greatest safe load in net tons evenly distributed, including beam itself.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centre of Beams of Least Section for Distributed Load as Below.* 100 Pounds per Sq. Foot.	150 Pounds per Sq. Foot.	200 Pounds per Sq. Foot.	250 Pounds per Sq. Foot.	*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
10	32.25	.34	.14	64.50	43.00	32.25	25.80	64.80
11	29.32	.30	.17	53.31	39.09	26.65	21.32	53.35
12	26.88	.27	.20	44.80	29.87	22.40	17.92	45.00
13	24.81	.25	.24	38.17	25.45	19.08	15.27	38.34
14	23.04	.24	.28	32.92	21.94	16.46	13.16	33.06
15	21.51	.23	.32	28.68	19.12	14.34	11.47	28.80
16	20.16	.22	.37	25.20	16.80	12.60	10.08	25.31
17	18.97	.21	.42	22.31	14.87	11.16	8.92	22.42
18	17.92	.19	.47	19.91	13.27	9.95	7.96	20.00
19	16.98	.18	.53	17.88	11.91	8.93	7.15	17.89
20	16.13	.17	.59	16.13	10.75	8.06	6.45	16.20
21	15.36	.16	.65	14.63	9.37	7.31	5.85	14.68
22	14.67	.15	.71	13.33	9.17	6.67	5.43	13.39
23	14.03	.14	.77	12.2)	8.13	6.10	4.88	12.25
24	13.44	.14	.84	11.20	7.46	5.60	4.48	11.25
25	12.90	.13	.91	10.32	6.88	5.16	4.12	10.37
26	12.40	.13	.98	9.53	6.35	4.76	3.81	9.59
27	11.95	.12	1.06	8.85	5.90	4.42	3.54	8.88
28	11.52	.12	1.14	8.21	5.48	4.11	3.29	8.27
29	11.12	.12	1.22	7.66	5.11	3.83	3 06	7.71
30	10.75	.11	1.30	7.16	4.75	3.58	2.80	7.20
31	10.41	.11	1.39	6.71	4.45	3.35	2.68	6.74
32	10.08	.11	1.50	6.30	4.12	3.15	2.60	6.33
33	9.47	.10	1.61	5.87	3.91	2.93	2.35	5.95

12″ I BEAMS.—No. 516.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	5.25	Flange width,	5.45
Web thickness,	.40	Web thickness,	.60
Area in square inches,	11.6	Area in square inches,	14.0
Resistance,	44 72	Resistance,	49.96
Pounds per foot,	39.4	Pounds per foot,	47.6

Greatest safe load in net tons evenly distributed, including beam itself.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.*				*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
				100 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	200 *Pounds per Sq. Foot.*	250 *Pounds per Sq. Foot.*	
10	23.57	.34	.14	49.50	33.00	24.75	19.80	64.80
11	21.81	.30	.17	41.63	27.75	20.82	16.55	53.55
12	20.00	.27	.20	34.98	23.32	17.49	13.99	45.00
13	18.46	.25	.24	29.81	19.87	14.92	11.92	38.34
14	17.13	.24	.28	25.70	17.13	12.85	10.28	33.06
15	15.99	.23	.32	22.38	14.92	11.19	8.95	28.80
16	14.99	.22	.37	19.05	12.70	9.53	7.62	25.31
17	14.11	.21	.42	17.43	11.62	8.72	6.97	22.42
18	13.32	.19	.47	15.54	10.36	7.77	6.21	20.00
19	12.63	.18	.53	13.95	9.30	6.98	5.58	17.89
20	11.99	.17	.59	12.59	8.39	6.29	5.13	16.20
21	11.42	.16	.65	11.41	7.60	5.71	4.56	14.68
22	10.90	.15	.71	10.40	6.93	5.20	4.16	13.39
23	10.84	.14	.77	9.90	6.60	4.95	3.96	12.25
24	9.99	.14	.84	8.74	5.82	4.37	3.49	11.25
25	9.59	.13	.91	8.05	5.36	4.02	3.22	10.37
26	9.23	.13	.98	7.46	4.97	3.73	2.98	9.59
27	8.89	.12	1.06	6.91	4.60	3.45	2.76	8.88
28	8.56	.12	1.14	6.42	4.28	3.21	2.56	8.27
29	8.28	.12	1.22	5.99	4.00	2.99	2.39	7.71
30	8.00	.11	1.30	5.60	3.73	2.80	2.24	7.20
31	7.73	.11	1.39	5.24	3.49	2.62	2.09	6.74
32	7.50	.11	1.50	4.91	3.27	2.45	1.96	6.33
33	7.27	.10	1.61	4.62	3.08	2.31	1.84	5.95

12″ I BEAMS.—No. 515.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	5.00	Flange width,	5.19
Web thickness,	.34	Web thickness,	.53
Area in square inches,	9.01	Area in square inches,	11.29
Resistance,	34.65	Resistance,	38.97
Pounds per foot,	30.6	Pounds per foot,	38.4

Greatest safe load in net tons evenly distributed, including beam itself.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Load as Below.*				*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
				100 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	200 *Pounds per Sq. Foot.*	250 *Pounds per Sq. Foot.*	
10	18.48	.34	.14	38.81	25.87	19.40	15.53	64.80
11	16.80	.30	.17	32.08	21.38	16.03	12.83	53.55
12	15.41	.27	.20	26.96	17.97	13.48	10.79	45.00
13	14.22	.25	.24	22.97	15.31	11.48	9.19	38.34
14	13.20	.24	.28	19.80	13.20	9.90	7.90	33.06
15	12.32	.23	.32	17.24	11.50	8.63	6.90	28.80
16	11.55	.22	.37	15.17	10.12	7.58	6.07	25.31
17	10.87	.21	.42	13.43	8.95	6.71	5.38	22.42
18	10.27	.19	.47	11.98	7.98	5.99	4.79	20.00
19	9.72	.18	.53	10.75	7.16	5.38	4.30	17.89
20	9.25	.17	.59	9.71	6.47	4.86	3.89	16.20
21	8.80	.16	.65	8.80	5.87	4.40	3.62	14.68
22	8.40	.15	.71	8.02	5.34	4.01	3.20	13.39
23	8.04	.14	.77	7.33	4.90	3.67	2.94	12.25
24	7.70	.14	.84	6.74	4.49	3.37	2.70	11.25
25	7.39	.13	.91	6.22	4.14	3.11	2.48	10.37
26	7.10	.13	.98	5.74	3.83	2.87	2.29	9.59
27	6.85	.12	1.06	5.33	3.55	2.66	2.12	8.88
28	6.61	.12	1.14	4.96	3.30	2.47	1.98	8.27
29	6.38	.12	1.22	4.62	3.08	2.30	1.85	7.71
30	6.16	.11	1.30	4.31	2.88	2.16	1.73	7.20
31	5.96	.11	1.39	4.04	2.69	2.02	1.62	6.74
32	5.77	.11	1.50	3.79	2.52	1.90	1.51	6.33
33	5.60	.10	1.61	3.56	2.38	1.78	1.43	5.95

10″ I BEAMS.—No. 512.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	4.75	Flange width,	4.90
Web thickness,	.35	Web thickness,	.50
Area in square inches,	8.78	Area in square inches,	10.28
Resistance,	28.29	Resistance,	30.79
Pounds per foot,	29.8	Pounds per foot,	34.9

Greatest safe load in net tons evenly distributed, including beam itself.

For a load in middle of beam, allow one-half of the tabular load.

Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.

Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.*				*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
				100 Pounds per Sq. Foot.	*150 Pounds per Sq. Foot.*	*200 Pounds per Sq. Foot.*	*250 Pounds per Sq. Foot.*	
10	15.40	.26	.17	30.80	20.53	15.40	12.32	52.00
11	14.00	.24	.20	25.45	16.97	12.73	10.18	44.00
12	12.83	.22	.24	21.38	14.25	10.69	8.55	36.60
13	11.85	.20	.28	18.23	12.15	9.11	7.29	30.76
14	11.00	.19	.32	15.71	10.48	7.86	6.28	27.00
15	10.27	.17	.37	13.69	9.13	6.85	5.48	22.60
16	9.63	.16	.43	12.04	8.02	6.02	4.81	20.00
17	9.06	.15	.48	10.66	7.10	5.33	4.26	17.64
18	8.56	.14	.54	9.50	6.34	4.75	3.80	15.55
19	8.11	.14	.60	8.54	5.69	4.27	3.41	14.73
20	7.70	.13	.66	7.70	5.13	3.85	3.08	13.00
21	7.33	.12	.73	6.98	4.65	3.49	2.79	11.42
22	7.00	.12	.80	6.36	4.24	3.18	2.54	11.00
23	6.70	.11	.88	5.83	3.88	2.91	2.33	9.56
24	6.42	.11	.96	5.35	3.57	2.67	2.14	9.16
25	6.16	.10	1.04	4.93	3.28	2.46	1.97	8.00
26	5.92	.10	1.12	4.55	3.03	2.28	1.82	7.70
27	5.70	.10	1.21	4.22	2.81	2.11	1.69	7.40
28	5.50	.09	1.30	3.93	2.62	1.96	1.57	6.50
29	5.31	.09	1.40	3.66	2.44	1.83	1.46	6.20
30	5.13	.09	1.49	3.42	2.28	1.71	1.37	5.80
31	4.97	.08	1.60	3.21	2.14	1.60	1.28	5.16
32	4.81	.08	1.70	3.01	2.00	1.50	1.20	5.00
33	4.67	.08	1.81	2.83	1.89	1.41	1.13	4.84

10″ I BEAMS.—No. 511.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	4.50	Flange width,	4.70
Web thickness,	.30	Web thickness,	.50
Area in square inches,	6.91	Area in square inches,	8.91
Resistance,	22.48	Resistance,	25.82
Pounds per foot,	23.5	Pounds per foot,	30.3

Greatest safe load in net tons evenly distributed, including beam itself.

For a load in middle of beam, allow one-half of the tabular load.

Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.*				*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
				100 Pounds per Sq. Foot.	*150 Pounds per Sq. Foot.*	*200 Pounds per Sq. Foot.*	*250 Pounds per Sq. Foot.*	
10	12.00	.28	.18	25.18	16.79	12.59	10.07	54.00
11	10.90	.25	.21	20.80	15.26	10.40	8.32	44.64
12	10.00	.23	.25	17.48	11.66	8.74	6.99	37.50
13	9.22	.21	.30	14.89	9.93	7.45	5.96	31.95
14	8.56	.20	.35	12.84	8.56	6.42	5.14	27.55
15	7.99	.19	.40	11.19	7.46	5.60	4.47	24.00
16	7.50	.18	.45	9.84	6.56	4.92	3.94	21.09
17	7.06	.17	.51	8.72	5.81	4.36	3.49	18.69
18	6.66	.16	.57	7.77	5.18	3.88	3.11	16.67
19	6.31	.15	.64	6.98	4.65	3.49	2.79	14.96
20	5.99	.14	.71	6.29	4.19	3.15	2.52	13.50
21	5.70	.13	.78	5.70	3.80	2.85	2.28	12.25
22	5.45	.13	.85	5.20	3.47	2.60	2.08	11.16
23	5.21	.12	.93	4.76	3.17	2.38	1.90	10.21
24	5.00	.12	1.01	4.38	2.92	2.19	1.75	9.37
25	4.80	.11	1.10	4.00	2.69	2.00	1.61	8.64
26	4.61	.11	1.19	3.73	2.48	1.87	1.49	7.99
27	4.44	.11	1.28	3.45	2.30	1.73	1.38	7.41
28	4.28	.10	1.38	3.21	2.14	1.61	1.28	6.89
29	4.13	.10	1.48	2.99	2.00	1.50	1.20	6.42
30	4.00	.09	1.58	2.80	1.87	1.40	1.12	6.00
31	3.87	.09	1.69	2.62	1.75	1.31	1.05	5.62
32	3.74	.08	1.80	2.46	1.64	1.23	.98	5.27
33	3.63	.08	1.92	2.31	1.54	1.16	.92	4.96

9″ I BEAMS.—No. 509.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	4.30	Flange width,	4.46
Web thickness,	.28	Web thickness,	.44
Area in square inches,	6.04	Area in square inches,	7.48
Resistance,	17.95	Resistance,	20.11
Pounds per foot,	20.5	Pounds per foot,	25.4

Greatest safe load in net tons evenly distributed, including beam itself.

For a load in middle of beam, allow one-half of the tabular load.

Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.

Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.*				*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
				100 Pounds per Sq. Foot.	*150 Pounds per Sq. Foot.*	*200 Pounds per Sq. Foot.*	*250 Pounds per Sq. Foot.*	
8	11.71	.31	.12	30.75	20.50	15.38	12.30	75.94
9	10.64	.28	.15	24.82	16.55	12.41	9.90	60.00
10	9.57	.25	.19	20.10	13.40	10.05	8.04	48.60
11	8.70	.23	.23	16.62	11.08	8.31	6.65	40.17
12	7.98	.20	.28	13.97	9.31	6.98	5.59	33.75
13	7.36	.19	.33	11.89	7.93	5.95	4.76	28.76
14	6.84	.18	.38	10.26	6.84	5.13	4.10	24.80
15	6.38	.17	.44	8.93	5.96	4.47	3.57	21.67
16	5.98	.16	.50	7.85	5.23	3.93	3.14	18.98
17	5.63	.15	.56	6.95	4.64	3.48	2.78	16.82
18	5.32	.14	.63	6.21	4.14	3.11	2.48	15.00
19	5.04	.13	.70	5.57	3.71	2.78	2.23	13.46
20	4.79	.12	.78	5.03	3.35	2.52	2.01	12.15
21	4.56	.12	.86	4.56	3.04	2.28	1.82	11.02
22	4.35	.11	.94	4.15	2.80	2.08	1.66	10.04
23	4.16	.11	1.03	3.80	2.53	1.90	1.52	9.19
24	3.99	.11	1.12	3.49	2.33	1.75	1.40	8.44
25	3.83	.10	1.22	3.22	2.14	1.61	1.29	7.76
26	3.69	.10	1.32	2.98	1.98	1.49	1.19	7.19
27	3.54	.09	1.42	2.76	1.84	1.38	1.10	6.67
28	3.42	.09	1.53	2.56	1.71	1.28	1.03	6.19
29	3.30	.08	1.64	2.39	1.60	1.20	.96	5.78
30	3.19	.08	1.76	2.23	1.49	1.12	.89	5.40
31	3.09	.07	1.88	2.09	1.39	1.05	.84	5.06

8″ I BEAMS.—No. 507.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	4.00	Flange width,	4.14
Web thickness,	.26	Web thickness,	.40
Area in square inches,	5.12	Area in square inches,	6.24
Resistance,	13.58	Resistance,	15.07
Pounds per foot,	17.4	Pounds per foot,	21.2

Greatest safe load in net tons evenly distributed, including beam itself.

For a load in middle of beam, allow one-half of the tabular load.

Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.

Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.*				*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
				100 Pounds per Sq. Foot.	*150 Pounds per Sq. Foot.*	*200 Pounds per Sq. Foot.*	*250 Pounds per Sq. Foot.*	
6	10.02	.37	.08	35.07	23.38	17.53	14.03	120.00
7	10.02	.32	.11	30.06	20.00	15.03	12.00	87.16
8	9.06	.28	.14	23.78	15.85	11.89	9.51	67.50
9	8.05	.25	.18	18.78	12.52	9.39	7.51	53.33
10	7.24	.22	.22	15.20	10.13	7.60	6.08	43.20
11	6.58	.20	.26	12.56	8.38	6.28	5.03	35.70
12	6.04	.18	.31	10.57	7.04	5.28	4.23	30.00
13	5.57	.17	.37	9.00	6.00	4.50	3.60	25.56
14	5.17	.16	.43	7.76	5.17	3.88	3.10	22.04
15	4.83	.15	.49	6.76	4.51	3.39	2.70	19.20
16	4.52	.14	.56	5.94	3.96	2.97	2.38	16.88
17	4.26	.13	.64	5.26	3.51	2.63	2.10	14.95
18	4.02	.12	.71	4.69	3.13	2.34	1.88	13.33
19	3.81	.12	.79	4.21	2.80	2.10	1.68	11.97
20	3.62	.11	.88	3.80	2.53	1.90	1.52	10.80
21	3.45	.11	.97	3.45	2.30	1.73	1.38	9.80
22	3.30	.10	1.07	3.15	2.10	1.57	1.26	8.93
23	3.15	.10	1.16	2.88	1.92	1.44	1.15	8.17
24	3.02	.10	1.27	2.64	1.76	1.32	1.06	7.50
25	2.90	.09	1.38	2.43	1.62	1.22	.97	6.91
26	2.78	.09	1.49	2.25	1.50	1.12	.90	6.39
27	2.69	.08	1.61	2.09	1.39	1.05	.84	5.93
28	2.59	.08	1.73	1.94	1.30	.97	.78	5.51
29	2.50	.07	1.85	1.80	1.20	.90	.72	5.14

7″ I BEAMS.—No. 505.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	3.75	Flange width,	3.88
Web thickness,	.24	Web thickness,	.37
Area in square inches,	4.31	Area in square inches,	5.29
Resistance,	10.12	Resistance,	11.27
Pounds per foot,	14.6	Pounds per foot,	17.98

Greatest safe load in net tons evenly distributed, including beam itself.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.* 100 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	200 *Pounds per Sq. Foot.*	250 *Pounds per Sq. Foot.*	*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
6	8.42	.32	.10	30.00	20.00	15.00	12.00	105.00
7	7.68	.28	.12	23.03	15.35	11.52	9.21	77.14
8	6.71	.24	.16	17.63	11.75	8.82	7.05	59.06
9	5.97	.22	.20	13.93	9.29	6.97	5.57	46.67
10	5.37	.19	.25	11.28	7.52	5.64	4.51	37.80
11	4.89	.18	.30	9.33	6.22	4.67	3.73	31.24
12	4.48	.17	.36	7.83	5.22	3.92	3.13	26.25
13	4.13	.16	.42	6.68	4.45	3.34	2.67	22.37
14	3.84	.14	.49	5.76	3.84	2.88	2.30	19.29
15	3.58	.13	.56	5.01	3.34	2.51	2.00	16.80
16	3.35	.12	.64	4.40	2.93	2.20	1.76	14.77
17	3.15	.12	.72	3.91	2.60	1.95	1.56	13.08
18	2.98	.11	.81	3.48	2.32	1.74	1.39	11.67
19	2.83	.11	.91	3.13	2.08	1.56	1.25	10.47
20	2.69	.10	1.01	2.82	1.88	1.41	1.13	9.45
21	2.56	.10	1.10	2.56	1.71	1.28	1.02	8.57
22	2.44	.08	1.21	2.33	1.55	1.16	0.93	7.81
23	2.34	.08	1.32	2.13	1.40	1.07	0.85	7.15
24	2.24	.08	1.44	1.96	1.30	0.98	0.78	6.56
25	2.15	.08	1.56	1.81	1.20	0.90	0.72	6.05
26	2.07	.07	1.69	1.67	1.11	0.84	0.67	5.74
27	1.99	.07	1.82	1.55	1.03	0.78	0.62	5.19
28	1.91	.07	1.96	1.44	0.96	0.72	0.57	4.82
29	1.85	.07	2.11	1.34	0.89	0.67	0.53	4.49

6″ I BEAMS.—No. 503.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	5.25	Flange width,	5.50
Web thickness,	.63	Web thickness,	.88
Area in square inches,	12.06	Area in square inches,	13.56
Resistance,	21.36	Resistance,	22.86
Pounds per foot,	41.0	Pounds per foot,	46.1

Greatest safe load in net tons evenly distributed, including beam itself.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.* 100 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	200 *Pounds per Sq. Foot.*	250 *Pounds per Sq. Foot.*	*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
6	18.98	.28	.11	66.44	42.29	33.22	26.58	90.00
7	16.28	.24	.14	48.83	32.54	24.41	19.52	66.12
8	14.24	.21	.19	37.38	24.92	18.70	14.95	50.63
9	12.67	.19	.24	29.54	19.69	14.77	11.82	40.00
10	11.39	.17	.29	23.93	15.95	11.96	9.58	32.40
11	10.35	.15	.35	19.76	13.18	9.89	7.91	26.78
12	9.50	.14	.42	16.62	11.08	8.32	6.65	22.50
13	8.76	.13	.49	14.16	9.44	7.08	5.66	19.17
14	8.13	.12	.57	12.20	8.14	6.11	4.88	16.53
15	7.51	.11	.66	10.64	7.09	5.32	4.26	14.40
16	7.12	.11	.75	9.35	6.23	4.67	3.74	12.66
17	6.70	.10	.85	8.27	5.52	4.14	3.31	11.21
18	6.33	.10	.95	7.39	4.92	3.70	2.95	10.00
19	6.00	.08	1.05	6.64	4.42	3.31	2.65	8.97
20	5.70	.08	1.16	5.98	3.98	2.99	2.13	8.10
21	5.43	.08	1.28	5.42	3.62	2.71	2.17	7.35
22	5.18	.07	1.41	4.94	3.30	2.47	1.98	6.69
23	4.95	.07	1.54	4.52	3.01	2.26	1.81	6.11
24	4.74	.07	1.68	4.15	2.77	2.08	1.66	5.63
25	4.56	.07	1.82	3.83	2.56	1.92	1.54	5.18
26	4.38	.06	1.98	3.54	2.35	1.76	1.42	4.79
27	4.22	.06	2.14	3.28	2.18	1.64	1.31	4.44
28	4.07	.06	2.30	3.05	2.04	1.52	1.22	4.13
29	3.93	.06	2.47	2.84	1.90	1.43	1.14	3.85

6″ I BEAMS.—No. 502.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	4.88	Flange width,	5.13
Web thickness,	.50	Web thickness,	.75
Area in square inches,	9.49	Area in square inches,	10.99
Resistance,	17.51	Resistance,	19.01
Pounds per foot,	32.3	Pounds per foot,	37.4

Greatest safe load in net tons evenly distributed, including beam itself.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.*				*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
				100 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	200 *Pounds per Sq. Foot.*	250 *Pounds per Sq. Foot.*	
6	15.56	.28	.11	54.48	36.32	27.24	21.79	90.00
7	13.33	.24	.14	40.01	26.68	20.00	16.01	66.12
8	11.67	.21	.19	30.64	20.42	15.31	12.25	50.63
9	10.38	.19	.24	24.22	16.14	12.11	9.68	40.00
10	9.33	.17	.29	19.61	13.07	9.80	7.85	32.40
11	8.50	.15	.35	16.21	10.81	8.10	6.48	26.78
12	7.78	.14	.42	13.62	9.08	6.82	5.45	22.50
13	7.19	.13	.49	11.62	7.74	5.81	4.64	19.17
14	6.68	.12	.57	10.01	6.67	5.00	4.01	16.53
15	6.23	.11	.66	8.72	5.81	4.36	3.49	14.40
16	5.84	.11	.75	7.67	5.11	3.83	3.07	12.66
17	5.50	.10	.85	6.79	4.52	3.40	2.71	11.21
18	5.19	.10	.95	6.05	4.03	3.02	2.42	10.00
19	4.91	.08	1.05	5.44	3.62	2.71	2.17	8.97
20	4.78	.08	1.16	4.91	3.28	2.46	1.97	8.10
21	4.45	.08	1.28	4.44	2.96	2.22	1.78	7.35
22	4.24	.07	1.41	4.04	2.70	2.03	1.62	6.69
23	4.06	.07	1.54	3.71	2.47	1.85	1.48	6.11
24	3.89	.07	1.68	3.40	2.27	1.70	1.36	5.63
25	3.73	.07	1.82	3.14	2.09	1.57	1.26	5.18
26	3.59	.06	1.98	2.90	1.93	1.45	1.16	4.79
27	3.47	.06	2.14	2.69	1.80	1.34	1.08	4.44
28	3.33	.06	2.30	2.51	1.67	1.25	1.00	4.13
29	3.22	.06	2.47	2.33	1.56	1.16	0.94	3.85

6″ I BEAMS.—No. 501.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	3.40	Flange width,	3.55
Web thickness,	.22	Web thickness,	.37
Area in square inches,	3.51	Area in square inches,	4.47
Resistance,	7.05	Resistance,	8.01
Pounds per foot,	11.9	Pounds per foot,	15.20

Greatest safe load in net tons evenly distributed, including beam itself.
For a load in middle of beam, allow one-half of the tabular load.
Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.
Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.*				*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
				100 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	200 *Pounds per Sq. Foot.*	250 *Pounds per Sq. Foot.*	
6	6.27	.28	.11	21.93	14.62	10.97	8.77	90.00
7	5.37	.24	.14	16.11	10.74	8.06	6.45	66.12
8	4.70	.21	.19	12.35	8.23	6.18	4.94	50.63
9	4.18	.19	.24	9.76	6.50	4.88	3.90	40.00
10	3.76	.17	.29	7.90	5.27	3.95	3.16	32.40
11	3.42	.15	.35	6.53	4.35	3.27	2.25	26.78
12	3.13	.14	.42	5.48	3.66	2.74	2.19	22.50
13	2.90	.13	.49	4.68	3.12	2.34	1.87	19.17
14	2.69	.12	.57	4.03	2.69	2.02	1.61	16.53
15	2.50	.11	.66	3.51	2.34	1.75	1.40	14.40
16	2.35	.11	.75	3.10	2.06	1.55	1.24	12.66
17	2.21	.10	.85	2.73	1.82	1.37	1.09	11.21
18	2.09	.10	.95	2.43	1.60	1.22	.97	10.00
19	1.98	.08	1.05	2.19	1.46	1.10	.88	8.97
20	1.88	.08	1.16	1.97	1.31	.99	.79	8.10
21	1.79	.08	1.28	1.79	1.19	.90	.72	7.35
22	1.70	.07	1.41	1.63	1.08	.82	.65	6.69
23	1.64	.07	1.54	1.50	1.00	.75	.60	6.11
24	1.57	.07	1.68	1.38	.92	.69	.55	5.63
25	1.50	.07	1.82	1.27	.84	.63	.51	5.18
26	1.45	.06	1.98	1.17	.78	.59	.47	4.79
27	1.39	.06	2.14	1.08	.72	.54	.43	4.44
28	1.34	.06	2.30	1.01	.67	.51	.40	4.13
29	1.30	.06	2.47	.94	.63	.47	.38	3.85

5″ I BEAMS.—No. 500.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	3.00	Flange width,	3.17
Web thickness,	.20	Web thickness,	.37
Area in square inches,	2.76	Area in square inches,	3.61
Resistance,	4.63	Resistance,	5.34
Pounds per foot,	9.4	Pounds per foot,	12.3

Greatest safe load in net tons evenly distributed, including beam itself.

For a load in middle of beam, allow one-half of the tabular load.

Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.

Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.* 100 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	200 *Pounds per Sq. Foot.*	250 *Pounds per Sq. Foot.*	*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
4	5.54	.35	.06	29.10	19.40	14.55	11.64	168.75
5	4.94	.28	.08	20.76	13.84	10.38	8.30	108.00
6	4.13	.23	.12	14.40	9.60	7.20	5.76	75.00
7	3.52	.20	.17	10.57	7.05	5.29	4.23	55.10
8	3.09	.18	.23	8.10	5.40	4.05	3.24	42.19
9	2.74	.16	.29	6.40	4.27	3.20	2.56	33.33
10	2.46	.14	.35	5.18	3.45	2.59	2.07	27.00
11	2.24	.13	.42	4.29	3.10	2.15	1.88	22.31
12	2.06	.12	.50	3.60	2.40	1.80	1.44	18.75
13	1.90	.11	.59	3.06	2.04	1.53	1.22	15.98
14	1.76	.10	.68	2.64	1.76	1.32	1.06	13.77
15	1.65	.09	.79	2.31	1.54	1.16	.92	12.00
16	1.54	.08	.90	2.03	1.35	1.02	.81	10.55
17	1.45	.08	1.02	1.79	1.19	.90	.72	9.34
18	1.37	.07	1.14	1.60	1.07	.80	.64	8.33
19	1.30	.07	1.27	1.43	.95	.72	.57	7.48
20	1.24	.07	1.40	1.30	.87	.65	.52	6.75
21	1.17	.07	1.55	1.17	.78	.59	.47	6.12
22	1.10	.06	1.69	1.07	.72	.54	.43	5.58
23	1.08	.06	1.86	.98	.66	.49	.39	5.10
24	1.03	.06	2.03	.90	.60	.45	.36	4.69
25	.99	.06	2.20	.83	.55	.42	.33	4.32
26	.95	.05	2.36	.77	.51	.38	.31	3.99
27	.92	.05	2.54	.71	.47	.36	.29	3.70

4″ I BEAMS.—No. 20.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	2.30	Flange width,	2.39
Web thickness,	.16	Web thickness,	.25
Area in square inches,	1.81	Area in square inches,	2.17
Resistance,	2.51	Resistance,	2.91
Pounds per foot,	6.2	Pounds per foot,	7.4

Greatest safe load in net tons evenly distributed, including beam itself.

For a load in middle of beam, allow one-half of the tabular load.

Deflection for centre load will be $\frac{8}{10}$ of the tabular deflection.

Figures in small type denote cases where deflection is excessive.

Distance Between Supports in Feet.	*Greatest Safe Load in Net Tons for Least Section.*	*Addition to Safe Load for Each Pound per Foot Increase.*	*Deflection in Inches.*	*Greatest Distance in Feet Between Centres of Beams of Least Section for Distributed Loads as Below.* 100 *Pounds per Sq. Foot.*	150 *Pounds per Sq. Foot.*	200 *Pounds per Sq. Foot.*	250 *Pounds per Sq. Foot.*	*Divide by Load per Sq. Foot and Add to Corresponding Distance for Each Pound per Foot Increase of Beam.*
4	3.35	.28	.07	17.58	11.72	8.80	7.03	135.00
5	2.68	.23	.11	11.23	7.49	5.62	4.49	86.40
6	2.23	.19	.16	7.80	5.20	3.90	3.12	60.00
7	1.90	.16	.22	5.72	3.82	2.87	2.29	44.08
8	1.66	.14	.28	4.38	2.92	2.20	1.75	33.75
9	1.48	.12	.36	3.47	2.32	1.73	1.39	26.67
10	1.33	.11	.44	2.81	1.87	1.40	1.13	21.60
11	1.20	.10	.53	2.32	1.54	1.15	.92	17.85
12	1.12	.09	.64	1.96	1.31	.98	.78	15.00
13	1.03	.08	.74	1.66	1.10	.83	.66	12.78
14	.96	.08	.86	1.44	.96	.72	.58	11.02
15	.90	.07	.98	1.25	.83	.62	.50	9.60

3″ I BEAMS.—No. 22.

LEAST SECTION.		GREATEST SECTION.	
Flange width,	2.20	Flange width,	2.29
Web thickness,	.16	Web thickness,	.31
Area in square inches,	1.56	Area in square inches,	2.01
Resistance,	1.61	Resistance,	1.83
Pounds per foot,	5.3	Pounds per foot,	6.8

4	2.15	.22	.09	11.28	7.52	5.64	4.51	101.25
5	1.71	.17	.14	7.20	4.80	3.60	2.88	64.80
6	1.43	.14	.21	5.00	3.34	2.50	2.00	45.00
7	1.22	.12	.29	3.67	2.45	1.84	1.46	33.15
8	1.07	.11	.37	2.82	1.88	1.42	1.13	25.31
9	.96	.10	.47	2.21	1.48	1.10	.89	20.00
10	.86	.08	.59	1.80	1.20	.90	.72	16.20
11	.78	.07	.71	1.49	.98	.74	.59	13.39
12	.72	.07	.85	1.26	.84	.64	.50	11.25
13	.66	.06	1.00	1.07	.71	.54	.43	9.59
14	.62	.06	1.15	.92	.61	.47	.37	8.27
15	.57	.06	1.32	.80	.53	.40	.32	7.20

PENCOYD CHANNELS

Greatest safe distributed load in net tons for least section.
For increased sections use coefficient of fifth column.
For centre loads take half of table.

Size in Inches.	Section Number.	Weight in Pounds per Foot.	Coefficient for Safe Load Distributed.	Add to Coefficient for Each Increase of a Pound per Foot.	Length of Span in Feet. 4	6	8	10	12
15	434	49.8	309.84	3.50				30.98 .12	25.82 .17
15	433	32.7	203.96	3.50				20.40 .12	17.00 .17
12	428	31.4	168.82	2.80				16.88 .15	14.07 .21
12	427	19.8	105.18	2.80				10.52 .15	8.77 .21
12	32	20.6	109.67	2.80				10.97 .15	9.14 .21
10	424	20.9	93.87	2.33				9.39 .17	7.82 .25
10	423	16.5	75.82	2.33				7.58 .17	6.32 .25
9	422	17.6	70.98	2.10		11.83 .07	8.87 .12	7.10 .19	5.91 .28
9	421	13.4	55.08	2.10		9.18 .07	6.88 .12	5.51 .19	4.59 .28
8	420	14.6	53.01	1.87		8.83 .08	6.63 .14	5.30 .22	4.42 .32
8	419	10.9	39.67	1.87		6.61 .08	4.96 .14	3.97 .22	3.31 .32
7	418	12.8	41.35	1.633		6.89 .09	5.17 .16	4.13 .25	3.45 .36
7	417	9.1	29.54	1.633		4.92 .09	3.69 .16	2.95 .25	2.46 .36
6	416	11.0	31.17	1.400	7.79 .05	5.20 .10	3.90 .19	3.12 .29	2.60 .42
6	415	7.7	20.66	1.400	5.17 .05	3.44 .10	2.58 .19	2.07 .29	1.72 .42
5	413	6.6	14.17	1.166	3.54 .06	2.36 .13	1.77 .22	1.42 .35	1.18 .50
4	411	5.4	9.78	0.933	2.45 .07	1.63 .16	1.22 .28	0.98 .44	0.81 .63
3	49	5.1	7.24	0.700	0.18 .09	0.12 .21	0.09 .37	0.07 .58	0.06 .84

PENCOYD CHANNELS.

Figures under loads in fine type denote corresponding deflections in inches. For half the load in centre this deflection will be reduced one-fifth. For spans below black line the deflection is excessive.

Length of Span in Feet. 14	16	18	20	22	24	26	28	30	Size in Inches.
22.13 .23	19.36 .30	17.21 .38	15.49 .47	14.08 .57	12.91 .67	11.92 .79	11.06 .91	10.33 1.05	15
14.57 .23	12.75 .30	11.33 .38	10.20 .47	9.27 .57	8.50 .67	7.84 .79	7.28 .91	6.80 1.05	15
12.06 .29	10.55 .37	9.38 .47	8.44 .58	7.67 .70	7.03 .84	6.49 .99	6.03 1.15	5.63 1.31	12
7.51 .29	6.57 .37	5.84 .47	5.26 .58	4.78 .70	4.38 .84	4.06 .99	3.76 1.15	3.51 1.31	12
7.83 .29	6.85 .37	6.09 .47	5.48 .58	4.98 .70	4.57 .84	4.22 .99	3.92 1.15	3.66 1.31	12
6.70 .34	5.87 .45	5.21 .57	4.69 .70	4.27 .85	3.91 1.01	3.61 1.18	3.35 1.37	3.13 1.58	10
5.42 .34	4.74 .45	4.21 .57	3.79 .70	3.45 .85	3.16 1.01	2.92 1.18	2.71 1.37	2.53 1.58	10
5.07 .38	4.43 .50	3.94 .63	3.55 .78	3.23 .95	2.96 1.12	2.73 1.32	2.53 1.53	2.37 1.76	9
3.93 .38	3.44 .50	3.06 .63	2.75 .78	2.50 .95	2.29 1.12	2.12 1.32	1.97 1.53	1.84 1.76	9
3.79 .43	3.31 .56	2.94 .71	2.65 .88	2.41 1.06	2.21 1.26	2.04 1.48	1.89 1.72	1.77 1.96	8
2.83 .43	2.48 .56	2.20 .71	1.98 .88	1.80 1.06	1.65 1.26	1.53 1.48	1.42 1.72	1.32 1.96	8
2.95 .49	2.58 .64	2.30 .81	2.07 1.00	1.88 1.21	1.72 1.44	1.59 1.69	1.48 1.97	1.38 2.25	7
2.11 .49	1.85 .64	1.64 .81	1.48 1.00	1.34 1.21	1.23 1.44	1.14 1.69	1.05 1.97	0.98 2.25	7
2.23 .57	1.95 .75	1.73 .95	1.56 1.17	1.42 1.42	1.30 1.68	1.20 1.97	1.11 2.28	1.04 2.63	6
1.48 .57	1.29 .75	1.15 .95	1.03 1.17	0.94 1.42	0.86 1.68	0.79 1.97	0.74 2.28	0.69 2.63	6
1.01 .68	0.89 .89	0.79 1.13	0.71 1.40	0.64 1.69	0.59 2.03	0.54 2.34	0.51 2.75	0.47 3.14	5
0.70 .86	0.61 1.13	0.53 1.41	0.49 1.76	0.44 2.12	0.41 2.52	0.38 2.97	0.35 3.43	0.33 3.92	4
0.05 1.14	0.04 1.48	0.04 1.88	0.04 2.34	0.03 2.78	0.03 3.40	0.03 3.92	0.02 4.55	0.02 5.19	3

PENCOYD DECK BEAMS.

Greatest safe distributed load in net tons for least section. For increased sections use coefficient of fifth column. For centre loads take half of table.

Figures under loads in fine type denote corresponding deflections in inches. For half the load in centre this deflection will be reduced one-fifth. For spans below black line the deflection is excessive.

Number of Section.	Size in Inches.	Weight in Pounds per Foot.	Coefficient for Safe Load Distributed.	Add to Coefficient for Each Increase of a Pound per Foot.	6	8	10	12	14	16	18	20	22	24	26	28	30	Size in Inches.
					LENGTH OF SPAN IN FEET.													
*69	11½	35.84	187.10	2.66	31.18 .04	23.39 .10	18.71 .15	15.59 .22	13.36 .30	11.69 .39	10.40 .50	9.36 .61	8.50 .74	7.80 .88	7.20 1.04	6.68 1.20	6.24 1.38	11½
62	10	28.12	135.24	2.33	22.54 .06	16.91 .11	13.52 .18	11.27 .25	9.66 .34	8.45 .45	7.51 .57	6.76 .70	6.15 .85	5.64 1.01	5.20 1.19	4.83 1.38	4.51 1.58	10
63	9	24.68	105.49	2.10	17.58 .07	13.19 .12	10.55 .19	8.79 .28	7.53 .38	6.59 .50	5.86 .63	5.27 .78	4.80 .95	4.39 1.12	4.06 1.32	3.77 1.53	3.52 1.76	9
64	8	20.98	80.72	1.87	13.45 .08	10.09 .14	8.07 .22	6.73 .32	5.77 .43	5.05 .56	4.48 .71	4.04 .88	3.67 1.06	3.63 1.30	3.10 1.48	2.88 1.72	2.69 1.98	8
65	7	17.88	59.27	1.63	9.88 .09	7.40 .16	5.93 .25	4.94 .36	4.23 .49	3.70 .64	3.29 .81	2.96 1.00	2.69 1.21	2.47 1.44	2.24 1.66	2.12 1.97	1.98 2.26	7
66	6	14.35	40.97	1.40	6.83 .10	5.12 .19	4.10 .29	3.41 .43	2.93 .57	2.56 .75	2.28 .83	2.05 1.17	1.86 1.41	1.71 1.68	1.58 1.98	1.46 2.28	1.37 2.63	6
67	5	11.53	26.96	1.67	4.49 .13	3.37 .22	2.70 .35	2.25 .50	1.93 .69	1.69 .90	1.50 1.14	1.35 1.41	1.23 1.70	1.12 2.02	1.03 2.36	0.96 2.74	0.90 3.16	5

* This table refers to webs ½″ thick.

PENCOYD Z BARS.

Greatest safe load distributed in net tons for least section. For increased sections use coefficient of fifth column. For centre loads take half of table.

Figures under loads in fine type denote corresponding deflections in inches. For half the load in centre this deflection will be reduced one-fifth. For spans to the right of black line the deflection is excessive.

Number of Section.	Size in Inches.	Weight in Pounds per Foot	Coefficient for Safe Load Distributed.	Add to Coefficient for Each Increase of a Pound per Foot.	6	8	10	12	14	16	18	20	22	24	26	28	30	Size in Inches.
					LENGTH OF SPAN IN FEET.													
220	3	6.60	10.46	0.70	1.74 .21	1.31 .37	1.05 .59	.872 .84	.747 1.14	.653 1.49	.581 1.88	.523 2.33	.475 2.83	.435 3.37	.402 3.95	.373 4.57	.348 5.24	3
221	3	11.15	15.67	0.70	2.61 .21	1.96 .37	1.57 .59	1.30 .84	1.12 1.14	.978 1.49	.870 1.88	.783 2.33	.712 2.83	.652 3.37	.602 3.95	.559 4.57	5.18 5.24	3
222	4	7.88	16.68	0.93	2.78 .16	2.08 .28	1.67 .44	1.39 .63	1.19 .86	1.04 1.13	.926 1.42	.834 1.75	.758 2.12	.695 2.53	6.41 2.96	.595 3.44	.556 3.95	4
223	4	13.46	26.32	0.93	4.39 .16	3.29 .28	2.63 .44	2.20 .63	1.88 .86	1.64 1.13	1.46 1.42	1.32 1.75	1.20 2.12	1.10 2.53	1.01 2.96	.940 3.44	.847 3.95	4
224	4	18.80	33.94	0.93	5.66 .16	4.24 .28	3.39 .44	2.83 .63	2.42 .86	2.12 1.13	1.88 1.42	1.70 1.75	1.54 2.12	1.41 2.53	1.31 2.96	1.21 3.44	1.13 3.95	4
225	5	11.42	29.45	1.16	4.91 .13	3.68 .22	2.94 .35	2.45 .50	2.10 .68	1.84 .90	1.64 1.14	1.47 1.40	1.34 1.69	1.23 2.02	1.13 2.38	1.05 2.76	.981 3.16	5
226	5	17.78	42.61	1.16	7.10 .13	5.32 .22	4.26 .35	3.55 .50	3.04 .68	2.66 .90	2.37 1.14	2.13 1.40	1.94 1.69	1.77 2.02	1.64 2.38	1.52 2.76	1.42 3.16	5
227	5	23.66	53.02	1.16	8.84 .13	6.63 .22	5.30 .35	4.42 .50	3.79 .68	3.31 .90	2.94 1.14	2.65 1.40	2.41 1.69	2.21 2.02	2.04 2.38	1.89 2.76	1.77 3.16	5
228	6	15.61	47.26	1.40	7.88 .10	5.91 .19	4.73 .29	3.94 .42	3.37 .58	2.95 .74	2.62 .95	2.36 1.18	2.15 1.42	1.97 1.68	1.81 1.97	1.69 2.29	1.57 2.63	6
229	6	22.71	64.68	1.40	10.78 .10	8.08 .19	6.47 .29	5.39 .42	4.62 .58	4.04 .74	3.59 .95	3.23 1.18	2.94 1.42	2.69 1.68	2.49 1.97	2.31 2.29	2.16 2.63	6
230	6	29.37	78.62	1.40	13.10 .10	9.83 .19	7.86 .29	6.55 .42	5.61 .58	4.92 .74	4.37 .95	3.93 1.18	3.57 1.42	3.27 1.68	3.02 1.97	2.81 2.29	2.62 2.63	6

STEEL FLOOR BEAMS.

The proper spacing of beams depends on the amount and character of load and the length of span. Permissible deflection as well as positive strength must be considered. If the load is motionless, and especially if the span is small in comparison with the depth of beam, it will be safe to proportion the beams for the "greatest safe loads," as in preceding tables.

If, on the contrary, the floors are subject to vibration, or the action of moving loads, and especially if the span is great in proportion to depth of beam, it becomes necessary to consider the deflection, which may become so great as to be a source of injury to the structure. It is considered good practice to limit the deflection to $\frac{1}{30}$ of an inch per foot of span, or the total deflection not to exceed $\frac{1}{360}$ part of the span. For **I** beams subjected to the loads given in the tables, this deflection usually occurs when the depth of the beam is about $\frac{1}{22}$ of the span. The preceding tables indicate for each beam this limitation for deflection. Those in heavy type above the dark line deflect less, and those in fine type below the same line deflect more than $\frac{1}{360}$ of the span. If the spans are unusually long, it is best to reduce the deflection below this limit, and maintain the depth of the beam not less than $\frac{1}{20}$ of the span. It has been demonstrated that the greatest mass of people that can be packed on any floor will not exceed in weight 80 lbs. per square foot. The weight of the beams will depend on the span, for which see a general rule farther on. If brick arches are laid between the beams, the weight of a 4″ course of brick, including the concrete filling, will be about 70 lbs. per square foot.

Within the limits of practicable spans for rolled **I** beams, it will be found that a floor is safe for a packed mass of people when the beams are not strained above the "greatest safe load" of the tables, under the following rating:

I beam joists with wooden floor = 100 lbs. per sq. foot.
Wooden floor and plastered ceilings = 110 " " "
4″ brick arches and concrete filling = 150 " " "

These figures represent the total weight of floor itself and the imposed load.

Floors proportioned as follows for given purposes will be satisfactory. The weight of the material may be included in the figures.

Character of Floor.	*Load per Square Foot.*
Lightest floors, plank covering, ...	100 lbs.
Lightest floors, brick arches, ...	150 "
Light warehouse floors, ...	200 "
Halls of audience, ...	200 "
Warehouses in which heavy pieces are moved, ...	250 "
Shop floors for light machinery, ...	250 "
Shop floors for heavy machinery, ...	300 to 500 lbs.

RULE FOR THE WEIGHT OF FLOOR BEAMS.

The following rule gives a close approximation to the actual weight of floor beams, when the beams are proportioned according to the tables.

$$\frac{\text{Load per sq. ft. in lbs.} \times \text{square of span in ft.}}{1000 \times \text{depth of beams in ins.}} = \text{lbs. of beams per sq. ft. of floor.}$$

Example.—A floor of 16 feet span bears 200 lbs. per sq. ft., required the weight of floor beams if 12″ beams are used.

$$\frac{200 \times 256}{1000 \times 12} = 4.3 \text{ lbs. per sq. ft. of beams.}$$

To the foregoing must be added the weight of the ends of the beams built into the supports, or a length at each end about the same as at the depth of the beam. The following table gives the weights of beams per square foot of floor, for a load of 100 lbs. per square foot, the beams, as in the preceding tables, subject to a stress of 16,000 lbs. per square inch. For greater floor loads the weight of beams increases in direct proportion. Thus, for a floor to carry 200 lbs. per square foot, the weight of floor beams will be twice that of the table. Also, if the floor beams are proportioned for a lower fibre stress, the weight of beams will increase in inverse ratio.

Thus, if the fibre strain allowed is 12,000 lbs. per square inch, the weight of beams will be increased as 12 to 16, or one-third heavier than the table.

PENCOYD I BEAMS.

LEAST WEIGHT OF FLOOR BEAMS IN POUNDS.

For each square foot of floor, including ends at supports, based on a load of 100 pounds per square foot of floor.

For heavier loads, the weights of beams are proportionately increased.

Size of I Beam.	Clear Span of Beams in Feet.										
	8	10	12	14	16	18	20	22	24	26	28
20		0.66	0.91	1.20	1.73	1.90	2.32	2.77	3.27	3.79	4.36
15		0.94	1.19	1.49	1.90	2.37	2.89	3.47	4.09	4.76	5.53
12		0.97	1.35	2.00	2.32	2.90	3.55	4.33	5.06	5.88	6.73
10		1.09	1.59	2.06	2.55	3.32	4.13	4.89	5.78	6.75	
9	0.78	1.17	1.65	2.22	2.79	3.58	4.38	5.34	6.26		
8	0.86	1.30	1.86	2.47	3.19	4.00	4.91	5.90	7.00		
7	0.96	1.46	2.07	2.79	3.61	4.53	5.56	6.71			
6	1.12	1.71	2.42	3.26	4.22	5.31	6.51				
5	1.29	1.99	2.83	3.86	4.93	6.22					
4	1.56	2.41	3.43	4.64							
3	2.08	3.21	4.58	6.23							

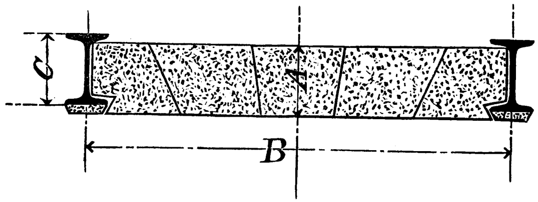
The figures above the dark line are for beams and corresponding spaces with deflections less than $\frac{1}{360}$ part of the span.

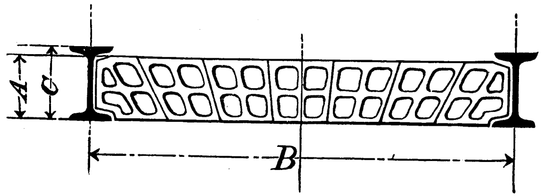
FLOORING MATERIAL.

For fire-proof flooring, the space between the floor beams may be spanned with brick arches, or with hollow or porous brick made especially for the purpose, the latter being much lighter than ordinary brick. Arches four inches thick of solid brick weigh about 70 pounds per square foot, including the ordinary amount of concrete leveling material, but exclusive of the supporting beams.

Substantial floors are thus made up to six feet span of arch, or much greater if the skew backs at the abutment of the arch are made deeper, or if the arch is stiffened by a suitable covering of concrete, the rise of the arch being preferably not less than one-tenth of the span.

The following table gives the weight and usual proportions of flat arches of hollow brick and porous terra cotta floors, and suitable **I** beams for given spans. By adding the weight of brick in the arches, as given in this table, to the weight for steel floor beams given in the previous table, the total weight per square foot of floor can be readily obtained.





Flooring Proportioned for an Evenly Distributed Load of 150 lbs. per Sq. Foot.

Depth of Brick Arch.	*Ordinary Span of Arch.*	*Maximum Safe Span.*	*Weight of Brick per Sq. Foot in Pounds.*		*Sizes (C) of Steel Floor Beams for Given Spans and Under, for Ordinary Spans of Arch (B).*					
A.	B.	B.	*Hollow Brick.*	*Porous Terra Cotta.*	*12 Feet.*	*15 Feet.*	*18 Feet.*	*21 Feet.*	*24 Feet.*	*27 Feet.*
6 ins.	3 ft. 9 in.	5 ft. 6 in.	29	22	7-inch. No. 505.	8-inch. No. 507.	10-inch. No. 511.	12-inch. No. 515.	15-inch. No. 521.	15-inch. No. 521.
7 ins.	4 ft. 3 in.	6 ft. 0 in.	32	27	7-inch. No. 505.	8-inch. No. 507.	10-inch. No. 511.	12-inch. No. 515.	15-inch. No. 521.	15-inch. No. 521.
8 ins.	4 ft. 9 in.	6 ft. 6 in.	35	30	7-inch. No. 505.	9-inch. No. 509.	10-inch. No. 511.	12-inch. No. 515.	15-inch. No. 521.	15-inch. No. 521.
9 ins.	5 ft. 3 in.	7 ft. 0 in.	38	33	8-inch. No. 507.	9-inch. No. 509.	10-inch. No. 511.	12-inch. No. 515.	15-inch. No. 521.	15-inch. No. 522.
10 ins.	6 ft. 0 in.	7 ft. 6 in.	42	35	8-inch. No. 507.	9-inch. No. 509.	12-inch. No. 515.	12-inch. No. 516.	15-inch. No. 521.	15-inch. No. 522.
12 ins.	7 ft. 0 in.	8 ft. 0 in.	48	42	9-inch. No. 509.	10-inch. No. 511.	12-inch. No. 515.	12-inch. No. 516.	15-inch. No. 521.	15-inch. No. 522.

TIE RODS FOR BEAMS SUPPORTING BRICK ARCHES.

The horizontal thrust of brick arches is as follows:

$$\frac{1.5\ WS^2}{R} = \text{pressure in lbs. per lineal foot of arch.}$$

$W =$ load in lbs. per square foot.
$S =$ span of arch in feet.
$R =$ rise in inches.

Place the tie rods as low through the webs of the beams as possible, and spaced so that the pressure of arches as obtained above will not produce a greater stress than 15,000 lbs. per square inch of the least section of the bolt.

Example.—The beams supporting an arched brick floor are 5 feet apart, and the rise of the arches is 6 inches. The total weight of floor and load equals 150 lbs. per square foot. Then $\frac{1.5 \times 150 \times 25}{6} = 937.5$ lbs. pressure per lineal foot of arch. If 1-inch screw bolts are used, which have an effective section of $\frac{6}{10}$ square inches, then $.6 \times 15{,}000 = 9{,}000$ lbs., which is the greatest load the bolt should be allowed to sustain, and $\frac{9000}{937.5} = 9.6$ feet = greatest distance apart of the bolts; or, in same manner, we would find 5.3 feet, if $\frac{7}{8}$-inch tie rods are used.

Ordinarily it will be found necessary to limit the spacing of the tie rods to avoid excessive bending stress on the outer beams of the floor, or to prevent this bending stress being transferred to the walls of the building.

The ability of the outer beams to resist the horizontal bending action caused by the pressure of the arches is determined as follows:

LATERAL STRENGTH OF BEAMS.

The resistance to a force acting at right angles to the web, or in the direction of the flanges, is as follows, based on fibre stresses of 16,000 lbs. for continuous beams:

$$W = \frac{1440\ AF}{L} \text{ for I beams.}$$

$$W = \frac{1680\ AF}{L} \text{ for channels.}$$

$$W = \frac{2760\ AF}{L} \text{ for angles.}$$

$W =$ safe load distributed in pounds, A = sectional area of beam in square inches, $F =$ width of flange in inches, $L =$ length between supports in feet.

Knowing the pressure per lineal foot and requiring distance L between tie bolts, the foregoing equations become $L = \sqrt{\frac{CAF}{w}}$, in which $w =$ lateral pressure in pounds per lineal foot. $C =$ either of the coefficients in the previous equations. If the concrete between the beams, or the brick work, was a free mass with no power to transfer the pressure over some extent, it would then be necessary not to exceed the length L as obtained above; but as in practice this is not the case, the spacing L is not imperative, but is useful as a guide.

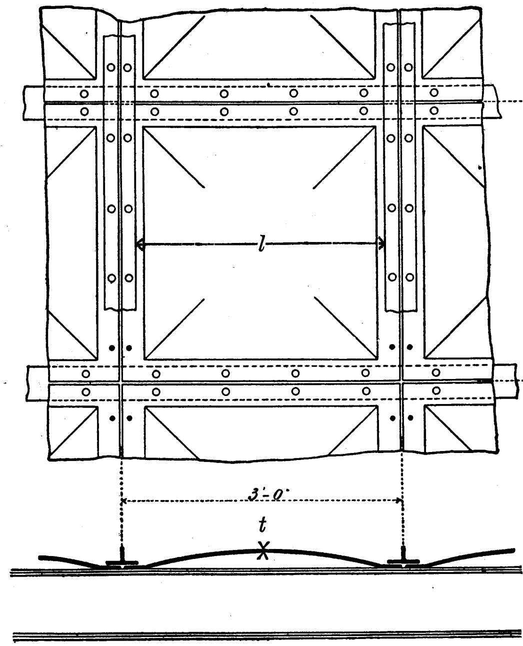
BUCKLED PLATES.

Buckled plates are usually made three feet square and from one-quarter inch to one-half inch thick. They can be made of any desired size or thickness, or extended length, having several buckles in a single plate.

They are usually riveted to the supporting beams and the transverse joint supported by a ⊥ or other suitable section, as indicated on the cut.

Experiment shows considerable advantage by having the edges properly secured.

Buckled plates, if used inverted—that is, with the buckle suspended—develop from three to four times as much strength as if used as shown in sketch.



The strength of buckled plates may be given by the following formula:*

$$D = \frac{100\,k\,h\,t - 0.175\,g\,l^2}{6\,h + 15\,t} \times t$$

D = total concentrated load in pounds.
g = uniform load in pounds per square foot.
h = depth of buckle in inches.
l = length of buckle in inches.
t = thickness in inches.
k = permissible stress in pounds per square inch.

If we assume $g = 120$ lbs. per square foot, and $k = 6{,}000$ lbs. per square inch, we get the following values for D, for various dimensions of plates:

TOTAL CONCENTRATED LOAD IN POUNDS, ALLOWING FOR A DISTRIBUTED LOAD OF 120 POUNDS PER SQUARE FOOT.

Size of Plate.	36 *Inches Square.*	42 *Inches Square.*	48 *Inches Square.*	54 *Inches Square.*	60 *Inches Square.*
Thickness in Inches.	2 *Inches Depth of Buckle.*				
$\frac{1}{4}$	4350	4200	4000	3800	3550
$\frac{5}{16}$	6500	6350	6100	5900	5600
$\frac{3}{8}$	9000	8800	8550	8300	8000
$\frac{7}{16}$	11700	11500	11200	10900	10600
$\frac{1}{2}$	14700	14400	14100	13800	13400
	$2\frac{1}{2}$ *Inches Depth of Buckle.*				
$\frac{1}{4}$	4600	4500	4350	4200	4000
$\frac{5}{16}$	7000	6850	6650	6450	6250
$\frac{3}{8}$	9750	9550	9350	9100	8850
$\frac{7}{16}$	12750	12550	12350	12050	11750
$\frac{1}{2}$	16050	15850	15600	15300	15000
	3 *Inches Depth of Buckle.*				
$\frac{1}{4}$	4850	4750	4600	4450	4300
$\frac{5}{16}$	7350	7250	7050	6900	6700
$\frac{3}{8}$	10250	10150	9950	9750	9500
$\frac{7}{16}$	13550	13350	13150	12950	12700
$\frac{1}{2}$	17100	16900	16700	16450	16150

* Winkler, "Querconstructionen," Vienna, 1884.

The formula shows that the concentrated load and the total uniform load are independent of l. This, of course, is only correct as long as the buckled plate is not subject to local deformations, say within the limits given in the previous table. The total uniform load a buckled plate can carry, follows from the above formula as:

$$P = 4\,k\,h\,t.$$

If we assume $k = 6{,}000$ lbs. per square inch, we get the following:

TOTAL UNIFORMLY DISTRIBUTED LOAD ON ANY SIZE PLATE OF GIVEN THICKNESS AND DEPTH OF BUCKLE.

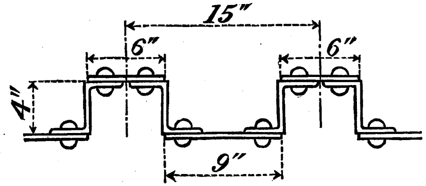
Depth of Buckle.	2 *Inches.*	$2\frac{1}{2}$ *Inches.*	3 *Inches.*
Thickness of Plate in Inches.	*Total Loads in Pounds.*		
$\frac{1}{4}$	12000	15000	18000
$\frac{5}{16}$	15000	18750	22500
$\frac{3}{8}$	18000	22500	27000
$\frac{7}{16}$	21000	26250	31500
$\frac{1}{2}$	24000	30000	36000

WEIGHT OF BUCKLED PLATES THREE FEET SQUARE.

Thickness of Plate in Inches.	*Weight of One Plate in Pounds.*	*Size and Weight of* T.	*Weight in Pounds per Square Foot of Floor.*
$\frac{3}{16}$	68	4 x 2 T = 20 lbs.	$9\frac{1}{2}$
$\frac{1}{4}$	92	4 x 2 T = 20 "	12
$\frac{5}{16}$	114	4 x 3 T = 25 "	15
$\frac{3}{8}$	139	4 x $3\frac{1}{2}$ T = 30 "	18
$\frac{7}{16}$	160	4 x 4 T = 35 "	22
$\frac{1}{2}$	184	4 x $4\frac{1}{2}$ T = 40 "	25

PENCOYD Z BAR FLOORING.

No 1.



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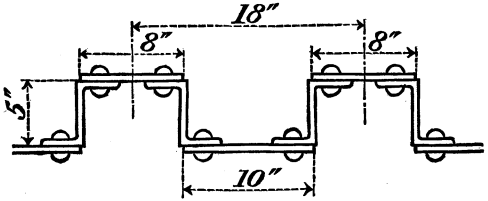

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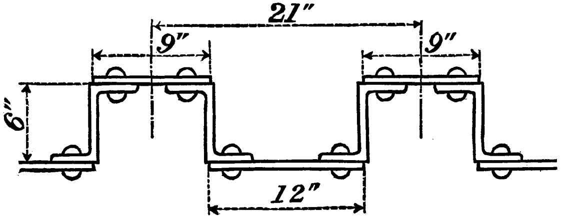
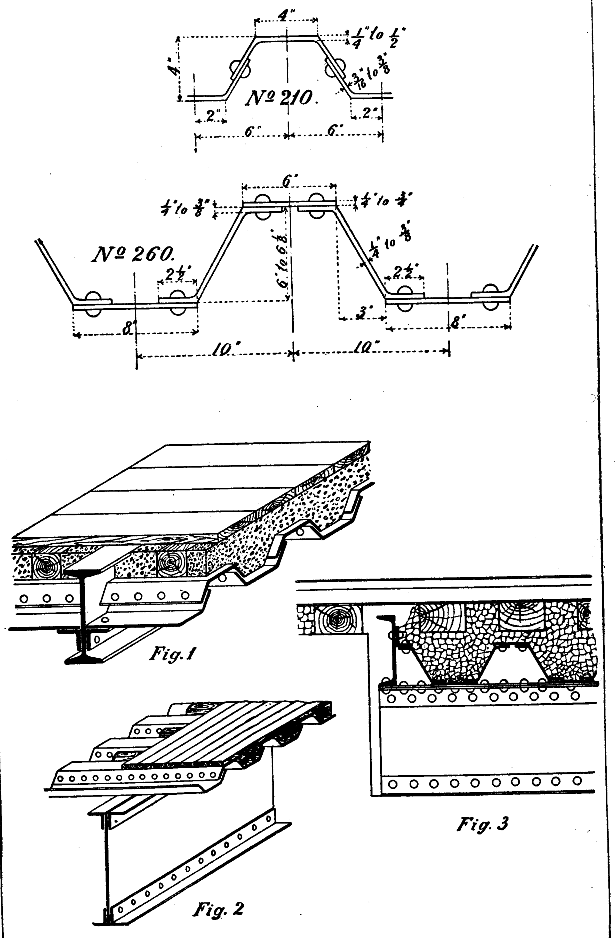


Divide the coefficient in last column, on the opposite page, by the span of the floor in feet. The quotient will be the safe load in tons, evenly distributed, for each foot of width of floor.

PENCOYD Z BAR FLOORING.

Section Number.	*Thickness of Z Bars.*	*Thickness of Plates.*	*Weight in Pounds per Square Foot.*	*Resistance per Foot of Width.*	*Coefficient for Distributed Load in Tons, per Foot of Width.*
1	1/4	1/4	25.9	9.3	46.7
1	1/4	3/8	31.0	12.0	60.0
1	1/4	1/2	36.1	14.7	73.7
1	5/16	1/4	29.1	10.4	52.0
1	5/16	3/8	34.2	12.9	64.5
1	5/16	1/2	39.3	15.7	78.5
1	3/8	1/4	32.3	11.4	57.2
1	3/8	3/8	37.4	14.0	70.0
1	3/8	1/2	42.5	16.7	83.5
2	5/16	5/16	32.1	14.3	71.5
2	5/16	7/16	37.3	17.6	88.0
2	5/16	9/16	42.3	20.9	104.7
2	3/8	5/16	35.2	15.5	77.5
2	3/8	7/16	40.3	18.8	94.0
2	3/8	9/16	45.4	22.1	110.7
2	7/16	5/16	38.4	16.6	83.2
2	7/16	7/16	43.5	20.0	100.0
2	7/16	9/16	48.6	23.3	116.5
3	3/8	3/8	39.3	20.3	101.7
3	3/8	1/2	44.3	24.1	120.7
3	3/8	5/8	49.5	28.1	140.5
3	7/16	3/8	42.4	21.7	108.7
3	7/16	1/2	47.5	25.4	127.0
3	7/16	5/8	52.6	29.4	147.0
3	1/2	3/8	45.5	23.1	115.5
3	1/2	1/2	50.6	26.7	133.5
3	1/2	5/8	55.7	30.7	153.6



PENCOYD CORRUGATED FLOORING.

Sections Nos. 210 and 260 are extensively used for floors of bridges and buildings. No. 210 is generally used in buildings; No. 260 is used for bridge-floors.

The following table gives the weights and strength for different thicknesses of each section:

WEIGHT AND STRENGTH OF CORRUGATED FLOORING.

Section Number.	*Flange Thickness in Inches.*	*Web Thickness in Inches.*	*Weight in Pounds per Square Foot.*	*Resistance per Foot of Width.*	*Coefficient for Distributed Load in Tons, per Foot of Width.*
210	1/4	3/16	14.8	4.4	22.0
210	5/16	15/64	18.4	5.5	27.5
210	3/8	9/32	21.9	6.6	33.0
210	7/16	21/64	25.5	7.7	38.7
210	1/2	3/8	29.1	8.9	44.4
260	1/4	1/4	20.0	10.5	52.5
260	3/8	1/4	23.6	13.2	66.0
260	1/2	1/4	27.1	15.9	79.5
260	5/8	1/4	30.7	18.6	93.0
260	3/8	5/16	26.5	14.3	71.5
260	1/2	5/16	30.1	17.0	85.0
260	5/8	5/16	33.7	19.7	98.5
260	3/4	5/16	37.2	22.4	112.0
260	3/8	3/8	29.4	15.3	76.5
260	1/2	3/8	32.9	18.1	90.5
260	5/8	3/8	36.5	20.9	104.5
260	3/4	3/8	40.1	23.7	118.5

The resistance and coefficients for distributed loads in tons are for each foot in width; the latter for fibre stress of 15,000 pounds per square inch. To find the load for any span, divide the coefficient by the length of span in feet; the quotient is the distributed load in tons, which produces fibre stress on the material, as aforesaid.

The following tables give safe loads for varying thickness of each section, based on the fibre stress aforesaid.

PENCOYD CORRUGATED FLOORING.

Loads in pounds per square foot of floor for a fibre stress of 15,000 pounds per square inch.

The figures in small type under the load in pounds are the corresponding centre deflections in inches. Those to the right of the dark line are where the centre deflection exceeds $\frac{1}{360}$ part of the span.

Section No. 210.

Weight of Material per Sq. Foot.	SPAN IN FEET.										
	6	7	8	9	10	11	12	13	14	15	16
14.8	1222 .15	898 .21	688 .28	543 .35	440 .43	364 .52	306 .62	260 .73	224 .84	196 .97	172 1.10
18.4	1528 .15	1122 .21	859 .28	679 .35	550 .43	455 .52	382 .62	325 .73	281 .84	244 .97	215 1.10
21.9	1833 .15	1347 .21	1031 .28	815 .35	660 .43	545 .52	458 .62	391 .73	337 .84	293 .97	258 1.10
25.5	2150 .15	1579 .21	1209 .28	956 .35	774 .43	640 .52	533 .62	458 .73	395 .84	344 .97	302 1.10
29.1	2467 .15	1812 .21	1388 .28	1096 .35	888 .43	734 .52	617 .62	525 .73	453 .84	395 .97	347 1.10

Section No. 260.

Weight of Material per Sq. Foot.	8	9	10	11	12	13	14	15	16	17	18
20.0	1641 .17	1309 .22	1050 .27	868 .32	729 .38	621 .45	536 .52	467 60	410 .68	363 .77	324 .86
23.6	2063 .16	1630 .21	1320 .26	1091 .31	917 .37	781 .44	693 .51	587 .58	516 .65	457 .74	407 .83
27.1	2484 .16	1963 .20	1590 .25	1314 .30	1104 .35	941 .41	811 .48	707 .55	620 .62	550 .71	491 .80
30.7	2906 .15	2296 .19	1860 .24	1537 .29	1292 .34	1101 .40	949 .47	827 .54	727 .61	644 .69	574 .77
26.5	2234 .16	1765 .20	1430 .25	1182 .30	993 .36	846 .43	730 .50	636 .57	559 .65	495 .73	441 .82
30.1	2656 .16	2099 .20	1700 .24	1405 .29	1181 .35	1006 .41	867 .48	756 .55	664 .63	588 .71	525 .79
33.7	3078 .15	2432 .19	1970 .24	1628 .29	1368 .34	1166 .40	1005 .46	876 .53	770 .60	682 .68	608 .76
37.2	3500 .15	2765 .20	2240 .23	1851 .28	1556 .33	1325 .39	1143 .45	996 .51	875 .58	775 .66	691 .74
29.4	2391 .16	1889 .20	1530 .24	1264 .29	1063 .35	905 .41	781 .48	680 .55	598 .63	529 .71	472 .79
32.9	2828 .16	2235 .20	1810 .24	1496 .29	1264 .35	1071 .41	923 .48	804 .55	707 .62	626 .70	559 .39
36.5	3266 .15	2580 .19	2090 .24	1727 .29	1451 .34	1237 .40	1066 .46	929 .53	816 .61	723 .69	645 .77
40.1	3703 .14	2926 .18	2370 .23	1959 .28	1646 .33	1402 .38	1209 .44	1053 .51	926 .58	820 .65	731 .73

PENCOYD CORRUGATED FLOORING.

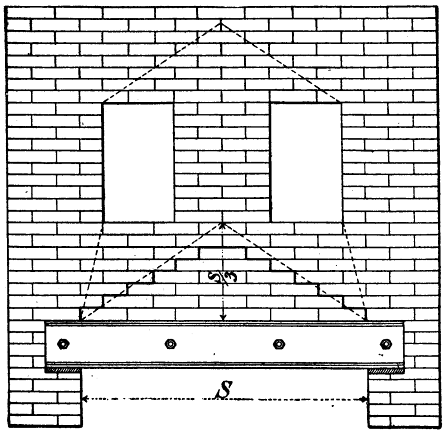
Loads in pounds per square foot which cause a deflection equal to $\frac{1}{400}$ of the span.

Section No. 210.

Weight of Material per Square Foot.	*SPAN IN FEET.*										
	5	6	7	8	9	10	11	12	13	14	15
14.8	2460	1400	900	600	420	300	230	180	140	110	90
18.4	3000	1750	1100	740	520	380	290	220	170	140	110
21.9	3600	2120	1300	900	630	460	340	250	210	170	130
25.5	4200	2500	1570	1050	740	540	400	310	240	200	160
29.1	4800	2850	1800	1200	850	620	460	360	280	220	180

Section No. 260.

Weight of Material per Square Foot.	*SPAN IN FEET.*										
	8	9	10	11	12	13	14	15	16	17	18
20.0	2420	1650	1200	880	680	540	430	350	290	240	200
23.6	3050	2200	1580	1200	910	710	570	460	380	310	260
27.1	3670	2650	1910	1450	1140	890	720	580	470	390	330
30.7	4650	3310	2350	1760	1380	1040	860	690	570	480	400
26.5	3300	2240	1630	1250	990	780	636	500	420	350	290
30.1	3920	2670	1940	1480	1170	950	770	620	510	430	360
33.7	4920	3280	2360	1790	1410	1140	910	750	620	510	430
37.2	5600	3980	2830	2220	1720	1330	1070	870	730	610	510
29.4	3830	2550	1840	1390	1090	860	690	550	460	390	320
32.9	4530	3220	2290	1720	1290	1010	810	660	540	460	380
36.5	5230	3720	2640	1990	1550	1210	970	780	640	540	450
40.1	5930	4210	3160	2350	1820	1410	1130	930	770	640	530



BEAMS SUPPORTING BRICK WALLS.

When the masonry alone, without any floor attachment, is supported, the load on the girder will vary according to several conditions. If the masonry is not thoroughly bonded throughout, or if great inflexibility is desired, it may be necessary to consider the whole mass of wall as sustained by the girder.

If the wall has no openings, and the brick is laid with the usual bond, the material incumbent on the girder would be indicated by the dark line—height, one-fourth of the span. It is best to consider this as a triangle, whose height equals one-third of span, as in lower dotted line; and as the weight of brick walls is nearly 10 lbs. per square foot for each inch of thickness, from these data we find the bending stress on the beam to be the same as that caused by a distributed load, in pounds equal to

$$\frac{25 \times \text{square of span in feet} \times \text{thickness of wall in inches.}}{9}$$

And from the table of distributed loads suitable beams can be selected, with proper limitations, for deflection, if the spans are long, to avoid cracking of wall. If the wall has

openings as illustrated, it is necessary to consider the mass of brickwork indicated by the upper course of dotted lines as supported by the beams, which can be selected accordingly.

It is usually best to use two or more beams bolted together, to give a better bearing or to insure lateral rigidity, and the following tables give suitable beams for solid brick walls properly bonded, selected to deflect less than $\frac{1}{360}$ of spans up to 10 feet, and $\frac{1}{500}$ of spans 15 to 20 feet. Particulars for separators for these beams can be found on page 219.

	SPANS IN FEET.					
Thickness of Wall in Inches.	*8 or 9 Feet.*	*10 or 11 Feet.*	*12 or 13 Feet.*	*14 or 15 Feet.*	*16 or 17 Feet.*	*18 or 20 Feet.*
9	1–4″ No. 20	1–5″ No. 500	2–6″ No. 501	2–7″ No. 505	2–7″ No. 505	2–9″ No. 509
13	1–5″ No. 500	2–5″ No. 500	2–6″ No. 502	2–7″ No. 505	2–8″ No. 507	2–10″ No. 512
18	2–5″ No. 500	2–6″ No. 501	2–7″ No. 505	2–8″ No. 507	2–8″ No. 507	
22	2–5″ No. 500	2–6″ No. 501	2–8″ No. 507	2–8″ No. 507	2–9″ No. 509	

SUPPORTS AND CONNECTIONS FOR BEAMS AND GIRDERS.

WHEN the span becomes too great, or the loads excessive for rolled beams, refer to the tables on pages 99 to 111 for the strength of riveted girders of the several sections described.

When the support of the beam or girder is formed on masonry, a bearing plate should be provided for the ends of the beams to distribute the pressure over a sufficient area. This pressure should not exceed five (5) tons per square foot for ordinary brick-work laid in lime mortar. For hard brick laid in cement mortar, the pressure may be as much as ten (10) tons per square foot. For stone masonry, the pressure may run from five (5) to twenty (20) tons per square foot, according to the character of the work.

When two or more beams are used together, they should be tied at intervals with fitted separators between them as described on page 219. These separators should be spaced near the supports, and at intervals of 5 or 6 feet.

The standard angle connections for framing "I" beams are described on pages 212 and 213. These connections have been designed to provide for beams of the sizes and length of spans given in the table on page 213. If the beams are much shorter, and the total load supported greater than described, it may become necessary to design special connections, to provide for the increased end shear.

APPROXIMATE FORMULÆ FOR ROLLED BEAMS.

The following rules for the strength and stiffness of rolled beams of various sections are intended for convenient application in cases where strict accuracy is not required.

The rules for rectangular and circular sections are correct, while those for the flanged sections are approximate and limited in their application to the standard shapes as given in our tables. They will be found to give results which have been proved by experiment to be sufficiently accurate for practical purposes. When the section of any beam is increased above the standard minimum dimensions, the flanges remaining unaltered, and the web alone being thickened, the tendency will be for the load as found by the rules to be in excess of the actual, but within the limits that it is possible to vary any section in the rolling, the rules will apply without any serious inaccuracy.

The loads are the same as in the beam tables, producing a fibre stress of 16,000 lbs. per square inch, on the assumption that the steel referred to has a tenacity about 20 per cent. in excess of iron. These loads will be approximately one-half of loads that would injure the elasticity of the material.

The rules for deflection apply to any load below the elastic limit, or less than double the greatest safe load by the rules.

If the beams are long without lateral support, reduce the loads for the ratios of width to span, as described on page 37.

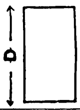
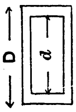
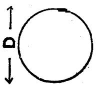
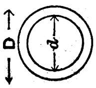
Example.—A 12-inch No. 515 **I** beam, area 9.01 square inches, 10 feet span, by the tables, will support a distributed load of $18\frac{1}{2}$ tons, and by the approximate rule $\frac{3560 \times 9.01 \times 12}{10} = 38{,}500$ lbs.

The deflection by the rule will also be found nearly as in the tables.

APPROX. GREATEST SAFE LOADS IN LBS. ON IRON OR STEEL BEAMS.

Based on fibre strains of 14,000 lbs. for iron and 16,800 lbs. for steel.

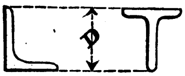
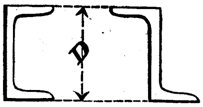
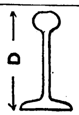
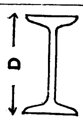
L = Length in feet between supports.
A = Sectional area of beam in square inches.
D = Depth of beam in inches.
a = Interior area in square inches.
d = Interior depth in inches.
w = Working load in net tons.

I.	II.	III.	IV.	V.	VI.	VII.
	W = Greatest Safe Load in Pounds.				$\triangle$ = Deflection in Inches.	
Shape of Section.	Load in Middle of Beam.		Load Distributed.			
	Iron.	Steel.	Iron.	Steel.	Load in Middle.	Distributed Load.
 Solid Rectangle.	$W=\frac{780AD}{L}$	$W=\frac{940AD}{L}$	$W=\frac{1560AD}{L}$	$W=\frac{1880AD}{L}$	$\triangle=\frac{wL^3}{32AD^2}$	$\triangle=\frac{wL^3}{52AL^2}$
 Hollow Rectangle.	$W=\frac{780(AD-ad)}{L}$	$W=\frac{940(AD-ad)}{L}$	$W=\frac{1560(AD-ad)}{L}$	$W=\frac{1880(AD-ad)}{L}$	$\triangle=\frac{wL^3}{32(AD^2-ad^2)}$	$\triangle=\frac{wL^3}{52(AD^2-ad^2)}$
 Solid Cylinder.	$W=\frac{580AD}{L}$	$W=\frac{700AD}{L}$	$W=\frac{1160AD}{L}$	$W=\frac{1400AD}{L}$	$\triangle=\frac{wL^3}{24AD^2}$	$\triangle=\frac{wL^3}{38AD^2}$
 Hollow Cylinder.	$W=\frac{580(AD-ad)}{L}$	$W=\frac{700(AD-ad)}{L}$	$W=\frac{1160(AD-ad)}{L}$	$W=\frac{1400(AD-ad)}{L}$	$\triangle=\frac{wL^3}{24(AD^2-ad^2)}$	$\triangle=\frac{wL^3}{38(AD^2-ad^2)}$

APPROX. GREATEST SAFE LOADS IN LBS. ON IRON OR STEEL BEAMS.

Based on fibre strains of 14,000 lbs. for iron and 16,800 lbs. for steel.

L = Length in feet between supports.
A = Sectional area of beam in square inches.
D = Depth of beam in inches.
a = Interior area in square inches.
d = Interior depth in inches.
w = Working load in net tons.

I.	II.	III.	IV.	V.	VI.	VII.
	W = Greatest Safe Load in Pounds.				$\triangle$ = Deflection in Inches.	
Shape of Section.	Load in Middle of Beam.		Load Distributed.		Load in Middle.	Distributed Load.
	Iron.	Steel.	Iron.	Steel.		
 Even-legged Angle or Tee.	$W=\frac{770AD}{L}$	$W=\frac{930AD}{L}$	$W=\frac{1540AD}{L}$	$W=\frac{1860AD}{L}$	$\triangle=\frac{wL^3}{32AD^2}$	$\triangle=\frac{wL^3}{52AD^2}$
 Channel or Z Bars.	$W=\frac{1335AD}{L}$	$W=\frac{1600AD}{L}$	$W=\frac{2670AD}{L}$	$W=\frac{3200AD}{L}$	$\triangle=\frac{wL^3}{53AD^2}$	$\triangle=\frac{wL^3}{85AD^2}$
 Deck Beam.	$W=\frac{1200AD}{L}$	$W=\frac{1450AD}{L}$	$W=\frac{2400AD}{L}$	$W=\frac{2900AD}{L}$	$\triangle=\frac{wL^3}{50AD^2}$	$\triangle=\frac{wL^3}{80AD^2}$
 I Beam.	$W=\frac{1485AD}{L}$	$W=\frac{1780AD}{L}$	$W=\frac{2970AD}{L}$	$W=\frac{3560AD}{L}$	$\triangle=\frac{wL^3}{58AD^2}$	$\triangle=\frac{wL^3}{93AD^2}$

The preceding rules apply to beams supported at each end. For beams supported otherwise alter the coefficients of the table as described below, referring to the respective columns indicated by number.

CHANGES OF COEFFICIENTS FOR SPECIAL FORMS OF BEAMS.

Kind of Beam.	*Coefficient for Safe Load.*	*Coefficient for Deflection.*
Fixed at one end, loaded at the other.	One-fourth ($\frac{1}{4}$) of the coefficient of col. II or III.	One-sixteenth ($\frac{1}{16}$) of the coefficient of col. VI.
Fixed at one end, load evenly distributed.	One-fourth ($\frac{1}{4}$) of the coefficient of col. IV or V.	Five-forty-eighths ($\frac{5}{48}$) of the coefficient of col. VII.
Both ends rigidly fixed, or a continuous beam, with a load in middle.	Twice the coefficient of col. II or III.	Four times the coefficient of col. VI.
Both ends rigidly fixed, or a continuous beam with load evenly distributed.	One and one-half ($1\frac{1}{2}$) times the coefficient of col. IV or V.	Five times the coefficient of col. VII.

It will be observed that these rules apply only to the intermediate spans of continuous beams; when continuity does not occur at the ends, the conditions are altered. If, however, the outer ends of a continuous beam overhang the end-supports from one-fifth to one-fourth of a span, and bear the same proportion of load as the parts between supports, then the outer spans may be of same length as the intermediate spans, subject to the same load, and the strength and stiffness are determined by the same rules; otherwise the outer spans ought to be only four-fifths of the

length of the intermediate spans when the load is distributed, or three-fourths of the same when the load is concentrated in the middle; or, if the lengths of spans are all alike, the loads on outer spans ought to be reduced in the same proportion.

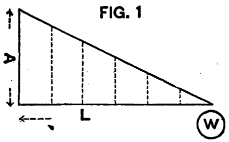
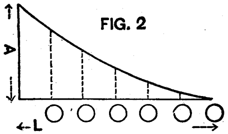
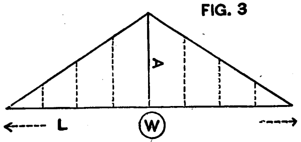
The following table exhibits the relative proportion of strength and stiffness existing between various classes of beams when they have the same lengths and uniform cross-section; the deflections being comparative figures for the same loads on any beam.

Kind of Beam.	*Maximum Load as*	*Deflection as*
Fixed at one end—loaded at the other . .	$\frac{1}{4}$	16
Fixed at one end—load evenly distributed	$\frac{1}{2}$	6
Supported at both ends—load in middle .	1	1
Supported at both ends—load evenly distributed	2	$\frac{5}{8}$
Continuous beam—load in middle . . .	2	$\frac{1}{4}$
Continuous beam—load evenly distributed	3	$\frac{1}{8}$

The load and deflection of a beam supported at both ends and loaded in the middle have been taken as the units for comparison. Beams of uniform length and section will be equally strained when loaded in the ratio described in the first column, or if the beams are loaded equally, within their elastic limits, the respective deflections will be in the ratio described in second column.

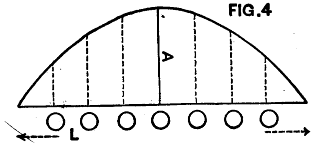
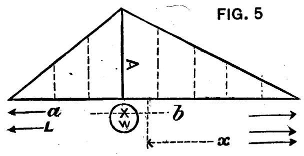
BENDING MOMENTS AND DEFLECTIONS FOR BEAMS OF UNIFORM SECTION.

W = Total load. E = Modulus of elasticity.
L = Length of beam. I = Moment of inertia.

Form of Beam and Position of Load.	*Maximum Bending Moment.*	*Maximum Shearing Stress.*	*Deflection.*
Beam fixed at one end, loaded at the other: FIG. 1  Draw triangle having $A = WL$. Vertical lines give bending moments at corresponding points on the beam.	at point of support $= WL$.	at point of support $= W$.	at end of beam $= \frac{WL^3}{3EI}$.
Beam fixed at one end, load uniformly distributed: FIG. 2  Draw parabola having $A = \frac{WL}{2}$. Ordinates give bending moments at corresponding points on the beam.	at point of support $= \frac{WL}{2}$.	at point of support $= W$.	at end of beam $= \frac{WL^3}{8EI}$.
Beam supported at both ends, loaded in the middle: FIG. 3  Draw triangle having $A = \frac{WL}{4}$. Vertical lines give bending moments at corresponding points on the beam.	at middle of beam $= \frac{WL}{4}$.	at point of support $= \frac{W}{2}$.	at middle of beam $= \frac{WL^3}{48EI}$.

BENDING MOMENTS AND DEFLECTIONS FOR BEAMS OF UNIFORM SECTION.

W = Total load. E = Modulus of elasticity.
L = Length of beam. I = Moment of inertia.

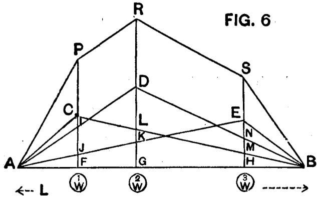
Form of Beam and Position of Load.	*Maximum Bending Moment.*	*Maximum Shearing Stress.*	*Deflection.*
Beam supported at both ends, load uniformly distributed: FIG. 4  Draw parabola having $A = \frac{WL}{8}$. Ordinates give bending moments at corresponding points on the beam.	at middle of beam $= \frac{WL}{8}$.	at point of support $= \frac{W}{2}$.	at middle of beam $= \frac{WL^3}{76.8EI}$.
Beam supported at both ends, load concentrated at any point: FIG. 5  Draw triangle having $A = \frac{Wab}{L}$. Vertical lines give bending moments at corresponding points on the beam.	at position of load $= \frac{Wab}{L}$.	at point of support next to a $= \frac{Wb}{L}$. at point of support next to b $= \frac{Wa}{L}$.	at position of load $= \frac{a^2b^2W}{3EIL}$. Max. def. at x $= \frac{1}{27}\frac{Wab(a+L)}{EIL}\sqrt{3b(a+L)}$, a being less than b. $x = \sqrt{\frac{b(a+L)}{3}}$

BENDING MOMENTS AND DEFLECTIONS FOR BEAMS OF UNIFORM SECTION.

W = Total load. E = Modulus of elasticity.
L = Length of beam. I = Moment of inertia.

Beam supported at both ends, with concentrated loads at various points:

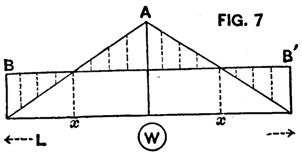
FIG. 6



Draw (by 5) the triangles having vertices at C, D and E, the verticals representing bending moments for loads w^1, w^2 and w^3, respectively. Extend FC to P, GD to R, and HE to S, making each long vertical equal to the sum of the bending moments corresponding to its position. That is, $FP = FC + FI + FJ$. $GR = GD + GL + GK$. And $HS = HE + HN + HM$. Verticals drawn from any point on the polygon, $APRSB$ to AB, will represent the bending moments at the corresponding points on the beam.

Beam rigidly secured at each end, and loaded in the middle. Or the intermediate spans of a continuous beam, equally loaded in the middle of each span:

FIG. 7



Points of contraflexure at x, x, where Moment $= O$. Distance of x from either support $= \frac{L}{4}$. Equal moments at middle and ends $= \frac{WL}{8}$. Deflection $= \frac{WL^3}{192EI}$.

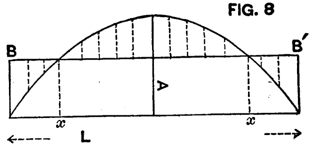
Draw a triangle having $A = \frac{WL}{4}$, and at ends draw verticals BB', each $= \frac{WL}{8}$, join BB'. The vertical distances between BB' and the sides of the triangle represent the moments for corresponding points on the beam.

BENDING MOMENTS AND DEFLECTIONS FOR BEAMS OF UNIFORM SECTIONS.

W = Total load. E = Modulus of elasticity.
L = Length of beam. I = Moment of inertia.

Beam rigidly secured at each end, with load uniformly distributed.
Or the intermediate spans of a continuous beam bearing a uniformly distributed load on each span.

FIG. 8



Points of contraflexure at x, x, where moment $= O$. Distance of x from either support $= .21L$.

Draw parabola having $A = \frac{WL}{8}$. Draw verticals B, B', each equal to $\frac{WL}{12}$, join BB'. The vertical distances between BB' and the curve of the parabola represent the moments of corresponding points on the beam.

Maximum moment at points of support $= \frac{WL}{12}$.

Moment at middle of beam $= \frac{WL}{24}$.

Maximum deflection at middle of beam $= \frac{WL^3}{384EI}$.

BEAMS FOR SUPPORTING IRREGULAR LOADS.

When a beam has its load unequally distributed, the proper size of the beam can be determined by finding the maximum bending moment and proportioning the beam accordingly. Equilibrium is obtained when the bending moment is equal to the moment of resistance. That is, when the external force multiplied by the leverage with which it acts is equal to the strength of the material in the cross-section of the beam multiplied by the leverage with which it acts.

The resistance of a beam is found by dividing the moment of inertia of the section by the distance from neutral axis to extreme fibres, and this value for any rolled section will be found in the tables, pages 114 to 139. This tabulated resistance, multiplied by the limiting fibre stress on the beam, is the measure of strength of the section.

RULE FOR BEAMS BEARING IRREGULAR LOADS.

Finding by the methods described on pages 88 to 91, the maximum bending moment on the beam, divide the bending moment by the limiting fibre stress, and select from the tables, pages 114 to 139, a beam whose resistance is not less than this quotient. The greatest safe fibre stress in our tables is 16,000 lbs. The stress should be modified for various considerations, as described on pages 36 to 38.

Example.—An **I** beam 8 feet long is to be fixed at one end and loaded at the other with 5,000 lbs. and carrying also an evenly distributed load of 8,000 lbs. What size of beam should be used so as not to be strained over 16,000 lbs.?

$$\begin{aligned}
&\text{Moment for end load} &&= 5{,}000 \times 96 = 480{,}000 \text{ inch-lbs.}\\
&\text{“} \quad \text{“ distributed load} &&= \frac{8{,}000 \times 96}{2} = 384{,}000 \quad \text{“} \quad \text{“}\\
& &&\text{Total} = \overline{864{,}000} \quad \text{“} \quad \text{“}
\end{aligned}$$

Divide this bending moment by the fibre stress aforesaid, and select from column XI., page 115, beams whose resistances are nearest the quotients, as follows:

12-inch. No. 517. 55.5 lbs. per foot.
or 15-inch. No. 521. 41.2 “ “ “

The 15-inch beams being both strongest and lightest.

In some instances the maximum bending moment can be most readily found by the use of diagrams, as described in the succeeding article. When this is done use any convenient scale, making all loads and all distances respectively of the same denominations. The maximum bending moment can then be measured to scale.

Example.—A beam 20 feet long between supports will carry three loads, which we will call A, B and C.
$A = 4{,}000$ lbs. and is 4 feet from one end of the beam.
$C = 6{,}000$ lbs. and is 3 feet from the other end of the beam.
$B = 5{,}000$ lbs. and is 5 feet from C and 8 feet from A.

Required a suitable beam, not strained over 12,000 lbs.

Describe a diagram as in Fig. 6, page 90, when the following bending moments will be obtained.

At point A.		At point B.		At point C.	
For load A,	12,800	For load B,	24,000	For load C,	15,300
“ B,	8,000	“ A,	10,800	“ B,	8,900
“ C,	3,600	“ C,	6,400	“ A,	2,400
	Total, 24,400		Total, 41,200		Total, 26,600

The maximum moment at $B = 41{,}200$ foot-lbs. or 494,400 inch-lbs. Dividing by 10,000 and 12,000, select the following beams, whose resistances are nearest the quotients, column XI., page 115.

15-inch beam, No. 521, 41.2 lbs. per foot, or
12-inch “ No. 515, 30.6 “ “ “

NOTE.—The tables of elements, except where otherwise specified, are calculated for dimensions in inches and weights in pounds, consequently in examples of above character it is necessary to obtain bending moments in inch-pounds.

BEAMS SUBJECT TO BOTH BENDING AND COMPRESSION.

When a beam is subjected to bending action and simultaneously has to act as a strut by resisting compression, the stress of the fibres of the beam otherwise in tension will be relieved and those in compression correspondingly augmented.

No general rules can be given for such conditions, as every particular case requires its own proper determination. The following methods, though not strictly correct, will give safe results for some simple forms of trussed girders, etc.

WHEN THE BEAM IS SUBJECT TO COMPRESSION, BUT IS SO CONFINED LATERALLY THAT IT CANNOT FAIL BY BENDING LIKE A STRUT.

Rule.—Find by the methods previously described the section of beam required to resist bending, then allowing from 10,000 to 17,000 lbs. per square inch for the compression, according to the material or factor of safety used, add the two sectional areas together, which will give the section of beam required.

Example.—A beam trussed 3 feet deep in the manner illustrated at Fig. 6, page 186, spans an opening of 30 feet, the beam having ample lateral support, and bearing a uniform load of 500 lbs. per lineal foot. Required a suitable beam strained about 12,000 lbs. per inch.

The trussed beam can be considered as composed of two beams reaching from the centre of truss to each support. Each beam 15 feet long, uniform load 7,500 lbs., and subject to a compression resulting from the trussing of 18,750 lbs.

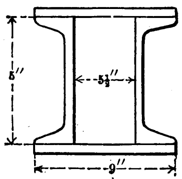
Bending moment $= \frac{7{,}500 \times 180}{8}$, dividing this by fibre stress of 12,000 lbs. gives a quotient 14. The nearest resistance for an **I** beam, column XI., page 117, is 8 inches, 5.12 square inches area, adding for compression $\frac{18{,}750}{12{,}000} = 1.56$ square inch, or a total area of 6.68 square inches for an 8-inch beam.

WHEN THE BEAM IS SUBJECT TO COMPRESSION AND IS LIABLE TO FAIL LIKE A HORIZONTAL STRUT BY LATERAL FLEXURE.

Rule.—Consider first the resistance as a strut and then make the necessary increment of section to resist the bending stress, remembering that if the addition is made to the flanges then only flange stresses have to be considered, but if the increased area is obtained by thickening the web of **I** beam or channel section, then the additional area so obtained should be treated as a rectangular section whose thickness is the amount added to the web, and whose depth is the depth of the beam.

Example.—A trussed girder of the form exhibited in Fig. 8, page 186, is a box section made up of two channels separated with flanges outward, and plated top and bottom. The whole girder is 30 feet long and is loaded 1,000 lbs. per lineal foot. The compression resulting from the trussing is 25,000 lbs. The structure has no lateral bracing. What will be safe proportions for it, the stresses not to exceed one-fifth of the ultimate, or 10,000 lbs. per inch?

It is evident that we have to consider it as a flat-ended strut 30 feet long, liable to fail horizontally, and also as a series of three beams each 10 feet long and loaded with 10,000 lbs. evenly distributed. Trying two light 5-inch channels, each 2.5 square inches section, separated $5\frac{1}{2}$ inches so as to be covered by 9-inch plates, we have (omitting the plates in this calculation) the radius of gyration around



vertical axis (see page 142) = 3.4 inches, $\frac{l}{r} = 106$, one-fifth of ultimate (by Table I, page 150) = 5,600 lbs. per square inch, or $5{,}600 \times 5 = 28{,}000$ lbs. safe resistance, which is ample. Now proportioning the plates to resist the bending strain, we have maximum bending moments (see page 89), $\frac{120 \times 10{,}000}{8} = 150{,}000$ inch-lbs.

The plates act with a leverage equal to the depth of the channel, viz., 5 inches; $\frac{150,000}{5} = 30,000$ lbs. tension on top or compression on bottom plate, which, allowing for 10,000 lbs. per square inch, and allowing for loss by rivets, will require a plate $\frac{3}{8}$ inch thick.

Taking the last example, if it was desired to form the section from a pair of channels latticed top and bottom with no cover plates, we would have to consider the section added to the channels (being on the web alone) as a simple rectangular section. By the formula on page 84, approximate rules, we find that such a section only 5 inches deep would require a thickness of 3.8 inches, which is impracticable; we have therefore to use deeper and heavier channels. Trying 8-inch channels separated as before $5\frac{1}{2}$ inches, with flanges outward, and having radius of gyration for the pair around vertical axis $= 3.4, \frac{l}{r} = 106$. Safe load $\frac{29,000}{5}$ $= 5,800$ lbs. per square inch. As the compression is 25,000 lbs., there is required 4.3 square inches for this purpose. By formula IV, page 84, $\frac{1100 \times \text{area} \times 8}{10} = 10,000$ lbs., from which is found the area required to resist bending $= 12$ square inches. $12 + 4.3 = 16.3$ square inches for two channels, or the heaviest 8-inch channels 20.6 lbs. per foot would be required.

By the same method we find 10-inch channels, 24.8 lbs. per foot, will answer the purpose, or our lightest 12-inch channels, 20 lbs. per foot, will exactly meet the requirements and be the lightest channel that can be used in the manner proposed for the purpose.

In cases where the load is concentrated at the truss points, there being no bending stress, the resistance as a strut has only to be considered, and when braced laterally the strut length is reduced to the distances between bracing.

BEAMS OF ANGLE AND TEE SECTION.

It is frequently convenient to use angle or tee sections for roof purlines and similar purposes.

The length of span may be so great as compared to depth in these cases, that deflection instead of excessive fibre stress is the measure of utility.

An even-flanged angle or tee will deflect slightly less than an equally loaded rectangular section of the same depth and sectional area; but the extreme fibre stress of the former will be greater than in the rectangular section.

Therefore, for long beams, where deflection reaches the permissible limit before fibre stress becomes excessive, the rule for beams of angle and tee section given on page 85 will safely apply.

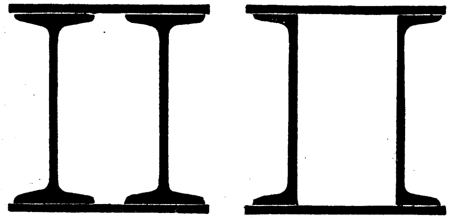
If, however, the fibre stress must be kept lower than this rule indicates, refer to the columns "resistance," pages 130 to 139, and apply as described on page 92.

Example.—A 4″ × 4″ tee, 3.72 square inches area, has a resistance of 1.97 (see col. VII, page 138). Required its greatest safe load distributed over a beam of 10 feet span.

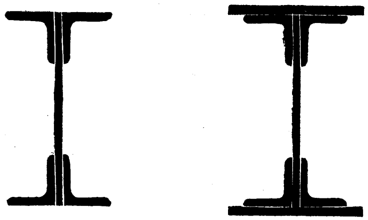
By the method on page 89 bending moment $= \frac{120w}{8} =$ $1.97 \times 14,000$ lbs., or $w = 1,750$ lbs. nearly.

By the rule on page 85 col. IV, the safe load would be $\frac{1540 \times 3.72 \times 4}{10} = 2,290$ lbs., and the deflection by col. VII, page 85, would be $\frac{1.145 \times 1090}{52 \times 3.72 \times 16} = .37$ inch, or only a little over $\frac{1}{360}$ of the span, while the extreme fibre stress at the outer edge of the stem would be about 17,000 lbs., or sufficiently below the elastic limit to justify its use for light purlines, etc.

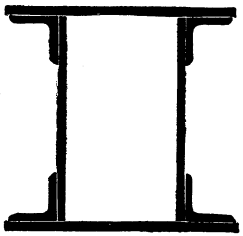
RIVETED GIRDERS.



FOR TABLES, SEE PAGES 110-111



FOR TABLES, SEE PAGES 101 to 103



FOR TABLES, SEE PAGES 105 to 109

RIVETED GIRDERS.

The tables, pages 101 to 111, represent a few of the sections of riveted girders most frequently used in structures. The single-webbed girders are the most economical in material, and most accessible for painting and inspection. But where great width and lateral stiffness are required, the double web or box girder is the best. If the length of the girder exceeds twenty times the width of the flange, the girder should either be given some lateral support, or else the section of the top flange should be increased. It is usual to allow flange strains of 15,000 lbs. per square inch of net section for steel girders for buildings. The safe loads for the girders in the accompanying tables are calculated on this assumption, the entire sectional area of the girder being considered.

The web of the girder should be made of such thickness that the vertical shearing strain will not exceed three-fourths of the horizontal strains, or 11,000 lbs. per square inch of section in the case of girders for buildings. The shearing strain is greatest at the supports, and is found by dividing half the load on the girder by the web section.

If the thickness of the web is less than $\frac{1}{60}$ of its depth, it should be stiffened to resist buckling, by the addition of vertical angles riveted to the web at invervals of not more than the depth of the girder. These stiffeners should always be used at the supports and at points where concentrated loading occurs.

The rivets should be from $\frac{3}{4}$ to $\frac{7}{8}$ inch in diameter, spaced not closer than three diameters, nor farther apart than sixteen times the thickness of plate connected.

It is good practice to limit the least depth of the girder to $\frac{1}{20}$ of the span, on account of deflection.

The following tables are calculated by the moments of inertia of the girder sections, for a fibre strain of 15,000 lbs. per square inch, and for a uniformly distributed load. Coefficient $= \frac{\text{Inertia} \times 8}{\text{extreme depth of girder}}$. The numbers in the first columns of the tables correspond with those of the various sections of girders on the plates.

The tables give coefficients of strength, also weights per lineal foot, including stiffeners for each section, excepting girders without cover plates in first table, where stiffeners are omitted.

TO FIND THE SAFE DISTRIBUTED LOAD FOR ANY GIRDER.

Divide the coefficient of strength by the length of span in feet between centres of supports. The quotient will be the load in tons of 2,000 lbs.

TO FIND THE COEFFICIENT OF STRENGTH NECESSARY TO CARRY A CERTAIN LOAD ON A GIVEN SPAN.

Multiply the load in tons of 2,000 lbs. by the length of span in feet between centres of supports. If the load is concentrated at the centre of the girder, it must not exceed one-half the weight of the permissible uniformly distributed load. If the load is concentrated at some point not in the middle of the girder, it may exceed in weight the permissible middle load, in the ratio of the square of half the span, to the product of the segments formed by the position of the load.

EXAMPLES FOR APPLICATION OF TABLES.

I. What is the carrying capacity of the single-web plate girder No. 16, with $\frac{3}{4}$-inch cover or flange plates, the girder being 20 feet long between centres of supports?

In the column of coefficients, and opposite the girder referred to, find proper coefficient for strength, which in this case is 2,678.

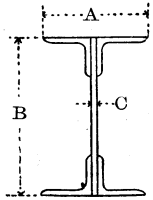
Answer. $\frac{2678}{20} = 134$ tons equally distributed,

or 67 tons in middle of girder.

II. A box girder is required 24 feet long between supports to carry a 20-inch brick wall weighing 66 tons. What is the requisite coefficient of strength?

Answer. $66 \times 24 = 1584$.

Referring to the table of box girders 16 inches wide, we find that girder No. 2, 18 inches deep, with a $\frac{5}{8}$-inch cover plate, has a coefficient of strength of 1587, or a little in excess of that required.



STRENGTH AND WEIGHT OF RIVETED PLATE GIRDERS.

To find the distributed safe load in net tons, divide the coefficient in right-hand column by the length of span in feet.

To find the coefficients of strength for a given load and span, multiply the uniformly distributed load in tons by the span in feet between centres of supports.

Weights do not include stiffeners.

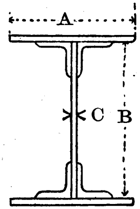
Depth. B.	*Web Thickness. C.*	*Flange Width. A.*	*Size of Angles.*	*Resistance.*	*Weight in Pounds per Lineal Foot.*	*Coefficient of Strength.*
18	$\frac{5}{16}$	$10\frac{5}{16}$	$5 \times 3\frac{1}{2} \times \frac{5}{16}$	92.9	57	464
18	$\frac{3}{8}$	$10\frac{3}{8}$	$5 \times 3\frac{1}{2} \times \frac{3}{8}$	110.0	67	550
18	$\frac{7}{16}$	$10\frac{7}{16}$	$5 \times 3\frac{1}{2} \times \frac{7}{16}$	126.9	77	634
18	$\frac{1}{2}$	$10\frac{1}{2}$	$5 \times 3\frac{1}{2} \times \frac{1}{2}$	143.7	88	718
20	$\frac{3}{8}$	$10\frac{3}{8}$	$5 \times 3\frac{1}{2} \times \frac{3}{8}$	126.8	69	634
20	$\frac{7}{16}$	$10\frac{7}{16}$	$5 \times 3\frac{1}{2} \times \frac{7}{16}$	146.4	80	731
20	$\frac{1}{2}$	$10\frac{1}{2}$	$5 \times 3\frac{1}{2} \times \frac{1}{2}$	165.8	91	829
22	$\frac{3}{8}$	$10\frac{3}{8}$	$5 \times 3\frac{1}{2} \times \frac{3}{8}$	144.1	72	720
22	$\frac{7}{16}$	$10\frac{7}{16}$	$5 \times 3\frac{1}{2} \times \frac{7}{16}$	166.5	83	832
22	$\frac{1}{2}$	$10\frac{1}{2}$	$5 \times 3\frac{1}{2} \times \frac{1}{2}$	188.7	94	943
24	$\frac{3}{8}$	$11\frac{3}{8}$	$5\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$	170.7	77	853
24	$\frac{7}{16}$	$11\frac{7}{16}$	$5\frac{1}{2} \times 3\frac{1}{2} \times \frac{7}{16}$	198.1	89	990
24	$\frac{1}{2}$	$11\frac{1}{2}$	$5\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$	225.4	102	1127
26	$\frac{3}{8}$	$11\frac{3}{8}$	$5\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$	189.7	80	948
26	$\frac{7}{16}$	$11\frac{7}{16}$	$5\frac{1}{2} \times 3\frac{1}{2} \times \frac{7}{16}$	220.4	92	1101
26	$\frac{1}{2}$	$11\frac{1}{2}$	$5\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$	250.9	105	1254
28	$\frac{3}{8}$	$12\frac{3}{8}$	$6 \times 3\frac{1}{2} \times \frac{3}{8}$	218.0	84	1090
28	$\frac{7}{16}$	$12\frac{7}{16}$	$6 \times 3\frac{1}{2} \times \frac{7}{16}$	255.5	98	1277
28	$\frac{1}{2}$	$12\frac{1}{2}$	$6 \times 3\frac{1}{2} \times \frac{1}{2}$	292.8	113	1464
30	$\frac{3}{8}$	$13\frac{3}{8}$	$6\frac{1}{2} \times 4 \times \frac{3}{8}$	256.3	92	1281
30	$\frac{7}{16}$	$13\frac{7}{16}$	$6\frac{1}{2} \times 4 \times \frac{7}{16}$	298.5	107	1492
30	$\frac{1}{2}$	$13\frac{1}{2}$	$6\frac{1}{2} \times 4 \times \frac{1}{2}$	340.4	122	1701
32	$\frac{3}{8}$	$13\frac{3}{8}$	$6\frac{1}{2} \times 4 \times \frac{3}{8}$	279.2	95	1396
32	$\frac{7}{16}$	$13\frac{7}{16}$	$6\frac{1}{2} \times 4 \times \frac{7}{16}$	325.1	110	1625
32	$\frac{1}{2}$	$13\frac{1}{2}$	$6\frac{1}{2} \times 4 \times \frac{1}{2}$	370.6	125	1853
34	$\frac{3}{8}$	$13\frac{3}{8}$	$6\frac{1}{2} \times 4 \times \frac{3}{8}$	302.5	97	1512
34	$\frac{7}{16}$	$13\frac{7}{16}$	$6\frac{1}{2} \times 4 \times \frac{7}{16}$	352.3	113	1761
34	$\frac{1}{2}$	$13\frac{1}{2}$	$6\frac{1}{2} \times 4 \times \frac{1}{2}$	401.8	129	2009
36	$\frac{3}{8}$	$13\frac{3}{8}$	$6\frac{1}{2} \times 4 \times \frac{3}{8}$	326.3	100	1631
36	$\frac{7}{16}$	$13\frac{7}{16}$	$6\frac{1}{2} \times 4 \times \frac{7}{16}$	380.1	116	1900
36	$\frac{1}{2}$	$13\frac{1}{2}$	$6\frac{1}{2} \times 4 \times \frac{1}{2}$	433.5	132	2167

THICKNESS OF COVER PLATES IN INCHES.

Section Number.	Depth of Girder in Inches.	Width of Cover Plates in Inches.	⅜ Coefficient of Strength.	⅜ Weight in Pounds per Lineal Foot.	½ Coefficient of Strength.	½ Weight in Pounds per Lineal Foot.	⅝ Coefficient of Strength.	⅝ Weight in Pounds per Lineal Foot.	¾ Coefficient of Strength.	¾ Weight in Pounds per Lineal Foot.
1	18	12	940	105	1056	115	1296	125	1326	135
2	18	12			1307	138	1432	148	1558	159
3	18	12					1525	171	1648	181
4	21	12	1122	110	1282	120	1432	130	1583	140
5	21	12			1482	145	1630	156	1530	166
6	21	12					1846	179	1992	189
7	24	12	1330	114	1502	124	1675	134	1848	144
8	24	12			1745	153	1915	163	2086	173
9	24	12					2178	188	2348	198
10	27	12	1535	120	1730	130	1925	140	2120	150
11	27	12			2015	158	2207	168	2400	178
12	27	12					2522	197	2712	208
13	30	12	1746	125	1962	135	2180	145	2396	156
14	30	12			2293	166	2507	176	2725	186
15	30	12					2876	205	3087	215
16	33	12	1962	129	2200	139	2440	149	2678	160
17	33	12			2580	172	2816	182	3052	192
18	33	12					3238	212	3472	222
19	36	12	2185	133	2445	143	2706	154	2995	164
20	36	12			2878	177	3133	187	3392	197
21	36	12					3612	218	3867	228

Section Number.	⅞ Coefficient of Strength.	⅞ Weight in Pounds per Lineal Foot.	1 Coefficient of Strength.	1 Weight in Pounds per Lineal Foot.	1⅛ Coefficient of Strength.	1⅛ Weight in Pounds per Lineal Foot.	1¼ Coefficient of Strength.	1¼ Weight in Pounds per Lineal Foot.	Width of Cover Plates in Inches.	Depth of Girder in Inches.	Section Number.
1	1455	145	1585	156	1715	166	1845	176	12	18	1
2	1685	168	1812	179	1940	189	2067	199	12	18	2
3	1775	191	1900	201	2026	212	2151	222	12	18	3
4	1735	150	1886	161	2037	171	2188	181	12	21	4
5	1928	176	2078	186	2228	196	2378	207	12	21	5
6	2133	199	2286	210	2435	220	2585	230	12	21	6
7	2022	155	2196	165	2358	175	2532	185	12	24	7
8	2256	183	2427	193	2598	204	2770	214	12	24	8
9	2515	209	2683	219	2853	229	3021	239	12	24	9
10	2313	161	2508	171	2703	181	2898	191	12	27	10
11	2591	188	2786	198	2980	209	3175	219	12	27	11
12	2902	218	3092	228	3283	238	3222	248	12	27	12
13	2612	166	2828	176	3045	186	3261	196	12	30	13
14	2937	196	3152	207	3367	217	3582	227	12	30	14
15	3288	225	3511	235	3725	245	3937	256	12	30	15
16	2918	170	3158	180	3398	190	3638	200	12	33	16
17	3288	202	3526	213	3763	223	4000	233	12	33	17
18	3706	232	3940	242	4175	252	4408	263	12	33	18
19	3230	174	3491	184	3752	194	4013	205	12	36	19
20	3651	208	3910	218	4168	228	4427	238	12	36	20
21	4123	238	4380	288	4635	259	4891	269	12	36	21

STRENGTH AND WEIGHT OF RIVETED PLATE GIRDERS.



To find the distributed safe load in net tons, divide the coefficient on opposite page corresponding to the number below by the length of span in feet.

To find the coefficient of strength for a given load and span, multiply the uniformly distributed load in tons by the span in feet between centres of supports.

See opposite page for coefficients.

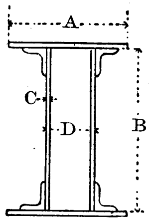
Weights include stiffeners.

Number of Section.	*Width of Cover (A) in Inches.*	*Depth of Web (B) in Inches.*	*Thickness of Web (C) in Inches.*	*Size of Corner Angles in Inches.*
1	12	18	⅜	5 x 3½ x ⅜
2	12	18	½	5 x 3½ x ½
3	12	18	⅝	5 x 3½ x ⅝
4	12	21	⅜	5 x 3½ x ⅜
5	12	21	½	5 x 3½ x ½
6	12	21	⅝	5 x 3½ x ⅝
7	12	24	⅜	5 x 3½ x ⅜
8	12	24	½	5 x 3½ x ½
9	12	24	⅝	5 x 3½ x ⅝
10	12	27	⅜	5 x 3½ x ⅜
11	12	27	½	5 x 3½ x ½
12	12	27	⅝	5 x 3½ x ⅝
13	12	30	⅜	5 x 3½ x ⅜
14	12	30	½	5 x 3½ x ½
15	12	30	⅝	5 x 3½ x ⅝
16	12	33	⅜	5 x 3½ x ⅜
17	12	33	½	5 x 3½ x ½
18	12	33	⅝	5 x 3½ x ⅝
19	12	36	⅜	5 x 3½ x ⅜
20	12	36	½	5 x 3½ x ½
21	12	36	⅝	5 x 3½ x ⅝

THICKNESS OF COVER PLATES IN INCHES.

Section Number.	Depth of Girder in Inches.	Width of Cover Plates in Inches.	3/8 Coefficient of Strength.	3/8 Weight in Pounds per Lineal Foot.	1/2 Coefficient of Strength.	1/2 Weight in Pounds per Lineal Foot.	5/8 Coefficient of Strength.	5/8 Weight in Pounds per Lineal Foot.	3/4 Coefficient of Strength.	3/4 Weight in Pounds per Lineal Foot.	7/8 Coefficient of Strength.	7/8 Weight in Pounds per Lineal Foot.	1 Coefficient of Strength.	1 Weight in Pounds per Lineal Foot.	$1\frac{1}{8}$ Coefficient of Strength.	$1\frac{1}{8}$ Weight in Pounds per Lineal Foot.	$1\frac{1}{4}$ Coefficient of Strength.	$1\frac{1}{4}$ Weight in Pounds per Lineal Foot.	Width of Cover Plates in Inches.	Depth of Girder in Inches.	Section Number.
1	18	16	1078	133	1252	146	1426	160	1600	173	1775	186	1950	199	2126	213	2301	227	16	18	1
2	18	16			1415	176	1587	189	1760	202	1932	216	2105	229	2280	242	2452	256	16	18	2
3	21	16	1312	142	1515	156	1718	169	1922	182	2126	195	2330	209	2536	222	2740	235	16	21	3
4	21	16			1725	188	1925	201	2126	215	2327	228	2530	241	2732	255	2935	268	16	21	4
5	24	16	1558	151	1790	165	2022	178	2295	191	2493	205	2722	218	2957	231	3190	244	16	24	5
6	24	16			2050	200	2280	214	2510	227	2740	240	2971	253	3202	267	3433	280	16	24	6
7	27	16	1816	161	2077	174	2338	187	2601	200	2855	214	3126	227	3390	240	3652	253	16	27	7
8	27	16			2390	213	2648	226	2908	239	3167	252	3427	266	3688	279	3950	292	16	27	8
9	30	16	2085	169	2376	183	2666	196	2957	210	3250	223	3542	236	3835	249	4130	263	16	30	9
10	30	16			2746	225	3033	238	3322	251	3611	265	3900	278	4190	291	4478	304	16	30	10
11	33	16	2427	178	2685	191	3006	205	3312	218	3647	231	3968	244	4293	258	4617	271	16	33	11
12	33	16			3117	236	3435	249	3752	263	4070	276	4388	289	4707	302	5025	316	16	33	12
13	36	16	2660	186	3035	199	3385	213	3735	226	4085	239	4435	252	4758	266	5110	279	16	36	13
14	36	16			3503	246	3850	260	4197	273	4542	286	4895	299	5240	313	5585	326	16	36	14
15	21	20	1507	156	1757	173	2012	190	2268	207	2525	224	2781	240	3043	258	3300	275	20	21	15
16	21	20			1973	208	2235	225	2482	242	2742	259	2995	275	3252	292	3507	310	20	21	16
17	24	20	1781	165	2112	182	2365	199	2657	216	2950	233	3240	249	3537	267	3830	284	20	24	17
18	24	20			2345	220	2635	237	2925	254	3215	271	3505	287	3797	304	4090	322	20	24	18

STRENGTH AND WEIGHT OF RIVETED PLATE GIRDERS.



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To find the coefficient of strength for a given load and span, multiply the uniformly distributed load in tons by the span in feet between centres of supports.

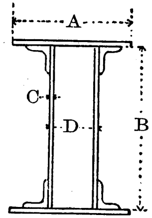
See opposite page for coefficients.

Number of Section.	*Width of Cover (A) in Inches.*	*Depth of Web (B) in Inches.*	*Thickness of Web (C) in Inches.*	*Width of (D) in Inches.*	*Size of Corner Angles in Inches.*
1	16	18	3/8	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$
2	16	18	1/2	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$
3	16	21	3/8	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$
4	16	21	1/2	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$
5	16	24	3/8	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$
6	16	24	1/2	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$
7	16	27	3/8	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$
8	16	27	1/2	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$
9	16	30	3/8	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$
10	16	30	1/2	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$
11	16	33	3/8	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$
12	16	33	1/2	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$
13	16	36	3/8	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$
14	16	36	1/2	8	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$
15	20	21	3/8	11	$4 \times 3\frac{1}{2} \times \frac{3}{8}$
16	20	21	1/2	11	$4 \times 3\frac{1}{2} \times \frac{1}{2}$
17	20	24	3/8	11	$4 \times 3\frac{1}{2} \times \frac{3}{8}$
18	20	24	1/2	11	$4 \times 3\frac{1}{2} \times \frac{1}{2}$

THICKNESS OF COVER PLATES IN INCHES.

Section Number.	Depth of Girder in Inches.	Width of Cover Plates in Inches.	3/8 Coefficient of Strength.	3/8 Weight in Pounds per Lineal Foot.	1/2 Coefficient of Strength.	1/2 Weight in Pounds per Lineal Foot.	5/8 Coefficient of Strength.	5/8 Weight in Pounds per Lineal Foot.	3/4 Coefficient of Strength.	3/4 Weight in Pounds per Lineal Foot.	7/8 Coefficient of Strength.	7/8 Weight in Pounds per Lineal Foot.	1 Coefficient of Strength.	1 Weight in Pounds per Lineal Foot.	1 1/8 Coefficient of Strength.	1 1/8 Weight in Pounds per Lineal Foot.	1 1/4 Coefficient of Strength.	1 1/4 Weight in Pounds per Lineal Foot.	Width of Cover Plates in Inches.	Depth of Girder in Inches.	Section Number.
19	27	20	2066	174	2392	191	2723	209	3052	225	3382	242	3712	259	4043	276	4375	293	20	27	19
20	27	20			2723	232	3048	249	3375	266	3701	283	4030	299	4357	317	4685	334	20	27	20
21	30	20	2362	184	2728	208	3095	225	3460	241	3827	259	4193	275	4561	292	4930	208	20	30	21
22	30	20			3116	244	3478	262	3842	278	5046	295	4570	312	4933	329	5300	346	20	30	22
23	33	20	2731	191	3135	225	3537	242	3947	259	4342	276	4746	292	5150	310	5555	327	20	33	23
24	33	20			3525	255	3925	272	4293	288	4728	306	5125	322	5526	339	5927	357	20	33	24
25	36	20	2991	199	3431	217	3870	234	4310	250	4750	268	5195	284	5632	301	6073	319	20	36	25
26	36	20			3908	266	4385	283	4791	299	5257	317	5700	333	6132	350	6571	367	20	36	26
27	24	24			2580	204	2930	224	3280	244	3630	265	3985	285	4333	306	4687	326	24	24	27
28	24	24			2695	234	3043	263	3392	283	3742	303	4092	324	4443	344	4795	365	24	24	28
29	27	24			3012	213	3401	233	3800	253	4194	274	4589	294	4960	315	5381	335	24	27	29
30	27	24			3158	256	3550	276	3942	296	4336	317	4730	337	5125	358	5520	378	24	27	30
31	30	24			3416	222	3852	242	4292	263	4731	283	5170	303	5610	324	6047	344	24	30	31
32	30	24			3597	267	4033	287	4470	308	4907	328	5346	348	5785	369	6223	389	24	30	32
33	33	24			3838	231	4320	251	4802	272	5285	292	5745	313	6252	333	6385	353	24	33	33
34	33	24			4128	277	4538	297	5020	318	5500	338	5958	359	6466	379	6948	399	24	33	34
35	36	24			4480	237	5005	258	5530	278	6042	298	6587	319	7110	329	7638	349	24	36	35
36	36	24			4737	288	5260	309	5783	329	6307	349	6837	372	7356	390	7886	411	24	36	36

STRENGTH AND WEIGHT OF RIVETED PLATE GIRDERS.



To find the distributed safe load in net tons, divide the coefficient on opposite page corresponding to the number below by the length of span in feet.

To find the coefficient of strength for a given load and span, multiply the uniformly distributed load in tons by the span in feet between centres of supports.

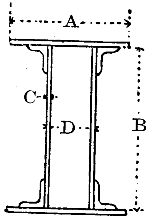
See opposite page for coefficients.

Number of Section.	*Width of Cover (A) in Inches.*	*Depth of Web (B) in Inches.*	*Thickness of Web (C) in Inches.*	*Width of (D) in Inches.*	*Size of Corner Angles in Inches.*
19	20	27	3/8	11	4 x 3½ x 3/8
20	20	27	½	11	4 x 3½ x ½
21	20	30	3/8	11	4 x 3½ x 3/8
22	20	30	½	11	4 x 3½ x ½
23	20	33	3/8	11	4 x 3½ x 3/8
24	20	33	½	11	4 x 3½ x ½
25	20	36	3/8	11	4 x 3½ x 3/8
26	20	36	½	11	4 x 3½ x ½
27	24	24	3/8	13	5 x 4 x 3/8
28	24	24	½	13	5 x 4 x ½
29	24	27	3/8	13	5 x 4 x 3/8
30	24	27	½	13	5 x 4 x ½
31	24	30	3/8	13	5 x 4 x 3/8
32	24	30	½	13	5 x 4 x ½
33	24	33	3/8	13	5 x 4 x 3/8
34	24	33	½	13	5 x 4 x ½
35	24	36	3/8	13	5 x 4 x 3/8
36	24	36	½	13	5 x 4 x ½

Section Number.	Depth of Girder in Inches.	Width of Cover Plates in Inches.	3/8 Coefficient of Strength.	3/8 Weight in Pounds per Lineal Foot.	1/2 Coefficient of Strength.	1/2 Weight in Pounds per Lineal Foot.	5/8 Coefficient of Strength.	5/8 Weight in Pounds per Lineal Foot.	3/4 Coefficient of Strength.	3/4 Weight in Pounds per Lineal Foot.	7/8 Coefficient of Strength.	7/8 Weight in Pounds per Lineal Foot.	1 Coefficient of Strength.	1 Weight in Pounds per Lineal Foot.	1 1/8 Coefficient of Strength.	1 1/8 Weight in Pounds per Lineal Foot.	1 1/4 Coefficient of Strength.	1 1/4 Weight in Pounds per Lineal Foot.	Width of Cover Plates in Inches.	Depth of Girder in Inches.	Section Number.
37	30	30			3866	243	4417	269	4972	294	5518	320	6071	345	6625	371	7227	396	30	30	37
38	30	30			4047	288	4597	314	5146	336	5695	365	6247	390	6798	416	7351	441	30	30	38
39	33	30			4307	251	4938	274	5545	299	6152	325	6760	350	7368	381	7977	406	30	33	39
40	33	30			4553	298	5157	323	5762	349	6367	375	7973	400	7581	426	8188	451	30	33	40
41	36	30			5047	259	5678	386	6340	310	7001	335	7670	361	8326	386	8988	412	30	36	41
42	36	30			5277	309	5935	334	6593	360	7253	385	7920	411	8575	436	9236	461	30	36	42
43	39	30			5301	267	6018	292	6736	318	7453	343	8182	369	8892	394	9611	420	30	39	43
44	39	30			5560	320	6325	345	7041	371	7757	396	8473	422	9191	447	9910	473	30	39	44
45	42	30			5802	275	6575	300	7348	326	8351	351	8896	377	9681	402	10446	428	30	42	45
46	42	30			6161	330	6932	355	7653	381	8475	406	9297	432	10020	457	10793	483	30	42	46
47	36	36			5560	280	6255	311	7151	341	7947	372	8752	402	9542	433	10341	464	36	36	47
48	36	36			5817	331	6610	362	7405	392	8200	423	9002	453	9791	484	10587	515	36	36	48
49	39	36			5886	287	6750	318	7613	349	8478	380	9343	411	10210	441	11076	472	36	39	49
50	39	36			6195	342	7057	373	7918	400	8781	431	9645	462	10510	492	11248	523	36	39	50
51	42	36			6456	295	7362	326	8293	357	9225	387	10151	418	11090	448	12033	479	36	42	51
52	42	36			6792	380	7720	411	8646	441	9577	472	10507	502	11439	533	12370	564	36	42	52

THICKNESS OF COVER PLATES IN INCHES.

STRENGTH AND WEIGHT OF RIVETED PLATE GIRDERS.

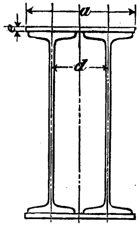


To find the distributed safe load in net tons, divide the coefficient on opposite page corresponding to the number below by the length of span in feet.

To find the coefficient of strength for a given load and span, multiply the uniformly distributed load in tons by the span in feet between centres of supports.

See opposite page for coefficients.

Number of Section.	*Width of Cover (A) in Inches.*	*Depth of Web (B) in Inches.*	*Thickness of Web (C) in Inches.*	*Width of (D) in Inches.*	*Size of Corner Angles in Inches.*
37	30	30	3/8	18	5 x 4 x 3/8
38	30	30	1/2	18	5 x 4 x 1/2
39	30	33	3/8	18	5 x 4 x 3/8
40	30	33	1/2	18	5 x 4 x 1/2
41	30	36	3/8	18	5 x 4 x 3/8
42	30	36	1/2	18	5 x 4 x 1/2
43	30	39	3/8	18	5 x 4 x 3/8
44	30	39	1/2	18	5 x 4 x 1/2
45	30	42	3/8	18	5 x 4 x 3/8
46	30	42	1/2	18	5 x 4 x 1/2
47	36	36	3/8	24	5 x 4 x 3/8
48	36	36	1/2	24	5 x 4 x 1/2
49	36	39	3/8	24	5 x 4 x 3/8
50	36	39	1/2	24	5 x 4 x 1/2
51	36	42	3/8	24	5 x 4 x 3/8
52	36	42	1/2	24	5 x 4 x 1/2

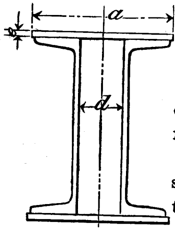


STRENGTH AND WEIGHT OF RIVETTED PLATE GIRDERS.

To find the distributed safe load in net tons, divide the coefficient in right-hand column by the length of span in feet.

To find the coefficient of strength for a given load and span, multiply the uniformly distributed load in tons by the span in feet between centres of supports.

Size of Beams in Inches.	*Section Number and Weight.*		*Width of Cover (A) in Inches.*	*Thickness (E) of Cover in Inches.*	*Space (D) in Inches.*	*Total Weight per Lineal Foot.*	*Coefficient for Distributed Load in Tons.*
	Section Number.	*Weight.*					
10	511	23.5	10	3/8	5	74.5	367
10	511	23.5	10	1/2	5	83.0	427
10	511	23.5	10	5/8	5	91.5	487
10	512	29.8	10	3/8	5	87.1	423
10	512	29.8	10	1/2	5	95.6	481
10	512	29.8	10	5/8	5	104.1	541
12	515	30.6	12	3/8	6 1/2	94.8	553
12	515	30.6	12	1/2	6 1/2	105.0	634
12	515	30.6	12	5/8	6 1/2	115.2	728
12	516	39.4	12	3/8	6 1/4	112.4	648
12	516	39.4	12	1/2	6 1/4	122.6	728
12	516	39.4	12	5/8	6 1/4	132.8	822
12	517	55.5	12	1/2	6	154.8	946
12	517	55.5	12	5/8	6	165.0	969
12	517	55.5	12	3/4	6	175.2	1059
15	521	41.2	14	3/8	8	122.1	895
15	521	41.2	14	1/2	8	134.0	1014
15	521	41.2	14	5/8	8	145.9	1127
15	522	49.3	14	1/2	7 3/4	150.2	1130
15	522	49.3	14	5/8	7 3/4	162.1	1242
15	522	49.3	14	3/4	7 3/4	174.0	1368
15	523	57.6	14	1/2	7 1/4	166.8	1118
15	523	57.6	14	5/8	7 1/4	178.7	1319
15	523	57.6	14	3/4	7 1/4	190.6	1448
15	524	69.2	14	5/8	7	201.9	1363
15	524	69.2	14	3/4	7	213.8	1608
15	524	69.2	14	7/8	7	225.7	1837
20	530	64.8	16	5/8	9 1/4	202.9	1971
20	530	64.8	16	3/4	9 1/4	216.5	2136
20	530	64.8	16	7/8	9 1/4	230.1	2302
20	531	78.0	16	3/4	8 3/4	242.9	2343
20	531	78.0	16	7/8	8 3/4	256.5	2507
20	531	78.0	16	1	8 3/4	270.1	2671



STRENGTH AND WEIGHT OF RIVETED PLATE GIRDERS.

To find the distributed safe load in net tons, divide the coefficient in right-hand column by the length of span in feet.

To find the coefficient of strength for a given load and span, multiply the uniformly distributed load in tons by the span in feet between centres of supports.

Size of Chan's in Inches.	*Section Number and Weight.*		*Width of Cover (A) in Inches.*	*Thickness (E) of Cover in Inches.*	*Span (D) in Inches.*	*Total Weight per Lineal Foot.*	*Coefficient for Distributed Load in Tons.*
	Section Number.	*Weight.*					
10	423	16.5	10	3/8	4	42.5	289
10	423	16.5	10	1/2	4	45.0	349
10	423	16.5	10	5/8	4	47.5	410
10	424	20.9	10	3/8	3 1/2	51.3	321
10	424	20.9	10	1/2	3 1/2	53.8	381
10	424	20.9	10	5/8	3 1/2	56.3	441
12	427	19.8	12	3/8	5 1/2	51.6	413
12	427	19.8	12	1/2	5 1/2	54.6	501
12	427	19.8	12	5/8	5 1/2	57.6	588
12	428	31.4	12	1/2	5	77.8	613
12	428	31.4	12	5/8	5	80.8	699
12	428	31.4	12	3/4	5	83.8	789
15	433	32.7	14	1/2	6 1/2	117.0	822
15	433	32.7	14	5/8	6 1/2	128.9	948
15	433	32.7	14	3/4	6 1/2	140.8	1084
15	434	49.8	14	5/8	5 1/2	163.1	1133
15	434	49.8	14	3/4	5 1/2	175.0	1253
15	434	49.8	14	7/8	5 1/2	186.9	1395

GENERAL RULE FOR GIRDERS OF ANY SECTION.

Find the moment of inertia of the section as described on page 142, and thence the coefficient of strength for a distributed load in tons, as described on page 99, viz.:

$$\text{Coefficient} = \frac{\text{Inertia} \times 8}{3 \times \text{depth of girder}} \times \text{fibre stress.}$$

Apply as described on page 100.

BY FLANGE STRAINS ALONE.

If one-sixth of the web area is added to the area of each flange, and the sum considered as the effective flanges, then the area of one effective flange, multiplied by the distance between effective flange centres, will be the moment of resistance of the girder section. Apply this rule as described on page 92, or

$$\text{distributed load in net tons} = \frac{\frac{2}{3}\,d\,f\,s}{L}$$

$d =$ distance in inches between flange centres.
$f =$ effective area of each flange in square inches.
$s =$ fibre strain allowed in tons per square inch.
$L =$ span of girder in feet.

Example.—Required distributed load for a 20-foot span girder 20 inches deep, flange area 10 square inches, web area 9 square inches—each effective flange $= 11\frac{1}{2}$ square inches, distance between flange centres $= 19$ inches, allowing flange strain of 5 tons.

$$\frac{\frac{2}{3} \times 19 \times 11\frac{1}{2} \times 5}{20} = 36.4 \text{ tons distributed load,}$$

or half this in centre of girder.

ELEMENTS OF PENCOYD STRUCTURAL SHAPES.

In the following tables various fundamental properties of rolled sections are given, whereby the strength or stiffness of each can be readily determined.

The calculations are made accurately for the least and greatest thickness of each shape, but intermediate thicknesses can be approximated by interpolation.

Moments of Inertia for the sections are obtained as hereafter described.

Radius of Gyration equals $\sqrt{\frac{\text{Inertia}}{\text{area}}}$, is used for determining the resistance of struts or columns.

Moment of Resistance equals $\frac{\text{Inertia}}{\text{distance from axis to extreme fibres}}$ is used for determining transverse strength in beams, etc., as described on page 92.

Coefficent for Safe Load is the calculated load in net tons, on a beam one foot between supports, that produces fibre strains of 16,000 lbs. per square inch. A corresponding load for any beam is found by dividing this coefficient by the length of span in feet.

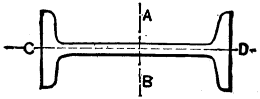
Coefficients for Deflection are found by the formulæ on page 88, based on a modulus of elasticity of 28,000,000 lbs. They apply to beams one foot long, bearing one ton (2,000 lbs.). The deflection of any beam in inches is found by multiplying its coefficient by the load in tons and by the cube of the length in feet.

Maximum Load in Tons indicates the greatest load in tons that a beam, however short, should carry, unless its web is reinforced, to prevent crippling. This load is obtained by the formula:

$$W = \frac{xdt}{1 + \frac{l^2}{3000t^2}}$$

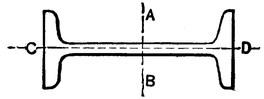
$x = 8$ tons.
$d =$ depth of beam.
$t =$ thickness of web.
$l = d \times$ secant 45° ($l^2 = 2d^2$).

ELEMENTS OF PENCOYD BEAMS.



I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
Size in Inches.	*Section Number.*	*Area in Square Inches.*	*Weight in Pounds per Foot.*	*Moments of Inertia.*		*Square of Radius of Gyration.*		*Radius of Gyration.*	
				Axis A. B.	*Axis C. D.*	*Axis A. B.*	*Axis C. D.*	*Axis A. B.*	*Axis C.D.*
20	531	22.94	78.0	1367.37	37.86	59.61	1.65	7.72	1.28
20	531	28.94	98.4	1567.37	45.53	54.16	1.57	7.36	1.25
20	530	19.04	64.8	1145.79	26.70	60.18	1.40	7.76	1.18
20	530	24.04	81.7	1312.46	31.37	54.60	1.30	7.39	1.14
18	. .	. . . .	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. .
18	. .	. . . .	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. .
18	. .	. . . .	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. .
18	. .	. . . .	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. .
15	524	20.38	69.2	710.00	36.23	34.84	1.78	5.90	1.33
15	524	25.03	85.1	789.24	42.56	31.53	1.70	5.61	1.30
15	523	16.95	57.6	583.78	26.95	34.44	1.59	5.87	1.26
15	523	20.70	70.4	654.09	30.90	31.60	1.49	5.62	1.22
15	522	14.49	49.3	518.61	19.71	35.79	1.36	5.98	1.17
15	522	16.74	56.9	560.79	21.50	33.50	1.28	5.79	1.13
15	521	12.11	41.2	433.00	14.85	35.75	1.23	5.98	1.11
15	521	15.56	52.9	497.68	17.08	31.98	1.10	5.65	1.05
12	517	16.32	55.5	362.88	25.31	22.23	1.55	4.71	1.24
12	517	19.68	66.9	403.38	29.74	20.50	1.51	4.53	1.23
12	516	11.60	39.4	268.30	14.57	23.13	1.26	4.81	1.12
12	516	14.00	47.6	299.76	16.52	21.41	1.18	4.63	1.09
12	515	9.01	30.6	207.90	9.00	23.07	1.00	4.80	1.00
12	515	11.29	38.4	233.80	10.19	20.71	0.90	4.55	0.95
10	512	8.78	29.8	141.44	9.03	16.11	1.03	4.01	1.01
10	512	10.28	34.9	153.94	10.02	14.97	0.97	3.87	0.99
10	511	6.91	23.5	112.42	5.76	16.27	0.83	4.03	0.91
10	511	8.91	30.3	129.08	6.69	14.49	0.75	3.81	0.87
9	509	6.04	20.5	80.78	4.72	13.37	0.78	3.66	0.88
9	509	7.48	25.4	90.50	5.34	12.10	0.71	3.48	0.84

ELEMENTS OF PENCOYD BEAMS.



XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	II.	I.
Resistance.	*Add to Previous Coeff. for each Additional Pound per Foot.*	*Coeff. in Net Tons for Greatest Safe Load Distributed.*	*Add to Previous Coeff. for each Additional Pound per Foot.*	*Coefficient for Deflection.*		*Maximum Load in Net Tons.*	*Section Number.*	*Size in Inches.*
Axis A. B.				*Distributed.*	*Centre.*			
136.74	1.000	729.26	4.624	.00000115	.00000188	55.17	531	20
156.74	"	835.93	"	.00000100	.00000164	108.35	531	20
114.58	"	611.09	"	.00000136	.00000224	38.72	530	20
131.24	"	699.98	"	.00000119	.00000199	81.41	530	20
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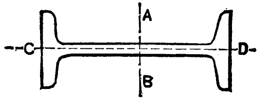
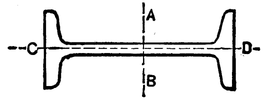
94.67	0.75	504.88		.0000022	.0000036	49.51	524	15
105.23	"	561.23		.0000019	.0000032	91.14	524	15
77.84	"	415.12	3.233	.0000026	.0000044	37.50	523	15
87.21	"	465.12	"	.0000023	.0000039	71.09	523	15
69.15	"	368.78	"	.0000030	.0000049	31.03	522	15
74.77	"	398.78	"	.0000027	.0000045	50.85	522	15
57.73	"	307.90	"	.0000036	.0000059	21.19	521	15
66.36	"	353.90	"	.0000031	.0000052	50.85	521	15
60.48	0.60	322.56	2.667	.0000043	.0000070	41.16	517	12
67.23	"	358.56	"	.0000038	.0000063	70.99	517	12
44.72	"	238.48	"	.0000058	.0000095	24.00	516	12
49.96	"	266.45	"	.0000052	.0000085	45.50	516	12
34.65	"	184.80		.0000075	.0000124	17.84	515	12
38.97	"	207.82		.0000067	.0000109	37.94	515	12
28.29	0.50	148.16	2.312	.0000110	.0000182	18.13	512	10
30.79	"	161.49	"	.0000102	.0000167	31.59	512	10
22.48	"	119.91	"	.0000139	.0000228	13.79	511	10
25.82	"	137.68	"	.0000121	.0000199	31.59	511	10
17.95	0.45	95.74	2.000	.0000194	.0000318	11.94	509	9
20.11	"	107.28	"	.0000173	.0000284	24.79	509	9

ELEMENTS OF PENCOYD BEAMS.



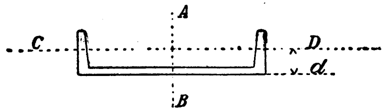
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
Size in Inches.	*Section Number.*	*Area in Square Inches.*	*Weight in Pounds per Foot.*	*Moments of Inertia.*		*Square of Radius of Gyration.*		*Radius of Gyration.*	
				Axis A. B.	*Axis C. D.*	*Axis A. B.*	*Axis C. D.*	*Axis A. B.*	*Axis C.D.*
8	507	5.12	17.4	54.31	3.52	10.61	0.69	3.26	0.83
8	507	6.24	21.2	60.28	3.96	9.66	0.63	3.11	0.80
7	505	4.31	14.6	35.43	2.68	8.22	0.62	2.87	0.79
7	505	5.29	17.9	39.43	3.03	7.45	0.57	2.75	0.76
6	503	12.06	41.0	64.07	17.86	5.31	1.48	2.30	1.22
6	503	13.56	46.1	68.57	21.15	5.06	1.56	2.25	1.25
6	502	9.49	32.3	52.53	11.74	5.53	1.24	2.35	1.11
6	502	10.99	37.4	57.03	13.87	5.19	1.26	2.28	1.12
6	501	3.51	11.9	21.14	1.83	6.02	0.52	2.45	0.72
6	501	4.47	15.2	24.02	2.14	5.37	0.48	2.32	0.69
5	500	2.76	9.4	11.58	1.14	4.19	0.41	2.05	0.64
5	500	3.61	12.3	13.34	1.38	3.69	0.38	1.92	0.62
4	20	1.81	6.2	5.02	0.49	2.77	0.27	1.66	0.52
4	20	2.17	7.4	5.82	0.60	2.68	0.28	1.64	0.53
3	22	1.56	5.3	2.41	0.40	1.54	0.26	1.24	0.51
3	22	2.01	6.8	2.75	0.50	1.37	0.25	1.17	0.50

ELEMENTS OF PENCOYD BEAMS.



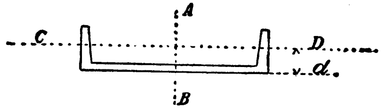
XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	II.	I.
Resistance.	*Add to Previous Coeff. for each Additional Pound per Foot.*	*Coeff. in Net Tons for Greatest Safe Load Distributed.*	*Add to Previous Coeff. for each Additional Pound per Foot.*	*Coefficient for Deflection.*		*Maximum Load in Net Tons.*	*Section Number.*	*Size in Inches.*
Axis A. B.				*Distributed.*	*Centre.*			
13.58	0.40	72.41	1.778	.0000288	.0000473	10.20	507	8
15.07	"	80.40	"	.0000260	.0000426	20.20	507	8
10.12	0.35	54.00	1.556	.0000442	.0000725	8.58	505	7
11.27	"	60.08	"	.0000397	.0000652	17.36	505	7
21.36	0.30	113.84	1.334	.0000245	.0000401	28.53	503	6
22.86	"	121.90	"	.0000228	.0000375	40.97	503	6
17.51	"	93.36	"	.0000298	.0000489	21.90	502	6
19.01	"	101.38	"	.0000275	.0000451	34.55	502	6
7.05	0.30	37.52	"	.0000741	.0001216	7.06	501	6
8.01	"	42.70	"	.0000652	.0001070	15.64	501	6
4.63	0.25	24.70	1.111	.0001354	.0002219	5.65	500	5
5.34	"	28.40	"	.0001175	.0001927	13.20	500	5
2.51	0.20	13.38	0.889	.0003122	.0005121	3.61	20	4
2.91	"	15.52	"	.0002693	.0004417	6.84	20	4
1.61	0.15	8.57	0.667	.0006502	.0010667	3.11	22	3
1.83	"	9.78	"	.0005699	.0009348	7.00	22	3

ELEMENTS OF PENCOYD CHANNELS.



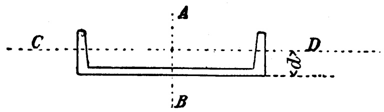
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
Size in Inches.	*Section Number.*	*Area in Square Inches.*	*Weight in Pounds per Foot.*	*Moments of Inertia.*		*Square of Radius of Gyration.*		*Radius of Gyration.*		*Distance "d." Base to Neutral Axis.*
				Axis A. B.	*Axis C. D.*	*Axis A. B.*	*Axis C. D.*	*Axis A. B.*	*Axis C. D.*	
15	434	14.64	49.8	435.72	16.30	29.76	1.11	5.45	1.05	0.95
15	434	20.34	69.2	542.59	21.86	26.68	1.07	5.16	1.04	1.01
15	433	9.62	32.7	286.84	7.79	29.82	0.81	5.46	0.90	0.75
15	433	14.87	50.6	385.28	10.77	26.03	0.73	5.10	0.85	0.77
12	428	9.24	31.4	189.93	7.36	20.55	0.80	4.53	0.89	0.85
12	428	16.32	55.5	274.89	12.96	16.84	0.79	4.10	0.89	0.94
12	427	5.81	19.8	118.32	3.62	20.16	0.62	4.49	0.78	0.65
12	427	9.17	31.2	157.20	4.95	17.26	0.54	4.15	0.74	0.64
12	32	6.07	20.6	123.38	3.12	20.33	0.51	4.51	0.72	0.62
12	32	9.43	32.1	163.71	4.45	17.36	0.47	4.17	0.69	0.62
10	424	6.17	20.9	88.01	3.83	14.26	0.62	3.78	0.79	0.72
10	424	10.37	35.3	123.01	6.12	11.86	0.59	3.44	0.77	0.76
10	423	4.84	16.5	71.09	2.61	14.57	0.54	3.82	0.73	0.66
10	423	7.24	24.6	91.09	3.62	12.79	0.50	3.57	0.70	0.64
9	422	5.17	17.6	59.89	2.85	11.58	0.55	3.40	0.74	0.67
9	422	7.96	27.1	78.72	4.15	9.89	0.52	3.14	0.72	0.69
9	421	3.94	13.4	46.48	1.77	11.79	0.45	3.43	0.67	0.59
9	421	5.74	19.5	58.63	2.38	10.21	0.41	3.19	0.64	0.57
8	420	4.29	14.6	39.76	2.14	9.27	0.50	3.04	0.71	0.65
8	420	6.05	20.6	49.15	2.89	8.12	0.48	2.85	0.69	0.65
8	419	3.22	10.9	29.76	1.23	9.24	0.38	3.04	0.62	0.54
8	419	4.42	15.0	36.16	1.57	8.18	0.36	2.86	0.60	0.52

ELEMENTS OF PENCOYD CHANNELS.



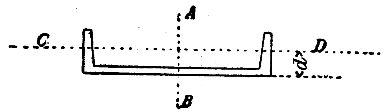
XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	I.
Resistance.	*Add to Previous Coeff. for Each Additional Pound per Foot.*	*Coeff. in Net Tons for Greatest Safe Load Distributed.*	*Add to Previous Coeff. for Each Additional Pound per Foot.*	*Coefficient for Deflection.*		*Maximum Load in Net Tons.*	*Size in Inches.*
Axis A. B.				*Distributed.*	*Centre.*		
58.09	0.75	309.84	3.334	.00000546	.00000896	24.74	15
72.34	"	385.84	"	.00000406	.00000667	71.09	15
38.25	"	203.96	"	.00000359	.00000590	53.52	15
51.30	"	273.98	"	.00000288	.00000473	104.35	15
31.65	0.60	168.82	2.667	.00001327	.00002172	13.00	12
45.81	"	244.34	"	.00000997	.00001635	41.16	12
19.72	"	105.18	"	.00000825	.00001353	25.05	12
26.20	"	139.74	"	.00000570	.00000935	87.59	12
20.56	"	109.67	"	.00001270	.00002083	12.09	12
27.28	"	145.52	"	.00000957	.00001570	41.16	12
17.60	0.50	93.87	2.220	.00002204	.00003616	10.47	10
24.60	"	131.21	"	.00001720	.00002822	31.57	10
14.22	"	75.82	"	.00001781	.00002921	16.38	10
18.62	"	97.15	"	.00001274	.00002089	53.67	10
13.31	0.45	70.98	2.000	.00003372	.00005531	8.92	9
17.49	"	93.30	"	.00002673	.00004384	24.79	9
10.33	"	55.08	"	.00002617	.00004292	14.29	9
13.03	"	69.48	"	.00001991	.00003265	39.16	9
9.94	0.40	53.01	1.781	.00005267	.00008638	7.49	8
12.28	"	65.53	"	.00004334	.00007109	18.06	8
7.44	"	39.67	"	.00003942	.00006465	11.61	8
9.04	"	48.21	"	.00003189	.00005230	27.33	8

ELEMENTS OF PENCOYD CHANNELS.



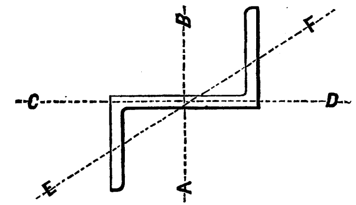
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
Size in Inches.	*Section Number.*	*Area in Square Inches.*	*Weight in Pounds per Foot.*	*Moments of Inertia.*		*Square of Radius of Gyration.*		*Radius of Gyration.*		*Distance "d." Base to Neutral Axis.*
				Axis A. B.	*Axis C. D.*	*Axis A. B.*	*Axis C. D.*	*Axis A. B.*	*Axis C. D*	
7	418	3.75	12.8	27.14	1.71	7.24	0.46	2.69	0.68	0.64
7	418	7.11	24.2	40.86	3.19	5.75	0.45	2.40	0.67	0.70
7	417	2.67	9.1	19.39	0.90	7.26	0.34	2.69	0.58	0.52
7	417	3.86	13.1	24.25	1.21	6.28	0.31	2.51	0.56	0.50
6	416	3.24	11.0	17.54	1.39	5.41	0.43	2.34	0.65	0.65
6	416	5.46	18.6	24.20	2.35	4.43	0.43	2.10	0.66	0.67
6	415	2.27	7.7	11.62	0.64	5.28	0.29	2.30	0.54	0.49
6	415	3.35	11.4	14.86	0.89	4.53	0.27	2.13	0.52	0.47
5	413	1.93	6.6	6.64	0.47	3.44	0.24	1.85	0.49	0.47
5	413	2.83	9.6	8.52	0.67	3.01	0.24	1.73	0.49	0.46
4	411	1.58	5.4	3.67	0.34	2.40	0.22	1.55	0.47	0.46
4	411	2.30	7.8	4.64	0.49	2.06	0.22	1.43	0.47	0.46
3	49	1.51	5.1	2.04	0.32	1.31	0.21	1.14	0.45	0.50
3	49	1.78	6.1	2.24	0.39	1.23	0.21	1.11	0.46	0.51
2¼	50	1.12	3.8	0.80	0.19	0.71	0.17	0.84	0.41	0.47
2	51	0.87	2.97	0.48	0.08	0.55	0.06	0.74	0.24	0.36
2	51	1.06	3.60	0.52	0.11	0.83	0.10	0.91	0.32	0.35
1¾	52	0.33	1.1	0.14	0.01	0.44	0.03	0.66	0.16	0.18

ELEMENTS OF PENCOYD CHANNELS.



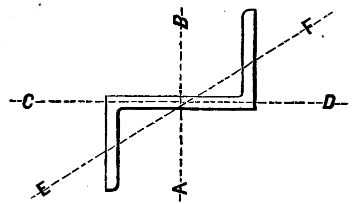
XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	I.
Resistance.	*Add to Previous Coeff. for Each Additional Pound per Foot.*	*Coeff. in Net Tons for Greatest Safe Load Distributed.*	*Add to Previous Coeff. for Each Additional Pound per Foot.*	*Coefficient for Deflection.*		*Maximum Load in Net Tons.*	*Size in Inches.*
Axis A. B.				*Distributed.*	*Centre.*		
7.75	0.35	41.35	1.556	.00008084	.00013258	6.17	7
11.67	"	62.26	"	.00006463	.00010601	16.74	7
5.54	"	29.54	"	.00005774	.00009471	10.44	7
6.93	"	36.95	"	.00003835	.00006291	39.70	7
5.84	0.30	31.17	1.334	.00013486	.00022119	5.48	6
8.06	"	43.02	"	.00010546	.00017297	15.11	6
3.87	"	20.66	"	.00008938	.00014659	8.67	6
4.95	"	26.42	"	.00006477	.00010512	28.02	6
2.66	0.25	14.17	1.111	.00023598	.00063141	5.20	5
3.41	"	18.18	"	.00018392	.00030165	13.38	5
1.84	0.20	9.78	0.889	.00042708	.00070046	4.33	4
2.32	"	12.37	"	.00033794	.00055426	10.65	4
1.36	0.15	7.240	0.667	.00076976	.00126262	4.70	3
1.49	"	7.95	"	.00070035	.00114865	7.00	3
0.35	0.11	3.79	0.498	.00195924	.00321336	4.27	2¼
0.48	0.10	2.56	0.444	.00326541	.00535561	3.37	2
0.52	"	2.78	"	.00301017	.00493699	4.34	2
0.16	0.09	0.88	0.387	.01080964	.01772892	1.01	1¾

ELEMENTS OF PENCOYD Z BARS.



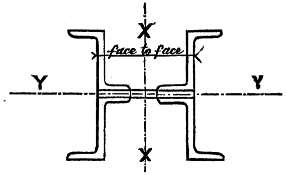
Section Number.	Size in Inches.	Area in Square Inches.	Weight per Foot in Pounds.	Moments of Inertia. Axis A. B.	Moments of Inertia. Axis C. D.	Resistance. Axis A. B.	Resistance. Axis C. D.
220	$2\frac{5}{8}$ x 3 x $2\frac{5}{8}$ x $\frac{1}{4}$	1.94	6.60	2.81	2.61	1.87	1.04
220	$2\frac{3}{4}$ x $3\frac{1}{8}$ x $2\frac{3}{4}$ x $\frac{3}{8}$	2.94	10.00	4.34	4.22	2.70	1.65
221	$2\frac{21}{32}$ x 3 x $2\frac{21}{32}$ x $\frac{7}{16}$	3.28	11.15	4.20	4.24	2.80	1.74
221	$2\frac{23}{32}$ x $3\frac{1}{16}$ x $2\frac{23}{32}$ x $\frac{1}{2}$	3.75	12.75	4.89	5.04	3.19	2.04
222	$2\frac{7}{8}$ x 4 x $2\frac{7}{8}$ x $\frac{1}{4}$	2.32	7.88	5.95	3.47	2.98	1.26
222	3 x $4\frac{1}{8}$ x 3 x $\frac{3}{8}$	3.50	11.90	9.14	5.58	4.43	1.98
223	$2\frac{31}{32}$ x 4 x $2\frac{31}{32}$ x $\frac{7}{16}$	3.96	13.46	9.40	6.09	4.70	2.21
223	$3\frac{3}{32}$ x $4\frac{1}{8}$ x $3\frac{3}{32}$ x $\frac{9}{16}$	5.16	17.54	12.40	8.40	6.01	2.99
224	$3\frac{1}{16}$ x 4 x $3\frac{1}{16}$ x $\frac{5}{8}$	5.53	18.80	12.11	8.73	6.06	3.17
224	$3\frac{3}{16}$ x $4\frac{1}{8}$ x $3\frac{3}{16}$ x $\frac{3}{4}$	6.75	22.95	14.97	11.24	7.26	4.00
225	$3\frac{3}{16}$ x 5 x $3\frac{3}{16}$ x $\frac{5}{16}$	3.36	11.42	13.14	5.81	5.26	1.92
225	$3\frac{5}{16}$ x $5\frac{1}{8}$ x $3\frac{5}{16}$ x $\frac{7}{16}$	4.75	16.15	18.76	8.67	7.32	2.80
226	$3\frac{7}{32}$ x 5 x $3\frac{7}{32}$ x $\frac{1}{2}$	5.23	17.78	19.03	8.77	7.61	2.95
226	$3\frac{11}{32}$ x $5\frac{1}{8}$ x $3\frac{11}{32}$ x $\frac{5}{8}$	6.60	22.44	24.33	11.70	9.49	3.86
227	$3\frac{1}{4}$ x 5 x $3\frac{1}{4}$ x $\frac{11}{16}$	6.96	23.66	23.68	11.37	9.47	3.91
227	$3\frac{5}{16}$ x $5\frac{1}{16}$ x $3\frac{5}{16}$ x $\frac{3}{4}$	7.64	25.97	26.16	12.83	10.34	4.36
228	$3\frac{1}{2}$ x 6 x $3\frac{1}{2}$ x $\frac{3}{8}$	4.59	15.61	25.32	9.11	8.44	2.75
228	$3\frac{5}{8}$ x $6\frac{1}{8}$ x $3\frac{5}{8}$ x $\frac{1}{2}$	6.19	21.05	34.36	12.87	11.22	3.81
229	$3\frac{1}{2}$ x 6 x $3\frac{1}{2}$ x $\frac{9}{16}$	6.68	22.71	34.64	12.59	11.55	3.91
229	$3\frac{5}{8}$ x $6\frac{1}{8}$ x $3\frac{5}{8}$ x $\frac{11}{16}$	8.25	28.05	43.18	16.34	14.10	4.98
230	$3\frac{1}{2}$ x 6 x $3\frac{1}{2}$ x $\frac{3}{4}$	8.64	29.37	42.12	15.44	14.04	4.94
230	$3\frac{5}{8}$ x $6\frac{1}{8}$ x $3\frac{5}{8}$ x $\frac{7}{8}$	10.16	34.54	50.22	19.18	16.40	6.02

ELEMENTS OF PENCOYD Z BARS.



Radii of Gyration. Axis A. B.	Radii of Gyration. Axis C. D.	Radii of Gyration. Least Axis E. F.	Coefficient in Net Tons for Greatest Safe Load Distributed.	Coefficient for Deflection About Axis A. B. Centre.	Coefficient for Deflection About Axis A. B. Distributed.	Maximum Load in Net Tons.	Section Number.
1.20	1.16	0.52	10.46	.0009148	.0005578	5.65	220
1.21	1.20	0.57	15.56	.0003612	.0003612	9.28	220
1.13	1.14	0.54	15.67	.0006121	.0003732	10.50	221
1.14	1.16	0.57	17.86	.0005257	.0003205	12.33	221
1.60	1.22	0.63	16.68	.0004320	.0002634	7.04	222
1.61	1.26	0.65	24.80	.0002813	.0001715	11.80	222
1.54	1.24	0.64	26.32	.0002735	.0001667	13.67	223
1.55	1.28	0.65	33.65	.0002073	.0001264	18.48	223
1.48	1.25	0.65	33.94	.0002123	.0001294	20.07	224
1.49	1.29	0.66	40.66	.0001717	.0001050	25.02	224
1.98	1.33	0.72	29.45	.0001956	.0001193	12.67	225
1.99	1.35	0.74	40.99	.0001370	.0000836	17.05	225
1.91	1.30	0.73	42.61	.0001351	.0000824	19.34	226
1.92	1.33	0.75	53.14	.0001057	.0000644	25.28	226
1.84	1.28	0.73	53.02	.0001086	.0000662	27.38	227
1.85	1.30	0.74	57.90	.0000983	.0000599	30.46	227
2.35	1.41	0.83	47.26	.0001015	.0000619	15.86	228
2.36	1.44	0.84	62.83	.0000748	.0000456	22.96	228
2.28	1.37	0.80	64.68	.0000742	.0000452	25.89	229
2.29	1.41	0.83	78.96	.0000595	.0000363	32.46	229
2.21	1.34	0.80	78.62	.0000610	.0000372	35.61	230
2.22	1.37	0.82	91.84	.0000512	.0000312	42.82	230

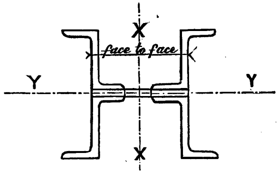
ELEMENTS OF Z BAR COLUMNS.

I = Mom. of Inertia.  R = Rad. of Gyration.

THE THICKNESS OF WEB PLATE AND Z BAR IS THE SAME.

Size of Z Bar in Inches.	7″ Web Plate. 7¼″ Face to Face.					7½″ Web Plate. 7¾″ Face to Face.				
	Area of 4 Z Bars and 1 Plate	Axis XX.		Axis YY.		Area of 4 Z Bars and 1 Plate	Axis XX.		Axis YY.	
		I.	R^2.	I.	R^2.		I.	R^2.	I.	R^2.
$3\frac{1}{2}\times6\times3\frac{1}{2}\times\frac{3}{8}$	20.99	264.18	12.59	287.91	13.72	21.17	299.34	14.14	287.91	13.60
$3\frac{9}{16}\times6\frac{1}{16}\times3\frac{9}{16}\times\frac{7}{16}$	24.62	306.41	12.45	346.95	14.09	24.84	347.30	13.98	346.95	13.97
$3\frac{5}{8}\times6\frac{1}{8}\times3\frac{5}{8}\times\frac{1}{2}$	28.26	347.81	12.31	409.27	14.48	28.51	392.86	13.78	409.28	14.36
$3\frac{1}{2}\times6\times3\frac{1}{2}\times\frac{9}{16}$	30.66	365.24	11.91	426.30	13.90	30.94	415.23	13.42	426.31	13.78
$3\frac{9}{16}\times6\frac{1}{16}\times3\frac{9}{16}\times\frac{5}{8}$	34.22	403.02	11.78	489.32	14.30	34.53	458.45	13.28	489.33	14.17
$3\frac{5}{8}\times6\frac{1}{8}\times3\frac{5}{8}\times\frac{11}{16}$	37.81	440.25	11.64	555.79	14.70	38.16	500.93	13.13	455.80	14.57
$3\frac{1}{2}\times6\times3\frac{1}{2}\times\frac{3}{4}$	39.81	448.24	11.26	562.41	14.13	40.19	511.45	12.73	562.42	13.99
$3\frac{9}{16}\times6\frac{1}{16}\times3\frac{9}{16}\times\frac{13}{16}$	43.21	481.06	11.13	628.31	14.54	43.61	549.08	12.59	628.33	14.41
$3\frac{5}{8}\times6\frac{1}{8}\times3\frac{5}{8}\times\frac{7}{8}$	46.77	514.73	11.00	699.07	14.95	47.20	587.80	12.45	699.10	14.81
	6½″ Web Plate. 6¾″ Face to Face.					7″ Web Plate. 7¼″ Face to Face.				
$3\frac{3}{16}\times5\times3\frac{3}{16}\times\frac{5}{16}$	15.47	169.65	10.97	147.39	9.53	15.63	193.91	12.41	147.39	9.43
$3\frac{1}{4}\times5\frac{1}{16}\times3\frac{1}{4}\times\frac{3}{8}$	18.64	202.04	10.84	183.47	9.84	18.83	231.00	12.27	183.47	9.74
$3\frac{5}{16}\times5\frac{1}{8}\times3\frac{5}{16}\times\frac{7}{16}$	21.84	233.93	10.71	223.00	10.21	22.06	267.61	12.13	223.00	10.11
$3\frac{7}{32}\times5\times3\frac{7}{32}\times\frac{1}{2}$	24.17	249.97	10.34	234.39	9.70	24.42	287.67	11.78	234.39	9.60
$3\frac{9}{32}\times5\frac{1}{16}\times3\frac{9}{32}\times\frac{9}{16}$	27.30	279.93	10.25	273.72	10.03	27.58	321.22	11.65	273.72	9.93
$3\frac{11}{32}\times5\frac{1}{8}\times3\frac{11}{32}\times\frac{5}{8}$	30.46	308.80	10.14	315.55	10.36	30.78	354.42	11.52	315.56	10.25
$3\frac{1}{4}\times5\times3\frac{1}{4}\times\frac{11}{16}$	32.31	316.97	9.81	320.08	9.91	32.65	364.83	11.17	320.09	9.80
$3\frac{5}{16}\times5\frac{1}{16}\times3\frac{5}{16}\times\frac{3}{4}$	35.44	343.48	9.69	362.93	10.24	35.81	395.52	11.04	362.95	10.14
	6″ Web Plate. 6¼″ Face to Face.					6½″ Web Plate. 6¾″ Face to Face.				
$2\frac{7}{8}\times4\times2\frac{7}{8}\times\frac{1}{4}$	10.78	101.90	9.45	65.72	6.10	10.91	117.62	10.78	65.72	6.02
$2\frac{15}{16}\times4\frac{1}{16}\times2\frac{15}{16}\times\frac{15}{16}$	13.52	126.20	9.34	85.86	6.35	13.67	145.72	10.66	85.86	6.28
$3\times4\frac{1}{8}\times3\times\frac{3}{8}$	16.25	149.91	9.23	107.47	6.61	16.44	173.18	10.53	107.47	6.54
$2\frac{31}{32}\times4\times2\frac{31}{32}\times\frac{7}{16}$	18.47	166.01	8.99	115.63	6.26	18.68	192.14	10.29	115.64	6.19
$3\frac{1}{32}\times4\frac{1}{16}\times3\frac{1}{32}\times\frac{1}{2}$	21.24	188.60	8.88	138.44	6.52	21.49	218.39	10.16	138.45	6.44
$3\frac{3}{32}\times4\frac{1}{8}\times3\frac{3}{32}\times\frac{9}{16}$	24.02	210.67	8.77	163.09	6.79	24.30	244.05	10.04	163.10	6.71
$3\frac{1}{16}\times4\times3\frac{1}{16}\times\frac{5}{8}$	25.87	221.21	8.55	166.90	6.45	26.18	256.76	9.83	166.91	6.39
$3\frac{1}{8}\times4\frac{1}{16}\times3\frac{1}{8}\times\frac{11}{16}$	28.69	242.12	8.44	192.70	6.72	29.03	281.15	9.69	192.70	6.64
$3\frac{3}{16}\times4\frac{1}{8}\times3\frac{3}{16}\times\frac{3}{4}$	31.50	262.65	8.32	220.68	7.01	31.88	305.12	9.57	220.70	6.92
	5½″ Web Plate. 5¾″ Face to Face.					6″ Web Plate. 6¼″ Face to Face.				
$2\frac{5}{8}\times3\times2\frac{5}{8}\times\frac{1}{4}$	9.14	72.59	7.94	31.74	3.47	9.26	84.82	9.16	31.74	3.43
$2\frac{11}{16}\times3\frac{1}{16}\times2\frac{11}{16}\times\frac{5}{16}$	11.48	90.17	7.85	42.14	3.67	11.64	105.31	9.05	42.15	3.62
$2\frac{3}{4}\times3\frac{1}{8}\times2\frac{3}{4}\times\frac{3}{8}$	13.82	107.05	7.75	53.40	3.86	14.01	125.14	8.93	53.41	3.81
$2\frac{21}{32}\times3\times2\frac{21}{32}\times\frac{7}{16}$	15.53	115.58	7.44	55.61	3.58	15.75	135.63	8.61	55.61	3.53
$2\frac{23}{32}\times3\frac{1}{16}\times2\frac{23}{32}\times\frac{1}{2}$	17.75	130.45	7.35	67.20	3.79	18.00	153.14	8.51	67.20	3.73

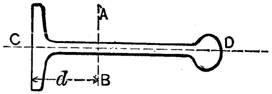
ELEMENTS OF Z BAR COLUMNS.

I = Mom. of Inertia.  R = Rad. of Gyration.

THE THICKNESS OF WEB PLATE AND Z BAR IS THE SAME.

Size of Z Bar in Inches.	8″ Web Plate. 8¼″ Face to Face.					8½″ Web Plate. 8¾″ Face to Face.				
	Area of 4 Z Bars and 1 Plate	Axis XX.		Axis YY.		Area of 4 Z Bars and 1 Plate	Axis XX.		Axis YY.	
		I.	R^2.	I.	R^2.		I.	R^2.	I.	R^2.
$3\frac{1}{2}\times6\times3\frac{1}{2}\times\frac{3}{8}$	21.36	337.17	15.78	287.92	13.48	21.55	377.65	17.52	287.92	13.36
$3\frac{9}{16}\times6\frac{1}{16}\times3\frac{9}{16}\times\frac{7}{16}$	25.06	391.37	15.62	346.96	13.85	25.28	438.55	17.35	346.96	13.73
$3\frac{5}{8}\times6\frac{1}{8}\times3\frac{5}{8}\times\frac{1}{2}$	28.76	444.57	15.46	409.28	14.23	29.01	498.35	17.18	409.29	14.11
$3\frac{1}{2}\times6\times3\frac{1}{2}\times\frac{9}{16}$	31.22	469.16	15.03	426.32	13.65	31.50	527.03	16.73	426.33	13.53
$3\frac{9}{16}\times6\frac{1}{16}\times3\frac{9}{16}\times\frac{5}{8}$	34.84	518.19	14.88	489.34	14.05	35.15	582.27	16.65	489.35	13.92
$3\frac{5}{8}\times6\frac{1}{8}\times3\frac{5}{8}\times\frac{11}{16}$	38.50	566.43	14.72	555.82	14.44	38.84	636.74	16.39	555.83	14.31
$3\frac{1}{2}\times6\times3\frac{1}{2}\times\frac{3}{4}$	40.56	579.76	14.29	562.44	13.87	40.94	653.06	15.95	562.46	13.74
$3\frac{9}{16}\times6\frac{1}{16}\times3\frac{9}{16}\times\frac{13}{16}$	44.02	622.59	14.14	628.36	14.27	44.43	701.62	15.79	628.38	14.14
$3\frac{5}{8}\times6\frac{1}{8}\times3\frac{5}{8}\times\frac{7}{8}$	47.64	666.83	14.00	699.13	14.67	48.08	751.66	15.63	699.15	14.54
	7½″ Web Plate. 7¾″ Face to Face.					8″ Web Plate. 8¼″ Face to Face.				
$3\frac{3}{16}\times5\times3\frac{3}{16}\times\frac{5}{16}$	15.78	220.13	13.95	147.39	9.35	15.94	248.29	15.58	147.39	9.25
$3\frac{1}{4}\times5\frac{1}{16}\times3\frac{1}{4}\times\frac{3}{8}$	19.01	262.32	13.80	183.47	9.65	19.20	296.02	15.42	183.48	9.56
$3\frac{5}{16}\times5\frac{1}{8}\times3\frac{5}{16}\times\frac{7}{16}$	22.28	303.96	13.64	223.00	10.01	22.50	343.21	15.25	223.01	9.91
$3\frac{7}{32}\times5\times3\frac{7}{32}\times\frac{1}{2}$	24.67	327.56	13.28	234.40	9.50	24.92	370.53	14.87	234.40	9.41
$3\frac{9}{32}\times5\frac{1}{16}\times3\frac{9}{32}\times\frac{9}{16}$	27.86	365.87	13.13	273.73	9.83	28.14	414.08	14.72	273.74	9.73
$3\frac{11}{32}\times5\frac{1}{8}\times3\frac{11}{32}\times\frac{5}{8}$	31.09	403.93	12.99	315.57	10.15	31.40	457.31	14.56	315.58	10.05
$3\frac{1}{4}\times5\times3\frac{1}{4}\times\frac{11}{16}$	33.00	416.75	12.63	320.10	9.70	33.34	472.79	14.18	320.12	9.60
$3\frac{5}{16}\times5\frac{1}{16}\times3\frac{5}{16}\times\frac{3}{4}$	36.19	452.01	12.49	362.96	10.03	36.56	513.78	14.05	362.98	9.93
	7″ Web Plate. 7¼″ Face to Face.					7½″ Web Plate. 7¾″ Face to Face.				
$2\frac{7}{8}\times4\times2\frac{7}{8}\times\frac{1}{4}$	11.03	134.71	12.21	65.72	5.96	11.16	153.17	13.72	65.72	5.89
$2\frac{15}{16}\times4\frac{1}{16}\times2\frac{15}{16}\times\frac{15}{16}$	13.83	166.97	12.07	85.86	6.21	13.98	189.95	13.59	85.86	6.14
$3\times4\frac{1}{8}\times3\times\frac{3}{8}$	16.63	198.52	11.94	107.47	6.46	16.81	225.94	13.44	107.47	6.39
$2\frac{31}{32}\times4\times2\frac{31}{32}\times\frac{7}{16}$	18.90	220.75	11.68	115.64	6.12	19.12	251.40	13.15	115.64	6.05
$3\frac{1}{32}\times4\frac{1}{16}\times3\frac{1}{32}\times\frac{1}{2}$	21.74	250.90	11.54	138.45	6.37	21.99	286.10	13.01	138.46	6.30
$3\frac{3}{32}\times4\frac{1}{8}\times3\frac{3}{32}\times\frac{9}{16}$	24.58	280.48	11.41	163.10	6.64	24.86	319.96	12.87	163.11	6.56
$3\frac{1}{16}\times4\times3\frac{1}{16}\times\frac{5}{8}$	26.50	295.54	11.15	166.92	6.30	26.81	337.59	12.59	166.93	6.23
$3\frac{1}{8}\times4\frac{1}{16}\times3\frac{1}{8}\times\frac{11}{16}$	29.37	323.83	11.03	192.73	6.56	29.72	370.17	12.45	192.74	6.49
$3\frac{3}{16}\times4\frac{1}{8}\times3\frac{3}{16}\times\frac{3}{4}$	32.25	351.60	10.90	220.72	6.84	32.63	402.09	12.32	220.73	6.77
	6½″ Web Plate. 6¾″ Face to Face.					7″ Web Plate. 7¼″ Face to Face.				
$2\frac{5}{8}\times3\times2\frac{5}{8}\times\frac{1}{4}$	9.39	98.12	10.45	31.74	3.38	9.51	112.65	11.85	31.74	3.34
$2\frac{11}{16}\times3\frac{1}{16}\times2\frac{11}{16}\times\frac{5}{16}$	11.79	121.99	10.35	42.15	3.58	11.95	140.07	11.71	42.15	3.53
$2\frac{3}{4}\times3\frac{1}{8}\times2\frac{3}{4}\times\frac{3}{8}$	14.20	144.98	10.21	53.41	3.76	14.39	166.60	11.58	53.41	3.71
$2\frac{21}{32}\times3\times2\frac{21}{32}\times\frac{7}{16}$	15.96	157.65	9.88	55.62	3.49	16.18	181.67	11.23	55.62	3.44
$2\frac{23}{32}\times3\frac{1}{16}\times2\frac{23}{32}\times\frac{1}{2}$	18.25	178.09	9.76	67.21	3.68	18.50	205.32	11.10	67.21	3.63

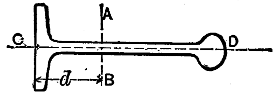
ELEMENTS OF PENCOYD DECK BEAMS.



I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
Size in Inches.	*Section Number.*	*Area in Square Inches.*	*Weight in Pounds per Foot.*	*Moments of Inertia.*		*Square of Radius of Gyration.*		*Radius of Gyration.*	
				Axis A. B.	*Axis C. D.*	*Axis A. B.*	*Axis C. D.*	*Axis A. B.*	*Axis C. D.*
*11½	69	10.54	35.84	192.01	7.84	18.36	0.75	4.28	0.87
11½	69	13.41	44.59	223.63	8.06	16.78	0.60	4.10	0.78
10	62	8.27	28.12	120.75	6.31	14.74	0.77	3.84	0.88
10	62	11.39	38.73	146.75	7.69	12.98	0.68	3.60	0.82
9	63	7.26	24.68	84.77	4.92	11.82	0.69	3.44	0.83
9	63	9.51	32.33	99.95	5.69	10.60	0.60	3.26	0.78
8	64	6.17	20.98	57.66	3.63	9.44	0.59	3.07	0.77
8	64	8.42	28.63	69.66	4.41	8.33	0.53	2.89	0.73
7	65	5.26	17.88	37.05	2.59	7.11	0.50	2.67	0.71
7	65	7.22	24.55	45.46	3.23	6.34	0.45	2.52	0.67
6	66	4.22	14.35	21.95	1.64	5.25	0.39	2.29	0.63
6	66	5.72	19.45	26.61	2.04	4.69	0.36	2.16	0.60
5	67	3.39	11.53	12.04	0.98	3.57	0.29	1.89	0.54
5	67	4.64	15.78	14.64	1.268	3.17	0.27	1.78	0.52

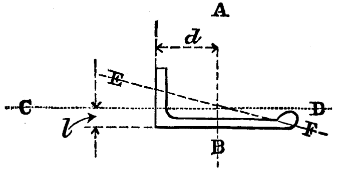
* This table refers to webs ½″ thick.

ELEMENTS OF PENCOYD DECK BEAMS.



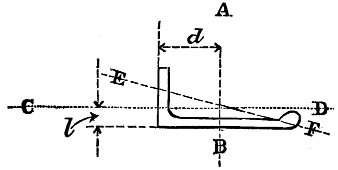
XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	II.	I.
Resistance.	*Add to Previous Co-eff. for each Additional Pound per Foot.*	*Coefficient in Net Tons for Greatest Safe Load Distributed.*	*Add to Previous Co-eff. for each Additional Pound per Foot.*	*Coefficient for Deflection.*		*Maximum Load in Net Tons.*	*Distance "d" from Base to Neutral Axis.*	*Section Nnmber.*	*Size in Inches.*
Axis A. B.				*Distributed.*	*Centre.*				
30.47	0.57	187.10	2.66	.0000082	.0000134	35.06	5.20	69	11½
37.90	0.57	217.80	2.66	.0000071	.0000115	61.51	5.60	69	11½
21.11	0.50	135.24	2.33	.0000130	.0000213	20.99	4.28	62	10
26.59	0.50	164.35	2.33	.0000107	.0000175	49.71	4.48	62	10
16.95	0.45	105.49	2.10	.0000185	.0000303	20.12	4.00	63	9
20.36	0.45	124.38	2.10	.0000157	.0000257	40.77	4.09	63	9
12.81	0.40	80.72	1.87	.0000272	.0000445	16.66	3.50	64	8
16.09	0.40	97.52	1.87	.0000225	.0000369	37.18	3.68	64	8
9.50	0.35	59.27	1.63	.0000423	.0000694	15.51	3.09	65	7
11.73	0.35	72.73	1.63	.0000345	.0000565	33.36	3.21	65	7
6.55	0.30	40.97	1.40	.0000712	.0000117	12.42	2.65	66	6
8.19	0.30	49.67	1.40	.0000589	.0000966	25.88	2.75	66	6
4.33	0.25	26.96	1.67	.0001302	.0002135	11.01	2.22	67	5
5.42	0.25	32.80	1.67	.0001071	.0001756	22.02	2.30	67	5

ELEMENTS OF PENCOYD BULB ANGLES.



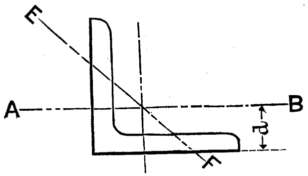
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.
Size in Inches.	*Section Number.*	*Area in Sq. Inches.*	*Weight in Pounds per Foot.*	*Moments of Inertia.*			*Square of Radius of Gyration.*			*Radius of Gyration.*		
				Axis A. B.	*Axis C. D.*	*Axis E. F.*	*Axis A. B.*	*Axis C. D.*	*Axis E. F.*	*Axis A. B.*	*Axis C. D.*	*Axis E. F.*
5	255	2.81	9.55	12.43	2.13	1.68	4.42	0.76	0.56	2.10	0.87	0.75
5	255	3.43	11.66	18.70	3.25	1.96	5.45	0.95	0.58	2.33	0.97	0.76
6	254	3.72	12.65	22.59	4.10	2.08	6.07	1.12	0.56	2.46	1.06	0.75
6	254	4.95	16.83	33.76	4.56	3.33	6.82	0.92	0.67	2.61	0.96	0.82
7	253	4.69	15.95	29.50	2.66	2.96	6.29	0.57	0.63	2.50	0.76	0.79
7	253	5.95	20.24	36.31	3.36	3.66	6.10	0.56	0.62	2.47	0.74	0.78
8	252	5.72	19.47	48.30	3.80	3.75	8.44	0.66	0.65	2.90	0.82	0.80
8	252	7.14	24.30	59.20	5.26	5.16	8.29	0.73	0.72	2.88	0.83	0.84
9	251	6.60	22.44	63.96	4.67	4.90	9.71	0.71	0.86	3.11	0.84	0.92
9	251	7.72	26.24	75.80	5.74	6.24	9.82	0.74	0.86	3.13	0.80	0.89
10	250	7.53	25.59	85.15	5.37	5.46	11.31	0.71	0.73	3.36	0.84	0.85
10	250	9.22	21.35	96.99	6.44	6.80	10.41	0.69	0.72	3.22	0.83	0.84

ELEMENTS OF PENCOYD BULB ANGLES.



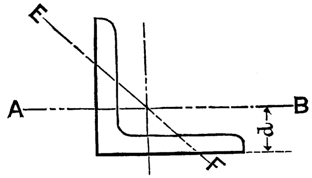
XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	II.	I.
Resistance.	*Add to Resistance for Each Additional Pound per Foot.*	*Coefficient in Net Tons for Greatest Safe Load Distributed.*	*Add to Previous Coeff. for Each Additional Pound per Foot.*	*Coefficient for Deflection.*		*Maximum Load in Net Tons.*	*Distance "d" from Base to Neutral Axis.*	*Distance "l" from Base in Neutral Axis.*	*Section Number.*	*Size in Inches.*
Axis A. B.				*Distributed.*	*Centre.*					
4.57	0.25	41.02	1.166	.0001260	.0002068	11.01	2.26	0.72	255	5
7.12	0.25	60.22	1.166	.0000838	.0001374	18.02	2.50	0.63	255	5
6.45	0.30	62.12	1.40	.0000694	.0001138	15.00	2.500	0.65	254	6
10.54	0.30	89.09	1.40	.0000464	.0000767	26.62	3.00	0.86	254	6
7.54	0.35	62.23	1.633	.0000531	.0000871	19.62	3.07	0.66	253	7
12.39	0.35	102.24	1.633	.0000431	.0000707	28.13	3.07	0.68	253	7
10.78	0.40	88.94	1.87	.0000324	.0000532	24.76	3.52	0.68	252	8
13.30	0.40	111.85	1.87	.0000265	.0000434	33.26	3.55	0.70	252	8
12.56	0.45	91.58	2.10	.0000245	.0000402	29.20	3.91	0.69	251	9
15.28	0.45	122.82	2.10	.0000206	.0000339	39.47	4.04	0.89	251	9
15.56	0.50	110.15	2.33	.0000184	.0000301	32.56	4.53	0.70	250	10
18.00	0.50	124.06	2.33	.0000155	.0000208	41.06	4.55	0.71	250	10

ELEMENTS OF PENCOYD ANGLES.



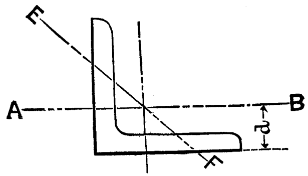
I.	II.	III.	IV.	V.	VI.	VII.
Section Number.	*Size in Inches.*	*Thickness.*	*Area.*	*Weight per Foot.*	*Moments of Inertia.*	
					Axis A. B.	*Axis E. F.*
173 173	8 x 8 8¼ x 8¼	½ 1	7.76 15.53	26.38 52.80	48.63 98.11	19.85 41.58
120 120	6 x 6 6 5/16 x 6 5/16	⅜ 1	4.36 11.55	14.82 39.27	15.38 41.73	6.19 17.33
121 121	5 x 5 5⅝ x 5⅝	⅜ 1	3.60 9.83	12.24 33.43	8.74 25.79	3.53 10.85
122 122	4 x 4 4 7/16 x 4 7/16	5/16 ¾	2.40 5.69	8.16 19.35	3.71 10.25	1.50 4.28
123 123	3½ x 3½ 3 13/16 x 3 13/16	5/16 ⅝	2.09 4.19	7.11 14.24	2.44 5.41	0.99 2.25
124 124	3 x 3 3⅜ x 3⅜	¼ ⅝	1.45 3.43	4.93 11.66	1.24 3.41	0.50 1.44
125 125	2¾ x 2¾ 3 x 3	¼ ½	1.31 2.63	4.45 8.94	0.95 1.93	0.38 0.81

ELEMENTS OF PENCOYD ANGLES.



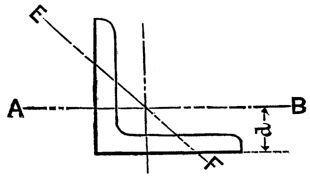
VIII.	IX.	X.	XI.	I.
Radii of Gyration.		*Resistance.*	*Distance from Base to Neutral Axis.*	*Section Number.*
Axis A. B.	*Axis E. F.*	*Axis A. B.*	*d.*	
2.503 2.513	1.60 1.64	8.35 17.58	2.18 2.42	173 173
1.88 1.90	1.19 1.22	3.53 9.64	1.64 1.92	120 120
1.56 1.61	0.99 1.05	2.42 6.94	1.39 1.72	121 121
1.14 1.34	0.79 0.86	1.29 3.50	1.12 1.37	122 122
1.08 1.14	0.69 0.73	1.97 2.09	0.99 1.16	123 123
0.92 0.99	0.59 0.64	0.57 1.51	0.84 1.04	124 124
0.85 0.86	0.53 0.55	0.48 0.96	0.78 0.90	125 125

ELEMENTS OF PENCOYD ANGLES.



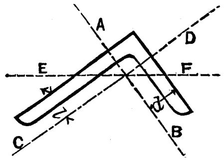
I.	II.	III.	IV.	V.	VI.	VII.
Section Number.	*Size in Inches.*	*Thickness.*	*Area.*	*Weight per Foot.*	*Moments of Inertia.*	
					Axis A. B.	*Axis E. F.*
126	$2\frac{1}{2}$ x $2\frac{1}{2}$	$\frac{3}{16}$	0.90	3.06	0.55	0.22
126	$2\frac{13}{16}$ x $2\frac{13}{16}$	$\frac{1}{2}$	2.40	8.16	1.67	0.70
127	$2\frac{1}{4}$ x $2\frac{1}{4}$	$\frac{3}{16}$	0.79	2.69	0.39	0.16
127	$2\frac{7}{16}$ x $2\frac{7}{16}$	$\frac{3}{8}$	1.59	5.41	0.76	0.32
128	2 x 2	$\frac{3}{16}$	0.72	2.45	0.27	0.11
128	$2\frac{3}{16}$ x $2\frac{3}{16}$	$\frac{3}{8}$	1.45	4.93	0.58	0.24
129	$1\frac{3}{4}$ x $1\frac{3}{4}$	$\frac{3}{16}$	0.63	2.14	0.18	0.07
129	$1\frac{15}{16}$ x $1\frac{15}{16}$	$\frac{3}{8}$	1.29	4.39	0.41	0.17
130	$1\frac{1}{2}$ x $1\frac{1}{2}$	$\frac{1}{8}$	0.34	1.16	0.07	0.03
130	$1\frac{3}{4}$ x $1\frac{3}{4}$	$\frac{3}{8}$	1.05	3.57	0.23	0.10
131	$1\frac{1}{4}$ x $1\frac{1}{4}$	$\frac{1}{8}$	0.30	1.02	0.04	0.02
131	$1\frac{3}{8}$ x $1\frac{3}{8}$	$\frac{1}{4}$	0.59	2.01	0.09	0.04
132	1 x 1	$\frac{1}{8}$	0.23	0.78	0.02	0.01
132	$1\frac{1}{8}$ x $1\frac{1}{8}$	$\frac{1}{4}$	0.45	1.53	0.05	0.02

ELEMENTS OF PENCOYD ANGLES.



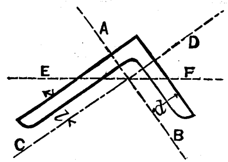
VIII.	IX.	X.	XI.	I.
Radii of Gyration.		*Resistance.*	*Distance from Base to Neutral Axis.*	*Section Number.*
Axis A. B.	*Axis E. F.*	*Axis A. B.*	*d.*	
0.78	0.49	0.31	0.70	126
0.83	0.54	0.91	0.87	126
0.69	0.44	0.24	0.63	127
0.69	0.49	0.48	0.72	127
0.62	0.39	0.19	0.57	128
0.63	0.41	0.40	0.67	128
0.54	0.33	0.15	0.51	129
0.56	0.36	1.33	0.61	129
0.45	0.29	0.06	0.42	130
0.47	0.31	0.21	0.54	130
0.37	0.26	0.04	0.35	131
0.39	0.26	1.00	0.42	131
0.29	0.21	0.03	0.30	132
0.33	0.21	0.07	0.37	132

ELEMENTS OF PENCOYD ANGLES.



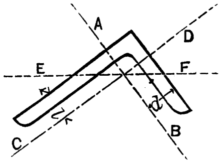
I.	II.	III.	IV.	V.	VI.	VII.	VIII.
					Moments of Inertia.		
Section Number.	*Size in Inches.*	*Thickness.*	*Area.*	*Weight per Foot.*	*Axis A. B.*	*Axis C. D.*	*Axis E. F.*
172 172	8 x 5 8 1/4 x 5 1/4	1/2 1	6.26 12.53	21.28 42.60	41.75 84.00	12.88 26.41	8.68 18.50
154 154	7 x 3 1/2 7 1/4 x 3 3/4	1/2 1	5.00 9.56	17.00 32.50	29.28 49.00	4.41 9.30	3.57 6.94
152 152	6 1/2 x 4 7 1/8 x 4 5/8	3/8 1	3.78 10.08	12.85 34.27	16.78 46.04	5.01 15.52	3.35 11.02
140 140	6 x 4 6 7/16 x 4 7/16	3/8 1	3.60 9.65	12.24 32.81	13.47 43.07	4.90 17.05	3.05 11.26
151 151	6 x 3 1/2 6 5/8 x 4 1/8	3/8 1	3.39 9.39	11.53 31.93	12.85 37.60	3.34 10.97	2.30 7.78
153 153	5 1/2 x 3 1/2 5 3/4 x 3 3/4	3/8 5/8	3.23 5.35	10.98 18.19	10.12 16.97	3.27 5.54	2.10 3.67
141 141	5 x 4 5 3/16 x 4 3/16	3/8 3/4	3.23 6.34	10.98 21.56	8.13 17.47	4.66 10.21	2.44 5.54
142 142	5 x 3 1/2 5 7/16 x 3 15/16	5/16 3/4	2.56 5.92	8.70 20.13	6.60 17.06	2.72 7.27	1.61 4.31
143 143	5 x 3 5 1/4 x 3 1/4	5/16 3/4	2.40 5.52	8.16 18.77	6.26 14.46	1.75 4.06	1.19 3.27
144 144	4 1/2 x 3 4 15/16 x 3 7/16	5/16 3/4	2.27 5.28	7.72 17.95	4.68 11.77	1.70 4.39	1.10 3.10
145 145	4 x 3 1/2 4 7/16 x 3 15/16	5/16 3/4	2.27 5.28	7.72 17.95	3.56 7.76	2.55 5.63	1.22 3.40

ELEMENTS OF PENCOYD ANGLES.



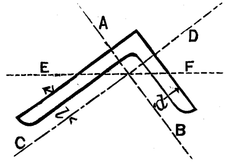
IX.	X.	XI.	XII.	XIII.	XIV.	XV.	I.
Radii of Gyration.			*Resistance.*		*Distance from Base to Neutral Axis.*		
Axis A. B.	*Axis C. D.*	*Axis E. F.*	*Axis A. B.*	*Axis C. D.*	*d.*	*l.*	*Section Number.*
2.60 2.59	1.43 1.45	1.18 1.21	7.80 15.64	3.34 6.84	2.65 2.88	1.15 1.39	172 172
2.42 2.02	0.90 0.99	0.84 0.85	6.54 11.34	1.61 3.70	2.53 2.71	0.76 1.02	154 154
2.11 2.14	1.15 1.12	0.93 1.02	3.85 10.08	1.94 4.76	2.15 2.43	0.90 1.25	152 152
1.93 2.05	1.17 1.32	0.90 1.07	3.32 10.30	1.60 5.36	1.94 2.32	0.94 1.32	140 140
1.94 2.00	0.99 1.08	0.84 0.90	3.24 9.01	1.23 3.90	2.05 2.35	0.79 1.14	151 151
1.77 1.78	1.01 1.01	0.81 0.83	2.75 4.48	1.22 2.00	1.82 1.94	0.82 0.94	153 153
1.59 1.65	1.20 1.26	0.87 0.92	2.35 4.86	1.57 3.32	1.53 1.73	1.03 1.23	141 141
1.61 1.69	1.03 1.10	0.79 0.85	1.93 4.90	1.03 2.66	1.61 1.82	0.86 1.07	142 142
1.61 1.61	0.85 0.86	0.70 0.76	1.88 4.21	0.75 1.67	1.70 1.87	0.68 0.87	143 143
1.43 1.48	0.86 0.89	0.69 0.76	1.51 3.72	0.75 1.82	1.46 1.69	0.72 0.94	144 144
1.25 1.21	1.05 1.03	0.73 0.79	1.26 2.59	0.99 2.05	1.18 1.36	0.93 1.11	145 145

ELEMENTS OF PENCOYD ANGLES.



I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Section Number.	*Size in Inches.*	*Thickness.*	*Area.*	*Weight per Foot.*	*Moments of Inertia.*		
					Axis A. B.	*Axis C. D.*	*Axis E. F.*
146	4 x 3	$\frac{5}{16}$	2.09	7.11	3.38	1.65	0.93
146	$4\frac{3}{16}$ x $3\frac{3}{16}$	$\frac{5}{8}$	4.13	14.04	7.20	3.59	2.14
147	$3\frac{1}{2}$ x 3	$\frac{5}{16}$	1.93	6.56	2.33	1.58	0.62
147	$3\frac{13}{16}$ x $3\frac{5}{16}$	$\frac{5}{8}$	3.86	13.12	3.66	3.15	1.81
150	$3\frac{1}{2}$ x $2\frac{1}{2}$	$\frac{1}{4}$	1.45	4.93	1.80	0.78	0.47
150	$3\frac{3}{4}$ x $2\frac{3}{4}$	$\frac{1}{2}$	2.77	9.42	3.64	1.60	0.99
159	$3\frac{1}{2}$ x 2	$\frac{15}{64}$	1.21	4.11	1.56	0.38	0.27
159	$3\frac{5}{8}$ x $2\frac{1}{8}$	$\frac{3}{8}$	1.97	6.70	2.60	0.57	0.83
148	3 x $2\frac{1}{2}$	$\frac{1}{4}$	1.31	4.45	1.17	0.74	0.37
148	$3\frac{1}{4}$ x $2\frac{3}{4}$	$\frac{1}{2}$	2.63	8.94	2.38	1.53	0.87
149	3 x 2	$\frac{1}{4}$	1.20	4.08	1.09	0.39	0.25
149	$3\frac{1}{4}$ x $2\frac{1}{4}$	$\frac{1}{2}$	2.40	8.16	2.52	0.98	0.60
155	$2\frac{1}{2}$ x 2	$\frac{3}{16}$	0.79	2.69	0.51	0.29	0.15
155	$2\frac{13}{16}$ x $2\frac{5}{16}$	$\frac{1}{2}$	2.12	7.21	1.40	0.85	0.46
156	$2\frac{1}{4}$ x $1\frac{1}{2}$	$\frac{3}{16}$	0.67	2.28	0.34	0.12	0.08
156	$2\frac{7}{16}$ x $1\frac{11}{16}$	$\frac{3}{8}$	1.34	4.56	0.70	0.26	0.18
139	2 x $1\frac{1}{2}$	$\frac{3}{16}$	0.62	2.11	0.25	0.12	0.05
139	$2\frac{3}{16}$ x $1\frac{11}{16}$	$\frac{3}{8}$	1.31	4.46	0.56	0.30	0.17
157	2 x $1\frac{1}{4}$	$\frac{3}{16}$	0.57	1.94	0.23	0.07	0.05
157	$2\frac{3}{16}$ x $1\frac{7}{16}$	$\frac{3}{8}$	1.17	3.98	0.50	0.16	0.12

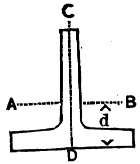
ELEMENTS OF PENCOYD ANGLES.



IX.	X.	XI.	XII.	XIII.	XIV.	XV.	I.
Radii of Gyration.			*Resistance.*		*Distance from Base to Neutral Axis.*		*Section Number.*
Axis A. B.	*Axis C. D.*	*Axis E. F.*	*Axis A. B.*	*Axis C. D.*	*d.*	*l.*	
1.27	0.89	0.67	1.23	0.74	1.26	0.76	146
1.30	0.92	0.70	2.54	1.54	1.42	0.92	146
1.10	0.90	0.57	0.95	0.72	1.06	0.81	147
0.96	0.90	0.67	1.37	1.21	1.09	0.99	147
1.11	0.73	0.57	0.75	0.41	1.11	0.61	150
1.14	0.76	0.59	1.50	0.84	1.23	0.73	150
1.13	0.56	0.47	0.65	0.25	1.31	0.45	159
1.16	0.55	0.66	1.14	0.37	1.32	0.55	159
0.95	0.75	0.53	0.56	0.40	0.92	0.66	148
0.95	0.76	0.57	1.34	0.83	1.03	0.78	148
0.95	0.56	0.46	0.54	0.25	0.99	0.49	149
1.02	0.64	0.49	1.22	0.62	1.14	0.64	149
0.80	0.60	0.44	0.29	0.19	0.76	0.51	155
0.81	0.62	0.46	0.80	0.57	0.92	0.67	155
0.71	0.42	0.35	0.23	0.10	0.74	0.37	156
0.72	0.44	0.36	0.46	0.23	0.83	0.46	156
0.64	0.45	0.28	0.18	0.11	0.64	0.39	139
0.65	0.44	0.36	0.38	0.25	0.75	0.50	139
0.63	0.35	0.30	0.18	0.07	0.69	0.31	157
0.65	0.37	0.31	0.38	0.17	0.78	0.41	157

ELEMENTS OF PENCOYD TEES.

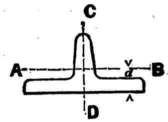
EVEN LEGS.



I. Section Number.	II. Size in Inches.	III. Area in Square Inches.	IV. Weight in Pounds per Foot.	V. Moments of Inertia. Axis A. B.	VI. Moments of Inertia. Axis C. D.	VII. Resistance. Axis A. B.	VIII. Resistance. Axis C. D.	IX. Radius of Gyration. Axis A. B.	X. Radius of Gyration. Axis C. D.	XI. Distance "d" from Base to Neutral Axis.	I. Section Number.
70	4 x 4 x $\frac{9}{16}$	3.72	12.65	5.56	2.70	1.97	1.35	1.23	0.85	1.19	70
71	$3\frac{1}{2}$ x $3\frac{1}{2}$ x $\frac{15}{32}$	3.05	10.37	3.47	1.70	1.38	0.97	1.06	0.74	1.00	71
72	3 x 3 x $\frac{15}{32}$	2.50	8.50	2.10	1.01	1.00	0.67	0.90	0.62	0.90	72
73	$2\frac{1}{2}$ x $2\frac{1}{2}$ x $\frac{7}{16}$	1.95	6.63	1.12	0.58	0.64	0.46	0.78	0.55	0.75	73
74	$2\frac{1}{2}$ x $2\frac{1}{2}$ x $\frac{3}{8}$	1.72	5.84	0.97	0.49	0.55	0.39	0.75	0.53	0.75	74
75	$2\frac{1}{4}$ x $2\frac{1}{4}$ x $\frac{1}{4}$	1.17	3.98	0.52	0.30	0.31	0.26	0.65	0.50	0.61	75
76	$2\frac{1}{4}$ x $2\frac{1}{4}$ x $\frac{9}{32}$	1.18	4.01	0.54	0.27	0.34	0.24	0.67	0.47	0.65	76
77	2 x 2 x $\frac{9}{32}$	1.04	3.54	0.38	0.19	0.27	0.19	0.60	0.43	0.60	77
78	$1\frac{3}{4}$ x $1\frac{3}{4}$ x $\frac{7}{32}$	0.71	2.41	0.21	0.10	0.16	0.11	0.54	0.37	0.50	78
79	$1\frac{1}{2}$ x $1\frac{1}{2}$ x $\frac{7}{32}$	0.60	2.04	0.13	0.06	0.12	0.08	0.46	0.32	0.45	79
80	$1\frac{1}{4}$ x $1\frac{1}{4}$ x $\frac{3}{16}$	0.45	1.53	0.07	0.04	0.08	0.06	0.37	0.27	0.37	80
81	1 x 1 x $\frac{3}{16}$	0.31	1.05	0.03	0.02	0.04	0.04	0.30	0.26	0.30	81
82	3 x 3 x $\frac{11}{32}$	1.93	6.56	1.59	0.75	0.73	0.50	0.91	0.62	0.84	82
83	3 x 3 x $\frac{13}{32}$	2.26	7.68	1.83	0.89	0.85	0.59	0.90	0.63	0.86	83
84	$2\frac{1}{2}$ x $2\frac{1}{2}$ x $\frac{11}{32}$	1.45	4.93	0.79	0.38	0.44	0.30	0.74	0.51	0.71	84
85	4 x 4 x $\frac{1}{2}$	3.29	11.19	5.1	2.5	1.79	1.25	1.20	0.83	1.15	85
86	$3\frac{1}{2}$ x $3\frac{1}{2}$ x $\frac{7}{16}$	2.64	8.97	3.41	1.81	1.35	1.05	1.13	0.83	0.99	86
87	$3\frac{1}{2}$ x $3\frac{1}{2}$ x $\frac{11}{32}$	2.06	6.99	3.04	1.09	1.18	0.62	1.21	0.72	0.94	87

ELEMENTS OF PENCOYD TEES.

UNEVEN LEGS.

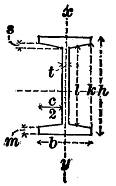


I. Section Number.	II. Size in Inches.	III. Area in Square Inches.	IV. Weight in Pounds per Foot.	V. Moments of Inertia. Axis A. B.	VI. Moments of Inertia. Axis C. D.	VII. Resistance. Axis A. B.	VIII. Resistance. Axis C. D.	IX. Radius of Gyration. Axis A. B.	X. Radius of Gyration. Axis C. D.	XI. Distance "d." Base to Neutral Axis.	I. Section Number.
94	4 x 3	2.59	8.81	1.94	2.18	0.87	1.09	0.86	0.92	0.77	94
95	6 x $5\frac{1}{4}$	11.59	39.41	28.68	18.80	16.39	6.26	1.57	1.27	1.75	95
96	4 x 2	1.93	6.56	0.55	1.84	0.36	0.92	0.53	0.98	0.47	96
97	3 x $3\frac{1}{2}$	2.81	9.55	3.12	1.06	1.30	0.70	1.05	0.61	1.10	97
$97\frac{1}{2}$	3 x $3\frac{1}{2}$	2.46	8.36	1.90	1.41	0.88	0.81	0.88	0.75	0.83	$97\frac{1}{2}$
98	3 x $2\frac{1}{2}$	2.38	8.09	1.38	0.94	0.82	0.62	0.76	0.63	0.82	98
99	3 x $1\frac{1}{2}$	1.12	3.81	0.19	0.56	0.17	0.37	0.41	0.71	0.37	99
100	$2\frac{1}{2}$ x $1\frac{1}{4}$	0.91	3.09	0.10	0.33	0.10	0.26	0.43	0.50	0.32	100
101	2 x $1\frac{1}{2}$	0.87	2.96	0.16	0.18	0.15	0.18	0.33	0.45	0.43	101
102	2 x 1	0.70	2.38	0.05	0.17	0.07	0.17	0.26	0.49	0.27	102
103	2 x $\frac{9}{16}$	0.61	2.07	0.01	0.17	0.02	0.17	0.13	0.54	0.17	103
104	$2\frac{3}{4}$ x $1\frac{3}{4}$	1.96	6.66	0.56	0.62	0.50	0.45	0.53	0.51	0.64	104
105	$2\frac{3}{4}$ x 2	2.14	7.28	0.83	0.63	0.66	0.45	0.63	0.55	0.75	105
106	5 x $3\frac{1}{2}$	4.84	16.46	5.37	5.31	2.19	2.12	1.05	1.01	1.05	106
107	5 x 4	4.41	14.99	6.24	5.25	2.13	2.10	1.19	1.09	1.08	107
108	$2\frac{1}{4}$ x $\frac{9}{16}$	0.66	2.24	0.01	0.24	0.02	0.21	0.12	0.61	0.18	108
109	4 x $4\frac{1}{2}$	3.97	13.50	7.77	2.71	2.49	1.36	1.40	0.82	1.39	109
110	3 x $2\frac{1}{2}$	1.76	5.98	0.94	0.74	0.52	0.49	0.73	0.05	0.69	110
111	3 x $2\frac{1}{2}$	2.06	7.00	1.08	0.89	0.60	0.59	0.72	0.66	0.70	111
112	2 x $1\frac{1}{16}$	0.62	2.11	0.04	0.17	0.05	0.17	0.23	0.17	0.23	112
113	$1\frac{3}{4}$ x $1\frac{1}{16}$	0.56	1.90	0.04	0.11	0.05	0.12	0.27	0.44	0.24	113
114	$1\frac{1}{2}$ x $\frac{15}{16}$	0.41	1.39	0.02	0.06	0.02	0.08	0.22	0.38	0.17	114
115	$1\frac{1}{4}$ x $\frac{15}{16}$	0.34	1.16	0.02	0.03	0.03	0.05	0.24	0.30	0.24	115
116	$1\frac{3}{4}$ x $1\frac{1}{4}$	1.04	3.54	0.12	0.05	0.14	0.06	0.34	0.22	0.42	116
117	3 x $2\frac{1}{2}$	1.50	5.10	0.79	0.60	0.42	0.40	0.73	0.63	0.65	117
118	$2\frac{1}{2}$x3 x$\frac{3}{8}$	1.77	6.03	1.6	0.44	1.01	0.30	0.94	0.51	0.92	118
119	$2\frac{1}{2}$x$2\frac{3}{4}$x$\frac{3}{8}$	1.69	5.74	1.2	0.44	0.72	0.32	0.83	0.51	0.83	119
88	$3\frac{1}{2}$x3 x$\frac{7}{16}$	2.52	8.57	1.97	1.46	0.91	0.83	0.89	0.76	0.84	88
89	$3\frac{1}{2}$x3 x$\frac{3}{8}$	2.16	7.36	1.87	1.24	0.85	0.71	0.93	0.76	0.81	89

MOMENTS OF INERTIA OF STANDARD SECTIONS.

When not otherwise specified, the inertia is the greatest around centre of gravity, or for horizontal axis in figures.

A = total area of section.



I Beam Section.

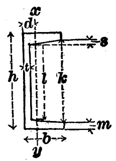
s = taper of flange.

$$l = k - \frac{2s}{3}.$$

$$I = \frac{bh^3 - ck^3}{12} + \frac{cs^3}{18} + \frac{csl^2}{4}.$$

$$I, \text{axis } xy = \frac{mb^3}{6} + \frac{kt^3}{12} + \frac{s\left(\frac{b-t}{2}\right)^3}{9} + 2s\left(\frac{b-t}{2}\right)\left(\frac{b}{6} + \frac{t}{3}\right)^2.$$

Channel Section.



s = taper of flange.

$$r = \frac{s}{b-t}.$$

$$I = \frac{bh^3 - \frac{1}{8r}\left(k^4 - l^4\right)}{12}.$$

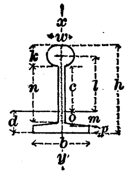
$$I, \text{axis } xy = \frac{2\,mb^3 + lt^3 + \frac{r}{2}\left(b^4 - t^4\right)}{3} - Ad^2.$$

$$d = \frac{mb^2 + \frac{kt^2}{2} + \frac{s}{3}\left(b - t\right)\left(b + 2t\right)}{A}.$$

Deck Beam Section.

s = taper of flange. a = area of bulb.

$$o = m - \frac{s}{3}.$$

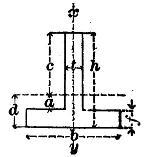


$$I = \frac{aw^2}{15} + al^2 + \frac{tc^3}{3} + \frac{bd^3}{3} - \frac{m^3(b-t)}{3} + \frac{(b-t)s^3}{36} + \frac{s\,(b-t)\,o^2}{2}.$$

$$I, \text{axis } xy = \frac{ak^2}{12.4} + \frac{nt^3}{12} + \frac{\left(p + \frac{s}{4}\right)b^3}{12}$$

$$d = \frac{a\,(2\,h - k) + t\,(h - k)^2 + (b - t)\,p^2 + s\,(b - t)\left(p + \frac{s}{3}\right)}{2A}.$$

Tee Section.

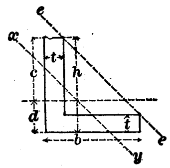


$$I = \frac{tc^3 + bd^3 - (b-t)\,a^3}{3}.$$

$$I, \text{axis } xy = \frac{fb^3 + (h - f)\,t^3}{12}.$$

$$d = \frac{bf^2 + t\,(h^2 - f^2)}{2A}.$$

Angle Section.



$$I = \frac{tc^3 + bd^3 - (b-t)\,(d-t)^3}{3}.$$ For even or uneven angles.

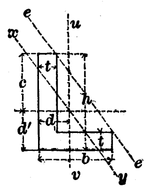
$$I, \text{axis } uv = \frac{t\,(b - d_1)^3 + hd_1^3 - (h - t)\,(d_1 - t)^3}{3}.$$ For uneven angles.

---

xy passes through centre of gravity parallel to ee.

$$I \text{ axis } xy = \frac{2d^4 - 2\,(d-t)^4 + t\left[b - \left(2d - \frac{t}{2}\right)\right]^3}{3}.$$ For even angles.

A close approximation for the latter is the following:



$$I, \text{axis } xy = \frac{Ab^2}{25}.$$ For even angles.

$$I, \text{axis } xy = \frac{Ah^2b^2}{13\,(h^2 + b^2)}.$$ For uneven angles.

$$d = \frac{bt^2 + t\,(h^2 - t^2)}{2A}.$$ For even and uneven angles.

$$d' = \frac{ht^2 + t\,(b^2 - t^2)}{2A}.\quad \text{For uneven angles.}$$

In uneven angles the distance from centre of gravity in direction of the long leg exceeds that in the direction of the short leg by half the difference in the length of the two legs.

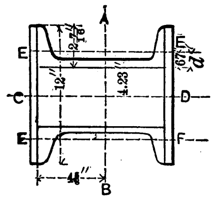
In angles and tees of equal legs and thickness

$$d = \tfrac{1}{4}\left(b + \frac{3}{2}t\right) \text{ nearly.}$$

Inertia of Compound Shapes.

"The moment of inertia of any section about any axis is equal to the I about a parallel axis passing through its centre of gravity + the area of the section multiplied by the square of the distance between the axes."

By use of this rule, the moments of inertia or radii of gyration of any single sections being known, corresponding values can readily be obtained for any combination of these sections.



Example No. 1.—A combination of two 9″ channels of 5.17 square inches section, and two 12 × ¼ plates as shown.

Axis A B of Section.

I for two channels, col. V, page 118, $= 119.78$

I for two plates $= \dfrac{12 \times .25^3}{12} \times 2 = .03125$ }

6 (area of plates) $\times\ 4\frac{5}{8}{}^2 = 128.34375$ } $= 128.375$

I for combined section $= 248.155$

which divided by area (16.34) gives 15.19 $= R^2$ or 3.9 radius of combined section.

Axis C D.

Find distance $d = (.67)$ from col. XI, page 118, then obtaining the distance (4.0763) between axes $C\,D$ and EF.

I for two channels around axis EF from col. VI, $= 5.70$

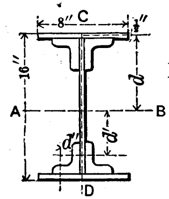
Area of channels × sq. of dist. $= 10.34 \times 4.0763^2 = 171.8115$

I for two plates $= \dfrac{.5 \times 12^3}{12} = 72.$

I for combined section $= 249.5115$

Radius of gyration $= \sqrt{\dfrac{249.5115}{16.34}} = 3.91.$

By similar methods, inertia or radius of gyration for any combination of shapes can readily be obtained.



Example No. 2.—A "built-up beam" composed of: 4 angles 3″ × 3″ × ¼″.
2 plates 8″ × ½″.
1 plate 15″ × ⅜″.

Axis A B.

I of two 8″ × ½ plates $= \dfrac{8 \times \frac{1}{2}^3}{12} \times 2 = .167$

+ 8 (area) × $7\frac{3}{4}{}^2$ (sq. of distance d) $= 480.5$ — 480.667

I of one 15″ × ⅜″ plate $= \dfrac{15^3 \times \frac{3}{8}}{12} = 105.469$

I of four 3 × 3 × ¼ angles = 4 × 1.24 (see col. VI, page 130, $= 4.96$ }

+ 5.80 (area) × 6.66^2 (sq. of distance d^1) $= 257.262$ } 262.222

Inertia of combined section around $A\,B = 848.358$

Radius of gyration $= \sqrt{\dfrac{848.358}{19.425}} = 6.61.$

Radius of Gyration of Compound Shapes.

In the case of a pair of any shape without a web the value of R can always be readily found without considering the moment of inertia.

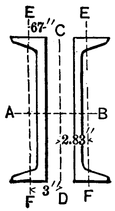
The radius of gyration for any section around an axis parallel to another axis passing through its centre of gravity is found as follows:

Let r = radius of gyration around axis through centre of gravity. R = radius of gyration around another axis parallel to above. d = distance between axis.

$$R = \sqrt{d^2 + r^2}.$$

When r is small, R may be taken as equal to d without material error. Thus, in the case of a pair of channels latticed together, or a similar construction.

Example No. 1.—Two 9″ channels of 5.17 square inches section placed 4.66″ apart, required the radius of gyration around axis CD for combined section.



Find r on col. X, page 118, = .74 and $r^2 = .5476$.

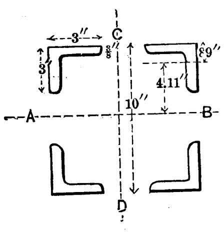
Find distance from base of channel to neutral axis, col. XI, same page, = .67, this added to one half the distance between the two bars, 2.33″ = 3″ = d, and $d^2 = 9$.

Radius of gyration of the pair as placed =

$$\sqrt{9 + .5476} = 3.09.$$

The value of R for the whole section in relation to the axis AB is the same as for the single channel, to be found in the tables.

Example No. 2.—Four 3″ × 3″ × $\frac{3}{8}$″ angles placed as shown, form a column of 10 inches square; required the radius of gyration.



Find r on col. VIII, page 131, = .94, and $r^2 = .8836$.

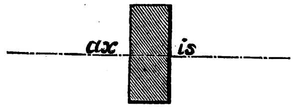
Find distance from side of angle to neutral axis, col. XI, same page, = .91. Subtract this from half the width of column = 5. — .91 = 4.09 = d or distance between two axes. $d^2 = 16.7281$.

Radius of gyration of four angles as placed =

$$\sqrt{16.7281 + .8836} = 4.20.$$

When the angles are large as compared with the outer dimensions of the combined section, the radius of gyration can be taken without serious error from the table of radii of gyration for square columns, on page 175.

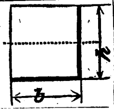
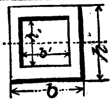
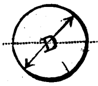
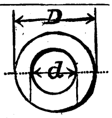
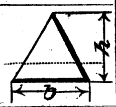
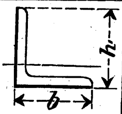
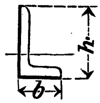
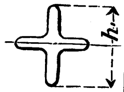
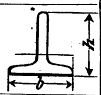
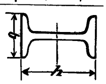
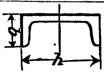
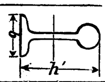
MOMENT OF INERTIA OF RECTANGLES.



Depth in Inches.	*Width of Rectangle in Inches.*						
	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$
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
31	620.65	775.81	930.97	1086.13	1241.30	1396.46	1551.62
32	682.67	853.33	1024.00	1194.67	1365.33	1536.00	1706.67
33	748.69	935.86	1123.03	1310.20	1497.38	1584.55	1871.72
34	818.83	1023.54	1228.25	1432.96	1637.67	1842.38	2047.08
35	893.23	1116.54	1339.84	1563.15	1786.46	2009.76	2233.07
36	972.00	1215.00	1458.00	1701.00	1944.00	2187.00	2430.00
37	1055.27	1319.09	1582.90	1846.72	2110.54	2374.35	2638.17
38	1143.17	1428.96	1714.75	2000.54	2286.33	2572.13	2857.92
39	1235.81	1544.77	1853.72	2162.67	2471.62	2780.58	3089.53
40	1333.33	1666.67	2000.00	2333.33	2666.67	3000.00	3333.33

ELEMENTS OF USUAL SECTIONS.

Moments refer to horizontal axis through centre of gravity. This table is intended for convenient application where extreme accuracy is not important. Some of the terms are only approximate; those marked * are correct. Values for radius of gyration in flanged beams apply to standard minimum sections only. A = area of section.

Shape of Section.		Moment of Inertia.	Moment of Resistance. = S	Distance of Base from Centre of Gravity.	Square of Least Radius of Gyration.	Least Radius of Gyration.
Solid Rectangle.		$\frac{bh^3}{12}$ *	$\frac{bh^2}{6}$ *	$\frac{h}{2}$	$\frac{(Least\ side)^2}{12}$ *	$\frac{Least\ side}{3.46}$ *
Hollow Square.		$\frac{bh^3-b_1h_1^3}{12}$ *	$\frac{bh^3-b_1h_1^3}{6h}$ *	$\frac{h}{2}$	$\frac{h^2+h_1^2}{12}$ *	$\frac{h+h_1}{4.89}$
Solid Circle.		$\frac{AD^2}{16}$ *	$\frac{AD}{8}$ *	$\frac{D}{2}$	$\frac{D^2}{16}$ *	$\frac{D}{4}$ *
Hollow Circle. A = area of large section. a = area of small section.		$\frac{AD^2-ad^2}{16}$	$\frac{AD^2-ad^2}{8D}$	$\frac{D}{2}$	$\frac{D^2+d^2}{16}$ *	$\frac{D+d}{5.64}$
Solid Triangle.		$\frac{bh^3}{36}$	$\frac{bh^2}{24}$	$\frac{h}{3}$	The least of the two: $\frac{h^2}{18}$ or $\frac{b^2}{24}$	The least of the two: $\frac{h}{4.24}$ or $\frac{b}{4.9}$
Even Angle.		$\frac{Ah^2}{10.2}$	$\frac{Ah}{7.2}$	$\frac{h}{3.3}$	$\frac{b^2}{25}$	$\frac{b}{5}$
Uneven Angle.		$\frac{Ah^2}{9.5}$	$\frac{Ah}{6.5}$	$\frac{h}{3.5}$	$\frac{(hb)^2}{13(h^2+b^2)}$	$\frac{hb}{2.6(h+b)}$
Even Cross.		$\frac{Ah^2}{19}$	$\frac{Ah}{9.5}$	$\frac{h}{2}$	$\frac{h^2}{22.5}$	$\frac{h}{4.74}$
Even Tee.		$\frac{Ah^2}{11.1}$	$\frac{Ah}{8}$	$\frac{h}{3.3}$	$\frac{b^2}{22.5}$	$\frac{b}{4.74}$
I *Beam.*		$\frac{Ah^2}{6.66}$	$\frac{Ah}{3.2}$	$\frac{h}{2}$	$\frac{b^2}{21}$	$\frac{b}{4.58}$
Channel.		$\frac{Ah^2}{7.34}$	$\frac{Ah}{3.67}$	$\frac{h}{2}$	$\frac{b^2}{12.5}$	$\frac{b}{3.54}$
Deck Beam.		$\frac{Ah^2}{6.9}$	$\frac{Ah}{4}$	$\frac{h}{2.3}$	$\frac{b^2}{36.5}$	$\frac{b}{6}$

STRUTS OF ROLLED SECTIONS.

In the following consideration of struts of various sections the least radius of gyration of the cross-section, around an axis through the centre of gravity, is assumed as the effective radius of the strut. The tables on pages 150 to 155 are the classified averages of an extensive series of experiments.

The tables for destructive pressures represent the ultimate load at the point of failure.

The greatest safe loads are the aforesaid crippling loads, divided by the factors of safety hereafter described.

As is well known, the method of securing the ends of the struts exercises an important influence on their resistance to bending, as the member is held more or less rigidly in the direct line of thrust.

In the general tables, struts are classified in four divisions, viz.: "Fixed Ended," "Flat Ended," "Hinged Ended," and "Round Ended."

In the class of "fixed ends" the struts are supposed to be so rigidly attached at both ends to the contiguous parts of the structure that the attachment would not be severed if the member was subjected to the ultimate load. "Flat-ended" struts are supposed to have their ends flat and normal to the axis of length, but not rigidly attached to the adjoining parts. "Hinged ends" embrace the class which have both ends properly fitted with pins, or ball and socket joints, of substantial dimensions as compared with the section of the strut; the centres of these end joints being practically coincident with an axis passing through the centre of gravity of the section of the strut. "Round-ended" struts are those which have only central points of contact, such as balls or pins resting on flat plates, but still the centres of the balls or pins coincident with the proper axis of the strut.

If in hinged-ended struts the balls or pins are of comparatively insignificant diameter, it will be safest in such cases to consider the struts as round-ended.

If there should be any serious deviation of the centres of

round or hinged ends from the proper axis of the strut, there will be a reduction of resistance that cannot be estimated without knowing the exact conditions.

When the pins of hinged-end struts are of substantial diameter, well fitted, and exactly centered, experiment shows that the hinged-ended will be equally as strong as flat-ended struts. But a very slight inaccuracy of the centering rapidly reduces the resistance to lateral bending, and as it is almost impossible in practice to uniformly maintain the rigid accuracy required, it is considered best to allow for such inaccuracies to the extent given in the tables, which are the average of many experiments.

It is considered good practice to increase the factors of safety as the length of the strut is increased, owing to the greater inability of the long struts to resist cross strains, etc. For similar reasons we consider it advisable to increase the factor of safety for hinged and round ends in a greater ratio than for fixed or flat ends.

Presuming that one-third of the ultimate load would constitute the greatest safe load for the shortest struts, the following progressive factors of safety are adopted for the increasing lengths.

$$3. + .01 \frac{l}{r} \text{ for flat and fixed ends.}$$

$$3 + .015 \frac{l}{r} \text{ for hinged and round ends.}$$

$l =$ length of strut. $r =$ least radius of gyration.

From the above we derive the following factors of safety:

$\frac{l}{r}$	*Fixed and Flat Ends.*	*Hinged and Round Ends.*	$\frac{l}{r}$	*Fixed and Flat Ends.*	*Hinged and Round Ends.*	$\frac{l}{r}$	*Fixed and Flat Ends.*	*Hinged and Round Ends.*
20	3.2	3.3	110	4.1	4.65	200	5.0	6.0
30	3.3	3.45	120	4.2	4.8	210	5.1	6.15
40	3.4	3.6	130	4.3	4.95	220	5.2	6.3
50	3.5	3.75	140	4.4	5.1	230	5.3	6.45
60	3.6	3.9	150	4.5	5.25	240	5.4	6.6
70	3.7	4.05	160	4.6	5.4	250	5.5	6.75
80	3.8	4.2	170	4.7	5.55	260	5.6	6.9
90	3.9	4.35	180	4.8	5.7	270	5.7	7.05
100	4.0	4.5	190	4.9	5.85	280	5.8	7.2

STRUTS OF WROUGHT IRON OR EXTREME SOFT STEEL.—No. 1.

Destructive pressure in pounds per square inch.

Length. / *Least Radius of Gyration.*	*Fixed Ends.*	*Flat Ends.*	*Hinged Ends.*	*Round Ends.*
20	46000	46000	46000	44000
30	43000	43000	43000	40250
40	40000	40000	40000	36500
50	38000	38000	38000	33500
60	36000	36000	36000	30500
70	34000	34000	33750	27750
80	32000	32000	31500	25000
90	31000	30900	29750	22750
100	30000	29800	28000	20500
110	29000	28050	26150	18500
120	28000	26300	24300	16500
130	26750	24900	22650	14650
140	25500	23500	21000	12800
150	24250	21750	18750	11150
160	23000	20000	16500	9500
170	21500	18400	14650	8500
180	20000	16800	12800	7500
190	18750	15650	11800	6750
200	17500	14500	10800	6000
210	16250	13600	9800	5500
220	15000	12700	8800	5000
230	14000	11950	8150	4650
240	13000	11200	7500	4300
250	12000	10500	7000	4050
260	11000	9800	6500	3800
270	10500	9150	6100	3500
280	10000	8500	5700	3200
290	9500	7850	5350	3000
300	9000	7200	5000	2800
310	8500	6600	4750	2650
320	8000	6000	4500	2500
330	7500	5550	4250	2300
340	7000	5100	4000	2100
350	6750	4700	3750	2000
360	6500	4300	3500	1900
370	6150	3900	3250	1800
380	5800	3500	3000	1700
390	5500	3250	2750	1600
400	5200	3000	2500	1500

STRUTS OF WROUGHT IRON OR EXTREME SOFT STEEL.—No. 2.

Greatest safe load in pounds per square inch of cross-section for vertical struts. Both ends are supposed to be secured as indicated at the head of each column.

If both ends are not secured alike, take a mean proportional between the values given for the classes to which each end belongs.

If the strut is hinged by any uncertain method, so that the centres of pins and axis of strut may not coincide, or the pins may be relatively small and loosely fitted, it is best in such cases to consider the strut as "round ended."

Length. / *Least Radius of Gyration.*	*Fixed Ends.*	*Flat Ends.*	*Hinged Ends.*	*Round Ends.*
20	14380	14380	13940	13330
30	13030	13030	12460	11670
40	11760	11760	11110	10140
50	10860	10860	10130	8930
60	10000	10000	9230	7820
70	9190	9190	8330	6850
80	8420	8420	7500	5950
90	7950	7920	6840	5230
100	7500	7450	6220	4560
110	7070	6840	5620	3980
120	6670	6260	5060	3440
130	6220	5790	4580	2960
140	5800	5340	4120	2510
150	5390	4830	3570	2120
160	5000	4350	3060	1760
170	4570	3920	2640	1530
180	4170	3500	2250	1310
190	3830	3190	2020	1150
200	3500	2900	1800	1000
210	3190	2670	1590	890
220	2880	2440	1400	790
230	2640	2250	1260	720
240	2410	2070	1140	650
250	2180	1910	1040	600
260	1960	1750	940	550
270	1840	1610	870	500
280	1720	1460	790	440
290	1610	1330	730	410
300	1500	1200	670	370
310	1390	1080	620	350
320	1290	970	580	320
330	1190	880	540	290
340	1090	800	490	260
350	1040	720	450	240
360	980	650	420	230
370	920	580	380	210
380	850	510	340	200
390	800	470	310	80
400	740	430	280	70

STRUTS OF MEDIUM STEEL.—No. 3.

Destructive pressure in pounds per square inch, for steel of medium grade, tensile strength, about 70,000 lbs. per square inch.

For extreme soft steel, use table No. 1.

Length. / *Least Radius of Gyration.*	*Fixed Ends.*	*Flat Ends.*	*Hinged Ends.*	*Round Ends.*
20	70000	70000	70000	66900
30	51000	51000	51000	47700
40	46000	46000	46000	41900
50	44000	44000	44000	38800
60	42000	42000	42000	35600
70	40000	40000	39700	32600
80	38000	38000	37400	29700
90	36100	36000	34700	26500
100	34200	34000	31900	23400
110	33100	32000	29800	21100
120	31900	30000	27700	18800
130	30100	28000	25500	16500
140	28200	26000	23200	14200
150	26800	24000	20700	12300
160	25300	22000	18100	10400
170	23400	20000	15900	9240
180	21400	18000	13700	8030
190	19400	16200	12200	6990
200	17900	14800	11000	6120
210	16200	13600	9800	5500
220	15000	12700	8800	5000
230	14000	11950	8100	4650
240	13000	11200	7500	4300
250	12000	10500	7000	4050
260	11000	9800	6500	3800
270	10500	9150	6100	3500
280	10000	8500	5700	3200
290	9500	7850	5330	3000
300	9000	7200	5000	2800

STRUTS OF MEDIUM STEEL.—No. 4.

Greatest safe load for steel of medium grade, tensile strength about 70,000 lbs. For extreme soft steel, use table No. 2.

The figures are the working loads in pounds per square inch for vertical struts. Both ends are supposed to be secured as indicated at the head of each column.

If both ends are not secured alike, take a mean proportional between the values given for the classes to which each end belongs.

If the strut is hinged by any uncertain method so that the centres of pins and axis of strut may not coincide, or the pins may be relatively small and loosely fitted, it is best in such cases to consider the strut as "round ended."

Length. / *Least Radius of Gyration.*	*Fixed Ends.*	*Flat Ends.*	*Hinged Ends.*	*Round Ends.*
20	21900	21900	21200	20300
30	15400	15400	14800	13800
40	13500	13500	12800	11600
50	12600	12600	11700	10300
60	11700	11700	10800	9130
70	10800	10800	9800	8050
80	10000	10000	8900	7070
90	9260	9230	7980	6090
100	8550	8500	7090	5200
110	8070	7800	6410	4540
120	7590	7140	5770	3920
130	7000	6510	5150	3330
140	6410	5910	4550	2780
150	5950	5330	3940	2340
160	5500	4780	3350	1920
170	4980	4250	2860	1660
180	4460	3750	2400	1410
190	3960	3310	2080	1190
200	3580	2960	1830	1020
210	3180	2670	1590	890
220	2880	2440	1400	790
230	2640	2250	1250	720
240	2410	2070	1140	650
250	2180	1910	1040	600
260	1960	1750	940	550
270	1840	1610	860	500
280	1720	1460	790	440
290	1610	1330	720	410
300	1500	1200	670	370

STRUTS OF HARD STEEL.—No. 5.

Destructive pressure in pounds per square inch for hard steel, tensile strength about 100,000 lbs.

For softer steel, see table No. 3.

Length. / *Least Radius of Gyration.*	*Fixed Ends.*	*Flat Ends.*	*Hinged Ends.*	*Round Ends.*
20	100000	100000	100000	95600
30	74000	74000	74000	69300
40	62000	62000	62000	56600
50	60000	60000	60000	52900
60	58000	58000	58000	49100
70	55500	55500	55100	45300
80	53000	53000	52200	41400
90	49900	49700	47800	36600
100	46800	46500	43700	32000
110	44700	43200	40400	28500
120	42600	40000	36900	25100
130	39400	36700	33500	21600
140	36300	33500	29900	18200
150	34200	30700	26500	15700
160	32200	28000	23100	13300
170	29800	25500	20300	11800
180	27400	23000	17500	10300
190	25100	21000	15800	9060
200	22900	19000	14100	7860
210	20300	17200	12400	6950
220	18300	15500	10700	6100
230	16900	14400	9820	5600
240	15500	13400	8960	5140
250	14200	12400	8270	4780
260	12900	11500	7630	4460
270	12200	10600	7060	4050
280	11400	9700	6500	3650
290	10900	9000	6130	3440
300	10600	8500	5890	3300

STRUTS OF HARD STEEL.—No. 6.

Greatest safe load for hard steel, tensile strength about 100,000 lbs.
For soft steel, see table No. 4.

The figures are the working loads in pounds per square inch for vertical struts.

Both ends are supposed to be secured as indicated at the head of each column.

If both ends are not secured alike, take a mean proportional between the values given for the classes to which each end belongs.

If the strut is hinged by any uncertain method, so that the centres of pins and axis of strut may not coincide, or the pins may be relatively small and loosely fitted, it is best in such cases to consider the strut as "round ended."

Length. / *Least Radius of Gyration.*	*Fixed Ends.*	*Flat Ends.*	*Hinged Ends.*	*Round Ends.*
20	31200	31200	30300	29000
30	22400	22400	21400	20100
40	18200	18200	17200	15700
50	17100	17100	16000	14100
60	16100	16100	14900	12600
70	15000	15000	13600	11200
80	13900	13900	12400	9860
90	12800	12700	11000	8410
100	11700	11600	9710	7110
110	10900	10500	8670	6130
120	10100	9520	7690	5230
130	9160	8530	6770	4360
140	8250	7610	5860	3570
150	7600	6820	5050	2990
160	7000	6090	4280	2460
170	6340	5420	3660	2130
180	5710	4790	3070	1810
190	5120	4280	2700	1550
200	4580	3800	2350	1310
210	3980	3370	2020	1130
220	3520	2980	1700	970
230	3190	2720	1500	870
240	2870	2480	1360	780
250	2580	2250	1220	710
260	2300	2050	1100	650
270	2240	1860	1000	570
280	1960	1670	900	510
290	1850	1520	830	470
300	1800	1420	780	440

ROLLED STRUCTURAL SHAPES AS STRUTS.

The following tables of safe loads for rolled struts are derived from previous tables, Nos. 2 and 4, and from the columns given for flat-ended bearings. The tables derived from No. 2 and described as applicable to extreme soft steel or wrought iron are intended for application when the softest grade of steel is used, and in the absence of definite knowledge on the subject, it is safest to use these tables to obtain strut resistances.

When steel of medium grade is used, say 65,000 pounds tensile strength or greater, the tables derived from No. 4 can be used, described as applicable to steel of medium grade.

In all cases the strut is supposed to be vertical. In short struts this distinction is immaterial, but in long horizontal struts some allowance is necessary for the deflection due to weight.

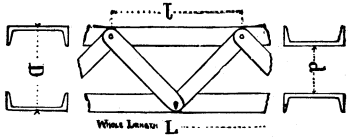
If the struts are rigidly connected at the ends to contiguous parts of a structure, the increase of resistance becomes considerable in extremely long struts, and proper allowance can be made by using the columns for "Fixed Ends" in tables Nos. 2 and 4. On the contrary, if the end bearing of the strut is to be of uncertain character or fit, it will be best to reduce the safe load to that in the columns for "Round Ends," in the same tables. In these working tables the calculations are made to apply to the mean thicknesses of each shape. Where more exact results are required for thicknesses above or below the mean, the true radius of gyration of the section will be found on pages 114 to 139. But within the range of variation of thickness possible for any shape the tables may be accepted as practically correct.

For **I** beams tables Nos. 7 to 8 apply to cases where the strut is braced in the direction of the flanges, so that failure could occur in the direction of the web only. For unbraced **I** struts use tables Nos. 9 and 10. Likewise for channel bars used as struts, and braced to resist failure in the directions of the flanges, use tables Nos. 19 to 20, same as for latticed channels.

For a pair of latticed channels, which form a more perfect column than single rolled sections, the safe loads are given for various conditions of the end bearings, as described on pages 148 and 149. On the tables Nos. 19 to 20 the distances D or d for flanges inward or outward, respectively, make the radii of gyration equal for either direction of axis, parallel to web or to the flanges.

Under each length of struts in the table, l represents the greatest distance apart in feet that centres of lateral bracing can be spaced, without allowing weakness in the individual channels. The distance l is obtained as shown in last example, that is, by making $\frac{l}{r} = \frac{L}{R}$.

l = length between bracing.
L = total length of strut.
r = least radius of gyration for a single channel.
R = least radius of gyration for the whole section.



It is customary to make l much shorter than given in the tables, the figures given being useful as a guide. If a column is composed of four angles, forming the corners of a square, and properly latticed as described above, find the radius of gyration of the combined section, as described on page 144, and then the working resistance from tables Nos. 2 to 6, or the safe load can be ascertained approximately from tables Nos. 24–25 and page 180 for square columns.

When a pair of angles are tied together forming a single strut

take the greatest radius of gyration, around axis A B, in column No. IX, page 135, for a single angle as the least radius of gyration of the pair, and proceed as before described.

PENCOYD I BEAM AS STRUTS.—No. 7.

Greatest safe load in pounds per square inch of section.

FOR EXTREME SOFT STEEL.

For struts secured against failure in the direction of the flanges and liable to bend only in the direction of the web.

Length in Feet.	*SIZE OF BEAM IN INCHES, With Radius of Gyration for Mean Thickness of Each Size.*										
	20 r = 8.00	15 r = 5.80	12 r = 4.67	10 r = 3.93	9 r = 3.57	8 r = 3.18	7 r = 2.81	6 r = 2.32	5 r = 1.98	4 r = 1.65	3 r = 1.20
4	15060	14940	14840	14740	14680	14610	14500	14290	13810	13150	11760
6	14890	14730	14580	14470	14350	14030	13620	12900	12220	11440	10000
8	14750	14540	14300	13790	13450	12990	12500	11630	10990	10160	8420
10	14610	14290	13610	12970	12370	12050	11520	10710	9950	8980	7450
12	14470	13730	12930	12190	11730	11280	10760	9830	8980	8050	6260
14	14250	13160	12270	11520	11120	10620	10010	9000	8180	7340	5340
16	13840	12760	11660	10960	10530	9970	9330	8280	7590	6470	4350
18	13430	12120	11190	10430	9960	9360	8660	7760	6990	5750	3500
20	13030	11630	10740	9910	9420	8770	8150	7240	6200	5060	2900
22	12650	11260	10300	9420	8890	8270	7730	6620	5640	4350	2440
24	12270	10890	9860	8940	8390	7890	7300	6070	5060	3730	2070
26	11890	10530	9450	8470	8050	7540	6780	5590	4460	3220	1750
28	11580	10180	9040	8150	7730	7110	6280	5050	3930	2820	1460
30	11310	9830	8580	7840	7400	6650	5880	4580	3440	2480	1200
32	11040	9500	8310	7560	6990	6230	5490	4110	3080	2200	
34	10770	9170	8050	7220	6590	5870	5070	3670	2760	1950	
36	10520	9080	7800	6850	6210	5530	4670	3310	2480	1720	
38	10260	8530	7560	6490	5900	5170	4250	3000	2240	1520	

PENCOYD I BEAMS AS STRUTS.—No. 8.

Greatest safe load in pounds per square inch of section.

FOR STEEL OF MEDIUM GRADE.

For struts secured against failure in the direction of the flanges and liable to bend only in the direction of the web.

Length in Feet.	*SIZE OF BEAM IN INCHES, with Radius of Gyration for Mean Thickness of Each Size.*										
	20 r = 8.00	15 r = 5.80	12 r = 4.67	10 r = 3.93	9 r = 3.57	8 r = 3.18	7 r = 2.81	6 r = 2.32	5 r = 1.98	4 r = 1.65	3 r = 1.20
4	22870	22700	22560	22430	22320	22220	22080	21440	19170	15990	13500
6	22650	22390	22190	21990	21770	20210	18260	15210	14180	13180	11700
8	22430	22110	21570	19040	17410	15360	14600	13370	12730	11860	10000
10	22220	21440	18650	15300	14720	13940	13260	12450	11650	10580	8500
12	22010	18780	15250	14150	13470	13020	12490	11510	10580	9440	7140
14	21250	16640	14260	13480	12860	12350	11750	10610	9630	8370	5910
16	19300	14810	13400	12700	12260	11660	10950	9780	8720	7380	4780
18	17350	14070	12940	12150	11660	10990	10250	9000	7860	6460	3750
20	15400	13370	12470	11600	11050	10360	9580	8250	7060	5590	2960
22	14830	13000	12010	11050	10480	9770	8940	7550	6310	4780	2440
24	14260	12630	11550	10540	9950	9190	8320	6880	5590	4025	2070
26	13690	12260	11090	10050	9430	8640	7730	6240	4910	3350	1750
28	13320	11890	10640	9580	8930	8100	7160	5630	4260	2850	1460
30	13050	11510	10230	9110	8440	7590	6630	5040	3670	2480	1200
32	12780	11140	9830	8670	7970	7090	6110	4490	3170	2100	1130
34	12510	10770	9430	8230	7510	6620	5610	3950	2780	1960	1090
36	12240	10440	9050	7810	7080	6160	5130	3480	2480	1880	1060
38	11970	10110	8670	7400	6650	5710	4660	3080	2250	1520	1030

PENCOYD I BEAMS AS STRUTS.—No. 9.

Greatest safe load in pounds per square inch of section.

FOR EXTREME SOFT STEEL.

When the struts are unsupported, or free to bend in the direction of the flanges.
r = radius of gyration for the mean thicknesses of each shape.

Section Number.	Size of Beam in Inches.		LENGTH IN FEET. 4	6	8	10	12	14	16	18	20	22
531	20	$r = 1.27$	12040	10280	8760	7710	6640	5690	4770	3920	3220	2720
530		$r = 1.16$	11630	9830	8280	7240	6070	5100	4110	3310	2740	2300
524	15	$r = 1.31$	12190	10440	8940	7850	6850	5870	5000	4140	3400	2860
523		$r = 1.24$	11930	10160	8620	7600	6490	5540	4600	3740	3090	2600
522		$r = 1.15$	11610	9790	8250	7180	6020	5030	4050	3260	2700	2260
521		$r = 1.08$	11360	9470	7980	6780	5640	4560	3590	2900	2400	1990
517	12	$r = 1.23$	11890	10130	8570	7560	6430	5490	4540	3690	3040	2560
516		$r = 1.10$	11440	9560	8060	7000	5750	4700	3730	3000	2480	2070
515		$r = 0.97$	10910	8870	7500	6090	4910	3790	2960	2390	1950	1580
512	10	$r = 1.00$	11040	9040	7640	6260	5140	4010	3130	2530	2070	1690
511		$r = 0.89$	10530	8380	6970	5570	4270	3230	2540	2030	1600	1250
509	9	$r = 0.86$	10360	8240	6750	5360	4030	3040	2380	1890	1460	1120
507	8	$r = 0.81$	10070	7980	6350	4930	3600	2730	2120	1650	1240	920
505	7	$r = 0.77$	9820	7760	6040	4430	3280	2480	1920	1450	1060	
503	6	$r = 1.23$	11890	10130	8570	7560	6430	5490	4540	3690	3040	2560
502		$r = 1.11$	11470	9610	8090	6960	5800	4760	3790	3060	2530	2110
501		$r = 0.70$	9300	7270	5470	3860	2770	2070	1550	1110		
500	5	$r = 0.63$	8710	6590	4710	3170	2280	1650	1140			
20	4	$r = 0.52$	7810	5410	3360	2240	1510	940				
22	3	$r = 0.50$	7640	5140	3130	2070	1360					

PENCOYD I BEAMS AS STRUTS.—No. 10.

Greatest safe load in pounds per square inch of section.

FOR STEEL OF MEDIUM GRADE.

When struts are unsupported, or free to bend in the direction of the flanges,
r = least radius of gyration for mean thickness of each shape.

Section Number.	Size of Beam in Inches.		LENGTH IN FEET. 4	6	8	10	12	14	16	18	20	22
531	20	$r = 1.27$	13920	12000	10400	8900	7580	6380	5260	4250	3350	2730
530		$r = 1.16$	13400	11510	9780	8260	6880	5630	4490	3480	2760	2290
524	15	$r = 1.31$	14150	12150	10540	9110	7810	6620	5530	4520	3610	2920
523		$r = 1.24$	13750	11870	10210	8730	7400	6180	5070	4040	3190	2600
522		$r = 1.15$	13350	11470	9730	8200	6810	5560	4410	3410	2700	2250
521		$r = 1.08$	13140	11100	9300	7730	6310	5030	3860	2960	2400	1990
517	12	$r = 1.23$	13690	11840	10160	8680	7330	6110	4990	3970	3130	2560
516		$r = 1.10$	13180	11210	9440	7860	6460	5180	4030	3090	2480	2070
515		$r = 0.97$	12650	10470	8570	6910	5420	4090	3860	2340	1960	1580
512	10	$r = 1.00$	12780	10640	8790	7140	5680	4360	3240	2530	2070	1680
511		$r = 0.89$	12250	9930	7950	6220	4680	3360	2510	2110	1610	1260
509	9	$r = 0.86$	12080	9720	7690	5940	4390	3120	2370	1910	1480	1160
507	8	$r = 0.81$	11760	9310	7240	5440	3860	2750	2120	1670	1250	1120
505	7	$r = 0.77$	11490	8970	6840	5010	3440	2480	2270	1460	1150	
503	6	$r = 1.23$	13690	11840	10160	8670	7330	6110	4990	3970	3130	2560
502		$r = 1.11$	13210	11260	9500	7930	6530	5260	4100	3150	2530	2110
501		$r = 0.70$	10930	8300	6080	4200	2800	2070	1550			
500	5	$r = 0.63$	10300	7520	5200	3290	2270	1670	1180			
20	4	$r = 0.52$	9060	6000	3550	2250	1500	1120				
22	3	$r = 0.50$	8790	5680	3240	2070	1360					

PENCOYD ANGLES AS STRUTS.—No. 11.

Greatest safe load in pounds per square inch of section.

EXTREME SOFT STEEL.

r = least radius of gyration for mean thickness of each size.

Size of Angles in Inches.	*LENGTH IN FEET.*									
	2	4	6	8	10	12	14	16	18	20
8 x 8 $r = 2.51$	14860	14420	13210	11990	11060	10220	9440	8690	8120	7660
6 x 6 $r = 1.19$	14360	11730	9960	8380	7400	6210	5280	4290	3450	2860
5 x 5 $r = .99$	13810	11000	8980	7590	6200	5060	3930	3070	2480	2030
4 x 4 $r = .79$	12990	9940	7860	6190	4740	3430	2610	2020	1550	1150
$3\frac{1}{2}$ x $3\frac{1}{2}$ $r = .69$	12430	9230	7180	5380	3750	2700	2010	1480		
3 x 3 $r = .59$	11700	8350	6160	4230	2820	2000	1390			
$2\frac{3}{4}$ x $2\frac{3}{4}$ $r = .53$	11290	7890	5520	3460	2310	1580				
$2\frac{1}{2}$ x $2\frac{1}{2}$ $r = .49$	10950	7540	4980	3010	1990	1280				
$2\frac{1}{4}$ x $2\frac{1}{4}$ $r = .44$	10470	6900	4190	2480	1570					
2 x 2 $r = .39$	9870	6110	3350	1970	1100					
$1\frac{3}{4}$ x $1\frac{3}{4}$ $r = .33$	8980	5060	2480	1310						
$1\frac{1}{2}$ x $1\frac{1}{2}$ $r = .29$	8280	4110	1930							
$1\frac{1}{4}$ x $1\frac{1}{4}$ $r = .26$	7810	3350	1500							
1 x 1 $r = .21$	6590	2270								

PENCOYD ANGLES AS STRUTS.—No. 12.

Greatest safe load in pounds per square inch of section.

FOR STEEL OF MEDIUM GRADE.

r = least radius of gyration for mean thickness of each size.

Size of Angles in Inches.	*LENGTH IN FEET.*									
	2	4	6	8	10	12	14	16	18	20
8 x 8 $r = 2.51$	22610	21940	16310	13840	12800	11930	11080	10280	9530	8820
6 x 6 $r = 1.19$	21830	13470	11650	9940	8440	7070	5840	4710	3680	2910
5 x 5 $r = .99$	19170	12740	10580	8720	7060	5590	4270	3170	2480	2030
4 x 4 $r = .79$	15370	11630	9150	7040	5230	3650	2610	2020	1550	1150
$3\frac{1}{2}$ x $3\frac{1}{2}$ $r = .69$	14970	10840	8190	5970	4050	2710	2010	1480		
3 x 3 $r = .59$	13440	9900	7010	4630	2860	2000	1390			
$2\frac{3}{4}$ x $2\frac{3}{4}$ $r = .53$	13030	9190	6160	3700	2310	1580				
$2\frac{1}{2}$ x $2\frac{1}{2}$ $r = .49$	12690	8650	5510	3100	1990	1280				
$2\frac{1}{4}$ x $2\frac{1}{4}$ $r = .44$	12190	7870	4590	2480	1570					
2 x 2 $r = .39$	11560	6950	3540	1970	1100					
$1\frac{3}{4}$ x $1\frac{3}{4}$ $r = .33$	10580	5590	2480	1310						
$1\frac{1}{2}$ x $1\frac{1}{2}$ $r = .29$	9790	4480	1930							
$1\frac{1}{4}$ x $1\frac{1}{4}$ $r = .26$	9060	3540	1500							
1 x 1 $r = .21$	7520	2270								

PENCOYD Z BARS AS STRUTS.—No. 13.

Greatest safe load in pounds per square inch of section.

FOR EXTREME SOFT STEEL.

When struts are unsupported, or free to bend in the direction of the flanges.

r = least radius of gyration for mean thickness of each size.

Section. No.	*Size in Inches.*	*LENGTH IN FEET.*								
		2	4	6	8	10	12	14	16	18
220 $r = .54$	2 11/16 x 3 1/16 x 2 11/16 x 5/16	11360	7980	5640	3590	2390	1650			
221 $r = .55$	2 11/16 x 3 1/32 x 2 11/16 x 15/32	11430	8060	5740	3730	2480	1720	1130		
222 $r = .64$	2 15/16 x 4 1/16 x 2 15/16 x 5/16	12070	8800	6690	4830	3260	2340	1710	1200	
223 $r = .64$	3 1/32 x 4 1/16 x 3 1/32 x 1/2	12070	8800	6690	4830	3260	2340	1710	1200	
224 $r = .65$	3 1/8 x 4 1/16 x 3 1/8 x 11/16	12150	8890	6800	4950	3350	2410	1770	1260	
225 $r = .73$	3 1/4 x 5 1/16 x 3 1/4 x 3/8	12670	9530	7510	5720	4160	2980	2240	1700	1250
226 $r = .74$	3 9/32 x 5 1/16 x 3 9/32 x 9/16	12720	9610	7580	5800	4250	3050	2300	1760	1300
227 $r = .73$	3 9/32 x 5 1/32 x 3 9/32 x 23/32	12670	9530	7510	5720	4160	2980	2240	1700	1250
228 $r = .83$	3 9/16 x 6 1/16 x 3 9/16 x 7/16	13170	10180	8080	6510	5110	3770	2840	2220	1740
229 $r = .81$	3 9/16 x 6 1/16 x 3 9/16 x 5/8	13080	10060	7980	6340	4920	3590	2730	2120	1650
230 $r = .81$	3 9/16 x 6 1/16 x 3 9/16 x 13/16	13080	10060	7980	6340	4920	3590	2730	2120	1650

PENCOYD Z BARS AS STRUTS.—No. 14.

Greatest safe load in pounds per square inch of section.

FOR STEEL OF MEDIUM GRADE.

When struts are unsupported, or free to bend in the direction of the flanges.

r = least radius of gyration for mean thickness of each size.

Section. No.	*Size in Inches.*	*LENGTH IN FEET.*								
		2	4	6	8	10	12	14	16	18
220 $r = .54$	2 11/16 x 3 1/16 x 2 11/16 x 5/16	13100	9320	6310	3860	2390	1650			
221 $r = .55$	2 11/16 x 3 1/32 x 2 11/16 x 15/32	13170	9440	6450	4020	2480	1720	1130		
222 $r = .64$	2 15/16 x 4 1/16 x 2 15/16 x 5/16	13970	10400	7630	5330	3420	2340	1710	1200	
223 $r = .64$	3 1/32 x 4 1/16 x 3 1/32 x 1/2	13970	10400	7630	5330	3420	2340	1710	1200	
224 $r = .65$	3 1/8 x 4 1/16 x 3 1/8 x 11/16	14080	10490	7750	5470	3540	2410	1770	1260	
225 $r = .73$	3 1/4 x 5 1/16 x 3 1/4 x 3/8	14860	11180	8600	6420	4550	3050	2240	1700	1250
226 $r = .74$	3 9/32 x 5 1/16 x 3 9/32 x 9/16	14940	11260	8700	6520	4660	3150	2300	1760	1300
227 $r = .73$	3 9/32 x 5 1/32 x 3 9/32 x 23/32	14860	11180	8600	6420	4550	3050	2240	1700	1250
228 $r = .83$	3 9/16 x 6 1/16 x 3 9/16 x 7/16	16110	11890	9480	7430	5640	4080	2890	2220	1740
229 $r = .81$	3 9/16 x 6 1/16 x 3 9/16 x 5/8	15660	11770	9320	7230	5440	3860	2740	2120	1650
230 $r = .81$	3 9/16 x 6 1/16 x 3 9/16 x 13/16	15660	11770	9320	7230	5440	3860	2740	2120	1650

PENCOYD TEES AS STRUTS.—No. 15.

Greatest safe load in pounds per square inch of section.

FOR EXTREME SOFT STEEL.

r = least radius of gyration of each size.

Size of Tees. Inches.	LENGTH IN FEET.									
	2	4	6	8	10	12	14	16	18	20
4 x 4 $r = .85$	13270	10340	8180	6670	5280	3940	2970	2330	1840	1430
3½ x 3½ $r = .74$	12780	9610	7580	5800	4260	3060	2300	1760	1300	930
3 x 3 $r = .62$	11920	8620	6480	4600	3080	2210	1590	1080	730	
2½ x 2½ $r = .53$	11290	7890	5520	3460	2310	1580	1140			
2¼ x 2¼ $r = .47$	10770	7320	4680	2800	1820	1120	670			
2 x 2 $r = .43$	10360	6740	4030	2370	1470	840				
1¾ x 1¾ $r = .37$	9610	5800	3060	1760	930					
1½ x 1½ $r = .32$	8800	4830	2340	1200	540					
1¼ x 1¼ $r = .27$	7980	3590	1650	670						
1 x 1 $r = .26$	7810	3350	1500	580						

PENCOYD TEES AS STRUTS.—No. 16.

Greatest safe load in pounds per square inch of section.

FOR STEEL OF MEDIUM GRADE.

r = least radius of gyration of each size.

Size of Tees. Inches.	LENGTH IN FEET.									
	2	4	6	8	10	12	14	16	18	20
4 x 4 $r = .85$	16570	12020	9630	7600	6840	4280	3040	2330	1840	1430
3½ x 3½ $r = .74$	14940	11260	8700	6510	4660	3150	2300	1760	1300	930
3 x 3 $r = .62$	13740	10200	7390	5060	3180	2210	1590	1080	730	
2½ x 2½ $r = .53$	13030	9190	6160	3700	2310	1580	1140			
2¼ x 2¼ $r = .47$	12510	8350	5160	2830	1820	1120	670			
2 x 2 $r = .43$	12070	7690	4380	2370	1470	840				
1¾ x 1¾ $r = .37$	11260	6520	3140	1760	930					
1½ x 1½ $r = .32$	10400	5330	2340	1200	540					
1¼ x 1¼ $r = .27$	9320	3860	1650	670						
1 x 1 $r = .26$	9060	3540	1500	580						

PENCOYD CHANNELS AS STRUTS.—No. 17.

Greatest safe load in pounds per square inch of section.

FOR EXTREME SOFT STEEL.

When struts are unsupported, or free to bend in the direction of the flanges, $r =$ least radius of gyration for mean thickness of each shape.

Section Number.	*Size of Channel in Inches.*		*LENGTH IN FEET.* 2	4	6	8	10	12	14	16	18	20
434	15	$r = 1.04$	13960	11210	9250	7810	6530	5410	4290	3360	2720	2250
433		$r = 0.87$	13350	10420	8280	6820	5430	4110	3100	2430	1940	1520
428	12	$r = 0.89$	13440	10530	8380	6970	5570	4270	3230	2540	2030	1610
427		$r = 0.76$	12840	9750	7700	5960	4450	3200	2420	1860	1410	1010
32		$r = 0.70$	12500	9300	7280	5470	3860	2770	2070	1550	1090	
424	10	$r = 0.78$	12930	9880	7810	6110	4650	3360	2550	1970	1500	
423		$r = 0.71$	12550	9380	7360	5560	3960	2840	2130	1610	1150	
422	9	$r = 0.73$	12660	9530	7520	5720	4160	2980	2250	1710	1250	
421		$r = 0.65$	12150	8890	6790	4950	3360	2410	1770	1260		
420	8	$r = 0.70$	12500	9300	7280	5470	3860	2770	2070	1550	1090	
419		$r = 0.61$	11850	8520	6380	4480	3000	2140	1530	1030		
418	7	$r = 0.67$	12290	9070	6990	5170	3540	2560	1900	1370		
417		$r = 0.57$	11570	8210	5960	3990	2660	1870	1260			
416	6	$r = 0.65$	12150	8890	6790	4950	3360	2410	1770	1260		
415		$r = 0.53$	11280	7890	5530	3470	2320	1580				
413	5	$r = 0.49$	10950	7540	4990	3020	1990	1280	780			
411	4	$r = 0.47$	10770	7320	4680	2800	1820	1120				
49	3	$r = 0.45$	10580	7040	4350	2590	1650					

PENCOYD CHANNELS AS STRUTS.—No. 18.

Greatest safe load in pounds per square inch of section.

FOR STEEL OF MEDIUM GRADE.

When struts are unsupported, or free to bend in the direction of the flanges, $r =$ least radius of gyration for mean thickness of each shape.

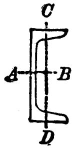
Section Number.	*Size of Channel in Inches.*		*LENGTH IN FEET.* 2	4	6	8	10	12	14	16	18	20
434	15	$r = 1.04$	19880	12940	10870	9060	7400	6000	4700	3540	2740	2250
433		$r = 0.87$	16960	12130	9780	7780	6040	4490	3200	2420	1940	1520
428	12	$r = 0.89$	17410	12250	9930	7950	6220	4680	3360	2540	2020	1610
427		$r = 0.76$	15100	11410	8890	6740	4890	3330	2440	1880	1410	1140
32		$r = 0.70$	14580	10930	8300	6080	4180	2790	2070	1550	1090	
424	10	$r = 0.78$	15250	11560	9060	6940	5120	3550	2550	2170	1510	
423		$r = 0.71$	14700	11020	8400	6200	4300	2880	2120	1610	1150	
422	9	$r = 0.73$	14850	11180	8600	6420	4550	3050	2250	1700	1260	
421		$r = 0.65$	14090	10500	7750	5460	3550	2420	1640	1260		
420	8	$r = 0.70$	14580	10930	8300	6080	4180	2790	2070	1610	1150	
419		$r = 0.61$	13630	10100	7270	4920	3070	2210	1590	1080		
418	7	$r = 0.67$	14300	10670	7970	5720	3790	2560	1910	1370		
417		$r = 0.57$	13310	9680	6740	4330	2660	1880	1260			
416	6	$r = 0.65$	14090	10500	7750	5460	3550	2400	1780	1260		
415		$r = 0.53$	13020	9190	6160	3700	2330	1580				
413	5	$r = 0.49$	12690	8650	5510	3100	1970	1280				
411	4	$r = 0.47$	12500	8350	5150	2840	1830	1170				
49	3	$r = 0.45$	12300	8030	4780	2590	1652					

TABLE OF STRUTS.—No. 19.

LATTICED CHANNEL STRUTS.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION.

FOR EXTREME SOFT STEEL.



For a pair of braced channels, or for a single channel secured from flexure in the direction of flanges and liable to fail only in the direction of the web *C D*.

r in the marginal columns gives the radius of gyration for axis *A B*, or for either axis of the combined pair of channels. See description, page 156.

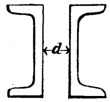
Size of Channels.	Condition of Ends.	LENGTH IN FEET. 6	8	10	12	14	16	18	20	22
15 ins.	Fixed.	15000	14570	14150	13570	12980	12430	11870	11450	11050
$r =$ 5.52	Flat.	15000	14570	14150	13570	12980	12430	11870	11450	11050
$D =$ 12.8	Hinged.	15000	14340	13690	13060	12400	11820	11230	10770	10340
$d =$ 8.8	Round.	15000	14020	13040	12330	11600	10950	10270	9720	9190
		1.18	1.58	1.97	2.37	2.76	3.15	3.55	3.95	4.34
12 ins.	Fixed.	15000	14120	13390	12670	11970	11410	10920	10450	9980
$r =$ 4.38	Flat.	15000	14120	13390	12670	11970	11410	10920	10450	9980
$D =$ 10.1	Hinged.	15000	13660	12870	12080	11340	10730	10190	9700	9210
$d =$ 7.1	Round.	15000	13010	12110	11240	10400	9680	9010	8400	7800
		1.09	1.46	1.83	2.19	2.55	2.92	3.28	3.65	4.01
10 ins.	Fixed.	15000	13590	12730	11910	11290	10710	10150	9620	9100
$r =$ 3.71	Flat.	15000	13590	12730	11910	11290	10710	10150	9620	9100
$D =$ 8.6	Hinged.	15000	13090	12150	11270	10600	9970	9390	8810	8230
$d =$ 5.9	Round.	15000	12360	11310	10320	9510	8740	8020	7370	6750
		1.19	1.59	1.99	2.39	2.79	3.19	3.58	3.98	4.38
9 ins.	Fixed.	14150	13160	12240	11440	10800	10170	9570	8990	8440
$r =$ 3.31	Flat.	14150	13160	12240	11440	10800	10170	9570	8990	8440
$D =$ 7.7	Hinged.	13690	12620	11620	10760	10060	9410	8760	8120	7520
$d =$ 5.2	Round.	13040	11830	10720	9710	8850	8040	7310	6620	5970
		1.23	1.64	2.05	2.46	2.87	3.28	3.70	4.11	4.52
8 ins.	Fixed.	13840	12770	11760	11040	10340	9670	9030	8420	8040
$r =$ 3.0	Flat.	13840	12770	11760	11040	10340	9670	9030	8420	8020
$D =$ 7.1	Hinged.	13350	12190	11110	10320	9590	9190	8160	7500	6970
$d =$ 4.6	Round.	12660	11360	10140	9170	8260	7430	6670	5950	5370
		1.32	1.76	2.20	2.64	3.08	3.52	3.96	4.40	4.84
7 ins.	Fixed.	13310	12110	11170	10360	9580	8850	8240	7810	7400
$r =$ 2.58	Flat.	13310	12110	11170	10360	9580	8850	8230	7770	7310
$D =$ 6.2	Hinged.	12780	11480	10470	9600	8770	7960	7250	6650	6080
$d =$ 3.9	Round.	12010	10560	9350	8280	7320	6450	5680	5020	4420
		1.39	1.86	2.35	2.79	3.25	3.72	4.18	4.65	5.11
6 ins.	Fixed.	12780	11540	10600	9700	8850	8190	7700	7230	6790
$r =$ 2.26	Flat.	12780	11540	10600	9700	8850	8170	7660	7070	6440
$D =$ 5.4	Hinged.	12200	10870	9860	8890	7970	7170	6490	5850	5240
$d =$ 3.3	Round.	11380	9950	8590	7460	6460	5590	4860	4200	3610
		1.51	2.01	2.52	3.02	3.44	4.25	4.54	5.04	5.54

TABLE OF STRUTS.—No. 19.

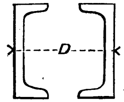
LATTICED CHANNEL STRUTS.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION.

FOR EXTREME SOFT STEEL.



The channels must be connected so as to insure unity of action, and separated not less than the distances *D* or *d* respectively given in inches in the marginal column. Figures in smaller type under each length represent the greatest distance apart in feet on each channel that centres of lateral bracing should be placed.



LENGTH IN FEET. 24	26	28	30	32	34	36	38	40	Condition of Ends.	Size of Channels.
10680	10300	9930	9570	9230	8890	8550	8290	8110	Fixed.	**15** ins.
10680	10300	9930	9570	9230	8890	8550	8290	8070	Flat.	$r =$ 5.52
9940	9540	9150	8760	8370	8000	7650	7320	7040	Hinged.	$D =$ 12.8
8690	8200	7740	7310	6890	6490	6110	5760	5450	Round.	$d =$ 8.8
4.74	5.13	5.53	5.92	6.32	6.71	7.11	7.50	7.90		
9530	9090	8670	8320	8060	7810	7560	7320	7090	Fixed.	**12** ins.
9530	9090	8670	8320	8040	7770	7510	7200	6870	Flat.	$r =$ 4.38
8710	8230	7770	7360	6990	6640	6300	5970	5650	Hinged.	$D =$ 10.1
7260	6740	6240	5790	5400	5020	4650	4320	4000	Round.	$d =$ 7.1
4.38	4.74	5.11	5.47	5.84	6.21	6.57	6.94	7.30		
8600	8220	7920	7630	7350	7070	6810	6540	6250	Fixed.	**10** ins.
8600	8210	7890	7590	7230	6840	6460	6120	5820	Flat.	$r =$ 3.71
7700	7230	6800	6400	6010	5620	5260	4920	4610	Hinged.	$D =$ 8.6
6160	5650	5190	4760	4350	3980	3630	3300	2990	Round.	$d =$ 5.9
4.78	5.18	5.58	5.98	6.38	6.78	7.18	7.58	7.98		
8090	7760	7430	7120	6830	6520	6190	5890	5590	Fixed.	**9** ins.
8070	7720	7350	6920	6490	6110	5760	5440	5080	Flat.	$r =$ 3.31
7030	6580	6130	5690	5280	4900	4550	4220	3840	Hinged.	$D =$ 7.7
5440	4760	4470	4050	3650	3280	2930	2610	2310	Round.	$d =$ 5.2
4.93	5.34	5.75	6.16	6.57	6.98	7.39	7.81	8 21		
7680	7320	6990	6670	6310	5960	5630	5310	5000	Fixed.	**8** ins.
7630	7200	6720	6260	5880	5520	5150	4730	4350	Flat.	$r =$ 3.0
6460	5980	5500	5060	4670	4300	3900	3460	3060	Hinged.	$D =$ 7.1
4820	4320	3870	3440	3050	2690	2350	2040	1760	Round.	$d =$ 4.6
5.28	5.72	6.16	6.60	7.04	7.48	7.92	8.36	8.80		
7000	6630	6210	5820	5400	5070	4680	4300	3960	Fixed.	**7** ins.
6740	6210	5780	5360	4890	4440	4030	3630	3310	Flat.	$r =$ 2.58
5530	5010	4570	4140	3630	3150	2750	2370	2110	Hinged.	$D =$ 6.2
3890	3390	2950	2530	2160	1820	1590	1380	1200	Round.	$d =$ 3.9
5.57	6.04	6.51	6.97	7.44	7.91	8.37	8.83	9.30		
6330	5880	5440	5050	4570	4150	3790	3440		Fixed.	**6** ins.
5910	5430	4900	4380	3920	3480	3160	2860		Flat.	$r =$ 2.26
4700	4210	3640	3100	2640	2230	1990	1760		Hinged.	$D =$ 5.4
3080	2600	2170	1780	1520	1300	1130	980		Round.	$d =$ 3.3
6.05	6.55	7.06	7.56	8.11	8.57	9.08	9.58			

TABLE OF STRUTS.—No. 20.

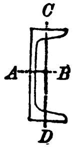
LATTICED CHANNEL STRUTS.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION.

FOR STEEL of Medium Grade.

For a pair of braced channels, or for a single channel secured from flexure in the direction of flanges and liable to fail only in the direction of the web *C D*.

r in the marginal columns gives the radius of gyration for axis *A B*, or for either axis of the combined pair of channels. See description, page 156.



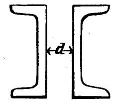
Size of Channels.	*Condition of Ends.*	*LENGTH IN FEET.* 6	8	10	12	14	16	18	20	22
15 ins.	Fixed.	20000	20000	20000	18000	15320	14500	13670	13190	12790
$r =$ 5.52	Flat.	20000	20000	20000	18000	15320	14500	13670	13190	12790
$D =$ 12.8	Hinged.	20000	20000	20000	17360	14720	13860	12980	12420	11940
$d =$ 8.8	Round.	20000	20000	19190	16400	13710	12760	11790	11150	10580
		1.18	1.58	1.97	2.37	2.76	3.15	3.55	3.95	4.34
12 ins.	Fixed.	20000	20000	17150	14860	13820	13150	12660	12170	11680
$r =$ 4.38	Flat.	20000	20000	17150	14860	13820	13150	12660	12170	11680
$D =$ 10.1	Hinged.	20000	19980	16520	14240	13140	12380	11770	11270	10780
$d =$ 7.1	Round.	20000	19050	15550	13180	11970	11100	10390	9750	9100
		1.09	1.46	1.83	2.19	2.55	2.92	3.28	3.65	4.01
10 ins.	Fixed.	20000	18130	14960	13720	13030	12440	11860	11280	10710
$r =$ 3.71	Flat.	20000	18130	14960	13720	13030	12440	11860	11280	10710
$D =$ 8.6	Hinged.	20000	17480	14340	13040	12220	11540	10960	10340	9700
$d =$ 5.9	Round.	20000	16530	13290	11860	10920	10100	9340	8630	7940
		1.19	1.59	1.99	2.39	2.79	3.19	3.58	3.98	4.38
9 ins.	Fixed.	20000	16050	14220	13180	12530	11880	11230	10600	10020
$r =$ 3.31	Flat.	20000	16050	14220	13180	12530	11880	11230	10600	10020
$D =$ 7.7	Hinged.	20000	15440	13560	12410	11630	10980	10280	9570	8920
$d =$ 5.2	Round.	19190	14450	12430	11140	10210	9360	8560	7800	7100
		1.23	1.64	2.05	2.46	2.87	3.28	3.70	4.11	4.52
8 ins.	Fixed.	19300	15020	13500	12780	12060	11340	10640	10000	9400
$r =$ 3.00	Flat.	19300	15020	13500	12780	12060	11340	10640	10000	9380
$D =$ 7.1	Hinged.	18640	14200	12800	11920	11160	10400	9620	8900	8160
$d =$ 4.6	Round.	17700	13360	11600	10560	9590	8690	7850	7070	6280
		1.32	1.76	2.20	2.64	3.08	3.52	3.96	4.40	4.84
7 ins.	Fixed.	16760	14030	12910	12070	11240	10440	9720	9040	8440
$r =$ 2.58	Flat.	16760	14030	12910	12070	11240	10440	9710	9010	8330
$D =$ 6.2	Hinged.	16140	13360	12080	11170	10290	9400	8560	7710	6930
$d =$ 3.9	Round.	15160	12210	10750	9620	8580	7610	6700	5820	5040
		1.39	1.86	2.35	2.79	3.25	3.72	4.18	4.65	5.11
6 ins.	Fixed.	15030	13280	12330	11360	10450	9630	8870	8250	7740
$r =$ 2.26	Flat.	15030	13280	12330	11360	10450	9620	8820	8070	7350
$D =$ 5.4	Hinged.	14420	12530	11430	10430	9410	8450	7490	6670	5970
$d =$ 3.3	Round.	13380	11280	9940	8730	7620	6590	5600	4790	4110
		1.51	2.01	2.52	3.02	3.44	4.25	4.54	5 04	5.54

TABLE OF STRUTS.—No. 20.

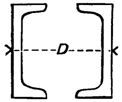
LATTICED CHANNEL STRUTS.

GREATEST SAFE LOAD IN POUNDS PER SQUARE INCH OF SECTION.

FOR STEEL of Medium Grade.



The channels must be connected so as to insure unity of action and separated not less than the distance *D* or *d* respectively given in the marginal columns. Figures in small type under each length represent the greatest distance apart in feet on each channel that centres of lateral bracing should be placed.



LENGTH IN FEET. 24	26	28	30	32	34	36	38	40	*Condition of Ends.*	*Size of Channels.*
12410	12010	11620	11230	10840	10480	10140	9800	9490	Fixed.	**15** ins.
12410	12010	11620	11230	10840	10480	10140	9800	9460	Flat.	$r =$ 5.52
11510	11110	10720	10280	9850	9440	9060	8660	8260	Hinged.	$D =$ 12.8
10050	9540	9040	8560	8100	7660	7240	6810	6390	Round.	$d =$ 8.8
4.74	5.13	5.53	5.92	6.32	6.71	7.11	7.50	7.90		
11180	10700	10260	9840	9430	9040	8650	8350	8090	Fixed.	**12** ins.
11180	10700	10260	9830	9410	9000	8600	8210	7830	Flat.	$r =$ 4.38
10230	9690	9190	8700	8200	7700	7210	6810	6440	Hinged.	$D =$ 10.1
8510	7930	7390	6860	6320	5810	5320	4930	4570	Round.	$d =$ 7.1
4.38	4.74	5.11	5.47	5.84	6.21	6.57	6.94	7.30		
10190	9690	9220	8760	8380	8070	7760	7410	7040	Fixed.	**10** ins.
10190	9680	9190	8710	8250	7800	7370	6950	6550	Flat.	$r =$ 3.71
9110	8520	7930	7350	6850	6410	6000	5590	5190	Hinged.	$D =$ 8.6
7300	6660	6040	5460	4960	4540	4140	3740	3370	Round.	$d =$ 5.9
4.78	5.18	5.58	5.98	6.38	6.78	7.18	7.58	7.98		
9480	8960	8470	8130	7780	7400	6970	6540	6180	Fixed.	**9** ins.
9460	8920	8390	7890	7400	6930	6480	6040	5620	Flat.	$r =$ 3.31
8250	7600	6980	6490	6020	5570	5120	4680	4240	Hinged.	$D =$ 7.7
6380	5710	5100	4620	4160	3730	3300	2900	2560	Round.	$d =$ 5.2
4.93	5.34	5.75	6.16	6.57	6.98	7.39	7.81	8.21		
8830	8350	7970	7590	7110	6640	6220	5860	5500	Fixed.	**8** ins.
8790	8220	7660	7140	6630	6150	5670	5220	4780	Flat.	$r =$ 3.0
7440	6810	6280	5770	5270	4790	4300	3820	3350	Hinged.	$D =$ 7.1
5550	4930	4410	3920	3440	3000	2600	2250	1920	Round.	$d =$ 4.6
5.28	5.70	6.16	6.60	7.04	7.48	7.92	8.36	8.80		
7990	7530	6980	6440	6000	5580	5110	4630	4160	Fixed.	**7** ins.
7690	7080	6480	5940	5400	4880	4380	3910	3480	Flat.	$r =$ 2.58
6300	5710	5130	4580	4010	3460	2980	2550	2200	Hinged.	$D =$ 6.2
4440	3860	3310	2800	2390	2000	1720	1490	1270	Round.	$d =$ 3.9
5.57	6.04	6.51	6.97	7.44	7.91	8.37	8.83	9.30		
7150	6520	6020	5530	4980	4430	3910	3510		Fixed.	**6** ins.
6670	6030	5410	4820	4250	3720	3270	2910		Flat.	$r =$ 2.26
5310	4670	4020	3390	2860	2380	2050	1790		Hinged.	$D =$ 5.4
3480	2890	2400	1950	1660	1390	1170	990		Round.	$d =$ 3.3
6.05	6.55	7.06	7.56	8.11	8.57	9.08	9.58			

COLUMNS OF ROUND AND SQUARE SECTION.

Experiments on columns of this class are not very complete, especially as denoting the comparative values for the various end conditions. The following tables, Nos. 22 to 25, are derived partly from experiment on actual columns, extended and completed by comparison with the experiments on rolled struts from which all our previous tables of strut resistances are derived.

Tables Nos. 2 and 4 are taken as the basis for the working values. On account of the more perfect symmetry of form possessed by round and square sections than the shapes for which these tables were especially calculated, the safe loads per square inch of section are increased ten (10) per cent. for round columns, and five (5) per cent. for square columns. That is, the factors of safety previously given remain the same, the ultimate strength is supposed to be 10 and 5 per cent. respectively greater than the rolled struts.

The tables are calculated for certain thicknesses, varying from $\frac{1}{8}$ inch for 2-inch diameter up to $\frac{5}{8}$ inch for 12-inch diameter, as marked in the margins. At the same place R represents the radius of gyration for the diameter and thickness given. When the thickness varies but a little from that given, the strength per square inch of section can be accepted as practically unchanged. But when the variation becomes of importance, the radius of gyration corresponding to the altered thickness will have to be obtained, and the strength of the column then ascertained from tables Nos. 2 and 4, as heretofore described.

The following table gives the values of the radius of gyration for round and square columns from 2 to 12 inches diameter, and from $\frac{1}{10}$ of an inch to 1 inch thick.

Example for Round Column:

What is the greatest safe load for a flat-ended round column 6 inches outer diameter, $\frac{1}{2}$ inch thick, 8.64 square inches area, and 18 feet long, $r = 1.95$ $\frac{l}{r} = 111$? By table No. 2 the corresponding safe load = 6,780 lbs. + 10 per cent. = 7,460 lbs. per square inch of section, or 64,440 lbs. for the column.

No. 21.

RADII OF GYRATION FOR ROUND COLUMNS.

Outside Diameter of Column in Inches.	*Thickness in Inches Varying by Tenths.*									
	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
	Corresponding Radius of Gyration in Inches.									
2	.67	.64	.61	.58	.56	.54	.52	.51	.50	.50
3	1.03	.99	.96	.93	.90	.88	.85	.83	.81	.79
4	1.38	1.35	1.31	1.28	1.25	1.22	1.19	1.16	1.14	1.12
5	1.73	1.70	1.66	1.63	1.60	1.57	1.54	1.51	1.48	1.46
6	2.08	2.05	2.02	1.98	1.95	1.92	1.89	1.86	1.83	1.80
7	2.43	2.40	2.36	2.33	2.30	2.27	2.24	2.21	2.18	2.15
8	2.79	2.76	2.72	2.69	2.66	2.62	2.59	2.56	2.53	2.50
9	3.15	3.11	3.08	3.04	3.01	2.97	2.94	2.91	2.88	2.85
10	3.51	3.47	3.44	3.40	3.37	3.33	3.30	3.27	3.23	3.20
11	3.86	3.82	3.79	3.75	3.72	3.68	3.65	3.62	3.58	3.55
12	4.21	4.18	4.15	4.11	4.08	4.04	4.01	3.97	3.94	3.90

RADII OF GYRATION FOR SQUARE COLUMNS.

Outer Diam. Across Flats in Inches.	*Thickness in Inches Varying by Tenths.*									
	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
	Corresponding Radius of Gyration in Inches.									
2	.78	.74	.71	.68	.65	.63	.61	.59	.58	.58
3	1.18	1.14	1.11	1.08	1.04	1.01	.98	.96	.93	.91
4	1.59	1.55	1.51	1.47	1.44	1.41	1.38	1.35	1.32	1.29
5	2.00	1.96	1.92	1.89	1.85	1.81	1.78	1.75	1.71	1.68
6	2.41	2.37	2.33	2.29	2.25	2.21	2.18	2.15	2.11	2.08
7	2.82	2.78	2.74	2.70	2.66	2.62	2.58	2.55	2.51	2.48
8	3.23	3.19	3.15	3.11	3.07	3.03	2.99	2.96	2.92	2.89
9	3.63	3.59	3.55	3.51	3.48	3.44	3.40	3.36	3.32	3.29
10	4.04	4.00	3.96	3.92	3.88	3.84	3.80	3.77	3.73	3.70
11	4.45	4.41	4.37	4.33	4.29	4.25	4.21	4.17	4.13	4.10
12	4.86	4.82	4.78	4.74	4.70	4.66	4.62	4.58	4.54	4.51

COLUMNS OF IRON OR EXTREME SOFT STEEL.—No. 22.

ROUND SECTION.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION.

By this table for the same ratios of $\frac{l}{r}$ the safe loads are increased 10 per cent. over the results obtained for previous tables, as given in table No. 2.

Size of Outer Diameter.	*Condition of Ends.*	*LENGTH IN FEET.* 2	4	6	8	10	12	14	16	18
12 ins.	Fixed.	16000	15800	15660	15220	14330	13350	12640	12040	11470
Diameter.	Flat.	16000	15800	15660	15220	14330	13350	12640	12040	11470
⅝″ thick.	Hinged.	16000	15800	15660	14680	13700	12670	12000	11250	10840
$R = 3.94$	Round.	16000	15800	15660	13940	12840	11660	10890	9950	9200
10 ins.	Fixed.	16000	15800	15660	14630	13490	12640	11940	11280	10640
Diameter.	Flat.	16000	15800	15660	14630	13490	12640	11940	11280	10640
½″ thick.	Hinged.	16000	15800	15160	14030	12810	12000	11140	10450	9750
$R = 3.37$	Round.	16000	15400	14470	13200	11820	10890	9820	8960	8170
8 ins.	Fixed.	16000	15500	14770	13490	12440	11570	10730	9940	9200
Diameter.	Flat.	15800	15300	14770	13490	12440	11570	10730	9940	9200
½″ thick.	Hinged.	15600	14800	14190	12810	11680	10740	9850	8970	8170
$R = 2.66$	Round.	15600	14600	13380	11820	10480	9330	8280	7330	6460
6 ins.	Fixed.	15400	15220	13490	12140	11000	9940	9050	8440	7860
Diameter.	Flat.	15400	15220	13490	12140	11000	9940	9040	8400	7650
⅜″ thick.	Hinged.	15200	14680	12810	11360	10150	8970	7960	7110	6310
$R = 2.00$	Round.	14800	13940	11820	10080	8600	7330	6220	5310	4490
5 ins.	Fixed.	14900	14470	12540	11090	9850	8840	8150	7460	6740
Diameter.	Flat.	14900	14470	12540	11090	9850	8820	8060	7260	6270
⅜″ thick.	Hinged.	14400	13870	11790	10250	8880	7660	6710	5920	4920
$R = 1.64$	Round.	14400	13020	10620	8720	7230	5790	4880	4130	3150
4 ins.	Fixed.	14600	13490	11570	9940	8740	7860	7040	6190	5400
Diameter.	Flat.	14600	13490	11570	9940	8710	7650	6560	5640	4680
¼″ thick.	Hinged.	13800	12810	10740	8970	7520	6310	5240	4290	3260
$R = 1.33$	Round.	13200	11820	9330	7330	5750	4490	3460	2580	1880
3 ins.	Fixed.	15220	12140	9940	8440	7330	6190	5110	4130	3300
Diameter.	Flat.	15220	12140	9940	8400	6880	5640	4400	3440	2780
3/16″ thick.	Hinged.	14680	11360	8970	7110	5560	4290	2990	2160	1600
$R = 1.00$	Round.	13940	10080	7330	5310	3780	2580	1720	1230	900
2 ins.	Fixed.	13490	9850	7820	6140	4510	3230	2290	1760	1300
Diameter.	Flat.	13490	9850	7590	5580	3770	2720	2000	1400	990
⅛″ thick.	Hinged.	12810	8880	6240	4220	2420	1570	1100	790	600
$R = .66$	Round.	11820	7230	4430	2540	1390	890	600	400	300

COLUMNS OF IRON OR EXTREME SOFT STEEL.—No. 22.

ROUND SECTION.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION.

The calculations are based on the thicknesses and radii of gyration marked under the diameters on marginal columns. See description.

LENGTH IN FEET. 20	22	24	26	28	30	32	34	36	*Condition of Ends.*	*Size of Outer Diameter.*
10910	10370	9850	9350	8990	8640	8340	8050	7770	Fixed.	**12** ins.
10910	10370	9850	9350	8980	8610	8290	7930	7520	Flat.	Diameter.
10050	9460	8880	8330	7880	7390	6970	6570	6180	Hinged.	⅝″ thick.
8490	7850	7230	6640	6030	5610	5150	4750	4370	Round.	$R = 3.94$
10020	9430	8990	8620	8250	7910	7600	7280	6940	Fixed.	**10** ins.
10020	9430	8980	8610	8190	7720	7260	6830	6460	Flat.	Diameter.
9070	8430	7880	7390	6840	6380	5930	5510	5130	Hinged.	½″ thick.
7430	6740	6030	5610	5010	4560	4130	3730	3350	Round.	$R = 3.37$
8740	8290	7860	7460	7040	6610	6190	5790	5400	Fixed.	**8** ins.
8710	8250	7650	7070	6560	6110	5640	5140	4680	Flat.	Diameter.
7520	6900	6310	5920	5240	4780	4290	3750	3260	Hinged.	½″ thick.
5750	5090	4490	3960	3460	3000	2580	2210	1880	Round.	$R = 2.66$
7330	6740	6190	5660	5110	4580	4130	3700	3300	Fixed.	**6** ins.
6880	6270	5640	4990	4400	3850	3440	3080	2780	Flat.	Diameter.
5560	4920	4290	3580	2990	2470	2160	1880	1600	Hinged.	⅜″ thick.
3780	3150	2580	2090	1720	1440	1230	1040	900	Round.	$R = 2.00$
6100	5440	4760	4210	3670	3160	2790	2400	2100	Fixed.	**5** ins.
5530	4730	4020	3500	3050	2680	2380	2100	1870	Flat.	Diameter.
4160	3310	2640	2220	1850	1540	1300	1100	1000	Hinged.	⅜″ thick.
2490	1900	1520	1260	1030	860	750	600	580	Round.	$R = 1.64$
4580	3880	3260	2770	2300	2000	1780	1560	1360	Fixed.	**4** ins.
3850	3210	2750	2370	2000	1740	1470	1220	1010	Flat.	Diameter.
2470	2000	1590	1300	1100	900	800	690	610	Hinged.	¼″ thick.
1440	1100	900	740	600	500	450	380	330	Round.	$R = 1.33$
2650	2100	1790	1500	1240	1070	910	770		Fixed.	**3** ins.
2270	1850	1480	1150	910	710	530	440		Flat.	Diameter.
1250	1000	800	670	560	460	350	280		Hinged.	3/16″ thick.
700	580	450	370	290	250	200	170		Round.	$R = 1.00$
1040	800								Fixed.	**2** ins.
680	470								Flat.	Diameter.
400	300								Hinged.	⅛″ thick.
200	100								Round.	$R = .66$

STEEL COLUMNS.—No. 23.

ROUND SECTION.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION FOR MEDIUM STEEL.

By this table for the same ratios of $\frac{l}{r}$ the safe loads are increased 10 per cent. over the results obtained for previous tables, as given in table No. 4.

Size of Outer Diameter.	*Condition of Ends.*	*LENGTH IN FEET.* 2	4	6	8	10	12	14	16	18
12 ins.	Fixed.	23000	23000	23000	21200	16900	15000	14600	13900	13400
Diameter.	Flat.	23000	23000	23000	21200	16900	15000	14600	13900	13400
$\frac{5}{8}''$ thick.	Hinged.	23000	23000	23000	20500	16300	14300	13700	13000	12400
$R = 3.94$	Round.	23000	23000	23000	19500	15200	13000	12300	11500	10700
10 ins.	Fixed.	23000	23000	23000	18400	15700	14600	13900	13100	12500
Diameter.	Flat.	23000	23000	23000	18400	15700	14600	13900	13100	12500
$\frac{1}{2}''$ thick.	Hinged.	23000	23000	22600	17700	15000	13700	12900	12200	11400
$R = 3.37$	Round.	23000	23000	21600	16600	13700	12300	11300	10400	9700
8 ins.	Fixed.	23000	23000	21000	15700	14400	13300	12900	11900	11000
Diameter.	Flat.	23000	23000	21000	15700	14400	13300	12900	11900	11000
$\frac{1}{2}''$ thick.	Hinged.	23000	23000	18400	13600	12300	12300	11900	10800	9800
$R = 2.66$	Round.	23000	23000	17300	12500	11000	10600	10000	8900	7800
6 ins.	Fixed.	23000	21230	15800	14100	12900	11700	10700	9700	9000
Diameter.	Flat.	23000	21230	15800	14100	12900	11700	10700	9700	8700
$\frac{3}{8}''$ thick.	Hinged.	23000	20500	15000	13100	11900	10600	9400	8200	7200
$R = 2.00$	Round.	23000	19500	13700	11600	10000	8600	7300	6100	5100
5 ins.	Fixed.	23000	16900	14500	13100	11900	10300	9300	8500	7600
Diameter.	Flat.	23000	16900	14500	13100	11900	10300	9200	8100	7000
$\frac{3}{8}''$ thick.	Hinged.	21500	16300	13600	12100	10800	9000	7600	6000	5500
$R = 1.64$	Round.	20500	15200	12200	9400	8900	6900	5600	4500	3500
4 ins.	Fixed.	23000	15700	13500	11700	10200	9000	8000	6800	5900
Diameter.	Flat.	23000	15700	13500	11700	10200	8700	7400	6200	5100
$\frac{1}{4}''$ thick.	Hinged.	21000	15000	12500	10600	8800	7200	5900	4700	3577
$R = 1.33$	Round.	20500	12500	10300	8600	6700	5100	3900	2900	2100
3 ins.	Fixed.	21200	14000	11700	9700	8300	6800	5600	4300	3300
Diameter.	Flat.	21200	14000	11700	9700	7900	6200	4800	3600	2800
$\frac{3}{16}''$ thick.	Hinged.	20500	11900	10600	8200	6300	4700	3300	2200	1600
$R = 1.00$	Round.	19500	11600	8600	6100	4300	2900	1900	1300	900
2 ins.	Fixed.	15700	11600	8900	6800	4800	3200	2300	1800	1300
Diameter.	Flat.	15700	11600	8700	6200	4000	2700	2000	1400	1000
$\frac{1}{8}''$ thick.	Hinged.	15000	10500	7100	4700	2600	1600	1100	900	600
$R = .66$	Round.	13700	8500	5100	2800	1600	900	600	400	300

STEEL COLUMNS.—No. 23.

ROUND SECTION.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION FOR MEDIUM STEEL.

The calculations are based on the thicknesses and radii of gyration marked under the diameters on marginal columns. See description.

LENGTH IN FEET. 20	22	24	26	28	30	32	34	36	*Condition of Ends.*	*Size of Outer Diameter.*
12800	12200	11600	11000	10600	10100	9600	9200	8900	Fixed.	**12** ins.
12800	12200	11600	11000	10600	10100	9600	9000	8600	Flat.	Diameter.
11800	11100	10500	9800	9300	8800	8100	7500	7100	Hinged.	$\frac{5}{8}''$ thick.
9900	9200	8500	7800	7200	6600	6000	5400	5000	Round.	$R = 3.94$
11800	11000	10600	10200	9400	9000	8800	8300	7700	Fixed.	**10** ins.
11800	11000	10600	10200	9300	8800	8500	7900	7200	Flat.	Diameter.
10600	9800	9300	8800	7800	6600	7000	6300	5700	Hinged.	$\frac{1}{2}''$ thick.
8700	7800	6600	6700	5700	4700	5000	4300	3700	Round.	$R = 3.37$
10200	9400	9000	8500	8000	7400	6800	6400	6100	Fixed.	**8** ins.
10200	9400	8700	8100	7400	6800	6200	5700	5300	Flat.	Diameter.
8800	7800	7200	6600	5900	5300	4700	4600	3700	Hinged.	$\frac{1}{2}''$ thick.
6700	5700	5100	4100	3600	3400	2900	2700	2100	Round.	$R = 2.66$
8300	7600	6800	6200	5600	4900	4300	3800	3300	Fixed.	**6** ins.
7900	7000	6200	5500	4800	4100	3600	3100	2800	Flat.	Diameter.
6300	5500	4700	3900	3300	2600	2200	1900	1600	Hinged.	$\frac{3}{8}''$ thick.
4300	3500	2900	2300	1900	1600	1300	1100	900	Round.	$R = 2.00$
6700	6000	5100	4400	3700	3500	2800	2400	2100	Fixed.	**5** ins.
6100	5200	4300	3600	3100	2700	2400	2100	1900	Flat.	Diameter.
4600	3600	2800	2300	1900	1500	1300	1100	1000	Hinged.	$\frac{3}{8}''$ thick.
2800	2100	1700	1300	1100	900	800	700	600	Round.	$R = 1.64$
4900	4000	3300	2800	2300	2000				Fixed.	**4** ins.
4100	3300	2800	2400	2000	1800				Flat.	Diameter.
2600	2000	1600	1300	1100	900				Hinged.	$\frac{1}{4}''$ thick.
1600	1100	900	800	600	500				Round.	$R = 1.33$
2700	2100	1800	1500						Fixed.	**3** ins.
2300	1900	1500	1200						Flat.	Diameter.
1300	1000	800	700						Hinged.	$\frac{3}{16}''$ thick.
700	600	500	400						Round.	$R = 1.00$
1100	800								Fixed.	**2** ins.
700	500								Flat.	Diameter.
400	300								Hinged.	$\frac{1}{8}''$ thick.
200	100								Round.	$R = .66$

COLUMNS OF IRON OR EXTREME SOFT STEEL.—No. 24.

SQUARE SECTION.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION.

By this table, for the same ratios of $\frac{l}{r}$, the safe loads are increased 5 per cent. over the results obtained in table No. 2.

Size of Column.	*Condition of Ends.*	*LENGTH IN FEET.* 2	4	6	8	10	12	14	16	18
2 ins.	Fixed.	13540	10330	8160	6760	5410	4130	3090	2300	1790
Diameter.	Flat.	13540	10330	8120	6320	4770	3440	2600	2000	1500
$\frac{1}{8}''$ thick.	Hinged.	12940	9500	6920	5060	3420	2180	1500	1100	800
$R = .77$	Round.	12100	8010	5210	3360	2000	1250	850	600	450
3 ins.	Fixed.	14950	12160	10330	8690	7690	6760	5830	4920	4080
Diameter.	Flat.	14950	12160	10330	8680	7570	6320	5280	4240	3410
$\frac{3}{16}''$ thick.	Hinged.	14480	11460	9500	7660	6280	5060	3980	2900	2160
$R = 1.15$	Round.	13810	10400	8010	6020	4540	3360	2380	1680	1240
4 ins.	Fixed.	15270	13540	11690	10330	9010	8150	7420	6720	6040
Diameter.	Flat.	15270	13540	11690	10330	9010	8110	7180	6220	5540
$\frac{1}{4}''$ thick.	Hinged.	14620	12940	10940	9500	8050	6920	5900	5010	4260
$R = 1.53$	Round.	13800	12100	9750	8010	6440	5210	4180	3310	2590
5 ins.	Fixed.	15450	14390	12610	11310	10250	9170	8400	7780	7260
Diameter.	Flat.	15450	14390	12610	11310	10250	9170	8370	7700	6930
$\frac{3}{8}''$ thick.	Hinged.	14800	13860	11950	10540	9410	8220	7260	6400	5660
$R = 1.89$	Round.	14200	13120	10960	9260	7910	6630	5460	4660	3950
6 ins.	Fixed.	15640	14950	13540	12160	11220	10330	9410	8690	8160
Diameter.	Flat.	15640	14950	13540	12160	11220	10330	9410	8680	8120
$\frac{3}{8}''$ thick.	Hinged.	15100	14480	12940	11460	10450	9500	8480	7660	6920
$R = 2.30$	Round.	14700	13820	12100	10390	9150	8010	6910	6020	5210
8 ins.	Fixed.	15990	15260	14670	13540	12480	11690	10950	10250	9650
Diameter.	Flat.	15990	15260	14670	13540	12480	11690	10950	10250	9650
$\frac{1}{2}''$ thick.	Hinged.	15300	14800	17170	12940	11800	10940	10160	9410	8750
$R = 3.07$	Round.	15100	14200	13440	12100	10800	9750	8790	8010	7190
10 ins.	Fixed.	16000	15260	14570	14380	13540	12750	12060	11400	10860
Diameter.	Flat.	16000	15260	14570	14380	13540	12750	12060	11400	10860
$\frac{1}{2}''$ thick.	Hinged.	16000	15260	14170	13860	12940	12090	11360	10640	10070
$R = 3.87$	Round.	16000	15100	14170	13120	12100	11130	10270	9380	8670
12 ins.	Fixed.	16000	15600	15150	14950	14250	13420	12750	12140	11690
Diameter.	Flat.	16000	15600	15150	14950	14250	13420	12750	12140	11690
$\frac{5}{8}''$ thick.	Hinged.	16000	15300	14650	14480	13700	12800	12090	11460	10940
$R = 4.55$	Round.	16000	15100	14250	13820	12950	11930	11130	10400	9750

COLUMNS OF IRON OR EXTREME SOFT STEEL.—No. 24.

SQUARE SECTION.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION.

The calculations are based on the thicknesses and radii of gyration marked under the diameters in marginal columns. See previous description.

LENGTH IN FEET. 20	22	24	26	28	30	32	34	36	*Condition of Ends.*	*Size of Column.*
1440	1120	930	760						Fixed.	**2** ins.
1100	810	580	430						Flat.	Diameter.
640	490	380	270						Hinged.	$\frac{1}{8}''$ thick.
360	260	210	170						Round.	$R = .77$
3380	2770	2290	1900	1660	1430	1210	1060	910	Fixed.	**3** ins.
2800	2360	2000	1670	1370	1090	880	710	560	Flat.	Diameter.
1690	1300	1090	900	750	630	550	450	370	Hinged.	$\frac{3}{16}''$ thick.
900	700	600	500	400	360	290	240	210	Round.	$R = 1.15$
5370	4670	4080	3540	3020	2650	2250	1960	1770	Fixed.	**4** ins.
4710	3980	3410	2940	2560	2270	1980	1700	1500	Flat.	Diameter.
3370	2630	2160	1800	1470	1260	1080	900	800	Hinged.	$\frac{1}{4}''$ thick.
1950	1530	1200	1000	830	700	600	500	400	Round.	$R = 1.53$
6670	6130	5580	5020	4500	4020	3570	3150	2790	Fixed.	**5** ins.
6230	5650	4970	4340	3800	3350	2900	2660	2370	Flat.	Diameter.
4960	4370	3630	2990	2480	2120	1800	1540	1330	Hinged.	$\frac{3}{8}''$ thick.
3460	2680	2140	1720	1440	1210	1000	870	760	Round.	$R = 1.89$
7690	7210	6760	6310	5830	5410	4920	4500	4080	Fixed.	**6** ins.
7570	6880	6320	5840	5280	4770	4240	3800	3410	Flat.	Diameter.
6280	5610	5060	4570	3980	3420	2900	2480	2160	Hinged.	$\frac{3}{8}''$ thick.
4540	3900	3360	2870	2380	2000	1800	1440	1240	Round.	$R = 2.30$
9010	8550	8160	7820	7470	7130	6760	6390	6040	Fixed.	**8** ins.
9010	8530	8120	7760	7250	6750	6320	5930	5540	Flat.	Diameter.
8050	7450	6920	6470	5960	5480	5060	4660	4260	Hinged.	$\frac{1}{2}''$ thick.
6430	5690	5210	4730	4230	3780	3360	2960	2590	Round.	$R = 3.07$
10330	9820	9320	8790	8490	8200	7920	7640	7340	Fixed.	**10** ins.
10330	9820	9320	8790	8470	8170	7870	7500	7060	Flat.	Diameter.
9500	8940	8400	7800	7390	6980	6590	6220	5780	Hinged.	$\frac{1}{2}''$ thick.
8010	7390	6810	6170	5620	5280	4860	4480	4060	Round.	$R = 3.87$
11130	10680	10250	9730	9320	8920	8640	8350	8110	Fixed.	**12** ins.
11130	10680	10250	9730	9320	8920	8630	8320	8060	Flat.	Diameter.
10350	9880	9410	8840	8400	7960	7600	7180	6860	Hinged.	$\frac{5}{8}''$ thick.
9030	8440	7910	7300	6810	6340	5940	5490	5130	Round.	$R = 4.55$

STEEL COLUMNS.—No. 25.

SQUARE SECTION.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION FOR MEDIUM STEEL.

By this table, for the same ratios of $\frac{l}{r}$, the safe loads are increased 5 per cent. over the results obtained in table No. 4.

Size of Column.	*Condition of Ends.*	*LENGTH IN FEET.* 2	4	6	8	10	12	14	16	18
2 ins. Diameter. $\frac{1}{8}''$ thick. $R = .77$	Fixed.	16000	12100	9400	7700	6000	4300	3100	2300	1800
	Flat.	16000	12100	9400	7200	5300	3600	2600	2000	1500
	Hinged.	15300	11100	8000	5700	3800	2300	1500	1100	800
	Round.	14300	9400	6000	3800	2200	1300	900	600	500
3 ins. Diameter. $\frac{3}{16}''$ thick. $R = 1.15$	Fixed.	22300	14000	12100	10300	8800	7700	6400	5400	4300
	Flat.	22300	14000	12100	10300	8600	7200	5800	4600	3600
	Hinged.	22300	13200	11100	9100	7200	5700	4400	3000	2300
	Round.	21300	11900	9400	7100	5200	3700	2600	1800	1300
4 ins. Diameter. $\frac{1}{4}''$ thick. $R = 1.53$	Fixed.	23000	16000	13500	12000	10500	9400	8500	7700	6700
	Flat.	23000	16000	13500	12000	10500	9400	8200	7200	6100
	Hinged.	22700	15300	13100	11000	9300	8000	6700	5700	4700
	Round.	21700	14300	11800	9200	7400	6000	4800	3800	2900
5 ins. Diameter. $\frac{3}{8}''$ thick. $R = 1.89$	Fixed.	23000	18900	14400	13100	12000	10500	9800	9100	8300
	Flat.	23000	18900	14400	13100	12000	10500	9800	8800	7900
	Hinged.	23000	18200	13500	11900	11000	9300	8500	7300	6500
	Round.	23000	17200	12400	10700	9200	7400	6500	5300	4400
6 ins. Diameter. $\frac{3}{8}''$ thick. $R = 2.30$	Fixed.	23000	22300	16000	14000	13000	12000	11100	10300	9400
	Flat.	23000	22300	16000	14000	13000	12000	11100	10300	9400
	Hinged.	23000	22300	15300	13200	12100	11000	10000	9100	8000
	Round.	23000	21300	14300	11900	10600	9200	8100	7100	6000
8 ins. Diameter. $\frac{1}{2}''$ thick. $R = 3.07$	Fixed.	23000	23000	20900	16000	14400	13500	12800	12000	11300
	Flat.	23000	23000	20900	16000	14400	13500	12800	12000	11300
	Hinged.	23000	22700	20200	15300	13700	12600	11800	11000	10200
	Round.	23000	21700	19300	14300	12400	11200	10200	9200	8300
10 ins. Diameter. $\frac{1}{2}''$ thick. $R = 3.87$	Fixed.	23000	23000	23000	19600	16000	14800	13900	13200	12700
	Flat.	23000	23000	23000	19600	16000	14800	13900	13200	12700
	Hinged.	23000	23000	22300	18900	15300	13800	13100	12300	11700
	Round.	23000	22100	21300	17900	13600	12300	11200	10800	10100
12 ins. Diameter. $\frac{5}{8}''$ thick. $R = 4.55$	Fixed.	23000	23000	23000	22300	18900	15800	14800	14000	13500
	Flat.	23000	23000	23000	22300	18900	15800	14800	14000	13500
	Hinged.	23000	22300	22300	21600	18200	15100	14100	13200	12600
	Round.	23000	22300	21700	20600	17200	14000	12900	11900	11200

STEEL COLUMNS.—No. 25.

SQUARE SECTION.

GREATEST SAFE LOADS IN POUNDS PER SQUARE INCH OF SECTION FOR MEDIUM STEEL.

The calculations are based on the thicknesses and radii of gyration marked under the diameters in marginal columns. See previous description.

LENGTH IN FEET. 20	22	24	26	28	30	32	34	36	*Condition of Ends.*	*Size of Column.*
									Fixed.	**2** ins. Diameter. $\frac{1}{8}''$ thick. $R = .77$
									Flat.	
									Hinged.	
									Round.	
3400	2800	2300	1900	1700					Fixed.	**3** ins. Diameter. $\frac{3}{16}''$ thick. $R = 1.15$
2800	2400	2000	1700	1400					Flat.	
1700	1300	1100	900	700					Hinged.	
900	700	600	500	400					Round.	
5900	5100	4200	3800	3000	2700	2300	2000	1800	Fixed.	**4** ins. Diameter. $\frac{1}{4}''$ thick. $R = 1.53$
4900	4100	3500	3100	2600	2300	2000	1700	1500	Flat.	
3500	2900	2200	1900	1500	1300	1100	900	800	Hinged.	
2000	1700	1200	1100	800	700	600	500	400	Round.	
7500	6700	6200	5500	4800	4200	3600	3200	2800	Fixed.	**5** ins. Diameter. $\frac{3}{8}''$ thick. $R = 1.89$
7000	6200	5500	4700	4000	3600	2900	2700	2500	Flat.	
5600	4800	4000	3300	2600	2200	1800	1600	1500	Hinged.	
3700	2900	2400	1900	1500	1300	1000	900	800	Round.	
8800	8200	7700	7000	6400	5900	5400	4800	4300	Fixed.	**6** ins. Diameter. $\frac{3}{8}''$ thick. $R = 2.30$
8600	7800	7200	6500	5800	5200	4600	4100	3600	Flat.	
7200	6400	5700	5000	4400	3700	3200	2700	2300	Hinged.	
5200	4400	3800	3200	2600	2148	1800	1600	1300	Round.	
10700	10000	9400	8900	8500	8100	7800	7200	6900	Fixed.	**8** ins. Diameter. $\frac{1}{2}''$ thick. $R = 3.07$
10700	10000	9400	8800	8300	7700	7400	6600	6100	Flat.	
9500	8800	8000	7300	6800	6300	5900	4200	4700	Hinged.	
7600	6500	6000	5300	4800	4300	4000	3300	2900	Round.	
12100	11500	11000	10400	10000	9500	9100	8700	8400	Fixed.	**10** ins. Diameter. $\frac{1}{2}''$ thick. $R = 3.87$
12100	11500	11000	10400	10000	9500	9000	8500	8100	Flat.	
11200	10500	9900	9200	8300	8100	7500	7400	6600	Hinged.	
9800	8700	8000	7300	6400	6114	5600	5000	3400	Round.	
12900	12500	12000	11400	11000	10600	10200	9700	9400	Fixed.	**12** ins. Diameter. $\frac{5}{8}''$ thick. $R = 4.55$
12900	12500	12000	11400	11000	10600	10200	9700	9300	Flat.	
12000	11500	11000	10400	9900	9400	9000	8400	7900	Hinged.	
10400	9800	9200	8600	7700	7500	7000	6400	5900	Round.	

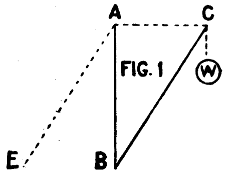
STRESSES IN SOME SIMPLE FORMS OF FRAMED STRUCTURES.

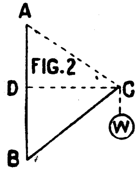
Compression indicated by the sign — and by solid lines. Tension by the sign + and by dotted lines.

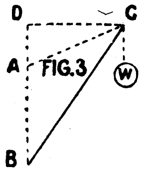
When the prefix "stress" is used, the load borne by the member is indicated; otherwise the length of the member is meant.

Cranes.

Supported at the points A and B, maximum longitudinal stresses, due to weight W, suspended at the end. These stresses are modified by the position of the hoisting chain.







D is the point where a line drawn from C at right angles to $A\,B$ will intersect the latter.

Stress $A\,C = +\frac{A\,C}{A\,B} \times W$ Stress $B\,C = \frac{B\,C}{A\,B} \times W$

" $A\,B = -\frac{A\,D}{A\,B} \times W$ in Fig. 2, or $= +\frac{A\,D}{A\,B} \times W$ in Fig. 3.

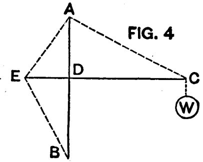
When point A is supported by inclined back stays as shown in Fig. 1, and when the back stay is in the plane of $A\,B$ and W.

$$\text{Stress } A\,E = +\frac{A\,C}{A\,B} \times W \times \frac{A\,E}{E\,B},$$

and a resulting compression ensues on

$$A\,B = -\frac{A\,C}{A\,B} \times W \times \frac{A\,B}{B\,E}.$$

Cranes.



Stress $C\,D = -\frac{C\,D}{A\,D} \times W$

" $A\,C = +\frac{A\,C}{A\,D} \times W$

" $E\,D = -$ stress $D\,C$.

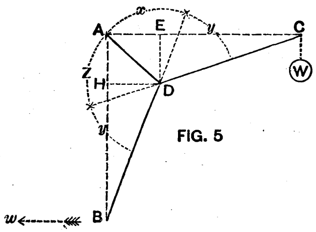
Let $w =$ the horizontal reaction at B

$$w = \frac{C\,D}{A\,B} \times W$$

Stress $B\,E = +\frac{B\,E}{E\,D} \times w$

" $A\,E = +\frac{A\,E}{D\,E} \times (\text{stress } C\,D - w)$

" $B\,A = -\left(\frac{B\,D}{D\,E} \times w + W\right)$



E and H are points where lines drawn from D intersect at right angles $A\,C$ and $A\,B$. X, Y and Z are the angles formed by extending the braces $C\,D$ and $B\,D$ as indicated by dotted lines. $w =$ the horizontal reaction at B

$$w = \frac{A\,C}{A\,B} \times W.$$

Stress $A\,C = +\frac{C\,E}{E\,D} \times W$. Stress $C\,D = -\frac{C\,D}{E\,D} \times W$

" $A\,B = +\frac{B\,H}{D\,H} \times w$. " $B\,D = -\frac{B\,D}{H\,D} \times w$

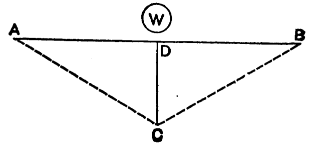
$A\,D = -$ stress $C\,D \times \frac{\text{Sine } Y}{\text{Sine } X}$

or $= -$ stress $B\,D \times \frac{\text{Sine } Y}{\text{Sine } Z}$

Trussed Girders.

Weight in Middle.

FIG. 6



Stress $A\,C$ or

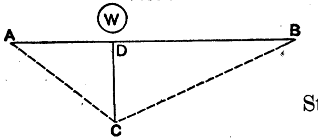
$$B\,C = +\frac{A\,C}{D\,C} \times \frac{W}{2}$$

" $$A\,B = -\frac{A\,D}{D\,C} \times \frac{W}{2}$$

" $$D\,C = -W$$

Weight out of Centre.

FIG. 7



$$\text{Stress } A\,C = +\frac{A\,C \times D\,B}{A\,B \times D\,C} \times W$$

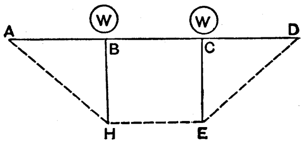
" $$B\,C = +\frac{B\,C \times A\,D}{A\,B \times C\,D} \times W$$

$$\text{Stress } A\,B = -\frac{A\,D \times D\,B}{A\,B \times D\,C} \times W$$

" $$D\,C = -W$$

Equal Loads W. W.

FIG. 8



$$\text{Stress } A\,H \text{ or } D\,E = +\frac{A\,H}{B\,H} \times W$$

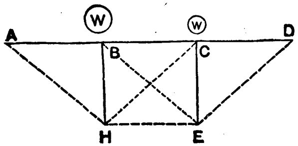
" $$H\,E = +\frac{A\,B}{B\,H} \times W$$

" $$A\,D = -\frac{A\,B}{B\,H} \times W$$

Stress $B\,H$ or $C\,E = -W$

Unequal Loads W and w.

FIG. 9

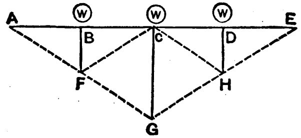


Stress as below on counter diagonals $B\,E$ or $H\,C$ according to position of greatest load.

$$\text{Stress } C\,H = +\frac{C\,H}{B\,H} \times \left(\frac{W-w}{3}\right)$$

Fink Truss.

FIG. 10



Stress $B\,F$ or $D\,H = -W$

" $C\,G = -2\,W$

" $$A\,E = -1\tfrac{1}{2}\,W \times \frac{A\,C}{C\,G}$$

$$\text{Stress } A\,F \text{ or } H\,E = +1\tfrac{1}{2}\,W \times \frac{A\,F}{F\,B}$$

" $$F\,G \text{ or } H\,G = +W \times \frac{A\,G}{C\,G}$$

$$F\,C \text{ or } C\,H = +\frac{W}{2} \times \frac{A\,G}{C\,G}$$

Roofs.

w = load concentrated on each triangular apex.

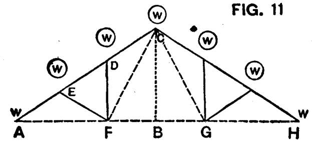


FIG. 11

Strut Stresses.

Stress $D\,F = -w$

" $$E\,F = \frac{w}{2} \times \frac{C\,H}{C\,B}$$

Stresses on Ties.

$$\text{Stress } F\,G = +1\tfrac{1}{2}\,w \times \frac{B\,H}{B\,C}$$

" $$A\,F = +2\tfrac{1}{2}\,w \times \frac{B\,H}{B\,C}$$

" $$C\,F = +1\tfrac{1}{2}\,w \times \frac{C\,G}{B\,C}$$

Rafter Stresses.

$$\text{Stress } C\,E = -2\,w \times \frac{C\,H}{C\,B}$$

" $$E\,A = -2\tfrac{1}{2}\,w \times \frac{C\,H}{C\,B}$$

Roofs.

$w =$ load concentrated on each triangular apex.

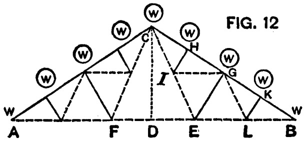


FIG. 12

Strut Stresses.

Stress HI or $KL = -w \times \frac{DB}{CB}$

" $GE = -2w \times \frac{DB}{CB}$

Rafter Stresses.

Stress $KB = -\left(\frac{7w}{2} \times \frac{CB}{CD}\right)$

" $GK = -\left(\frac{7w}{2} \times \frac{CB}{CD} - w \times \frac{CD}{CB}\right)$

" $HG = -\left(\frac{7w}{2} \times \frac{CB}{CD} - 2w \times \frac{CD}{CB}\right)$

" $CH = -\left(\frac{7w}{2} \times \frac{CB}{CD} - 3w \times \frac{CD}{CB}\right)$

Stresses on Ties.

Stress GI or $GL = +\frac{w}{2} \times \frac{DB}{CB} \times \frac{CB}{CD}$

" $EI = +w \times \frac{DB}{CB} \times \frac{CB}{CD}$

" $CI = +\frac{3w}{2} \times \frac{DB}{CB} \times \frac{CB}{CD}$

" $FE = +\frac{8w}{4} \times \frac{DB}{DC}$

" $EL =$ the sum of the stresses on FE and EI.

" $LB =$ the sum of the stresses on EL and GL.

Roofs.

$w =$ load concentrated on each triangular apex.

The rafters and horizontal tie being each uniformly subdivided.

Strut Stresses.

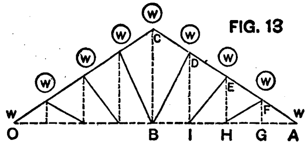


FIG. 13

Stress $FH = -\frac{w}{2} \times \frac{FH}{FG}$

" $EI = -w \times \frac{EI}{EH}$

" $DB = -\frac{3w}{2} \times \frac{DB}{DI}$

Vertical Ties.

Stress $EH = +\frac{w}{2}$. Stress $DI = +w$. Stress $CB = +3w$.

Rafter Stresses.

Stress $CD = -2\ w \times \frac{CA}{CB}$

" $DE = -2\tfrac{1}{2}\ w \times \frac{CA}{CB}$

" $EF = -3\ w \times \frac{CA}{CB}$

" $FA = -3\tfrac{1}{2}\ w \times \frac{CA}{CB}$

Horizontal Tie.

Stress at $B = +2w \times \frac{BA}{BC}$

" $BI = +$ stress at $B + \left(\text{stress } DB \times \frac{BI}{BD}\right)$

" $IH = +$ " $BI + \left(\text{" } EI \times \frac{HI}{EI}\right)$

" $HA = +$ " $IH + \left(\text{" } FH \times \frac{HG}{HF}\right)$

SHAFTING OF STEEL OR WROUGHT IRON.

The resistance to shearing averages about $\frac{8}{10}$ of the tensile strength, *i. e.*, about 40,000 lbs. for wrought iron, or 50,000 lbs. for soft steel, per square inch of section. The torsional resistance of any shaft can be determined when the shearing resistance is known; thus

$$T = .196\, d^3 s \text{ for round shafts,} \qquad (a)$$

$$T = .28\, d^3 s \text{ for square shafts.} \qquad (b)$$

d = diameter of the shaft in inches.
s = shearing strength in pounds per square inch.
T = the torsional moment in inch-pounds; that is, the force in pounds multiplied by the length in inches of the lever through which the force acts.

Taking s at 40,000 and 50,000 lbs., respectively for iron and steel, and assuming that in machinery the working value should be between one-fourth and one-fifth of the ultimate strength—adopting the mean—makes the working resistance to shearing 9,000 lbs. per square inch for iron, and 11,200 lbs. per square inch for steel. Putting this in terms of the torsional moment and diameter, we derive from equations a and b

$$T = 1760\, d^3 \text{ for round iron shafts,} \qquad (c)$$

$$T = 2200\, d^3 \text{ for round steel shafts,} \qquad (d)$$

$$T = 2520\, d^3 \text{ for square iron shafts,} \qquad (e)$$

$$T = 3150\, d^3 \text{ for square steel shafts,} \qquad (f)$$

$$d = \sqrt[3]{\frac{T}{1760}} \text{ for round iron shafts,} \qquad (g)$$

$$d = \sqrt[3]{\frac{T}{2200}} \text{ for round steel shafts,} \qquad (h)$$

$$d = \sqrt[3]{\frac{T}{2520}} \text{ for square iron shafts,} \qquad (i)$$

$$d = \sqrt[3]{\frac{T}{3150}} \text{ for square steel shafts,} \qquad (k)$$

Example 1.—What should be the diameter of a round wrought-iron shaft to safely resist a force of 1,000 lbs. acting through a lever 30 inches long?

$$(g) \qquad d = \sqrt[3]{\frac{1000 \times 30}{1760}} = 2.6 \text{ inches in diameter.}$$

These formulæ apply to shafts subject to twisting strains alone. In practice, however, such cases seldom occur, as shafts are generally subjected to combined bending and twisting strains. As there are no experimental data for such a combination of forces, we have to rely on analysis, which gives the following:

$$T^1 = M + \sqrt{M^2 + T^2} \qquad (l)$$

M = bending moments in inch-pounds. (See page 88.)
T = twisting " "
T^1 = a *new* twisting moment which, substituted for T in equations g to k, will give the desired proportions for the shaft.

In revolving shafts the longitudinal stress resulting from the bending action is continually changing from tension to compression, and vice versa.

It is therefore advisable, for reasons given on page 36, to increase the factor of safety as the bending stress increases comparatively to the torsional stress.

The following changes in factors of safety are recommended:

Ratio of M to T.	*Factor of Safety.*	*Divisor in Formulæ.*	
		(g) for Iron.	*(h) for Steel.*
$M = .3T$ or less,	$4\frac{1}{2}$	1760	2200
$M = .6T$ "	5	1570	1960
$M = T$ "	$5\frac{1}{2}$	1430	1790
M = greater than T,	6	1310	1640

Example 2.—What should be the diameter of the journals of a wrought-iron shaft of a steam engine, the piston being

12 inches diameter, crank 12 inches long, and the leverage from centre of crank to journal in the direction of the shaft being 6 inches, steam pressure 80 lbs. per square inch, making pressure on crank $= 9{,}050$ lbs.?

$$T = 9{,}050 \times 12 = 108{,}600 \text{ inch-lbs.}$$

$$M = 9{,}050 \times 6 = 54{,}300 \quad \text{"}$$

$$(l) \quad T^1 = 54{,}300 + \sqrt{54{,}300^2 + 108{,}600^2} = 175{,}720 \text{ inch-lbs.}$$

Substituting the above in equation (g), with the factor of safety as explained above,

$$d = \sqrt[3]{\frac{175{,}720}{1{,}570}} = 4.82 \text{ inches diameter.}$$

The following illustrates a case where the bending moment is greater than the twisting moment:

Example 3.—A non-continuous shaft is so located that it must have its bearings 84 inches apart, and carry in the middle a 60-inch pulley driven by a 12-inch belt, the effective weight at centre of shaft $= 600$ lbs., and the belt exercises a vertical pull of 1,000 lbs. What is the proper diameter of the shaft?

$$M = \frac{(1{,}000 + 600) \times 84}{4} = 33{,}600 \text{ inch-lbs. (see page 88.)}$$

$$T = 1{,}000 \times 30 = 30{,}000 \text{ inch-lbs.}$$

$$(l) \quad T^1 = 33{,}600 + \sqrt{33{,}600^2 + 30{,}000^2} = 78{,}640 \text{ inch-lbs.}$$

As M is greater than T, use a factor of safety of 6, which becomes by equation (g)

$$d = \sqrt[3]{\frac{78{,}640}{1{,}310}} = 4.12 \text{ inches diameter.}$$

If above shaft was continuous and uniformly loaded, the bending moment would be less. (See Table of Bending Moments, page 90.)

HORSE-POWER.

If it is desired to find the relations between horse-power and diameters of shafts, the elements of time and velocity have to be considered. Taking the horse-power HP at 396,000 inch-lbs. per minute, we have $HP = \frac{6.28 \times T \times V}{396{,}000}$, where $V =$ revolutions per minute.

$$(m) \qquad T = \frac{63{,}057\ HP}{V},$$

or in terms of the diameter by equation (d) we get for shafts of medium steel

$$d = \sqrt[3]{\frac{29\ HP}{V}}. \qquad (o)$$

The above will give the proper diameter of a shaft for transmitting any desired HP when the shaft is subjected to twisting stress alone; but since, as previously stated, such a case seldom occurs, we must combine the bending and twisting stresses, for which a general rule will be given at the close of the subject.

DEFLECTION OF SHAFTING.

As the deflection of steel and iron is practically alike under similar conditions of dimensions and loads, and as shafting is usually determined by its transverse stiffness rather than its ultimate strength, it follows that nearly the same dimensions should be used for steel that are found necessary for iron.

For continuous line shafting used for transmitting power in shops, factories, etc., it is considered good practice to limit the deflection to a maximum of $\frac{1}{100}$ of an inch per foot of length. The weight of bare shafting in pounds $= 2.6\ d^2l = W$, or when as fully loaded with pulleys as is customary in practice, and allowing 40 lbs. per inch of width for the vertical pull of the belts, experience shows the load in pounds to be about $13\ d^2l = W$. Taking the modulus of transverse elasticity at 26,000,000 lbs., we can derive from the authoritative formulæ the following:

$$l = \sqrt[3]{873d^2} \text{ for bare shafts,} \qquad (p)$$

$$l = \sqrt[3]{175d^2} \text{ for shafts carrying pulleys, etc.,} \qquad (r)$$

which would be the maximum distance in feet between bearings for continuous shafting subjected to bending stress alone.

If the length is fixed, and we desire the diameter of the shaft, we have,

$$d = \sqrt{\frac{l^3}{873}} \text{ for bare shafting.} \qquad (s)$$

$$d = \sqrt{\frac{l^3}{175}} \text{ for shafting carrying pulleys, etc.} \qquad (t)$$

To apply the above to revolving shafting subjected to both twisting and bending stress, it is necessary to combine equations (p) and (r) with equation (o).

But in shafting, with the same transmission of power, the torsional stress is inversely proportional to the velocity of rotation, while the bending stress will not be reduced in the same ratio. It is, therefore, impossible to write a formula covering the whole problem and sufficiently simple for practical application, but the following rules are correct within the range of velocities usual in practice.

WORKING FORMULÆ FOR CONTINUOUS SHAFTING.

For the diameter (d) in inches, and the maximum length (l) in feet between bearings of steel or iron shafting so proportioned as to deflect not more than $\frac{1}{100}$ of an inch per foot of length, allowance being made for the weakening effect of key seats,

$$d = \sqrt[3]{\frac{50\,HP}{V}} \text{ for bare shafts,} \qquad (u)$$

$$d = \sqrt[3]{\frac{70\,HP}{V}} \text{ for shafts carrying pulleys, etc.,} \qquad (v)$$

$$l = \sqrt[3]{720\,d^2} \text{ for bare shafts} \qquad (w)$$

$$l = \sqrt[3]{140\,d^2} \text{ for shafts carrying pulleys, etc.,} \qquad (x)$$

In the event of the whole power being received on a principal shaft, the proper size of the shaft can be estimated direct by formula (l).

Example 4.—A principal shaft receiving 150 HP from the engine, revolves 150 R. P. M., and is continuous over bearings located 6 feet apart, the centre of main pulley being 24 inches from one bearing and 48 inches from the other. The effective load at the centre of the pulley resulting from weight of pulley and shaft, and tension of belt, is 1,500 lbs. What should be the diameter of the shaft?

Note.—Excepting special cases which rarely occur in practice, it is best to treat such shafts as non-continuous.

By Fig. 5, page 89 we have

$$M = \frac{1{,}500 \times 24 \times 48}{72} = 24{,}000 \text{ inch-lbs.,}$$

and by formula (m) we have

$$T = \frac{63{,}000 \times 150}{150} = 63{,}000 \text{ inch-lbs.,}$$

then by formula (l) we have

$$T^1 = 24{,}000 + \sqrt{24{,}000^2 + 63{,}000^2} = 92{,}290 \text{ inch-lbs.,}$$

and by formula (g)

$$d = \sqrt[3]{\frac{92{,}290}{1{,}760}} = 3.74 \text{ inches.}$$

The moment of resistance of round shafts for bending is one-half of the resistance for twisting strains.

The resistances are simply and accurately expressed thus:

$$M = \frac{AD}{8} \text{ and } T = \frac{AD}{4} \text{ for solid shafts.}$$

$$M = \frac{AD^2 - ad^2}{8D} \text{ and } T = \frac{AD^2 - ad^2}{4D} \text{ for hollow shafts.}$$

D being full diameter and A corresponding area, d is internal diameter and a corresponding area.

BELTING.

When designing shafting, allow for the tension of belting, 50 lbs. per inch of width for single leather belt or its equivalent, or 80 lbs. per inch of width for double leather belt, or its equivalent of other material.

WORKING PROPORTIONS FOR CONTINUOUS SHAFTING.

MEDIUM STEEL.

Transmitting power, but subject to no bending action except its own weight.

Diameter of Shaft in Inches.	*Maximum Safe Torsional Moment in Foot Pounds.*	*Revolutions per Minute.* 100	150	200	250	300	*Maximum Distance in Feet Between Bearings.*
		HP	*HP*	*HP*	*HP*	*HP*	
1½	618	7	10	14	17	20	11.7
1⅝	786	9	13	17	21	26	12.4
1¾	982	11	16	21	26	32	13.0
1⅞	1208	13	20	26	33	40	13.6
2	1467	16	24	32	40	48	14.2
2⅛	1758	19	29	38	48	58	14.8
2¼	2088	23	34	46	57	68	15.4
2⅜	2457	27	40	54	67	80	16.0
2½	2865	31	47	63	78	94	16.5
2¾	3896	42	62	83	102	124	17.6
3	4950	54	81	108	134	162	18.6
3¼	6293	69	103	137	172	206	19.7
3½	7860	86	129	172	215	258	20.7
3¾	9668	105	158	211	264	316	21.6
4	11733	128	192	256	320	384	22.6

WORKING PROPORTIONS FOR CONTINUOUS SHAFTING.

MEDIUM STEEL.

Transmitting power, and subject to bending action of pulleys, belting, etc.

Diameter of Shaft in Inches.	*Maximum Safe Torsional Moment in Foot-Pounds.*	*Revolutions per Minute.* 100	150	200	250	300	*Maximum Distance in Feet Between Bearings.*
		HP	*HP*	*HP*	*HP*	*HP*	
1½	618	5	7	10	12	14	6.8
1⅝	786	6	9	12	15	18	7.2
1¾	982	8	11	15	18	22	7.5
1⅞	1208	9	14	19	23	28	7.9
2	1467	11	17	23	28	34	8.2
2⅛	1758	14	21	27	34	42	8.6
2¼	2088	16	24	33	41	48	8.9
2⅜	2457	19	29	38	48	58	9.2
2½	2865	22	33	45	55	66	9.6
2¾	3896	24	36	48	60	72	10.2
3	4950	39	58	77	96	116	10.8
3¼	6293	49	74	98	123	148	11.4
3½	7860	61	92	123	153	184	12.0
3¾	9668	75	113	151	188	226	12.5
4	11733	91	137	183	228	274	13.1

DIAMETER IN INCHES FOR ROUND STEEL SHAFTS.

PROPORTIONED FOR RESISTANCE TO TORSION, WITH THE LIMITATIONS DESCRIBED ON OPPOSITE PAGE.

Torsional Moments in Foot Pounds.	$\frac{H.P.}{R.P.M.}$	*Diameter in Inches for Conditions Described.*			*Torsional Moments in Foot Pounds.*	$\frac{H.P.}{R.P.M.}$	*Diameter in Inches for Conditions Described.*		
		No. 1.	*No. 2.*	*No. 3.*			*No. 1.*	*No. 2.*	*No. 3.*
500	.095	2.4	2.6	2.9	15000	2.855	5.7	6.2	6.8
600	.114	2.6	2.8	3.0	18000	3.425	6.0	6.5	7.1
800	.152	2.8	3.0	3.3	21000	3.996	6.2	6.7	7.4
1000	.190	2.9	3.2	3.5	25000	4.757	6.5	7.0	7.7
1200	.228	3.0	3.3	3.6	30000	5.709	6.8	7.4	8.1
1500	.286	3.2	3.5	3.8	35000	6.660	7.1	7.6	8.4
1800	.343	3.4	3.6	4.0	40000	7.612	7.3	7.9	8.7
2100	.400	3.5	3.8	4.2	45000	8.563	7.5	8.1	9.0
2500	.476	3.7	3.9	4.3	50000	9.515	7.7	8.4	9.2
3000	.571	3.8	4.1	4.6	60000	11.418	8.1	8.7	9.6
4000	.761	4.1	4.4	4.9	70000	13.321	8.4	9.1	10.0
5000	.952	4.4	4.7	5.2	80000	15.224	8.7	9.4	10.3
6000	1.142	4.6	4.9	5.4	90000	17.127	9.0	9.7	10.6
8000	1.522	4.9	5.3	5.8	100000	19.029	9.2	9.9	10.9
10000	1.903	5.2	5.6	6.1	120000	22.835	9.6	10.4	11.4
12000	2.284	5.4	5.8	6.4	150000	28.544	10.2	11.0	12.1

TORSIONAL STIFFNESS OF SHAFTS.

Torsional elasticity is calculated from the following formulæ:

$$X = \frac{T\,l}{E^1\,I p}$$

X = length of arc of deflection, for a unit of length and unit radius.
T = moment of torsion.
l = length of shaft subject to torsion.
Ip = polar moment of inertia of cross-section.
E^1 = modulus of torsional shear = $\frac{4}{10}$ of the modulus of elasticity or about 11,600,000 pounds for steel shafts.

From this is obtained the angle of torsion in degrees V for each foot of length L for steel shafts of diameter "d" in inches:

$$V = \frac{T\,L}{1661\,d^4} \text{ for round shafts.}$$

$$V = \frac{T\,L}{2820\,d^4} \text{ for square shafts.}$$

The amount of torsional yield or twist permissible is obtained by experience and depends on the service to which the shaft is subjected. The following is considered good practice within the limits of length usual in ordinary practice:

PERMISSIBLE TWIST PER FOOT OF LENGTH.

No. 1. .10 degree for ordinary service, no violent fluctuations.
No. 2. .075 degree with fluctuating loads, suddenly applied.
No. 3. .050 degree when suddenly reversed under full load.

These give, when applied to the foregoing rule, for round steel shafts diameter d in inches for torsional moments T in inch pounds or for

$$\frac{H.P.}{R.P.M.} = \frac{\text{horse-power in foot pounds per minute}}{\text{number of revolutions per minute}}$$

$$\text{No. 1.} \quad d = .278\sqrt[4]{T} = 4.4\sqrt[4]{\frac{H.P.}{R.P.M.}}$$

$$\text{No. 2.} \quad d = .30\sqrt[4]{T} = 4.75\sqrt[4]{\frac{H.P.}{R.P.M.}}$$

$$\text{No. 3.} \quad d = .33\sqrt[4]{T} = 5.23\sqrt[4]{\frac{H.P.}{R.P.M.}}$$

The table on opposite page gives diameters for shafts corresponding to given torsion moments or power transmission, and for the three cases of limitation of twist described above.

If the shaft is subjected to bending stress in addition to twisting, it should be reinforced as previously described.

MAXIMUM BENDING MOMENTS ON PINS,

WITH EXTREME FIBRE STRAINS

VARYING FROM 15,000 TO 25,000 POUNDS PER SQUARE INCH.

Diameter of Pin in Inches.	Area of Pin in Sq. Inches.	*Moments in Inch-Pounds for Fibre Strains of*				Diameter of Pin in Inches.
		15,000 *lbs.* *per Sq. Inch.*	20,000 *lbs.* *per Sq. Inch.*	22,000 *lbs.* *per Sq. Inch.*	25,000 *lbs.* *per Sq. Inch.*	
1	0.785	1470	1960	2160	2450	1
$1\frac{1}{8}$	0.994	2100	2800	3080	3500	$1\frac{1}{8}$
$1\frac{1}{4}$	1.227	2880	3830	4220	4790	$1\frac{1}{4}$
$1\frac{3}{8}$	1.485	3830	5100	5620	6380	$1\frac{3}{8}$
$1\frac{1}{2}$	1.767	4970	6630	7290	8280	$1\frac{1}{2}$
$1\frac{5}{8}$	2.074	6320	8430	9270	10500	$1\frac{5}{8}$
$1\frac{3}{4}$	2.405	7890	10500	11570	13200	$1\frac{3}{4}$
$1\frac{7}{8}$	2.761	9710	12900	14240	16200	$1\frac{7}{8}$
2	3.142	11800	15700	17280	19600	2
$2\frac{1}{8}$	3.547	14100	18800	20730	23600	$2\frac{1}{8}$
$2\frac{1}{4}$	3.976	16800	22400	24600	28000	$2\frac{1}{4}$
$2\frac{3}{8}$	4.430	19700	26300	28900	32900	$2\frac{3}{8}$
$2\frac{1}{2}$	4.909	23000	30700	33700	38400	$2\frac{1}{2}$
$2\frac{5}{8}$	5.412	26600	35500	39000	44400	$2\frac{5}{8}$
$2\frac{3}{4}$	5.940	30600	40800	44900	51000	$2\frac{3}{4}$
$2\frac{7}{8}$	6.492	35000	46700	51300	58300	$2\frac{7}{8}$
3	7.069	39800	53000	58300	66300	3
$3\frac{1}{8}$	7.670	44900	59900	65900	74900	$3\frac{1}{8}$
$3\frac{1}{4}$	8.296	50600	67400	74100	84300	$3\frac{1}{4}$
$3\frac{3}{8}$	8.946	56600	75500	83000	94400	$3\frac{3}{8}$
$3\frac{1}{2}$	9.621	63100	84200	92600	105200	$3\frac{1}{2}$
$3\frac{5}{8}$	10.321	70100	93500	102900	116900	$3\frac{5}{8}$
$3\frac{3}{4}$	11.045	77700	103500	113900	129400	$3\frac{3}{4}$
$3\frac{7}{8}$	11.793	85700	114200	125600	142800	$3\frac{7}{8}$
4	12.566	94200	125700	138200	157100	4
$4\frac{1}{8}$	13.364	103400	137800	151600	172300	$4\frac{1}{8}$
$4\frac{1}{4}$	14.186	113000	150700	165800	188400	$4\frac{1}{4}$
$4\frac{3}{8}$	15.033	123300	164400	180800	205500	$4\frac{3}{8}$
$4\frac{1}{2}$	15.904	134200	178900	196800	223700	$4\frac{1}{2}$
$4\frac{5}{8}$	16.800	145700	194300	213700	242800	$4\frac{5}{8}$
$4\frac{3}{4}$	17.721	157800	210400	231500	263000	$4\frac{3}{4}$
$4\frac{7}{8}$	18.665	170600	227500	250200	284400	$4\frac{7}{8}$
5	19.635	184100	245400	270000	306800	5
$5\frac{1}{8}$	20.629	198200	264300	290700	330400	$5\frac{1}{8}$
$5\frac{1}{4}$	21.648	213100	284100	312500	355200	$5\frac{1}{4}$
$5\frac{3}{8}$	22.691	228700	304900	335400	381100	$5\frac{3}{8}$
$5\frac{1}{2}$	23.758	245000	326700	359300	408300	$5\frac{1}{2}$
$5\frac{5}{8}$	24.850	262100	349500	384400	436800	$5\frac{5}{8}$
$5\frac{3}{4}$	25.967	280000	373300	410600	466600	$5\frac{3}{4}$
$5\frac{7}{8}$	27.109	298600	398200	438000	497700	$5\frac{7}{8}$

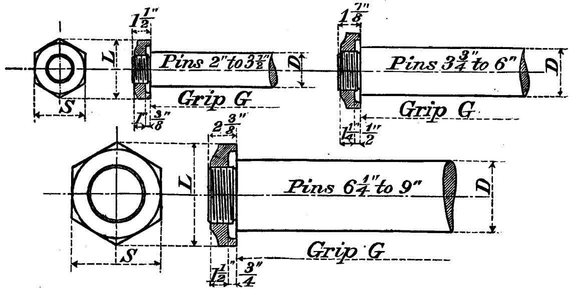
MAXIMUM BENDING MOMENTS ON PINS,

WITH EXTREME FIBRE STRAINS

VARYING FROM 15,000 TO 25,000 POUNDS PER SQUARE INCH.

Diameter of Pin in Inches.	Area of Pin in Sq. Inches.	*Moments in Inch-Pounds for Fibre Strains of*				Diameter of Pin in Inches.
		15,000 *lbs.* *per Sq Inch.*	20,000 *lbs.* *per Sq. Inch.*	22,000 *lbs.* *per Sq. Inch.*	25,000 *lbs.* *per Sq. Inch.*	
6	28.274	318100	424100	466500	530200	6
$6\frac{1}{8}$	29.465	338400	451200	496300	564000	$6\frac{1}{8}$
$6\frac{1}{4}$	30.680	359500	479400	527300	599200	$6\frac{1}{4}$
$6\frac{3}{8}$	31.919	381500	508700	559600	635900	$6\frac{3}{8}$
$6\frac{1}{2}$	33.183	404400	539200	593100	674000	$6\frac{1}{2}$
$6\frac{5}{8}$	34.472	428200	570900	628000	713700	$6\frac{5}{8}$
$6\frac{3}{4}$	35.785	452900	603900	664200	754800	$6\frac{3}{4}$
$6\frac{7}{8}$	37.122	478500	638000	701800	797500	$6\frac{7}{8}$
7	38.485	505100	673500	740800	841900	7
$7\frac{1}{8}$	39.871	532700	710200	781200	887800	$7\frac{1}{8}$
$7\frac{1}{4}$	41.282	561200	748200	823000	935300	$7\frac{1}{4}$
$7\frac{3}{8}$	42.718	590700	787600	866300	984500	$7\frac{3}{8}$
$7\frac{1}{2}$	44.179	621300	828400	911200	1035400	$7\frac{1}{2}$
$7\frac{5}{8}$	45.664	652900	870500	957500	1088100	$7\frac{5}{8}$
$7\frac{3}{4}$	47.173	685500	914000	1005300	1142500	$7\frac{3}{4}$
$7\frac{7}{8}$	48.707	719200	958900	1054800	1198700	$7\frac{7}{8}$
8	50.265	754000	1005300	1105800	1256600	8
$8\frac{1}{8}$	51.849	789900	1053200	1158500	1316500	$8\frac{1}{8}$
$8\frac{1}{4}$	53.456	826900	1102500	1212800	1378200	$8\frac{1}{4}$
$8\frac{3}{8}$	55.088	865100	1153400	1268800	1441800	$8\frac{3}{8}$
$8\frac{1}{2}$	56.745	904400	1205800	1326400	1507300	$8\frac{1}{2}$
$8\frac{5}{8}$	58.426	944900	1259800	1385800	1574800	$8\frac{5}{8}$
$8\frac{3}{4}$	60.132	986500	1315400	1446900	1644200	$8\frac{3}{4}$
$8\frac{7}{8}$	61.862	1029400	1372500	1509800	1715700	$8\frac{7}{8}$
9	63.617	1073500	1431400	1574500	1789200	9
$9\frac{1}{8}$	65.397	1118900	1491900	1641100	1864800	$9\frac{1}{8}$
$9\frac{1}{4}$	67.201	1165500	1554000	1709400	1942500	$9\frac{1}{4}$
$9\frac{3}{8}$	69.029	1213400	1617900	1779600	2022300	$9\frac{3}{8}$
$9\frac{1}{2}$	70.882	1262600	1683400	1851800	2104300	$9\frac{1}{2}$
$9\frac{5}{8}$	72.760	1313100	1750800	1925900	2188500	$9\frac{5}{8}$
$9\frac{3}{4}$	74.662	1364900	1819900	2001900	2274900	$9\frac{3}{4}$
$9\frac{7}{8}$	76.590	1418100	1890800	2079900	2363500	$9\frac{7}{8}$
10	78.54	1472600	1963500	2159900	2454400	10
$10\frac{1}{4}$	82.52	1585900	2114500	2325900	2643100	$10\frac{1}{4}$
$10\frac{1}{2}$	86.59	1704700	2273000	2500200	2841200	$10\frac{1}{2}$
$10\frac{3}{4}$	90.76	1829400	2439300	2683200	3049100	$10\frac{3}{4}$
11	95.03	1960100	2613400	2874800	3266800	11
$11\frac{1}{4}$	99.40	2096800	2795700	3075400	3494800	$11\frac{1}{4}$
$11\frac{1}{2}$	103.87	2239700	2986300	3284800	3732800	$11\frac{1}{2}$
12	113.10	2544700	3392900	3732200	4241200	12

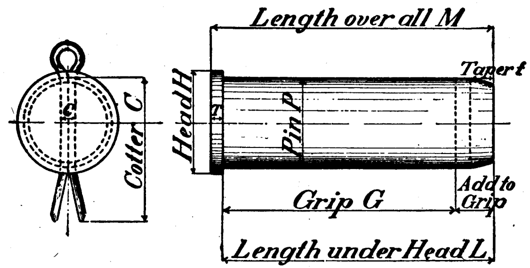
STANDARD PINS AND NUTS FROM 2″ TO 9″ DIAMETER.



	PIN.						NUT.				Additional Amt. Added for Grip.	WASHER.		
	Diameter of Pin.		Diameter of Pin Hole.	Play in Pin Hole.	Screw. Diameter.	Screw. Length.	Size of Rough Hole.	Short Diameter. S.	Long Diameter. L.	Weight of Nut.		Diameter.	Thickness.	Hole.
Lateral Pins.	2	2.00	2.030	0.030	1½	1½	1 5/16	3¼	3¾	1¼	¼	4¼	3/8	2 1/8
	2¼	2.25	2.280	0.030	1½	1½	1 5/16	3¼	3¾	1¼	¼	4¼	3/8	2 3/8
	2½	2.50	2.530	0.030	2	1½	1 13/16	3¾	4 5/16	2	¼	4¾	3/8	2 5/8
	2¾	2.75	2.780	0.030	2	1½	1 13/16	3¾	4 5/16	2	¼	5	3/8	2 7/8
	3	3.00	3.030	0.030	2½	1½	2 5/16	4½	5 3/16	2½	¼	5¾	3/8	3 1/8
	3¼	3.25	3.280	0.030	2½	1½	2 5/16	4½	5 3/16	2½	¼	5¾	3/8	3 3/8
	3½	3.50	3.530	0.030	2½	1½	2 5/16	4½	5 3/16	2½	¼	6 1/8	3/8	3 5/8
Truss Pins.	3¾	3.75	3.771	0.021	3	1 7/8	2 13/16	5	5¾	3¼	½	6½	½	3 7/8
	4	4.00	4.022	0.022	3	1 7/8	2 13/16	5	5¾	3¼	½	6¾	½	4 1/8
	4¼	4.25	4.273	0.023	3½	1 7/8	3 5/16	5¾	6 5/8	4½	½	7¼	½	4 3/8
	4½	4.50	4.524	0.024	3½	1 7/8	3 5/16	5¾	6 5/8	4½	½	7 3/8	½	4 5/8
	4¾	4.75	4.775	0.025	3½	1 7/8	3 5/16	5¾	6 5/8	4½	½	7¾	½	4 7/8
	5	5.00	5.026	0.026	4	1 7/8	3 13/16	6½	7½	6	½	8	½	5 1/8
	5¼	5.25	5.277	0.027	4	1 7/8	3 13/16	6½	7½	6	½	8 3/8	½	5 3/8
	5½	5.50	5.528	0.028	4½	1 7/8	4 5/16	7	8 1/8	7½	½	8¾	½	5 5/8
	5¾	5.75	5.779	0.029	4½	1 7/8	4 5/16	7	8 1/8	7½	½	9 1/8	½	5 7/8
	6	6.00	6.030	0.030	4½	1 7/8	4 5/16	7	8 1/8	7½	½	9½	½	6 1/8
	6¼	6.25	6.28	0.030	5	2 3/8	4 13/16	7¾	8 15/16		¾	9 7/8	5/8	6 3/8
	6½	6.50	6.53	0.030	5	2 3/8	4 13/16	7¾	8 15/16		¾	10¼	5/8	6 5/8
	6¾	6.75	6.78	0.030	5½	2 3/8	5 5/16	8¼	9½		¾	10 5/8	5/8	6 7/8
	7	7.00	7.03	0.030	5½	2 3/8	5 5/16	8¼	9½		¾	10 7/8	5/8	7 1/8
	7¼	7.25	7.28	0.030	6	2 3/8	5 13/16	9	10 3/8		¾	11 1/8	5/8	7 3/8
	7½	7.50	7.53	0.030	6	2 3/8	5 13/16	9	10 3/8		¾	11½	5/8	7 5/8
	7¾	7.75	7.78	0.030	6½	2 3/8	6 5/16	9½	11		¾	11 7/8	5/8	7 7/8
	8	8.00	8.03	0.030	6½	2 3/8	6 5/16	9½	11		¾	12¼	5/8	8 1/8
	8¼	8.25	8.28	0.030	7	2 3/8	6 13/16	10¼	11 13/16		¾	12 5/8	5/8	8 3/8
	8½	8.50	8.53	0.030	7	2 3/8	6 13/16	10¼	11 13/16		¾	13¼	5/8	8 5/8
	8¾	8.75	8.78	0.030	7½	2 3/8	7 5/16	11	12 11/16		¾	13 5/8	5/8	8 7/8
	9	9.00	9.03	0.030	7½	2 3/8	7 5/16	11	12 11/16		¾	14	5/8	9 1/8

Note.—To obtain grip *G* of pin, add 1/16 extra for each bar packed together with the proper additional amount given above in the table.

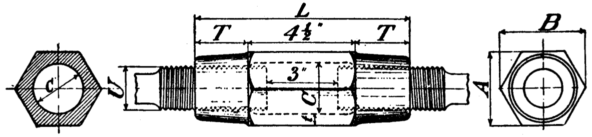
STANDARD COTTER PINS FROM 1″ TO 3¾″ DIAMETER.



Diameter of Pin.		Diameter of Pin Hole.	Play in Pin Hole.	Diameter of Head H.	Thickness of Head T.	Taper at End t.	Length L under Head equal to.	Length M over all equal to.	Size of Cotter C.	Diameter of Pin P.
1	1.00	1.03	0.03	1¼	¼	5/16 x 1/16	G + 5/8	G + 7/8	¼ x 1¾	1
1¼	1.25	1.28	0.03	1½	¼	5/16 x 1/16	G + 5/8	G + 7/8	¼ x 2	1¼
1½	1.50	1.53	0.03	1¾	¼	7/16 x 3/32	G + ¾	G + 1	5/16 x 2½	1½
1¾	1.75	1.78	0.03	2	¼	7/16 x 3/32	G + ¾	G + 1	5/16 x 2¾	1¾
2	2.00	2.03	0.03	2 3/8	3/8	½ x 1/8	G + 7/8	G + 1¼	3/8 x 3	2
2¼	2.25	2.28	0.03	2 5/8	3/8	½ x 1/8	G + 7/8	G + 1¼	3/8 x 3¼	2¼
2½	2.50	2.53	0.03	2 7/8	3/8	5/8 x 5/32	G + 1 1/8	G + 1½	7/16 x 3¾	2½
2¾	2.75	2.78	0.03	3 1/8	3/8	5/8 x 5/32	G + 1 1/8	G + 1½	7/16 x 4	2¾
3	3.00	3.03	0.03	3½	½	¾ x 3/16	G + 1 3/8	G + 1 7/8	½ x 5	3
3¼	3.25	3.28	0.03	3¾	½	¾ x 3/16	G + 1 3/8	G + 1 7/8	½ x 5	3¼
3½	3.50	3.53	0.03	4	½	7/8 x 7/32	G + 1 5/8	G + 2 1/8	5/8 x 6	3½
3¾	3.75	3.78	0.03	4¼	½	7/8 x 7/32	G + 1 5/8	G + 2 1/8	5/8 x 6	3¾

STANDARD SLEEVE NUTS.

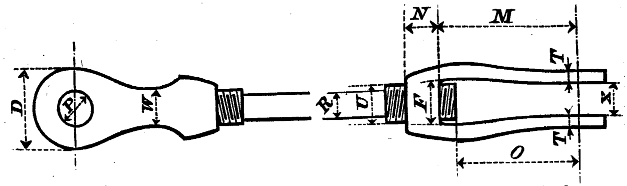
U. S. Standard Thread.



Round Bars. Diam.	Round Bars. Area.	Square Bars. Side.	Square Bars. Area.	Size of Upset. U.	Length of Thread. T.	Length of Nut. L.	Short Diam. Nut. A.	Long Diam. Nut. B.	Inside Diam. Nut. C.	Thickness. t.	Weight of One Sleeve Nut.
5/8	0.307			7/8 x 4	1 1/4	7	1 5/8	1 7/8	1 1/8	1/4	
3/4	0.442			1 x 4	1 1/4	7	1 5/8	1 7/8	1 1/8	1/4	
		3/4	0.563	1 1/8 x 4	1 1/2	7 1/2	2	2 5/16	1 3/8	5/16	3 1/2
7/8	0.601	7/8	0.766	1 1/4 x 4	1 1/2	7 1/2	2	2 5/16	1 3/8	5/16	4
1	0.785			1 3/8 x 4	1 3/4	8	2 3/8	2 3/4	1 5/8	3/8	4 1/2
1 1/8	0.994	1	1.000	1 1/2 x 4	1 3/4	8	2 3/8	2 3/4	1 5/8	3/8	6 1/2
1 1/4	1.227	1 1/8	1.266	1 5/8 x 4 1/2	2	8 1/2	2 3/4	3 3/16	1 7/8	7/16	8
1 3/8	1.485			1 3/4 x 4 1/2	2	8 1/2	2 3/4	3 3/16	1 7/8	7/16	8 1/2
		1 1/4	1.563	1 7/8 x 4 1/2	2 1/4	9	3 1/8	3 5/8	2 1/8	1/2	10
1 1/2	1.767	1 3/8	1.891	2 x 5	2 1/4	9	3 1/8	3 5/8	2 1/8	1/2	11
1 5/8	2.074			2 1/8 x 5	2 1/2	9 1/2	3 1/2	4 1/16	2 3/8	9/16	14
1 3/4	2.405	1 1/2	2.250	2 1/4 x 5	2 1/2	9 1/2	3 1/2	4 1/16	2 3/8	9/16	15
1 7/8	2.761	1 5/8	2.641	2 3/8 x 5 1/2	2 3/4	10	3 7/8	4 1/2	2 5/8	5/8	18
2	3.142	1 3/4	3.063	2 1/2 x 5 1/2	2 3/4	10	3 7/8	4 1/2	2 5/8	5/8	19
2 1/8	3.547			2 5/8 x 5 1/2	3	10 1/2	4 1/4	4 15/16	2 7/8	11/16	22
		1 7/8	3.516	2 3/4 x 6	3	10 1/2	4 1/4	4 15/16	2 7/8	11/16	23
2 1/4	3.976	2	4.000	2 7/8 x 6	3 1/4	11	4 5/8	5 3/8	3 1/8	3/4	27
2 3/8	4.430	2 1/8	4.516	3 x 6	3 1/4	11	4 5/8	5 3/8	3 1/8	3/4	28
2 1/2	4.909			3 1/8 x 6 1/2	3 1/2	11 1/2	5	5 13/16	3 3/8	13/16	34
2 5/8	5.412	2 1/4	5.063	3 1/4 x 6 1/2	3 1/2	11 1/2	5	5 13/16	3 3/8	13/16	35
2 3/4	5.940			3 3/8 x 7	3 3/4	12	5 3/8	6 1/8	3 5/8	7/8	39
		2 3/8	5.641	3 1/2 x 7	3 3/4	12	5 3/8	6 1/8	3 5/8	7/8	40
2 7/8	6.492	2 1/2	6.250	3 5/8 x 8	4	12 1/2	5 3/4	6 11/16	3 7/8	15/16	45
3	7.069			3 3/4 x 8	4	12 1/2	5 3/4	6 11/16	3 7/8	15/16	47
3 1/8	7.670	2 5/8	6.891	3 7/8 x 8	4 1/4	13	6 1/8	7 1/8	4 1/8	1	52
3 1/4	8.296	2 3/4	7.563	4 x 8	4 1/4	13	6 1/8	7 1/8	4 1/8	1	55

PENCOYD STEEL CLEVISES.

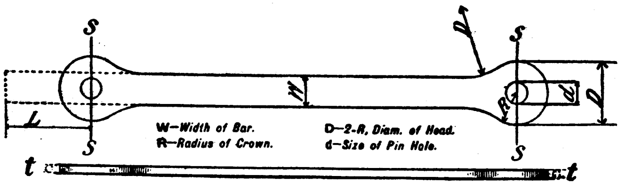
PROPORTIONED ACCORDING TO PENCOYD SPECIFICATIONS.



Distance *X* can be made to suit connections.—All dimensions in inches.

Number of Clevis.	Square Rod. R.	Upset. U.	Max. Pin. P.	Diameter. D.	Distance. M.	Nut. N.	Width. W.	Thickness. T.	Fork. F.	Distance. O.	Weight in Pounds.
1	1 1/8	1 5/8	1 3/4	4 1/2	9	2	2	1/2	2	8	
1	1	1 1/2	2	4 1/2	9	2	2	1/2	2	8	12 1/2
1	7/8	1 1/4	2 1/4	4 1/2	9	2	2	1/2	2	8	
2	1 3/8	2	2	5	9	2 1/4	2 1/4	5/8	2 1/4	8	
2	1 1/4	1 7/8	2 1/4	5	9	2 1/4	2 1/4	5/8	2 1/4	8	13 1/2
2	1 1/8	1 5/8	2 1/2	5	9	2 1/4	2 1/4	5/8	2 1/4	8	
3	1 5/8	2 3/8	2 1/4	5 1/2	9	2 1/2	2 1/2	3/4	2 1/2	8	
3	1 1/2	2 1/4	2 1/2	5 1/2	9	2 1/2	2 1/2	3/4	2 1/2	8	18
3	1 3/8	2	2 3/4	5 1/2	9	2 1/2	2 1/2	3/4	2 1/2	8	
4	1 7/8	2 3/4	2 3/4	6 1/2	9	3	3	7/8	3	8	
4	1 3/4	2 1/2	3	6 1/2	9	3	3	7/8	3	8	30
4	1 5/8	2 3/8	3 1/4	6 1/2	9	3	3	7/8	3	8	
5	2 1/4	3 1/4	3 1/4	7 1/2	9	3 1/2	3 1/2	1 1/8	3 1/2	8	
5	2 1/8	3	3 1/2	7 1/2	9	3 1/2	3 1/2	1 1/8	3 1/2	8	39
5	2	2 7/8	3 3/4	7 1/2	9	3 1/2	3 1/2	1 1/8	3 1/2	8	
6	2 5/8	3 7/8	4	9	12	4 1/4	4 1/4	1 5/16	4 1/4	10 1/2	
6	2 1/2	3 5/8	4 1/4	9	12	4 1/4	4 1/4	1 5/16	4 1/4	10 1/2	50
6	2 3/8	3 1/2	4 1/2	9	12	4 1/4	4 1/4	1 5/16	4 1/4	10 1/2	
7	3	4 1/2	4 3/4	10 1/2	15	5	5	1 1/2	5	13 1/2	
7	2 7/8	4 1/4	5	10 1/2	15	5	5	1 1/2	5	13 1/2	100
7	2 3/4	4	5 1/4	10 1/2	15	5	5	1 1/2	5	13 1/2	

TABLE OF STANDARD STEEL EYE BARS.

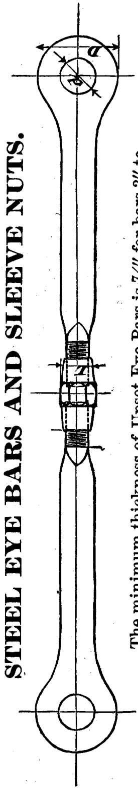


W Width of Bar. Inches.	t Minimum Thickness of Bar. Inches.	D Diameter of Head. Inches.	d Diameter of Largest Pin. Inches.	L Additional Length of Bar Beyond Centre of Eye Required to Form One Head. Inches.
3	3/4	7	3	15
3	3/4	8	3 7/8	17 1/2
4	3/4	9 1/2	4 1/8	19 1/2
4	3/4	10 1/2	5 1/16	22
5	3/4	11 1/2	4 13/16	21
5	1	12 1/2	5 11/16	24 3/4
6	3/4	13 1/2	5 1/2	23
6	1	14 1/2	6 5/16	26 1/4
7	7/8	16	6 11/16	26 3/4
7	15/16	17	7 1/2	31 3/4
7	1	18	8 1/2	36 3/4
8	1	17	6	26 3/4
8	1 1/16	18	7	30
8	1 1/8	18 1/2	7 1/2	33 3/4
9				
9				
9				
10				
10				
10				
12				
12				
12				

NOTE.—Pencoyd eye bars are hydraulic forged, and are guaranteed to develop the full strength of the bar, under conditions given in the above table, when tested to destruction. The maximum sizes of pins given in the above table allow an excess in sectional area of head on line "SS" over that of the body of the bar of 33 % for diameters of pins, not larger than the width of the bar and 36 % for pins of larger diameter than the width of the bar; the thickness of eye being the same as the thickness of the body of the bar, or not exceeding the same by more than 1/16 of an inch.

The steel manufactured by us for the use of eye bars is open hearth steel, and will be furnished of such quality as to satisfy the demands of engineers.

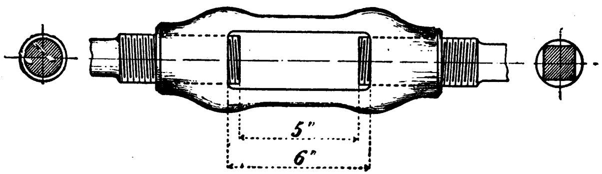
STEEL EYE BARS AND SLEEVE NUTS.



The minimum thickness of Upset Eye Bars is 7/8″ for bars 3″ to 5″ inclusive. 1″ for 6″ bars and 1 1/8″ for 7″ bars.

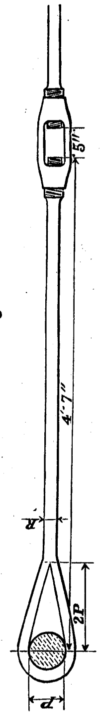
EYE BAR. Maximum Size. Inches.	Area. Sq. Ins.	Weight per Foot. Pounds.	D Diam. of Head. Inches.	d Diam. of Largest Pin. Inches.	Add for 1 Head.	UPSET. Diameter and Length of Screw. Inches.	Diam. at Root of Thread. Inches.	Area at Root of Thread. Sq. Ins.	Number of Threads per Inch.	Add for 1 Upset.	SLEEVE NUT. Length. Inches.	S Hexagon. Short Diam. Inches.	L Hexagon. Long Diam. Inches.	Weight of 1 Sleeve Nut. Lbs.
3 x 7/8	2.63	8.93	7	3	1′-3″	2 1/4 x 5	1.962	3.023	4 1/2	1′-4 1/2″	9 1/2	3 1/2	4 1/16	15
3 x 1 1/32	3.10	10.52	8	3 7/8	1′-5 1/2″	2 1/2 x 5 1/2	2.175	3.719	4	1′-4 1/2″	10	3 7/8	4 1/2	19
4 x 31/32	3.88	13.18	9 1/2	4 1/8	1′-7 1/2″	2 3/4 x 6	2.425	4.620	4	1′-7 1/2″	10 1/2	4 1/4	4 15/16	23
4 x 1 1/8	4.50	15.30	10 1/2	5 1/16	1′-10″	3 x 6	2.629	5.428	3 1/2	1′-7 1/2″	11	4 5/8	5 3/8	28
4 x 1 3/8	5.50	18.70	10 1/2	5 1/16	1′-10″	3 1/4 x 6 1/2	2.879	6.510	3 1/2	1′-7 1/2″	11 1/2	5	5 13/16	35
5 x 29/32	4.54	15.41	11 1/2	4 13/16	1′-9″	3 x 6	2.629	5.428	3 1/2	1′-9″	11	4 5/8	5 3/8	28
5 x 1 3/32	5.47	18.60	11 1/2	4 13/16	1′-9″	3 1/4 x 6 1/2	2.879	6.510	3 1/2	1′-9″	11 1/2	5	5 13/16	35
5 x 1 1/4	6.25	21.25	12 1/2	5 11/16	2′-0 3/4″	3 1/2 x 7	3.100	7.548	3 1/4	1′-9″	12	5 3/8	6 1/8	40
5 x 1 7/16	7.19	24.44	12 1/2	5 11/16	2′-0 3/4″	3 3/4 x 8	3.317	8.641	3 1/4	1′-9″	12 1/2	5 3/4	6 11/16	47
6 x 1 1/16	6.38	21.68	13 1/2	5 1/2	1′-11″	3 1/2 x 7	3.100	7.548	3 1/2	1′-11″	12	5 3/8	6 1/8	40
6 x 1 3/16	7.13	24.23	13 1/2	5 1/2	1′-11″	3 3/4 x 8	3.317	8.641	3 1/4	1′-11″	12 1/2	5 3/4	6 11/16	47
6 x 1 3/8	8.25	28.05	14 1/2	6 5/16	2′-2 1/4″	4 x 8	3.567	9.963	3	1′-11″	13	6 1/8	7 1/8	55
6 x 1 9/16	9.38	31.88	14 1/2	6 5/16	2′-2 1/4″	4 1/4 x 9	3.798	11.33	2 7/8	1′-11″	13 1/2	6 1/2	7 9/16	65
7 x 1 3/16	8.31	28.26	16	6 11/16	2′-2 3/4″	4 x 8	3.567	9.963	3	2′-2 3/4″	13	6 1/8	7 1/8	55
7 x 1 11/32	9.41	31.70	17	7 1/2	2′-7 3/4″	4 1/4 x 9	3.798	11.33	2 7/8	2′-2 3/4″	13 1/2	6 1/2	7 9/16	65
7 x 1 17/32	10.72	36.45	18	8 1/2	3′-0 3/4″	4 1/2 x 9	4.028	12.75	2 3/4	2′-2 3/4″	13 1/2	7	8 1/16	75

ALLOWANCE FOR UPSETS ON SQUARE AND ROUND BARS.



Round Bars.					Size of Upset.						Square Bars.				
Diameter.	Area Square Inches.	Weight per Lineal Foot.	Add for Upset.	Excess of Area @ Root of Thread.	Diameter.	Length.	Diameter at Root of Thread.	Area at Root of Thread.	Number of Threads per Inch.	Weight of One Turnbuckle.	Side of Square.	Area Square Inches.	Weight per Lineal Foot.	Add for Upset.	Excess of Area @ Root of Thread.
Ins.		*Lbs.*	*Ins.*	%	*Ins.*	*Ins.*	*Ins.*	*Sq. Ins.*		*Lbs.*	*Ins.*		*Lbs.*	*Ins.*	%
⅝	0.307	1.023	4½	36.8	⅞	4	0.731	0.420	9	2½					
¾	0.442	1.473	3⅞	24.4	1	4	0.837	0.550	8	3½					
					1⅛	4	0.940	0.694	7	4	¾	0.563	1.875	3½	20.6
⅞	0.601	2.004	5	48.3	1¼	4	1.065	0.891	7	5¼	⅞	0.766	2.552	4	16.3
1	0.785	2.618	4⅜	34.7	1⅜	4	1.160	1.057	6	6					
1⅛	0.994	3.313	3⅞	30.3	1½	4	1.284	1.295	6	7¼	1	1.000	3.333	4	29.5
1¼	1.227	4.091	3⅞	23.5	1⅝	4½	1.389	1.515	5½	8½	1⅛	1.266	4.219	4½	19.7
1⅜	1.485	4.950	3½	17.4	1¾	4½	1.490	1.744	5	10					
					1⅞	4½	1.615	2.049	5	11½	1¼	1.563	5.208	4½	31.1
1½	1.767	5.890	4⅝	30.3	2	5	1.712	2.302	4½	13	1⅜	1.891	6.302	4⅛	21.7
1⅝	2.074	6.913	4¼	27.8	2⅛	5	1.837	2.651	4½	15					
1¾	2.405	8.018	4	25.7	2¼	5	1.962	3.023	4½	18	1½	2.250	7.500	4¾	34
1⅞	2.761	9.204	4⅛	23.9	2⅜	5½	2.087	3.410	4	20	1⅝	2.641	8.802	4⅝	29.6
2	3.142	10.47	3⅞	18.3	2½	5½	2.175	3.716	4	24	1¾	3.063	10.21	4¼	21.3
2⅛	3.547	11.82	3⅝	17.1	2⅝	5½	2.300	4.155	4	28					
					2¾	6	2.425	4.619	4	30	1⅞	3.516	11.72	5⅛	31.4
2¼	3.976	13.25	4⅝	28.5	2⅞	6	2.550	5.107	3½	34	2	4.000	13.33	4¾	27.7
2⅜	4.430	14.77	4⅜	22.6	3	6	2.629	5.430	3½	38	2⅛	4.516	15.05	4⅜	20.2
2½	4.909	16.36	4⅜	21.3	3⅛	6½	2.754	5.957	3½	50					
2⅝	5.412	18.04	4¼	20.3	3¼	6½	2.879	6.510	3½	50	2¼	5.063	16.88	5⅛	28.0
2¾	5.940	19.80	4¼	19.3	3⅜	7	3.004	7.088	3¼	65					
					3½	7	3.100	7.548	3¼	65	2⅜	5.641	18.80	6⅛	33 8
2⅞	6.492	21.64	5½	25.9	3⅝	8	3.225	8.170	3¼		2½	6.250	20.83	6¼	30.7
3	7.069	23.56	5¼	22.2	3¾	8	3.317	8.641	3¼						
3⅛	7.670	25.57	5⅛	21.3	3⅞	8	3.442	9.305	3		2⅝	6.891	22.97	6¾	35.0
3¼	8.296	27.65	4⅞	20.7	4	8	3.567	9.9935	3		2¾	7.563	25.21	6	25.1

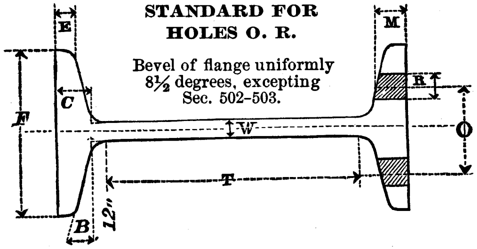
ALLOWANCE FOR EYE FOR SQUARE OR ROUND BARS.



Formula: Length in inches beyond pin centre to form one eye equals 3.7 $(P + R)$.

Diameter of Pin in Inches.	Diameter or Side of Bars in Inches.																			Diameter of Pin in Inches.
	¾	⅞	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2¼	2⅜	2½	2⅝	2¾	2⅞	3	
1	6½	7	7½																	1
1¼	7½	7⅞	8⅜	8⅞	9¼															1¼
1½	8⅜	8⅞	9¼	9¾	10¼	10⅝	11⅛													1½
1¾	9¼	9¾	10¼	10⅝	11⅛	11⅝	12	12½	13											1¾
2	10¼	10⅝	11⅛	11⅝	12	12½	13	13⅜	13⅞	14⅜	14¾									2
2¼	11⅛	11⅝	12	12½	13	13⅜	13⅞	14⅜	14¾	15¼	15¾	16⅛	16⅝							2¼
2½	12	12½	13	13⅜	13⅞	14⅜	14¾	15¼	15¾	16⅛	16⅝	17⅛	17⅝	18	18½					2½
2¾	13	13⅜	13⅞	14⅜	14¾	15¼	15¾	16⅛	16⅝	17⅛	17⅝	18	18½	19	19⅜	19⅞	20⅜			2¾
3	13⅞	14⅜	14¾	15¼	15¾	16⅛	16⅝	17⅛	17⅝	18	18½	19	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼	3
3¼	14¾	15¼	15¾	16⅛	16⅝	17⅛	17⅝	18	18½	19	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛	3¼
3½	15¾	16⅛	16⅝	17⅛	17⅝	18	18½	19	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛	23⅝	24	3½
3¾	16⅝	17⅛	17⅝	18	18½	19	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛	23⅝	24	24½	25	3¾
4	17⅝	18	18½	19	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛	23⅝	24	24½	25	25½	26	4
4¼	18½	19	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛	23⅝	24	24½	25	25½	26	26⅜	26⅞	4¼
4½	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛	23⅝	24	24½	25	25½	26	26⅜	26⅞	27¼	27¾	4½
4¾	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛	23⅝	24	24½	25	25½	26	26⅜	26⅞	27¼	27¾	28¼	28⅝	4¾
5	21¼	21¾	22¼	22⅝	23⅛	23⅝	24	24½	25	25½	26	26⅜	26⅞	27¼	27¾	28¼	28⅝	29⅛	29⅝	5
5¼	22¼	22⅝	23⅛	23⅝	24	24½	25	25½	26	26⅜	26⅞	27¼	27¾	28¼	28⅝	29⅛	29⅝	30	30½	5¼
5½	23⅛	23⅝	24	24½	25	25½	26	26⅜	26⅞	27¼	27¾	28¼	28⅝	29⅛	29⅝	30	30½	31	31½	5½
5¾	24	24½	25	25½	26	26⅜	26⅞	27¼	27¾	28¼	28⅝	29⅛	29⅝	30	30½	31	31½	32	32⅜	5¾
6	25	25½	26	26⅜	26⅞	27¼	27¾	28¼	28⅝	29⅛	29⅝	30	30½	31	31½	32	32⅜	32⅞	33⅜	6

PENCOYD BEAMS.

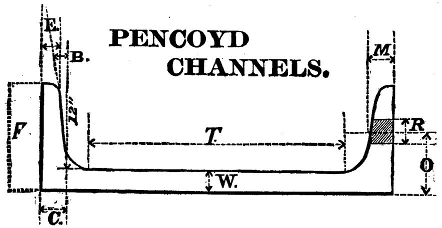


STANDARD FOR HOLES O. R.

Bevel of flange uniformly 8½ degrees, excepting Sec. 502-503.

Size in Inches.	Section Number.	Weight in Pounds per Foot.	W.	F.	C.	E.	B.	O.	R.	M.	T.
			Ins.	Ins.	Ins.	Ins.	In 12 Ins.	Ins.	Ins.	Ins.	Ins.
20	531	78.0	.60	6.75	1.09	.63	1.79	4.25	7/8 to 1	.82	16.5
20	530	64.8	.50	6.25	.98	.55	1.79	4.00	3/4 to 7/8	.72	16.9
15	524	69.2	.60	6.40	1.14	.71	1.79	4.25	7/8 to 1	.87	11.2
15	523	57.6	.50	6.10	1.01	.60	1.79	4.00	3/4 to 7/8	.75	11.7
15	522	49.3	.45	5.80	.89	.50	1.79	3.75	3/4 to 7/8	.59	12.1
15	521	41.2	.37	5.56	.79	.41	1.79	3.50	3/4 to 7/8	.56	12.4
12	517	55.5	.56	5.75	1.09	.70	1.79	3.50	3/4 to 7/8	.91	8.7
12	516	39.4	.40	5.25	.86	.50	1.79	3.00	3/4 to 7/8	.66	9.5
12	515	30.6	.34	5.00	.68	.33	1.79	3.00	3/4 to 7/8	.50	9.8
10	512	29.8	.35	4.75	.74	.41	1.79	3.00	3/4	.53	7.7
10	511	23.5	.30	4.50	.60	.29	1.79	2.50	5/8 to 3/4	.44	8.1
9	509	20.5	.28	4.30	.57	.27	1.79	2.50	5/8 to 3/4	.41	7.2
8	507	17.3	.26	4.00	.53	.25	1.79	2.25	5/8	.37	6.3
7	505	14.6	.24	3.75	.49	.23	1.79	2.25	5/8	.34	5.4
6	503	41.0	.63	5.25	1.06	.62	2.28	3.25	3/4 to 7/8	.81	2.6
6	502	32.3	.50	4.88	.87	.50	2.06	3.00	5/8 to 3/4	.66	3.0
6	501	11.9	.22	3.40	.45	.21	1.79	2.00	5/8	.31	4.5
5	500	9.4	.20	3.00	.40	.20	1.79	1.75	3/8 to 5/8	.28	3.7
4	20	6.3	.16	2.30	.35	.20	1.79	1.37	3/8	.25	2.9
3	22	5.4	.16	2.20	.34	.19	1.79	1.25	3/8	.25	1.9

PENCOYD CHANNELS.



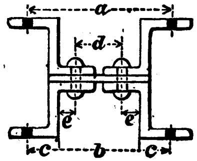
STANDARD FOR HOLES O. R.

Bevel of Flange uniformly 8½ degrees, excepting Sec. 32.

Size in Inches.	Section Number.	Minimum. Weight in Lbs. per Foot.	W.	F.	C.	E.	B.	O.	R.	M.	T.
			Ins.	Ins.	Ins.	Ins.	In 12 Ins.	Ins.	Ins.	Ins.	Ins.
15	434	49.8	.62	4.00	1.02	.51	1.79	2.37	7/8	.75	11.9
15	433	32.7	.40	3.45	.80	.35	1.79	2.00	7/8	.56	12.5
12	428	31.4	.41	3.11	.97	.57	1.79	1.87	3/4	.75	9.0
12	427	19.8	.28	2.93	.65	.26	1.79	1.75	3/4	.43	10.0
12	32	20.6	.28	2.62	.75	.34	2.12	1.50	3/4	.53	9.4
10	424	20.9	.33	2.79	.74	.37	1.79	1.62	3/4	.56	7.6
10	423	16.5	.26	2.58	.64	.30	1.79	1.37	3/4	.50	8.0
9	422	17.6	.31	2.65	.66	.31	1.79	1.50	3/4	.50	6.8
9	421	13.4	.24	2.41	.56	.24	1.79	1.37	3/4	.40	7.2
8	420	14.6	.28	2.50	.61	.28	1.79	1.37	3/4	.46	6.0
8	419	10.9	.22	2.24	.50	.20	1.79	1.25	3/4	.37	6.4
7	418	12.8	.27	2.37	.59	.27	1.79	1.37	5/8	.43	5.2
7	417	9.1	.20	2.07	.47	.19	1.79	1.18	5/8	.31	5.5
6	416	11.0	.25	2.25	.57	.27	1.79	1.25	5/8	.43	4.3
6	415	7.7	.19	1.90	.45	.19	1.79	1.12	1/2	.31	4.6
5	413	6.6	.19	1.79	.42	.18	1.79	1.06	1/2	.25	3.8
4	411	5.4	.18	1.63	.40	.18	1.79	0.94	3/8	.25	2.8
3	49	5.1	.22	1.53	.42	.22	1.79	0.87	3/8	.31	1.7

STANDARD SPACING of RIVETS THROUGH FLANGES OF Z BAR COLUMNS.

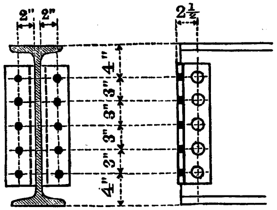
Size of Z Bar.	a.	b.	c.	d.	e.
6 inch.	11¼	7¼	2	4¼	1½
5 "	10	6½	1¾	4	1¼
4 "	8¾	5½	1⅝	3	1¼
3 "	7¾	4¾	1½	2½	1⅛



ALL RIVETS 3-4 INCH.

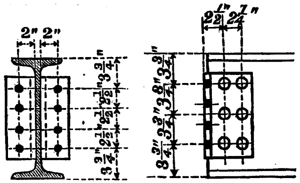
STANDARD FRAMING OF PENCOYD BEAMS.

20″



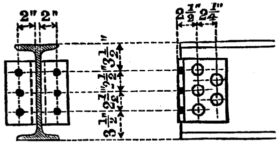
2 Angles 4 x $3\frac{1}{2}$ x $\frac{7}{16}$ x 1′3″

15″



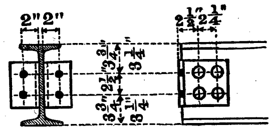
2 Angles 6 x $3\frac{1}{2}$ x $\frac{7}{16}$ x 0′$10\frac{1}{2}$″

12″



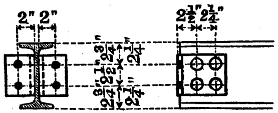
2 Angles 6 x $3\frac{1}{2}$ x $\frac{7}{16}$ x 0′8″

10″ and 9″



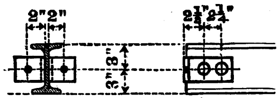
2 Angles 6 x $3\frac{1}{2}$ x $\frac{7}{16}$ x 0′$5\frac{1}{2}$″

8″ and 7″



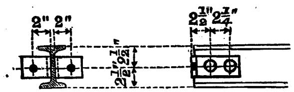
2 Angles 6 x $3\frac{1}{2}$ x $\frac{7}{16}$ x 0′5″

6″



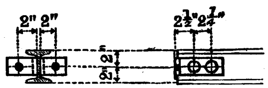
2 Angles 6 x $3\frac{1}{2}$ x $\frac{7}{16}$ x 0′3″

5″



2 Angles 6 x $3\frac{1}{2}$ x $\frac{7}{16}$ x 0′$2\frac{1}{2}$″

4″



2 Angles 6 x $3\frac{1}{2}$ x $\frac{7}{16}$ x 0′2″

STANDARD ANGLE CONNECTIONS.

The connections illustrated on opposite page are proportioned, for a load uniformly distributed over a minimum length of span as given below:

Size of Beams.	*Section Number.*	*Minimum Safe Span in Feet.*	*Size of Beams.*	*Section Number.*	*Minimum Safe Span in Feet.*	*Size of Beams.*	*Section Number.*	*Minimum Safe Span in Feet.*
20	531	17.5	12	517	12.0	8	507	5.0
20	530	16.0	12	516	9.0	7	505	4.0
15	524	14.5	12	515	7.5	6	503	6.0
15	523	12.0	10	512	8.5	5	18	4.5
15	522	10.0	10	511	7.0	4	20	3.0
15	521	9.5	9	509	5.5	3	22	2.0

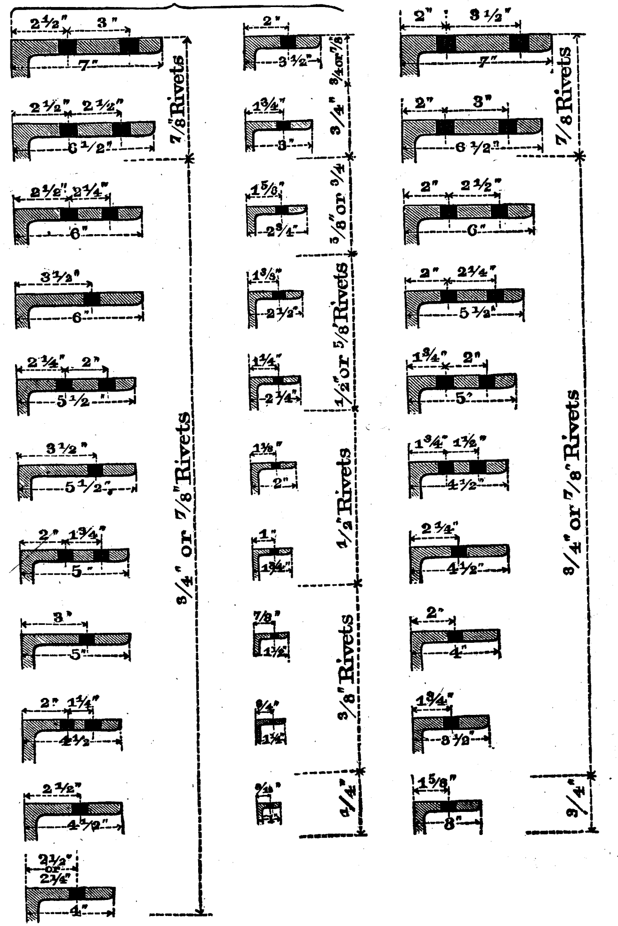
All holes $\frac{13}{16}$″. All rivets $\frac{3}{4}$″.

When beams frame opposite each other into another beam or girder with web thickness less than $\frac{9}{16}$″, the above given minimum lengths of spans ought to be increased in the protion of the web thickness to $\frac{9}{16}$″.

These connections are based on shearing strains of 10,000 pounds per square inch, and bearing strains of 20,000 pounds per square inch, when the length of attached beams correspond to the foregoing table, and extreme fibre stress of 16,000 pounds per square inch at beam flanges.

RIVET SPACING IN PENCOYD ANGLES.

Spacing for Flanges. **Spacing for Braces, Etc.**



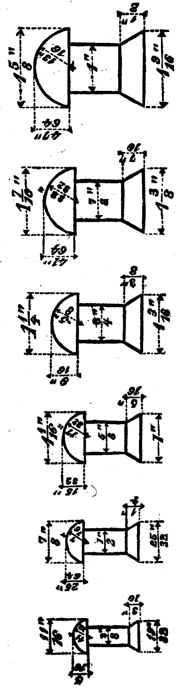
PENCOYD RIVET PROPORTIONS.

FINISHED HEADS.

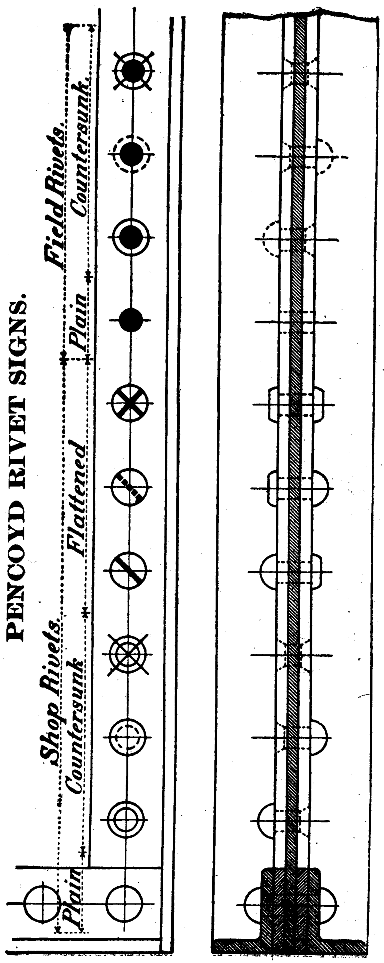
Diam. Head = 1½ Diam. of Shank + 1/8". Depth of Head = $\frac{45}{100}$ Diam. of Head.

COUNTERSUNK.

Depth of Head = ½ Diam. of Shank. Bevel of Head = 60 Degrees.



PENCOYD RIVET SIGNS.



SHEARING AND BEARING VALUE OF RIVETS IN POUNDS.

GENERAL SPECIFICATIONS.

All dimensions in inches.

Diameter of Rivet. Inches. Fraction.	Decimal.	Area in Square Inches.	Single Shear at 6,000 Lbs.	Bearing Value for Different Thicknesses of Plate in Inches, at 12,000 Pounds per Square Inch. $\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1
3/8	.375	.1104	660	1130	1410	1690										
1/2	.500	.1963	1180	1500	1880	2250	2630	3000								
5/8	.625	.3068	1840	1880	2340	2810	3280	3750	4220	4690						
3/4	.750	.4418	2650	2250	2810	3380	3940	4500	5160	5630	6190	6750				
7/8	.875	.6013	3610	2630	3280	3940	4590	5250	5910	6560	7220	7880	8530	9190	9840	
1	1.000	.7854	4710	3000	3750	4500	5250	6000	6750	7500	8250	9000	9750	10500	11250	12000

Diameter of Rivet. Inches. Fraction.	Decimal.	Area in Square Inches.	Single Shear at 7,500 Pounds.	Bearing Value for Different Thicknesses of Plate in Inches, at 15,000 Pounds per Square Inch. $\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1
3/8	.375	.1104	830	1410	1760	2110										
1/2	.500	.1963	1470	1880	2340	2810	3280	3750								
5/8	.625	.3068	2300	2340	2930	3520	4100	4690	5280	5860						
3/4	.750	.4418	3310	2810	3520	4220	4920	5630	6330	7030	7720	8440				
7/8	.875	.6013	4510	3280	4100	4920	5740	6560	7380	8200	9030	9850	10670	11480	12300	
1	1.000	.7854	5890	3750	4690	5620	6560	7500	8440	9380	10310	11250	12190	13130	14060	15000

In above tables all bearing values above or to right of upper zigzag lines are greater than double shear.
Values between upper and lower zigzag lines are less than double and greater than single shear.
Values below and to left of lower zigzag lines are less than single shear.

SHEARING AND BEARING VALUE OF RIVETS IN POUNDS.

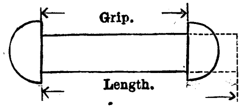
PENCOYD SPECIFICATIONS.

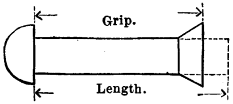
Diameter of Rivet. Inches. Fraction.	Decimal.	Area in Square Inches.	Single Shear at 11,000 Lbs.	Bearing Value for Different Thicknesses of Plate in Inches, at 22,000 Pounds per Square Inch. 1/4	$\frac{5}{16}$	3/8	$\frac{7}{16}$	1/2	$\frac{9}{16}$	5/8	$\frac{11}{16}$	3/4	$\frac{13}{16}$	7/8	$\frac{15}{16}$	1
3/8	.375	.1104	1210	2060	2580	3090										
1/2	.500	.1963	2160	2750	3440	4130	4820	5500								
5/8	.625	.3068	3370	3440	4300	5160	6020	6880	7740	8600						
3/4	.750	.4418	4860	4130	5160	6190	7220	8250	9280	10320	11340	12380				
7/8	.875	.6013	6610	4810	6020	7220	8430	9630	10840	12040	13240	14440	15640	16840	18050	
1	1.000	.7854	8640	5500	6880	8250	9630	11000	12380	13750	15130	16500	17880	19250	20630	22000

All bearing values above or to right of upper zigzag lines are greater than double shear.
Values below or to left of lower zigzag lines are less than single shear.

TABLE SHOWING LENGTH OF RIVET-SHANK REQUIRED TO FORM HEAD.

PLAIN RIVETS. **COUNTERSUNK RIVETS.**

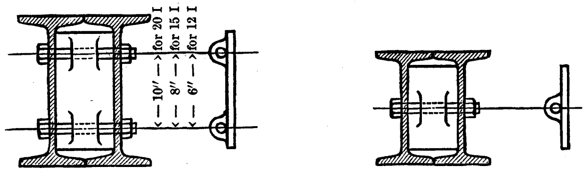




Grip in Inches.	Plain: Diameter in Inches. ½	⅝	¾	⅞	1	Grip in Inches.	Countersunk: Diameter in Inches. ½	⅝	¾	⅞	1	Grip in Inches.
	Length in Inches.						Length in Inches.					
½	1½	1¾	1⅞	2	2⅛	½	1⅛	1¼	1¼	1⅜	1⅜	½
⅝	1⅝	1⅞	2	2⅛	2¼	⅝	1¼	1⅜	1⅜	1½	1½	⅝
¾	1¾	2	2⅛	2¼	2⅜	¾	1⅜	1½	1½	1⅝	1⅝	¾
⅞	1⅞	2⅛	2¼	2⅜	2½	⅞	1½	1⅝	1⅝	1¾	1¾	⅞
1	2	2¼	2⅜	2½	2⅝	1	1⅝	1¾	1¾	1⅞	1⅞	1
1⅛	2⅛	2⅜	2½	2⅝	2¾	1⅛	1¾	1⅞	1⅞	2	2	1⅛
1¼	2¼	2½	2⅝	2¾	2⅞	1¼	1⅞	2	2	2⅛	2⅛	1¼
1⅜	2⅜	2⅝	2¾	2⅞	3	1⅜	2	2⅛	2⅛	2¼	2¼	1⅜
1½	2⅝	2⅞	3	3⅛	3¼	1½	2⅛	2¼	2⅜	2⅜	2½	1½
1⅝	2¾	3	3⅛	3¼	3⅜	1⅝	2¼	2⅜	2½	2½	2⅝	1⅝
1¾	2⅞	3⅛	3¼	3⅜	3½	1¾	2⅜	2½	2⅝	2⅝	2¾	1¾
1⅞	3	3¼	3⅜	3½	3⅝	1⅞	2½	2⅝	2¾	2¾	2⅞	1⅞
2	3⅛	3⅜	3½	3⅝	3¾	2	2⅝	2¾	2⅞	2⅞	3	2
2⅛	3¼	3½	3⅝	3¾	3⅞	2⅛	2¾	2⅞	3	3	3⅛	2⅛
2¼	3⅜	3⅝	3¾	3⅞	4	2¼	2⅞	3	3⅛	3⅛	3¼	2¼
2⅜	3½	3¾	3⅞	4	4⅛	2⅜	3	3⅛	3¼	3¼	3⅜	2⅜
2½	3⅝	3⅞	4	4⅛	4¼	2½	3⅛	3¼	3⅜	3⅜	3½	2½
2⅝	3¾	4	4⅛	4¼	4⅜	2⅝	3¼	3⅜	3½	3½	3⅝	2⅝
2¾	3⅞	4⅛	4¼	4⅜	4½	2¾	3⅜	3½	3⅝	3⅝	3¾	2¾
2⅞	4	4¼	4⅜	4½	4⅝	2⅞	3½	3⅝	3¾	3¾	3⅞	2⅞
3	4¼	4½	4⅝	4¾	4⅞	3	3¾	3¾	3⅞	4	4⅛	3
3⅛	4⅜	4⅝	4¾	4⅞	5	3⅛	3⅞	3⅞	4	4⅛	4¼	3⅛
3¼	4½	4¾	4⅞	5	5⅛	3¼	4	4⅛	4⅛	4¼	4⅜	3¼
3⅜	4⅝	4⅞	5	5⅛	5¼	3⅜	4⅛	4¼	4¼	4⅜	4½	3⅜
3½	4¾	5	5⅛	5¼	5⅜	3½	4¼	4⅜	4⅜	4½	4⅝	3½
3⅝	4⅞	5⅛	5¼	5⅜	5½	3⅝	4⅜	4½	4½	4⅝	4¾	3⅝
3¾	5	5¼	5⅜	5½	5⅝	3¾	4½	4⅝	4⅝	4¾	4⅞	3¾
3⅞	5⅛	5⅜	5½	5⅝	5¾	3⅞	4⅝	4¾	4¾	4⅞	5	3⅞
4	5¼	5½	5⅝	5¾	5⅞	4	4¾	4⅞	5	5	5⅛	4
4⅛	5⅜	5⅝	5¾	5⅞	6	4⅛	4⅞	5	5⅛	5⅛	5¼	4⅛
4¼	5½	5¾	5⅞	6	6⅛	4¼	5	5⅛	5¼	5¼	5⅜	4¼
4⅜	5⅝	5⅞	6	6⅛	6¼	4⅜	5⅛	5¼	5⅜	5⅜	5½	4⅜
4½	5⅞	6⅛	6¼	6⅜	6½	4½				5½	5⅝	4½
4⅝	6	6¼	6⅜	6½	6⅝	4⅝				5⅝	5¾	4⅝
4¾	6⅛	6⅜	6½	6⅝	6¾	4¾				5¾	5⅞	4¾
4⅞	6¼	6½	6⅝	6¾	6⅞	4⅞				5⅞	6	4⅞
5	6⅜	6⅝	6¾	6⅞	7	5				6	6⅛	5
5⅛	6½	6¾	6⅞	7	7⅛	5⅛				6⅛	6¼	5⅛
5¼	6⅝	6⅞	7	7⅛	7¼	5¼				6¼	6⅜	5¼
Heads	5.7	10.9	13.4	22.2	38.0							

For weight of rivets, see page 222.

STANDARD SEPARATORS FOR PENCOYD I BEAMS.



Size of Beam in Inches.	Weight of Separator in Pounds.	Weight of Each Additional Inch of Width in Pounds.	Bolts. Number.	Bolts. Size in Inches.	Weight of Each Complete Bolt in Pounds.	Weight of Each Additional Inch of Length in Pounds.
20	23.0	3.20	2	⅞	1.80	1.70
18						
15	14.75	1.90	2	¾	1.20	.124
12	9.75	1.50	2	¾	1.14	.124
10	6.5	1.20	1	¾	1.08	.124
9	5.75	1.10	1	¾	1.04	.124
8	4.50	1.00	1	¾	1.01	.124
7	3.75	0.90	1	¾	0.95	.124
6	2.25	0.65	1	¾	0.93	.124
5	2.00	0.55	1	¾	0.90	.124
4	1.75	0.45	1	¾	0.80	.124

WEIGHT OF BOLTS PER HUNDRED.

SQUARE HEADS AND NUTS.

Dimensions in inches.

Diameter.	¼	⅜	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
Length.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
1½	3.9	9.7	20.4	37.	58.						
1¾	4.2	10.5	21.3	37.9	60.5						
2	4.6	11.3	22.4	39.9	63.2	97.7	145				
2¼	5.	12.1	23.6	42.	66.	101.6	149				
2½	5.4	12.9	25.	44.4	69.	105.6	153				
2¾	5.8	13.7	26.4	46.2	72.1	109.7	158				
3	6.2	14.5	27.8	48.3	75.2	113.8	163	200	289	350	480
3½	6.9	16.1	30.6	52.5	81.4	122.	174	213	305	370	500
4	7.6	17.7	33.4	56.7	87.6	130.2	185	226	322	390	520
4½	8.3	19.2	36.2	60.9	93.8	138.4	196	240	339	410	545
5	9.	20.7	39.	65.1	100.	146.6	207	255	356	430	570
5½	9.7	22.2	41.8	69.2	106.1	154.9	218	270	373	450	595
6	10.4	23.7	44.6	73.4	112.2	163.2	229	285	390	470	620
6½	11.1	25.2	47.4	77.6	118.3	171.5	240	300	407	490	645
7	11.8	26.7	50.2	81.8	124.4	179.8	251	315	434	510	670
7½	12.5	28.2	53.1	86.	130.5	187.1	262	330	451	530	695
8	13.2	29.7	56.	90.	136.6	195.4	273	345	468	550	725
9		33.1	61.5	98.	148.8	212.	295	375	505	590	775
10		36.5	67.	106.3	161.	229.	317	405	540	630	825
11		40.0	72.5	114.6	173.2	246.	339	435	575	670	875
12		43.5	78.	122.9	184.4	263.	361	465	610	710	925
13			83.5	131.2	196.6	280.	383	495	645	751	975
14			89.	139.5	208.8	297.	405	525	680	793	1025
15			94.5	148.	221.	314.	427	555	715	835	1075
16			100.	156.5	233.2	331.	449	585	750	877	1125
17			105.5	165.	245.4	348.	471	615	785	919	1175
18			111.	173.5	257.6	365.	493	645	820	961	1225

WEIGHT OF BOLTS PER HUNDRED.

HEXAGON HEADS AND NUTS.

Dimensions in inches.

Diameter.	¼	⅜	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
Length.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
1½	3.4	8.5	17.7	32.5	49.0						
1¾	3.7	9.3	18.6	33.4	51.5						
2	4.1	10.1	19.7	35.4	54.2	86.6	128				
2¼	4.5	10.9	20.9	37.5	57.0	90.6	132				
2½	4.9	11.7	22.3	39.9	60.0	94.6	136				
2¾	5.3	12.5	23.7	41.7	63.1	98.7	141				
3	5.7	13.3	25.1	43.8	66.2	102.8	144	174	255	310	430
3½	6.1	14.1	26.6	45.7	69.4	107.0	151	187	271	330	450
4	6.8	15.7	29.4	49.9	75.6	115.2	162	200	288	350	470
4½	7.5	17.0	32.2	56.1	81.8	123.4	173	214	305	370	495
5	8.2	18.7	35.0	58.3	88.0	131.6	184	229	322	390	520
5½	8.9	20.2	37.8	62.4	94.1	139.9	195	244	339	410	545
6	9.6	21.7	40.6	66.6	100.2	148.2	206	259	356	430	570
6½	10.3	23.2	43.4	70.8	106.3	156.5	217	274	373	450	595
7	11.0	24.7	46.2	75.0	112.4	164.8	228	289	400	470	620
7½	11.7	26.2	49.1	79.2	118.5	172.1	239	304	417	490	645
8	12.4	27.7	52.0	83.2	124.6	180.3	250	319	424	510	670
9		29.7	54.8	87.0	130.8	189.0	262	336	465	530	700
10		33.1	60.3	95.0	143.0	206.0	284	366	500	570	750
11		36.6	65.8	103.6	155.2	223.0	306	396	535	610	800
12		40.1	71.3	111.9	166.4	240.0	328	426	570	650	850
13			76.8	120.2	178.6	257.0	350	456	605	691	900
14			82.3	128.5	190.8	274.0	372	486	640	733	950
15			87.8	137.0	203.0	291.0	384	516	675	775	1000
16			93.3	145.5	215.2	308.0	416	546	710	817	1050
17			98.8	154.0	227.4	325.0	438	576	745	859	1100
18			104.3	162.5	239.6	342.0	460	606	780	901	1150

WEIGHT OF BRIDGE RIVETS PER 100.

THIS TABLE ALSO APPLIES TO BUTTON-HEADED BOLTS.

Diam. of Rivet in Inches.	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4
Length of Rivet Under Head in Inches.	*Weight in Pounds.*	*Weight in Pounds.*	*Weight in Pounds.*	*Weight in Pounds.*	*Weight in Pounds.*	*Weight in Pounds.*	*Weight in Pounds.*	*Weight in Pounds.*
1 1/4	5.4	12.5	21.2	28.0	42.5	64.6	91.0	121.8
1 3/8	5.9	13.1	22.4	29.5	44.6	67.3	94.5	127.0
1 1/2	6.3	13.7	23.5	31.0	46.7	69.9	97.9	132.4
1 5/8	6.7	14.4	24.7	32.7	48.9	72.8	101.2	137.2
1 3/4	7.0	15.1	26.0	34.2	51.0	75.0	104.0	141.1
1 7/8	7.3	15.8	27.1	35.6	53.3	77.8	107.3	145.0
2	7.6	16.5	28.3	37.0	55.2	81.3	110.6	149.2
2 1/8	7.9	17.2	29.6	38.4	57.5	84.1	113.9	154.0
2 1/4	8.3	17.8	31.0	39.8	59.5	86.9	118.2	158.2
2 3/8	8.8	18.4	32.1	41.5	61.7	89.5	122.1	163.0
2 1/2	9.1	19.1	33.2	43.2	63.9	92.2	125.5	168.1
2 5/8	9.5	19.8	34.4	44.8	66.0	94.8	129.0	172.0
2 3/4	9.8	20.5	35.4	46.1	68.2	97.3	132.4	176.0
2 7/8	10.2	21.2	36.1	47.7	70.1	100.0	135.9	180.3
3	10.6	21.9	37.0	49.0	72.1	102.5	139.4	184.9
3 1/8	11.0	22.7	38.2	50.6	74.0	105.1	142.5	189.0
3 1/4	11.3	23.4	39.1	52.1	76.2	107.8	146.1	194.1
3 3/8	11.7	24.0	40.2	53.7	78.5	110.4	149.6	198.1
3 1/2	12.1	24.7	41.0	55.2	80.2	112.9	153.0	202.0
3 5/8	12.5	25.3	42.0	56.7	82.4	115.5	156.5	206.1
3 3/4	12.8	26.0	42.9	58.1	84.3	118.0	160.1	210.2
3 7/8	13.2	26.6	44.1	60.0	86.5	120.6	163.4	214.1
4	13.6	27.2	45.1	61.5	88.7	123.2	166.9	218.0
4 1/8	14.0	28.0	46.2	63.2	91.0	125.7	170.2	221.9
4 1/4	14.4	28.9	47.1	65.1	93.4	128.3	173.6	225.8
4 3/8	14.9	29.5	48.0	66.6	95.1	131.0	176.9	229.5
4 1/2	15.3	30.2	48.9	68.0	97.3	133.6	180.3	234.9
4 5/8	15.7	30.9	49.8	69.2	99.5	136.2	183.8	239.0
4 3/4	16.1	31.6	51.0	70.9	101.1	138.8	187.2	244.0
4 7/8	16.5	32.2	52.1	72.5	103.4	141.3	191.0	248.2
5	17.0	32.9	53.3	74.2	105.2	144.0	194.5	252.1
5 1/4	17.6	33.9	55.6	77.2	109.8	150.0	201.3	260.9
5 1/2	18.2	35.1	56.8	80.3	114.1	155.7	208.1	269.7
5 3/4	18.9	36.6	58.0	83.2	118.0	161.0	214.9	278.3
6	19.7	37.7	59.9	86.1	122.7	166.1	222.0	287.1
7	22.3	42.8	67.0	98.4	141.1	188.0	250.0	319.0
8	24.7	48.0	76.1	112.2	157.9	213.0	278.1	353.4
9	27.4	53.9	83.9	124.0	172.5	234.0	304.9	388.4
10	31.0	59.0	90.8	135.9	188.1	254.3	332.1	421.0
12	37.7	70.9	108.4	160.0	221.5	298.3	387.9	490.0

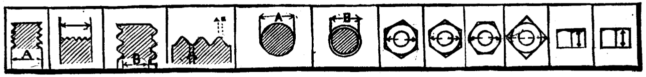
WEIGHT OF TWO (2) RIVET HEADS IN POUNDS.

	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4
Before driving. .	.036	.114	.218	.268	.444	.76	1.14	1.64
After driving. . .	.031	.080	.160	.260	.440	.64	.778	1.07

WEIGHT OF BODY PER INCH OF LENGTH IN POUNDS.

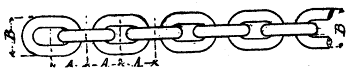
	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4
Before driving. .	.031	.54	.085	.123	.167	.218	.276	.341

U. S. STANDARD SCREW THREADS.



Diam.	*Threads per Inch.*	*Diam. of Root of Thread.*	*Width of Flat.*	*Area of Bolt Body in Sq. Inches.*	*Area at Root of Thread in Sq. Inches.*	*Short Diam., Rough.*	*Short Diam., Finish.*	*Long Diam., Rough.*	*Long Diam., Rough.*	*Thickness, Rough.*	*Thickness, Finish.*
Ins.		*Ins.*	*Ins.*			*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*
1/4	20	.185	.0062	.049	.027	1/2	7/16	37/64	7/10	1/4	3/16
5/16	18	.240	.0074	.077	.045	19/32	17/32	11/16	10/12	5/16	1/4
3/8	16	.294	.0078	.110	.068	11/16	5/8	51/64	63/64	3/8	5/16
7/16	14	.344	.0089	.150	.093	25/32	23/32	9/10	1 7/64	7/16	3/8
1/2	13	.400	.0096	.196	.126	7/8	13/16	1	1 15/64	1/2	7/16
9/16	12	.454	.0104	.249	.162	31/32	29/32	1 1/8	1 23/64	9/16	1/2
5/8	11	.507	.0113	.307	.202	1 1/16	1	1 7/32	1 1/2	5/8	9/16
3/4	10	.620	.0125	.442	.302	1 1/4	1 3/16	1 7/16	1 49/64	3/4	11/16
7/8	9	.731	.0138	.601	.420	1 7/16	1 3/8	1 21/32	2 1/32	7/8	13/16
1	8	.837	.0156	.785	.550	1 5/8	1 9/16	1 7/8	2 19/64	1	15/16
1 1/8	7	.940	.0178	.994	.694	1 13/16	1 3/4	2 3/32	2 9/16	1 1/8	1 1/16
1 1/4	7	1.065	.0178	1.227	.893	2	1 15/16	2 5/16	2 53/64	1 1/4	1 3/16
1 3/8	6	1.160	.0208	1.485	1.057	2 3/16	2 1/8	2 17/32	3 3/32	1 3/8	1 5/16
1 1/2	6	1.284	.0208	1.767	1.295	2 3/8	2 5/16	2 3/4	3 23/64	1 1/2	1 7/16
1 5/8	5 1/2	1.389	.0227	2.074	1.515	2 9/16	2 1/2	2 31/32	3 5/8	1 5/8	1 9/16
1 3/4	5	1.491	.0250	2.405	1.746	2 3/4	2 11/16	3 3/16	3 57/64	1 3/4	1 11/16
1 7/8	5	1.616	.0250	2.761	2.051	2 15/16	2 7/8	3 13/32	4 5/32	1 7/8	1 13/16
2	4 1/2	1.712	.0277	3.142	2.302	3 1/8	3 1/16	3 5/8	4 27/64	2	1 15/16
2 1/4	4 1/2	1.962	.0277	3.976	3.023	3 1/2	3 7/16	4 1/16	4 61/64	2 1/4	2 3/16
2 1/2	4	2.176	.0312	4.909	3.719	3 7/8	3 13/16	4 1/2	5 31/64	2 1/2	2 7/16
2 3/4	4	2.426	.0312	5.940	4.620	4 1/4	4 3/16	4 29/32	6	2 3/4	2 11/16
3	3 1/2	2.629	.0357	7.069	5.428	4 5/8	4 9/16	5 3/8	6 17/32	3	2 15/16
3 1/4	3 1/2	2.879	.0357	8.296	6.510	5	4 15/16	5 13/16	7 1/16	3 1/4	3 3/16
3 1/2	3 1/4	3.100	.0384	9.621	7.548	5 3/8	5 5/16	6 7/64	7 39/64	3 1/2	3 7/16
3 3/4	3	3.317	.0413	11.045	8.641	5 3/4	5 11/16	6 21/32	8 1/8	3 3/4	3 11/16
4	3	3.567	.0413	12.566	9.963	6 1/8	6 1/16	7 3/32	8 41/64	4	3 15/16
4 1/4	2 7/8	3.798	.0435	14.186	11.329	6 1/2	6 7/16	7 9/16	9 3/16	4 1/4	4 3/16
4 1/2	2 3/4	4.028	.0454	15.904	12.753	6 7/8	6 13/16	7 31/32	9 3/4	4 1/2	4 7/16
4 3/4	2 5/8	4.256	.0476	17.721	14.226	7 1/4	7 3/16	8 13/32	10 1/4	4 3/4	4 11/16
5	2 1/2	4.480	.0500	19.635	15.763	7 5/8	7 9/16	8 27/32	10 49/64	5	4 15/16
5 1/4	2 1/2	4.730	.0500	21.648	17.572	8	7 15/16	9 9/32	11 23/64	5 1/4	5 3/16
5 1/2	2 3/8	4.953	.0526	23.758	19.267	8 3/8	8 5/16	9 23/32	11 7/8	5 1/2	5 7/16
5 3/4	2 3/8	5.203	.0526	25.967	21.262	8 3/4	8 11/16	10 5/32	12 3/8	5 3/4	5 11/16
6	2 1/4	5.423	.0555	28.274	23.098	9 1/8	9 1/16	10 19/32	12 15/16	6	5 15/16

CRANE CHAINS.



DIMENSION.				"D. B. G." SPECIAL CRANE.			CRANE.		
Size of Chain. Inches.	Pitch A. Approximately. Inches.	Weight per Foot in Pounds. Approximately.	Outside Width. B. Inches.	Proof Test. Pounds.	Average Breakage Strain. Pounds.	Ordinary Safe Load. General Use. Pounds.	Proof Test. Pounds.	Average Breaking Strain. Pounds.	Ordinary Safe Load. General Use. Pounds.
1/4	25/32	7/8	7/8	1932	3864	1288	1680	3360	1120
5/16	27/32	1	1 1/16	2898	5796	1932	2520	5040	1680
3/8	31/32	1 7/10	1 1/4	4186	8372	2790	3640	7280	2427
7/16	1 5/32	2	1 3/8	5796	11592	3864	5040	10080	3360
1/2	1 11/32	2 1/2	1 11/16	7728	15456	5182	6720	13440	4480
9/16	1 15/32	3 2/10	1 7/8	9660	19320	6440	8400	16800	5600
5/8	1 23/32	4 1/8	2 1/16	11914	23828	7942	10360	20720	6907
11/16	1 27/32	5	2 1/4	14490	28980	9660	12600	25200	8400
3/4	1 31/32	5 7/8	2 1/2	17388	34776	11592	15120	30240	10080
13/16	2 3/32	6 7/10	2 11/16	20286	40572	13524	17640	35280	11760
7/8	2 7/32	8	2 7/8	22484	44968	14989	20440	40880	13627
15/16	2 15/32	9	3 1/16	25872	51744	17248	23520	47040	15680
1	2 19/32	10 7/10	3 1/4	29568	59136	19712	26880	53760	17920
1 1/16	2 23/32	11 [illegible]/10	3 5/16	33264	66538	22176	30240	60480	20160
1 1/8	2 27/32	12 1/2	3 3/4	37576	75152	25050	34160	68320	22773
1 3/16	3 5/32	13 7/10	3 7/8	41888	83776	27925	38080	76160	25387
1 1/4	3 7/32	16	4 1/8	46200	92400	30800	42000	84000	28000
1 5/16	3 15/32	16 1/2	4 3/8	50512	101024	33674	45920	91840	30613
1 3/8	3 5/8	18 4/10	4 9/16	55748	111496	37165	50680	101360	33787
1 7/16	3 25/32	19 7/10	4 3/4	60368	120736	40245	54880	109760	36587
1 1/2	3 31/32	21 7/10	5	66528	133056	44352	60480	120960	40320

The distance from centre of one link to centre of next is equal to the inside length of link, but in practice 1/32 inch is allowed for weld. This is approximate, and where exactness is required, chain should be made so.

FOR CHAIN SHEAVES.—The diameter, if possible, should be not less than twenty times the diameter of chain used. *Example*—For 1-inch chain use 20-inch sheaves.

DECIMAL EQUIVALENTS FOR VULGAR FRACTIONS.

The given decimals are the parts of inches corresponding to fraction of inches in first column; also, the parts of feet for the fraction of inches in third column.

		"									
	.0052	1/16		.2552	3 1/16		.5052	6 1/16		.7552	9 1/16
	.0104	1/8		.2604	3 1/8		.5104	6 1/8		.7604	9 1/8
1/64	.015625	3/16	17/64	.265625	3 3/16	33/64	.515625	6 3/16	49/64	.765625	9 3/16
	.0208	1/4		.2708	3 1/4		.5208	6 1/4		.7708	9 1/4
	.0260	5/16		.2760	3 5/16		.5260	6 5/16		.7760	9 5/16
1/32	.03125	3/8	9/32	.28125	3 3/8	17/32	.53125	6 3/8	25/32	.78125	9 3/8
	.0364	7/16		.2865	3 7/16		.5364	6 7/16		.7865	9 7/16
	.0417	1/2		.2917	3 1/2		.5411	6 1/2		.7917	9 1/2
3/64	.046875	9/16	19/64	.296875	3 9/16	35/64	.546875	6 9/16	51/64	.796875	9 9/16
	.0521	5/8		.3021	3 5/8		.5521	6 5/8		.8021	9 5/8
	.0573	11/16		.3073	3 11/16		.5573	6 11/16		.8073	9 11/16
1/16	.0625	3/4	5/16	.3125	3 3/4	9/16	.5625	6 3/4	13/16	.8125	9 3/4
	.0677	13/16		.3177	3 13/16		.5677	6 13/16		.8177	9 13/16
	.0729	7/8		.3229	3 7/8		.5729	6 7/8		.8229	9 7/8
5/64	.078125	15/16	21/64	.328125	3 15/16	37/64	.578125	6 15/16	53/64	.828125	9 15/16
	.0833	1		.3333	4		.5833	7		.8333	10
	.0885	1 1/16		.3385	4 1/16		.5885	7 1/16		.8385	10 1/16
3/32	.09375	1 1/8	11/32	.34375	4 1/8	19/32	.59375	7 1/8	27/32	.84375	10 1/8
	.0990	1 3/16		.3490	4 3/16		.5990	7 3/16		.8490	10 3/16
	.1042	1 1/4		.3542	4 1/4		.6042	7 1/4		.8542	10 1/4
7/64	.109375	1 5/16	23/64	.359375	4 5/16	39/64	.609375	7 5/16	55/64	.859375	10 5/16
	.1146	1 3/8		.3646	4 3/8		.6146	7 3/8		.8646	10 3/8
	.1198	1 7/16		.3698	4 7/16		.6198	7 7/16		.8698	10 7/16
1/8	.1250	1 1/2	3/8	.3750	4 1/2	5/8	.6250	7 1/2	7/8	.8750	10 1/2
	.1302	1 9/16		.3802	4 9/16		.6302	7 9/16		.8802	10 9/16
	.1354	1 5/8		.3854	4 5/8		.6354	7 5/8		.8854	10 5/8
9/64	.140625	1 11/16	25/64	.390625	4 11/16	41/64	.640625	7 11/16	57/64	.890625	10 11/16
	.1458	1 3/4		.3958	4 3/4		.6458	7 3/4		.8958	10 3/4
	.1510	1 13/16		.4010	4 13/16		.6510	7 13/16		.9010	10 13/16
5/32	.15625	1 7/8	13/32	.40625	4 7/8	21/32	.65625	7 7/8	29/32	.90625	10 7/8
	.1615	1 15/16		.4114	4 15/16		.6615	7 15/16		.9115	10 15/16
	.1667	2		.4167	5		.6667	8		.9167	11
11/64	.171875	2 1/16	27/64	.421875	5 1/16	43/64	.671875	8 1/16	59/64	.921875	11 1/16
	.1771	2 1/8		.4271	5 1/8		.6771	8 1/8		.9271	11 1/8
	.1823	2 3/16		.4323	5 3/16		.6823	8 3/16		.9323	11 3/16
3/16	.1875	2 1/4	7/16	.4375	5 1/4	11/16	.6875	8 1/4	15/16	.9375	11 1/4
	.1927	2 5/16		.4427	5 5/16		.6927	8 5/16		.9427	11 5/16
	.1979	2 3/8		.4479	5 3/8		.6979	8 3/8		.9479	11 3/8
13/64	.203125	2 7/16	29/64	.453125	5 7/16	45/64	.703125	8 7/16	61/64	.953125	11 7/16
	.2083	2 1/2		.4583	5 1/2		.7083	8 1/2		.9583	11 1/2
	.2135	2 9/16		.4635	5 9/16		.7135	8 9/16		.9635	11 3/16
7/32	.21875	2 5/8	15/32	.46875	5 5/8	23/32	.71875	8 5/8	31/32	.96875	11 5/8
	.2240	2 11/16		.4740	5 11/16		.7240	8 11/16		.9740	11 11/16
	.2292	2 3/4		.4792	5 3/4		.7292	8 3/4		.9792	11 3/4
15/64	.234375	2 13/16	31/64	.484375	5 13/16	47/64	.734375	8 13/16	63/64	.984375	11 13/16
	.2395	2 7/8		.4896	5 7/8		.7396	8 7/8		.9896	11 7/8
	.2448	2 15/16		.4948	5 15/16		.7448	8 15/16		.9948	11 15/16
1/4	.2500	3	1/2	.5000	6	3/4	.7500	9	1	1.0000	12

AREAS AND CIRCUMF. OF CIRCLES.

Diam. Ins.	Circumf. Ins.	Area. Sq. Ins.	Diam. Ins.	Circumf. Ins.	Area. Sq. Ins.	Diam. Ins.	Circumf. Ins.	Area. Sq. Ins.
1/64	.049087	.00019						
1/32	.098175	.00077	2	6.28319	3.1416	5	15.7080	19.635
3/64	.147262	.00173	1/16	6.47953	3.3410	1/16	15.9043	20.129
1/16	.196350	.00307	1/8	6.67588	3.5466	1/8	16.1007	20.629
3/32	.294524	.00690	3/16	6.87223	3.7583	3/16	16.2970	21.135
1/8	.392699	.01227	1/4	7.06858	3.9761	1/4	16.4934	21.648
5/32	.490874	.01917	5/16	7.26493	4.2000	5/16	16.6897	22.166
3/16	.589049	.02761	3/8	7.46128	4.4301	3/8	16.8861	22.691
7/32	.687223	.03758	7/16	7.65763	4.6664	7/16	17.0824	23.221
1/4	.785398	.04909	1/2	7.85398	4.9087	1/2	17.2788	23.758
9/32	.883573	.06213	9/16	8.05033	5.1572	9/16	17.4751	24.301
5/16	.981748	.07670	5/8	8.24668	5.4119	5/8	17.6715	24.850
11/32	1.07992	.09281	11/16	8.44303	5.6727	11/16	17.8678	25.406
3/8	1.17810	.11045	3/4	8.63938	5.9396	3/4	18.0642	25.967
13/32	1.27627	.12962	13/16	8.83573	6.2126	13/16	18.2605	26.535
7/16	1.37445	.15033	7/8	9.03208	6.4918	7/8	18.4569	27.109
15/32	1.47262	.17257	15/16	9.22843	6.7771	15/16	18.6532	27.688
1/2	1.57080	.19635	3	9.42478	7.0686	6	18.8496	28.274
17/32	1.66897	.22166	1/16	9.62113	7.3662	1/8	19.2423	29.465
9/16	1.76715	.24850	1/8	9.81748	7.6699	1/4	19.6350	30.680
19/32	1.86532	.27688	3/16	10.0138	7.9798	3/8	20.0277	31.919
5/8	1.96350	.30680	1/4	10.2102	8.2958	1/2	20.4204	33.183
21/32	2.06167	.33824	5/16	10.4065	8.6179	5/8	20.8131	34.472
11/16	2.15984	.37122	3/8	10.6029	8.9462	3/4	21.2058	35.785
23/32	2.25802	.40574	7/16	10.7992	9.2806	7/8	21.5984	37.122
3/4	2.35619	.44179	1/2	10.9956	9.6211	7	21.9911	38.485
25/32	2.45437	.47937	9/16	11.1919	9.9678	1/8	22.3838	39.871
13/16	2.55254	.51849	5/8	11.3883	10.321	1/4	22.7765	41.282
27/32	2.65072	.55914	11/16	11.5846	10.680	3/8	23.1692	42.718
7/8	2.74889	.60132	3/4	11.7810	11.045	1/2	23.5619	44.179
29/32	2.84707	.64504	13/16	11.9773	11.416	5/8	23.9546	45.664
15/16	2.94524	.69029	7/8	12.1737	11.793	3/4	24.3473	47.173
31/32	3.04342	.73708	15/16	12.3700	12.177	7/8	24.7400	48.707
1	3.14159	.78540	4	12.5664	12.566	8	25.1327	50.265
1/16	3.33794	.88664	1/16	12.7627	12.962	1/8	25.5224	51.849
1/8	3.53429	.99402	1/8	12.9591	13.364	1/4	25.9181	53.456
3/16	3.73064	1.1075	3/16	13.1554	13.772	3/8	26.3108	55.088
1/4	3.92699	1.2272	1/4	13.3518	14.186	1/2	26.7035	56.745
5/16	4.12334	1.3530	5/16	13.5481	14.607	5/8	27.0962	58.426
3/8	4.31969	1.4849	3/8	13.7445	15.033	3/4	27.4889	60.132
7/16	4.51604	1.6230	7/16	13.9408	15.466	7/8	27.8816	61.862
1/2	4.71239	1.7671	1/2	14.1372	15.904	9	28.2743	63.617
9/16	4.90874	1.9175	9/16	14.3335	16.349	1/8	28.6670	65.397
5/8	5.10509	2.0739	5/8	14.5299	16.800	1/4	29.0597	67.201
11/16	5.30144	2.2365	11/16	14.7262	17.257	3/8	29.4524	69.029
3/4	5.49779	2.4053	3/4	14.9226	17.721	1/2	29.8451	70.882
13/16	5.69414	2.5802	13/16	15.1189	18.190	5/8	30.2378	72.760
7/8	5.89049	2.7612	7/8	15.3153	18.665	3/4	30.6305	74.662
15/16	6.08684	2.9483	15/16	15.5116	19.147	7/8	31.0232	76.589

AREAS AND CIRCUMF. OF CIRCLES.

Diam. Ins.	Circumf. Ins.	Area Sq. Ins.	Diam. Ins.	Circumf. Ins.	Area Sq. Ins.	Diam. Ins.	Circumf. Ins.	Area Sq. Ins.
10	31.4159	78.540	16	50.2655	201.06	22	69.1150	380.13
1/8	31.8086	80.516	1/8	50.6582	204.22	1/8	69.5077	384.46
1/4	32.2013	82.516	1/4	51.0509	207.39	1/4	69.9004	388.82
3/8	32.5940	84.541	3/8	51.4436	210.60	3/8	70.2931	393.20
1/2	32.9867	86.590	1/2	51.8363	213.82	1/2	70.6858	397.61
5/8	33.3794	88.664	5/8	52.2290	217.08	5/8	71.0785	402.04
3/4	33.7721	90.763	3/4	52.6217	220.35	3/4	71.4712	406.49
7/8	34.1648	92.886	7/8	53.0144	223.65	7/8	71.8639	410.97
11	34.5575	95.033	17	53.4071	226.98	23	72.2566	415.48
1/8	34.9502	97.205	1/8	53.7998	230.33	1/8	72.6493	420.00
1/4	35.3429	99.402	1/4	54.1925	233.71	1/4	73.0420	424.56
3/8	35.7356	101.62	3/8	54.5852	237.10	3/8	73.4347	429.13
1/2	36.1283	103.87	1/2	54.9779	240.53	1/2	73.8274	433.74
5/8	36.5210	106.14	5/8	55.3706	243.98	5/8	74.2201	438.36
3/4	36.9137	108.43	3/4	65.7633	247.45	3/4	74.6128	443.01
7/8	37.3064	110.75	7/8	56.1560	250.95	7/8	75.0055	447.69
12	37.6991	113.10	18	56.5487	254.47	24	75.3982	452.39
1/8	38.0918	115.47	1/8	56.9414	258.02	1/8	75.7909	457.11
1/4	38.4845	117.86	1/4	57.3341	261.59	1/4	76.1836	461.86
3/8	38.8772	120.28	3/8	57.7268	265.18	3/8	76.5763	466.64
1/2	39.2699	122.72	1/2	58.1195	268.80	1/2	76.9690	471.44
5/8	39.6626	125.19	5/8	58.5122	272.45	5/8	77.3617	476.26
3/4	40.0553	127.68	3/4	58.9049	276.12	3/4	77.7544	481.11
7/8	40.4480	130.19	7/8	59.2976	279.81	7/8	78.1471	485.98
13	40.8407	132.73	19	59.6903	283.53	25	78.5398	490.87
1/8	41.2334	135.30	1/8	60.0830	287.27	1/8	78.9325	495.79
1/4	41.6261	137.89	1/4	60.4757	291.04	1/4	79.3252	500.74
3/8	42.0188	140.50	3/8	60.8684	294.83	3/8	79.7179	505.71
1/2	42.4115	143.14	1/2	61.2611	298.65	1/2	80.1106	510.71
5/8	42.8042	145.80	5/8	61.6538	302.49	5/8	80.5033	515.72
3/4	43.1969	148.49	3/4	62.0465	306.35	3/4	80.8960	520.77
7/8	43.5896	151.20	7/8	62.4392	310.24	7/8	81.2887	525.84
14	43.9823	153.94	20	62.8319	314.16	26	81.6814	530.93
1/8	44.3750	156.70	1/8	63.2246	318.10	1/8	82.0741	536.05
1/4	44.7677	159.48	1/4	63.6173	322.06	1/4	82.4668	541.19
3/8	45.1604	162.30	3/8	64.0100	326.05	3/8	82.8595	546.35
1/2	45.5531	165.13	1/2	64.4026	330.06	1/2	83.2522	551.55
5/8	45.9458	167.99	5/8	64.7953	334.10	5/8	83.6449	556.76
3/4	46.3385	170.87	3/4	66.1880	338.16	3/4	84.0376	562.00
7/8	46.7312	173.78	7/8	65.5807	342.25	7/8	84.4303	567.27
15	47.1239	176.71	21	65.9734	346.36	27	84.8230	572.56
1/8	47.5166	179.67	1/8	66.3661	350.50	1/8	85.2157	577.87
1/4	47.9093	182.65	1/4	66.7588	354.66	1/4	85.6084	583.21
3/8	48.3020	185.66	3/8	67.1515	358.84	3/8	86.0011	588.57
1/2	48.6947	188.69	1/2	67.5442	363.05	1/2	86.3938	593.96
5/8	49.0874	191.75	5/8	67.9369	367.28	5/8	86.7865	599.37
3/4	49.4801	194.83	3/4	68.3296	371.54	3/4	87.1792	604.81
7/8	49.8728	197.93	7/8	68.7223	375.83	7/8	87.5719	610.27

AREAS AND CIRCUMF. OF CIRCLES.

Diam. Ins.	*Circumf. Ins.*	*Area. Sq. Ins.*	*Diam. Ins.*	*Circumf. Ins.*	*Area. Sq. Ins.*	*Diam. Ins.*	*Circumf. Ins.*	*Area. Sq. Ins.*
28	87.9646	615.75	34	106.814	907.92	40	125.664	1256.6
1/8	88.3573	621.26	1/8	107.207	914.61	1/8	126.056	1264.5
1/4	88.7500	626.80	1/4	107.600	921.32	1/4	126.449	1272.4
3/8	89.1427	632.36	3/8	107.992	928.06	3/8	126.842	1280.3
1/2	89.5354	637.94	1/2	108.385	934.82	1/2	127.235	1288.2
5/8	89.9281	643.55	5/8	108.788	941.61	5/8	127.627	1296.2
3/4	90.3208	649.18	3/4	109.170	948.42	3/4	128.020	1304.2
7/8	90.7135	654.84	7/8	109.563	955.25	7/8	128.413	1312.2
29	91.1062	660.52	35	109.956	962.11	41	128.805	1320.3
1/8	91.4989	666.23	1/8	110.348	969.00	1/8	129.198	1328.3
1/4	91.8916	671.96	1/4	110.741	975.91	1/4	129.591	1336.4
3/8	92.2843	677.71	3/8	111.134	982.84	3/8	129.993	1344.5
1/2	92.6770	683.49	1/2	111.527	989.80	1/2	130.376	1352.7
5/8	93.0697	689.30	5/8	111.919	996.78	5/8	130.769	1360.8
3/4	93.4624	695.13	3/4	112.312	1003.8	3/4	131.161	1369.0
7/8	93.8551	700.98	7/8	112.705	1010.8	7/8	131.554	1377.2
30	94.2478	706.86	36	113.097	1017.9	42	131.947	1385.4
1/8	94.6405	712.76	1/8	113.490	1025.0	1/8	132.340	1393.7
1/4	95.0332	718.69	1/4	113.883	1032.1	1/4	132.732	1402.0
3/8	95.4259	724.64	3/8	114.275	1039.2	3/8	133.125	1410.3
1/2	95.8186	730.62	1/2	114.668	1046.3	1/2	133.518	1418.6
5/8	96.2113	736.62	5/8	115.061	1053.5	5/8	133.910	1427.0
3/4	96.6040	742.64	3/4	115.454	1060.7	3/4	134.303	1435.4
7/8	96.9967	748.69	7/8	115.846	1068.0	7/8	134.696	1443.8
31	97.3894	754.77	37	116.239	1075.2	43	135.088	1452.2
1/8	97.7821	760.87	1/8	116.632	1082.5	1/8	135.481	1460.7
1/4	98.1748	766.99	1/4	117.024	1089.8	1/4	135.874	1469.1
3/8	98.5675	773.14	3/8	117.417	1097.1	3/8	136.267	1477.6
1/2	98.9602	779.31	1/2	117.810	1104.5	1/2	136.659	1486.2
5/8	99.3529	785.51	5/8	118.202	1111.8	5/8	137.052	1494.7
3/4	99.7456	791.73	3/4	118.596	1119.2	3/4	137.445	1503.3
7/8	100.138	797.98	7/8	118.988	1126.7	7/8	137.837	1511.9
32	100.531	804.25	38	119.381	1134.1	44	138.230	1520.5
1/8	100.924	810.54	1/8	119.773	1141.6	1/8	138.623	1529.2
1/4	101.316	816.86	1/4	120.166	1149.1	1/4	139.015	1537.9
3/8	101.709	823.21	3/8	120.559	1156.6	3/8	139.408	1546.6
1/2	102.102	829.58	1/2	120.951	1164.2	1/2	139.801	1555.3
5/8	102.494	835.97	5/8	121.344	1171.7	5/8	140.194	1564.0
3/4	102.887	842.39	3/4	121.737	1179.3	3/4	140.586	1572.8
7/8	103.280	848.83	7/8	122.129	1186.9	7/8	140.979	1581.6
33	103.673	855.30	39	122.522	1194.6	45	141.372	1590.4
1/8	104.065	861.79	1/8	122.915	1202.3	1/8	141.764	1599.3
1/4	104.458	868.31	1/4	123.308	1210.0	1/4	142.157	1608.2
3/8	104.851	874.85	3/8	123.700	1217.7	3/8	142.550	1617.0
1/2	105.243	881.41	1/2	124.093	1225.4	1/2	142.942	1626.0
5/8	105.636	888.00	5/8	124.486	1233.2	5/8	143.335	1684.9
3/4	106.029	894.62	3/4	124.878	1241.0	3/4	143.728	1643.9
7/8	106.421	901.26	7/8	125.271	1248.8	7/8	144.121	1652.9

AREAS AND CIRCUMF. OF CIRCLES.

Diam. Ins.	*Circumf. Ins.*	*Area Sq. Ins.*	*Diam. Ins.*	*Circumf. Ins.*	*Area Sq. Ins.*	*Diam. Ins.*	*Circumf. Ins.*	*Area Sq. Ins.*
46	144.513	1661.9	52	163.363	2123.7	58	182.212	2642.1
1/8	144.906	1670.9	1/8	163.756	2133.9	1/8	182.605	2653.5
1/4	145.299	1680.0	1/4	164.148	2144.2	1/4	182.998	2664.9
3/8	145.691	1689.1	3/8	164.541	2154.5	3/8	183.390	2676.4
1/2	146.084	1698.2	1/2	164.934	2164.8	1/2	183.783	2687.8
5/8	146.477	1707.4	5/8	165.326	2175.1	5/8	184.176	2699.3
3/4	146.869	1716.5	3/4	165.719	2185.4	3/4	184.569	2710.9
7/8	147.262	1725.7	7/8	166.112	2195.8	7/8	184.961	2722.4
47	147.655	1734.9	53	166.504	2206.2	59	185.354	2734.0
1/8	148.048	1744.2	1/8	166.897	2216.6	1/8	185.747	2745.6
1/4	148.440	1753.5	1/4	167.290	2227.0	1/4	186.139	2757.2
3/8	148.833	1762.7	3/8	167.683	2237.5	3/8	186.532	2768.8
1/2	149.226	1772.1	1/2	168.075	2248.0	1/2	186.925	2780.5
5/8	149.618	1781.4	5/8	168.468	2258.5	5/8	187.317	2792.2
3/4	150.011	1790.8	3/4	168.861	2269.1	3/4	187.710	2803.9
7/8	150.404	1800.1	7/8	169.253	2279.6	7/8	188.103	2815.7
48	150.796	1809.6	54	169.646	2290.2	60	188.496	2827.4
1/8	151.189	1819.0	1/8	170.039	2300.8	1/8	188.888	2839.2
1/4	151.582	1828.5	1/4	170.431	2311.5	1/4	189.281	2851.0
3/8	151.975	1837.9	3/8	170.824	2322.1	3/8	189.674	2862.9
1/2	152.367	1847.5	1/2	171.217	2332.8	1/2	190.066	2874.8
5/8	152.760	1857.0	5/8	171.609	2343.5	5/8	190.459	2886.6
3/4	153.153	1866.5	3/4	172.002	2354.3	3/4	190.852	2898.6
7/8	153.545	1876.1	7/8	172.395	2365.0	7/8	191.244	2910.5
49	153.938	1885.7	55	172.788	2375.8	61	191.637	2922.5
1/8	154.331	1895.4	1/8	173.180	2386.6	1/8	192.030	2934.5
1/4	154.723	1905.0	1/4	173.573	2397.5	1/4	192.423	2946.5
3/8	155.116	1914.7	3/8	173.966	2408.3	3/8	192.815	2958.5
1/2	155.509	1924.4	1/2	174.358	2419.2	1/2	193.208	2970.6
5/8	155.902	1934.2	5/8	174.751	2430.1	5/8	193.601	2982.7
3/4	156.294	1943.9	3/4	175.144	2441.1	3/4	193.993	2994.8
7/8	156.687	1953.7	7/8	175.536	2452.0	7/8	194.386	3006.9
50	157.080	1963.5	56	175.929	2463.0	62	194.779	3019.1
1/8	157.472	1973.3	1/8	176.322	2474.0	1/8	195.171	3031.3
1/4	157.865	1983.2	1/4	176.715	2485.0	1/4	195.564	3043.5
3/8	158.258	1993.1	3/8	177.107	2496.1	3/8	195.957	3055.7
1/2	158.650	2003.0	1/2	177.500	2507.2	1/2	196.350	3068.0
5/8	159.043	2012.9	5/8	177.893	2518.3	5/8	196.742	3080.3
3/4	159.436	2022.8	3/4	178.285	2529.4	3/4	197.135	3092.6
7/8	159.829	2032.8	7/8	178.678	2540.6	7/8	197.528	3104.9
51	160.221	2042.8	57	179.071	2551.8	63	197.920	3117.2
1/8	160.614	2052.8	1/8	179.463	2563.0	1/8	198.313	3129.6
1/4	161.007	2062.9	1/4	179.856	2574.2	1/4	198.706	3142.0
3/8	161.399	2073.0	3/8	180.249	2585.4	3/8	199.098	3154.5
1/2	161.792	2083.1	1/2	180.642	2596.7	1/2	199.491	3166.9
5/8	162.185	2093.2	5/8	181.034	2608.0	5/8	199.884	3179.4
3/4	162.577	2103.3	3/4	181.427	2619.4	3/4	200.277	3191.9
7/8	162.970	2113.5	7/8	181.820	2630.7	7/8	200.669	3204.4

AREAS AND CIRCUMF. OF CIRCLES.

Diam. Ins.	*Circumf. Ins.*	*Area Sq. Ins.*	*Diam. Ins.*	*Circumf. Ins.*	*Area Sq. Ins.*	*Diam. Ins.*	*Circumf. Ins.*	*Area Sq. Ins.*
64	201.062	3217.0	70	219.911	3848.5	76	238.761	4536.5
1/8	201.455	3229.6	1/8	220.304	3862.2	1/8	239.154	4551.4
1/4	201.847	3242.2	1/4	220.697	3876.0	1/4	239.546	4566.4
3/8	202.240	3254.8	3/8	221.090	3889.8	3/8	239.939	4581.3
1/2	202.633	3267.5	1/2	221.482	3903.6	1/2	240.332	4596.3
5/8	203.025	3280.1	5/8	221.875	3917.5	5/8	240.725	4611.4
3/4	203.418	3292.8	3/4	222.268	3931.4	3/4	241.117	4626.4
7/8	203.811	3305.6	7/8	222.660	3945.3	7/8	241.510	4641.5
65	204.204	3318.3	71	223.053	3959.2	77	241.903	4656.6
1/8	204.596	3331.1	1/8	223.446	3973.1	1/8	242.295	4671.8
1/4	204.989	3343.9	1/4	223.838	3987.1	1/4	242.688	4686.9
3/8	205.382	3356.7	3/8	224.231	4001.1	3/8	243.081	4702.1
1/2	205.774	3369.6	1/2	224.624	4015.2	1/2	243.473	4717.3
5/8	206.167	3382.4	5/8	225.017	4029.2	5/8	243.866	4732.5
3/4	206.560	3395.3	3/4	225.409	4043.3	3/4	244.259	4747.8
7/8	206.952	3408.2	7/8	225.802	4057.4	7/8	244.652	4763.1
66	207.345	3421.2	72	226.195	4071.5	78	245.044	4778.4
1/8	207.738	3434.3	1/8	226.587	4085.7	1/8	245.437	4793.7
1/4	208.131	3447.2	1/4	226.980	4099.8	1/4	245.830	4809.0
3/8	208.523	3460.2	3/8	227.373	4114.0	3/8	246.222	4824.4
1/2	208.916	3473.2	1/2	227.765	4128.2	1/2	246.615	4839.8
5/8	209.309	3486.3	5/8	228.158	4142.5	5/8	247.008	4855.2
3/4	209.701	3499.4	3/4	228.551	4156.8	3/4	247.400	4870.7
7/8	210.094	3512.5	7/8	228.944	4171.1	7/8	247.793	4886.2
67	210.487	3525.7	73	229.336	4185.4	79	248.186	4901.7
1/8	210.879	3538.8	1/8	229.729	4199.7	1/8	248.579	4917.2
1/4	211.272	3552.0	1/4	230.122	4214.1	1/4	248.971	4932.7
3/8	211.665	3565.2	3/8	230.514	4228.5	3/8	249.364	4948.3
1/2	212.058	3578.5	1/2	230.907	4242.9	1/2	249.757	4963.9
5/8	212.450	3591.7	5/8	231.300	4257.4	5/8	250.149	4979.5
3/4	212.843	3605.0	3/4	231.692	4271.8	3/4	250.542	4995.2
7/8	213.236	3618.3	7/8	232.085	4286.3	7/8	250.935	5010.9
68	213.628	3631.7	74	232.478	4300.8	80	251.327	5026.5
1/8	214.021	3645.0	1/8	232.871	4315.4	1/8	251.720	5042.3
1/4	214.414	3658.4	1/4	233.263	4329.9	1/4	252.113	5058.0
3/8	214.806	3671.8	3/8	233.656	4344.5	3/8	252.506	5073.8
1/2	215.199	3685.3	1/2	234.049	4359.2	1/2	252.898	5089.6
5/8	215.592	3698.7	5/8	234.441	4373.8	5/8	253.291	5105.4
3/4	215.984	3712.2	3/4	234.834	4388.5	3/4	253.684	5121.2
7/8	216.377	3725.7	7/8	235.227	4403.1	7/8	254.076	5137.1
69	216.770	3739.3	75	235.619	4417.9	81	254.469	5153.0
1/8	217.163	3752.8	1/8	236.012	4432.6	1/8	254.862	5168.9
1/4	217.555	3766.4	1/4	236.405	4447.4	1/4	255.254	5184.9
3/8	217.948	3780.0	3/8	236.798	4462.2	3/8	255.647	5200.8
1/2	218.341	3793.7	1/2	237.190	4477.0	1/2	256.040	5216.8
5/8	218.733	3807.3	5/8	237.583	4491.8	5/8	256.433	5232.8
3/4	219.126	3821.0	3/4	237.976	4506.7	3/4	256.825	5248.9
7/8	219.519	3834.7	7/8	238.368	4521.5	7/8	257.218	5264.9

AREAS AND CIRCUMF. OF CIRCLES.

Diam. Ins.	*Circumf. Ins.*	*Area Sq. Ins.*	*Diam. Ins.*	*Circumf. Ins.*	*Area Sq. Ins.*	*Diam. Ins.*	*Circumf. Ins.*	*Area. Sq. Ins.*
82	257.611	5281.0	88	276.460	6082.1	94	295.310	6939.8
1/8	258.003	5297.1	1/8	276.853	6099.4	1/8	295.702	6958.2
1/4	258.396	5313.3	1/4	277.246	6116.7	1/4	296.095	6976.7
3/8	258.789	5329.4	3/8	277.638	6134.1	3/8	295.488	6995.3
1/2	259.181	5345.6	1/2	278.031	6151.4	1/2	296.881	7013.8
5/8	259.574	5361.8	5/8	278.424	6168.8	5/8	297.273	7032.4
3/4	259.967	5378.1	3/4	278.816	6186.2	3/4	297.666	7051.0
7/8	260.359	5394.3	7/8	279.209	6203.7	7/8	298.059	7069.6
83	260.752	5410.6	89	279.602	6221.1	95	298.451	7088.2
1/8	261.145	5426.9	1/8	279.994	6238.6	1/8	298.844	7106.9
1/4	261.538	5443.3	1/4	280.387	6256.1	1/4	299.237	7125.6
3/8	261.930	5459.6	3/8	280.780	6273.7	3/8	299.629	7144.3
1/2	262.323	5476.0	1/2	281.173	6291.2	1/2	300.022	7163.0
5/8	262.716	5492.4	5/8	281.565	6308.8	5/8	300.415	7181.8
3/4	263.108	5508.8	3/4	281.958	6326.4	3/4	300.807	7200.6
7/8	263.501	5525.3	7/8	282.351	6344.1	7/8	301.200	7219.4
84	263.894	5541.8	90	282.743	6361.7	96	301.593	7238.2
1/8	264.286	5558.3	1/8	283.136	6379.4	1/8	301.986	7257.1
1/4	264.679	5574.8	1/4	283.529	6397.1	1/4	302.378	7276.0
3/8	265.072	5591.4	3/8	283.921	6414.9	3/8	302.771	7294.9
1/2	265.465	5607.9	1/2	284.314	6432.6	1/2	303.164	7313.8
5/8	265.857	5624.5	5/8	284.707	6450.4	5/8	303.556	7332.8
3/4	266.250	5641.2	3/4	285.100	6468.2	3/4	303.949	7351.8
7/8	266.643	5657.8	7/8	285.492	6486.0	7/8	304.342	7370.8
85	267.035	5674.5	91	285.885	6503.9	97	304.734	7389.8
1/8	267.428	5691.2	1/8	286.278	6521.8	1/8	305.127	7408.9
1/4	267.821	5707.9	1/4	286.670	6539.7	1/4	305.520	7428.0
3/8	268.213	5724.7	3/8	287.063	6557.6	3/8	305.913	7447.1
1/2	268.606	5741.5	1/2	287.456	6575.5	1/2	306.305	7466.2
5/8	268.999	5758.3	5/8	287.848	6593.5	5/8	306.698	7485.3
3/4	269.392	5775.1	3/4	288.241	6611.5	3/4	307.091	7504.5
7/8	269.784	5791.9	7/8	288.634	6629.6	7/8	307.483	7523.7
86	270.177	5808.8	92	289.027	6647.6	98	307.876	7543.0
1/8	270.570	5825.7	1/8	289.419	6665.7	1/8	308.269	7562.2
1/4	270.962	5842.6	1/4	289.812	6683.8	1/4	308.661	7581.5
3/8	271.355	5859.6	3/8	290.205	6701.9	3/8	309.054	7600.8
1/2	271.748	5876.5	1/2	290.597	6720.1	1/2	309.447	7620.1
5/8	272.140	5893.5	5/8	290.990	6738.2	5/8	309.840	7639.5
3/4	272.533	5910.6	3/4	291.383	6756.4	3/4	310.232	7658.9
7/8	272.926	5927.6	7/8	291.775	6774.7	7/8	310.625	7678.3
87	273.319	5944.7	93	292.168	6792.9	99	311.018	7697.7
1/8	273.711	5961.8	1/8	292.561	6811.2	1/8	311.410	7717.1
1/4	274.104	5978.9	1/4	292.954	6829.5	1/4	311.803	7736.6
3/8	274.497	5996.0	3/8	293.346	6847.8	3/8	312.196	7756.1
1/2	274.889	6013.2	1/2	293.739	6866.1	1/2	312.588	7775.6
5/8	275.282	6030.4	5/8	294.132	6884.5	5/8	312.981	7795.2
3/4	275.675	6047.6	3/4	294.524	6902.9	3/4	313.374	7814.8
7/8	276.067	6064.9	7/8	294.917	6921.3	7/8	313.767	7834.4
						100	314.159	7854.0

PRODUCT OF FRACTIONS EXPRESSED IN DECIMALS.

0	1	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
1/16	.0625	.0039															
1/8	.1250	.0078	.0156														
3/16	.1875	.0117	.0234	.0351													
1/4	.2500	.0156	.0313	.0469	.0625												
5/16	.3125	.0195	.0391	.0587	.0781	.0977											
3/8	.3750	.0234	.0469	.0705	.0937	.1172	.1406										
7/16	.4375	.0273	.0547	.0823	.1093	.1367	.1641	.1914									
1/2	.5000	.0313	.0625	.0938	.1250	.1562	.1875	.2188	.2500								
9/16	.5625	.0352	.0703	.1056	.1406	.1757	.2110	.2462	.2813	.3164							
5/8	.6250	.0391	.0781	.1172	.1562	.1952	.2343	.2734	.3125	.3516	.3906						
11/16	.6875	.0430	.0859	.1289	.1718	.2148	.2578	.3007	.3438	.3867	.4297	.4727					
3/4	.7500	.0469	.0938	.1406	.1875	.2344	.2813	.3281	.3750	.4219	.4686	.5156	.5625				
13/16	.8125	.0508	.1016	.1523	.2031	.2539	.3047	.3555	.4063	.4570	.5078	.5586	.6094	.6601			
7/8	.8750	.0547	.1094	.1640	.2187	.2734	.3281	.3828	.4375	.4922	.5469	.6016	.6563	.7109	.7656		
15/16	.9375	.0586	.1172	.1757	.2343	.2929	.3515	.4102	.4688	.5274	.5859	.6445	.7031	.7617	.8203	.8789	
1	1.000	.0625	.1250	.1875	.2500	.3125	.3750	.4375	.5000	.5625	.6250	.6875	.7500	.8125	.8750	.9375	1.000

INDEX.

STEEL SECTIONS
ROLLED AT
PENCOYD.

For detailed information relating to these sections, refer to the following pages:

The standard sections of beams and channels have a uniform flange bevel of 8½ degrees or 15 per cent.

PLATES
OF
PENCOYD
STEEL
SECTIONS.

JULIUS BIEN & CO. N.Y.

Plate No.1.

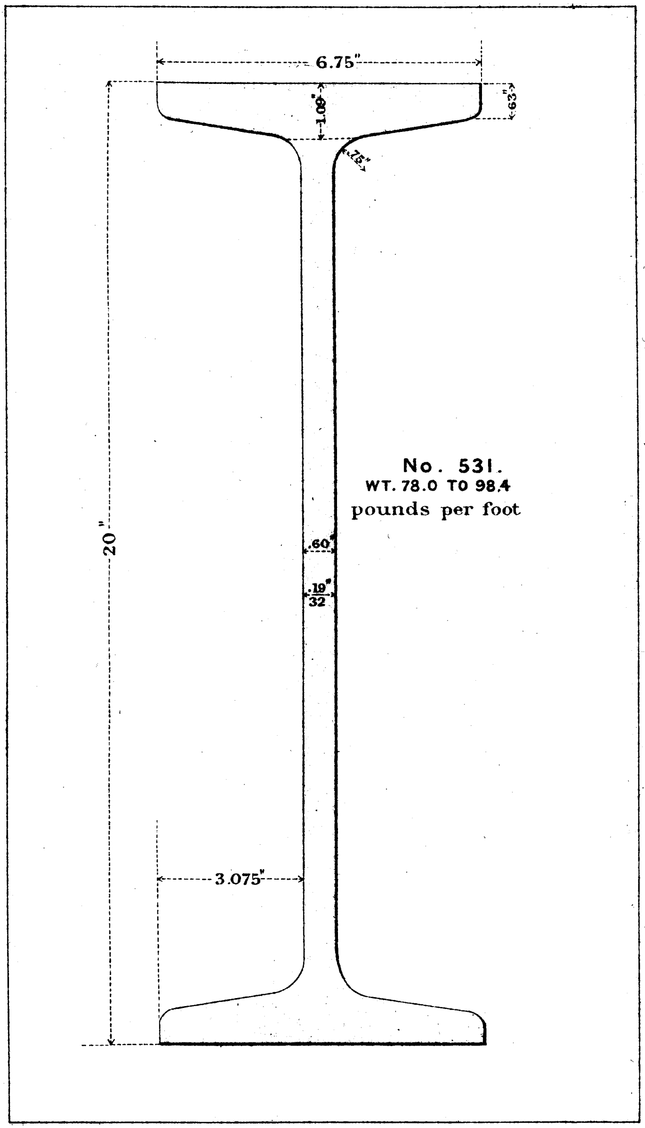


Plate No. 2

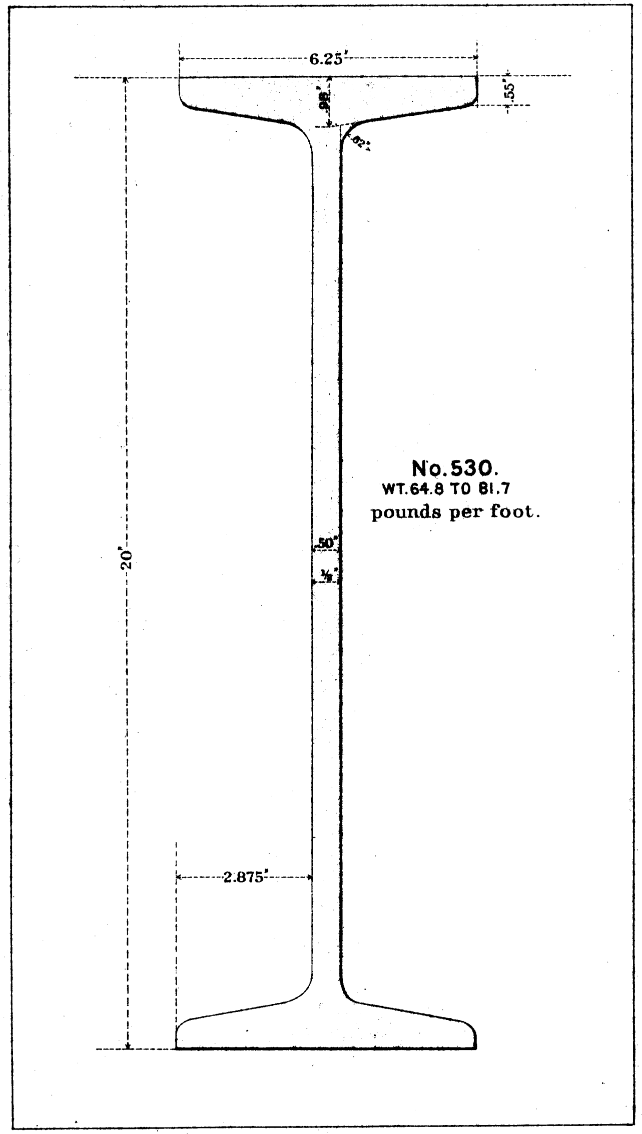


Plate No.3.

All weights given in pounds per foot

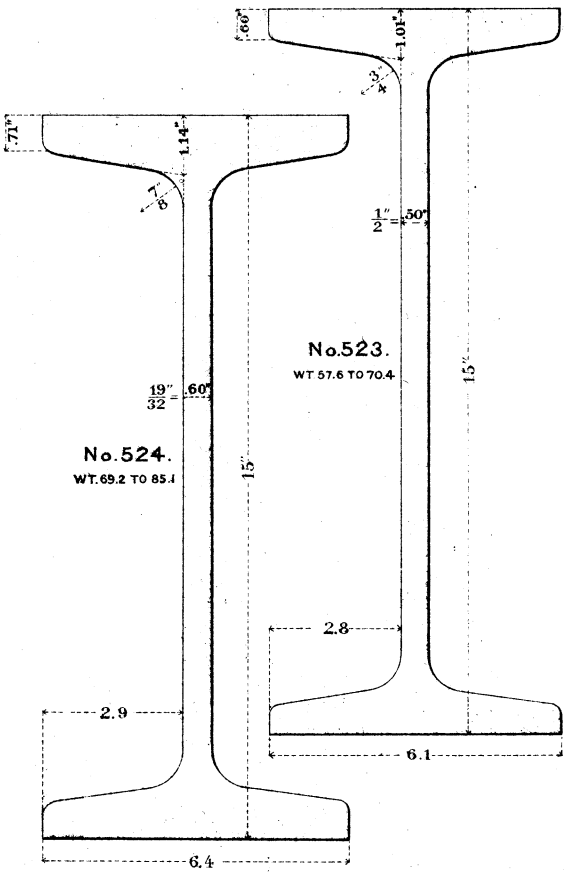
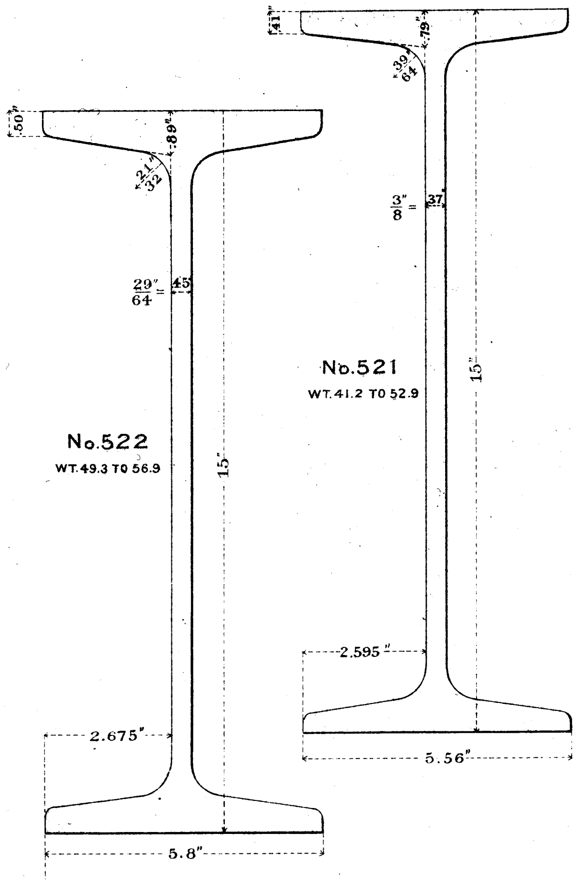
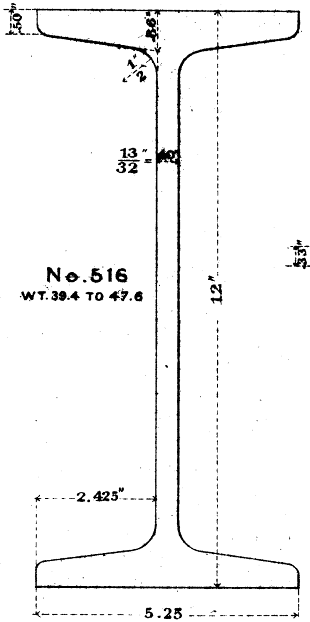


Plate No.4.

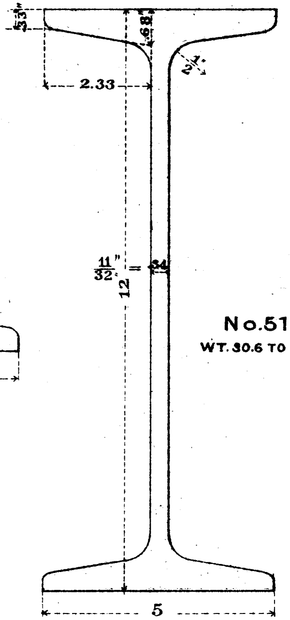
All weights given in pounds per foot



All weights given in pounds per foot.

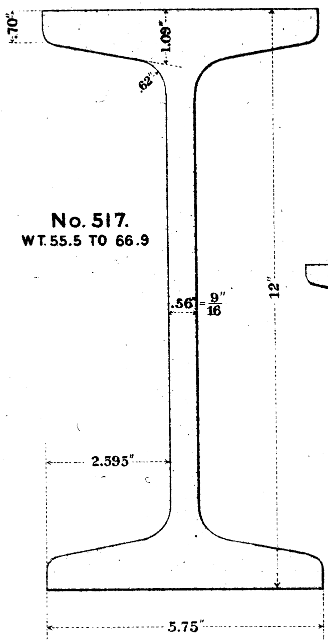


No. 516
WT. 39.4 TO 47.6

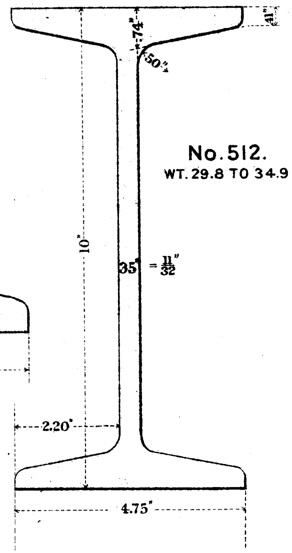


No. 515
WT. 30.6 TO 38.4

All weights given in pounds per foot.



No. 517.
WT. 55.5 TO 66.9



No. 512.
WT. 29.8 TO 34.9

Plate No. 7.

All weights given in pounds per foot.

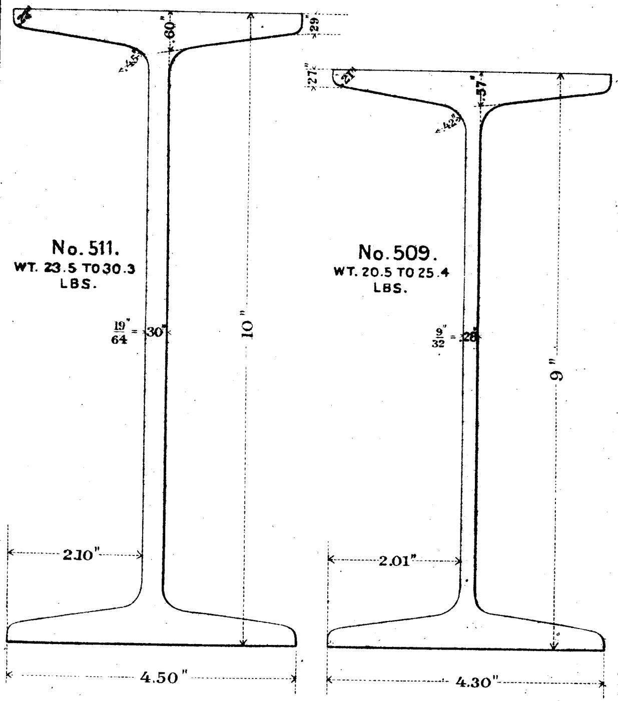


Plate No. 8.

All weights given in pounds per foot.

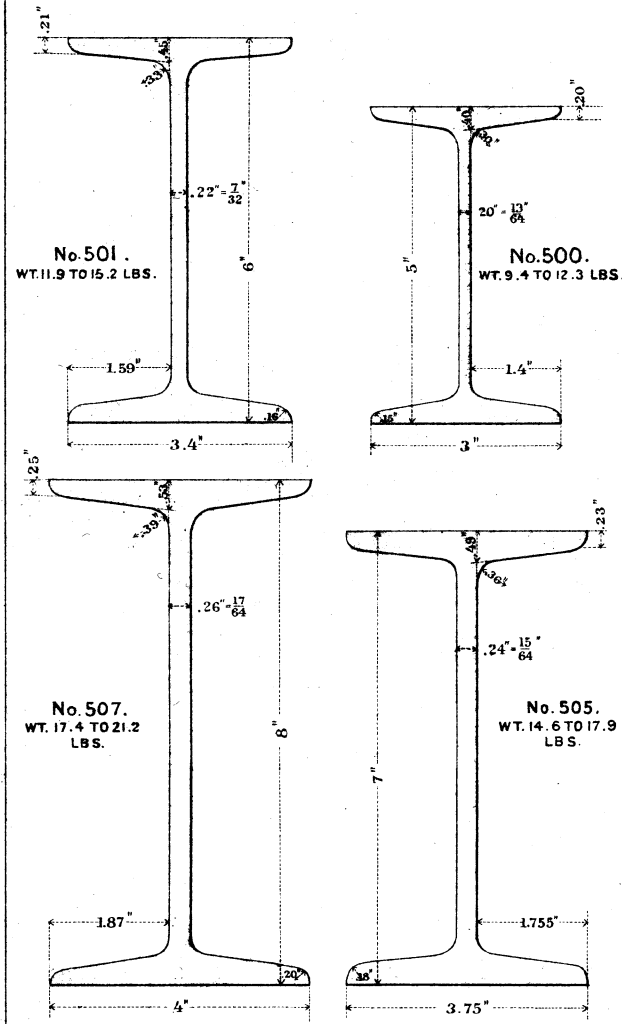


Plate No. 9.

All weights given in pounds per foot

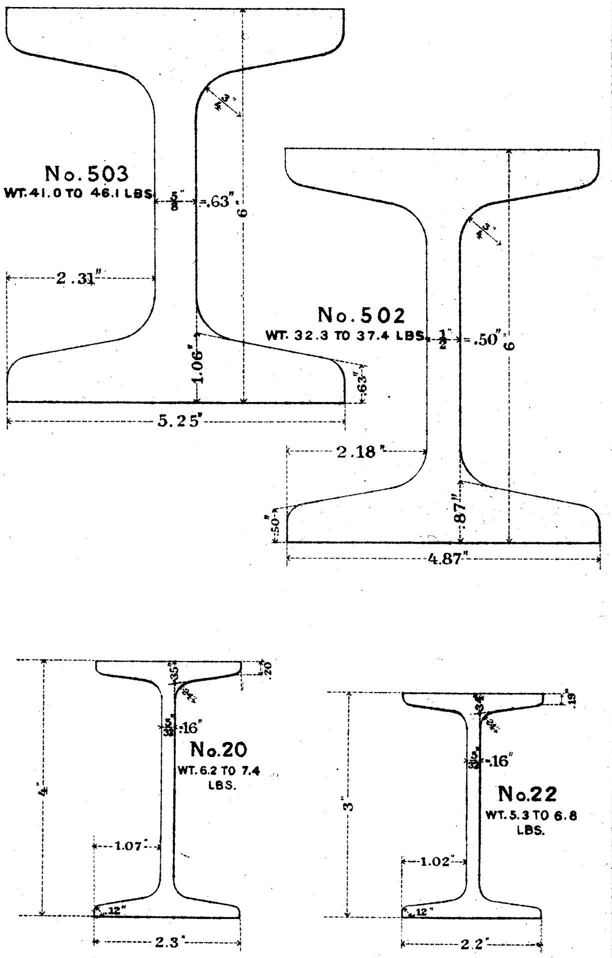


Plate No. 10

All weights given in Lbs. per ft.

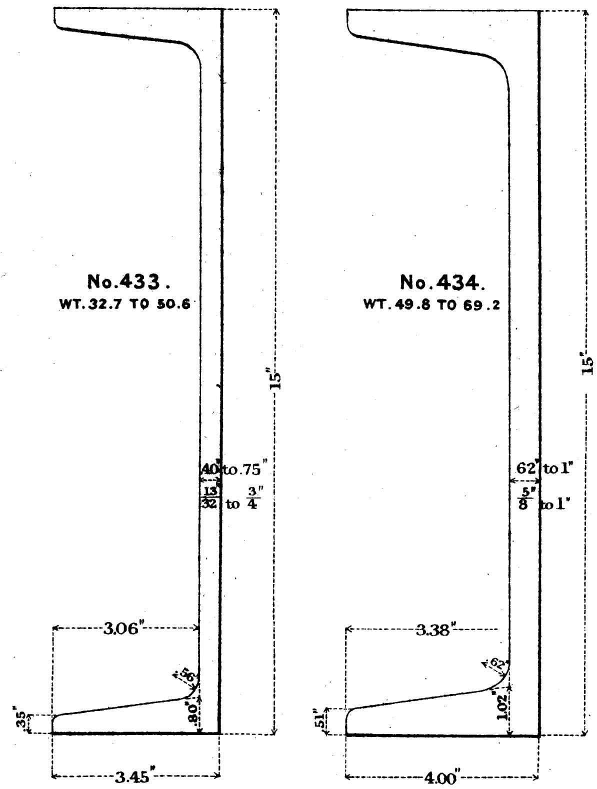


Plate No.11

All weights given in Lbs.per ft.

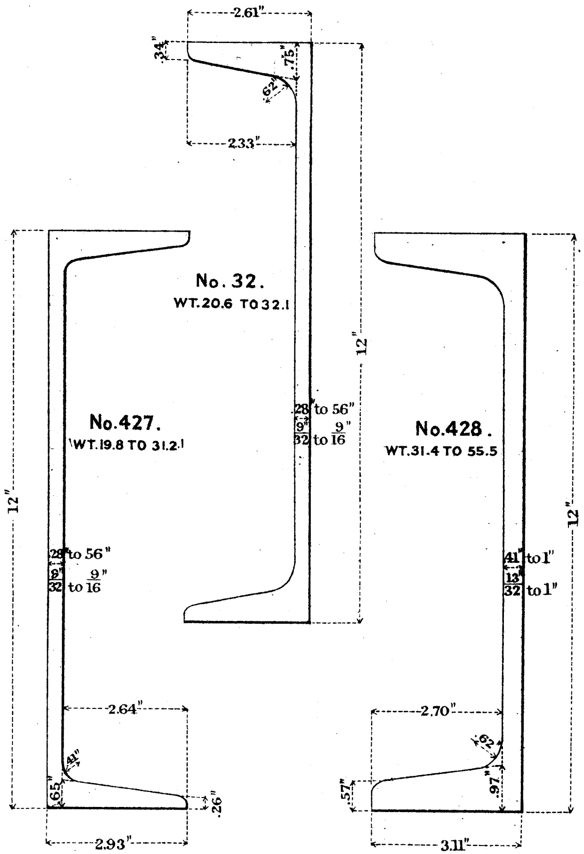


Plate No.12

All weights given in Lbs.per ft.

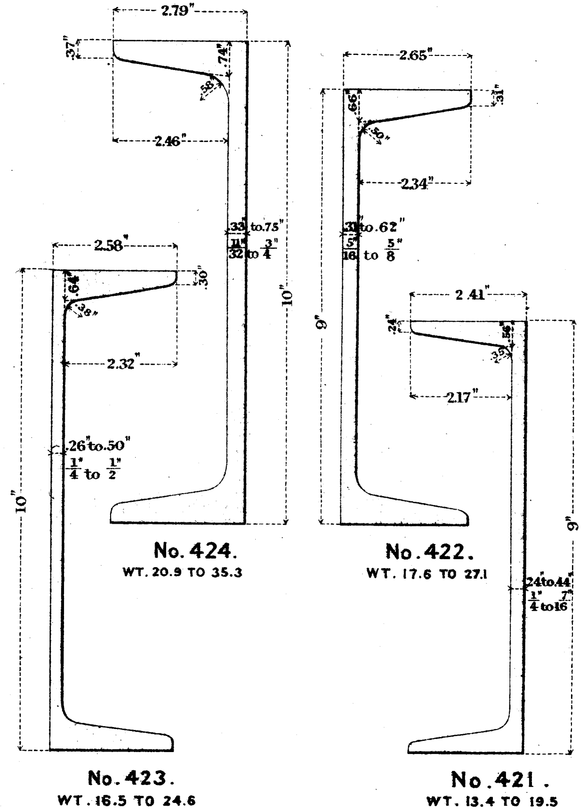


Plate No. 13

All weights given in lbs per ft.

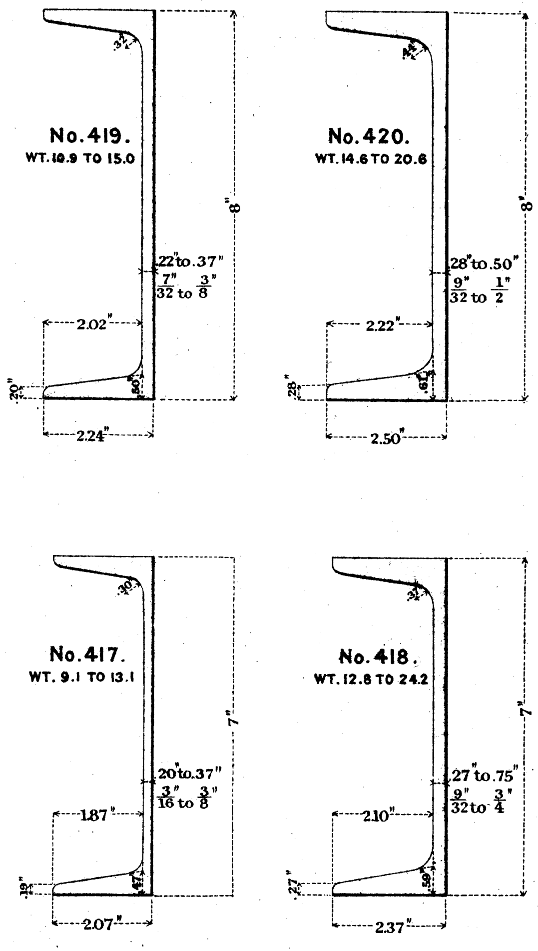


Plate No. 14.

All weights given in Lbs. per ft.

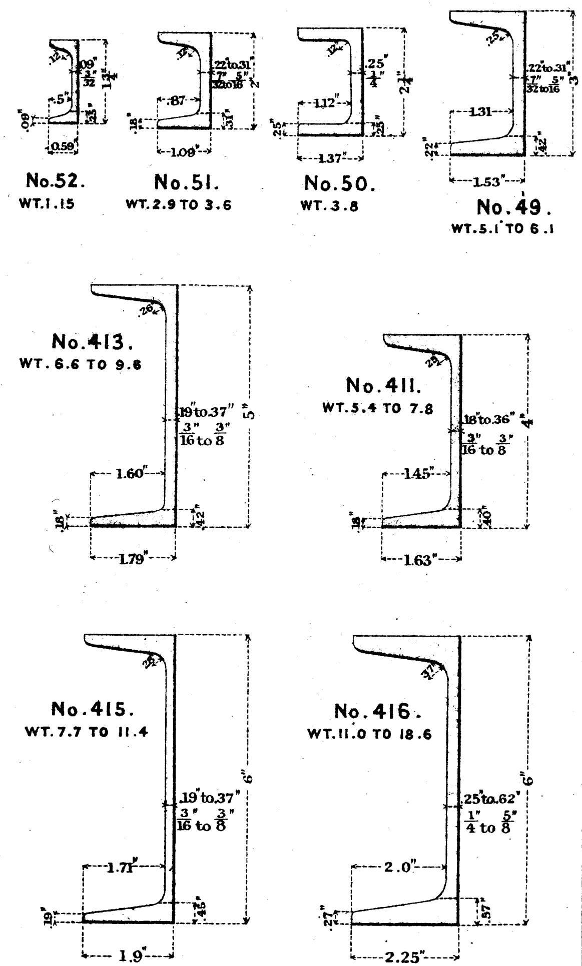
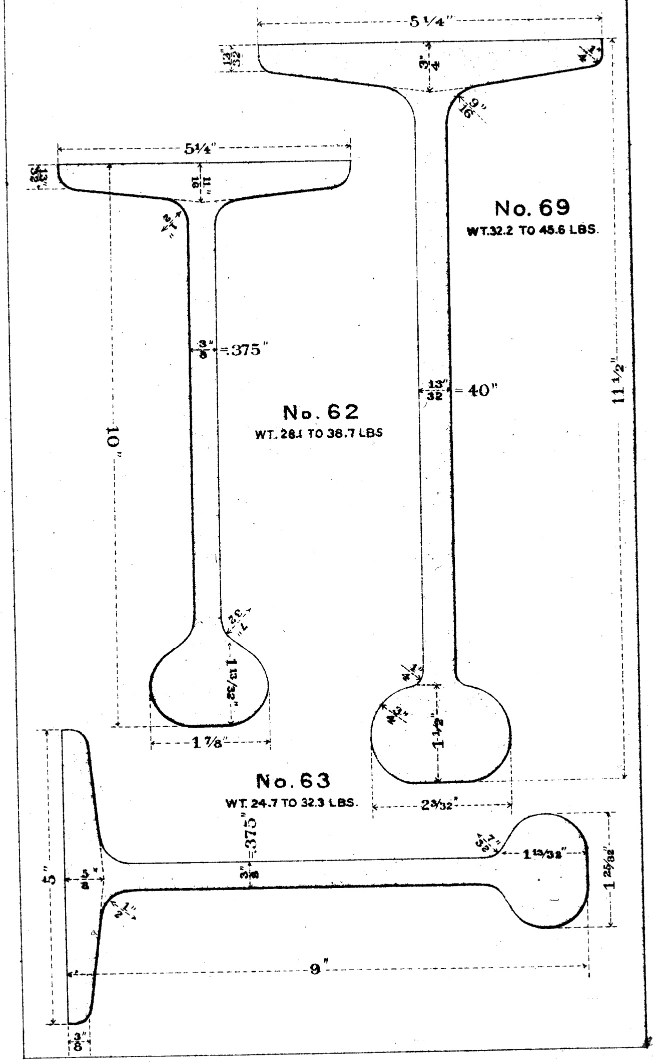
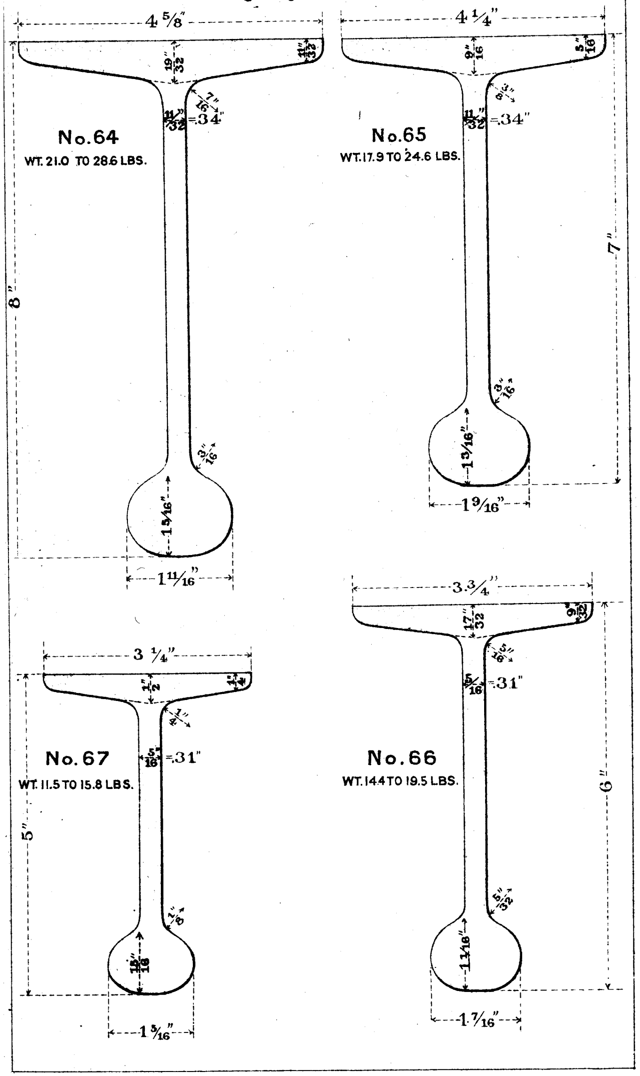


Plate No. 15.

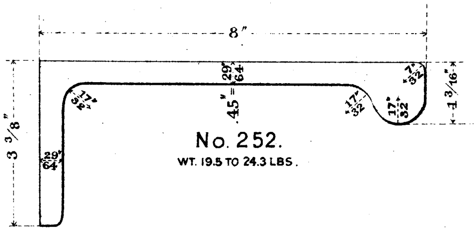
All weights given in pounds per foot.



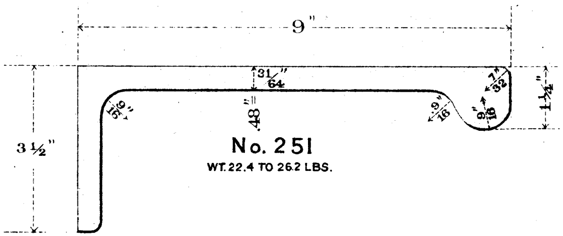
All weights given in lbs. per ft.



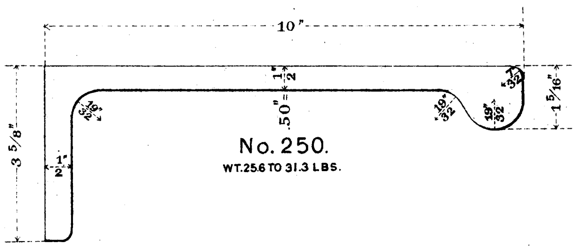
All weights given in pounds per foot



No. 252.
WT. 19.5 TO 24.3 LBS.

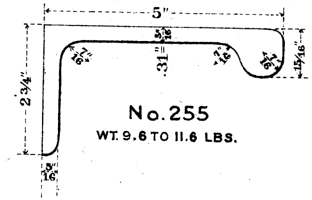


No. 251
WT. 22.4 TO 26.2 LBS.

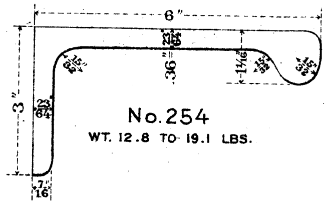


No. 250.
WT. 25.6 TO 31.3 LBS.

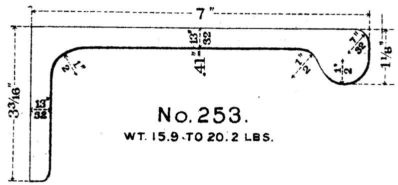
All weights given in pounds per foot



No. 255
WT. 9.6 TO 11.6 LBS.



No. 254
WT. 12.8 TO 19.1 LBS.



No. 253.
WT. 15.9 TO 20.2 LBS.

Plate No.19.

All weights given in lbs.per ft.

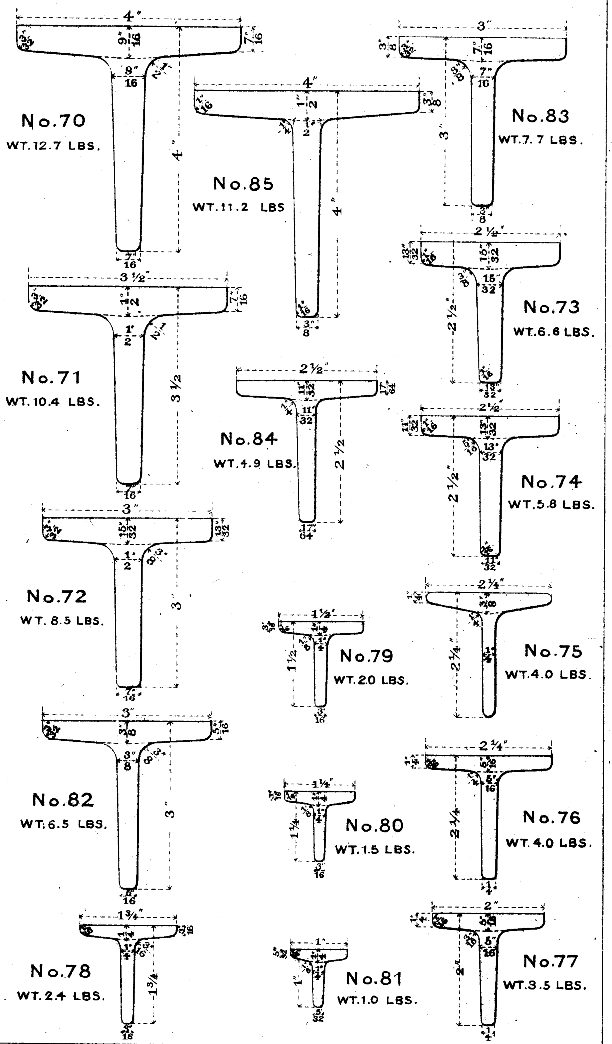


Plate No.20

All weights given in Lbs.per ft.

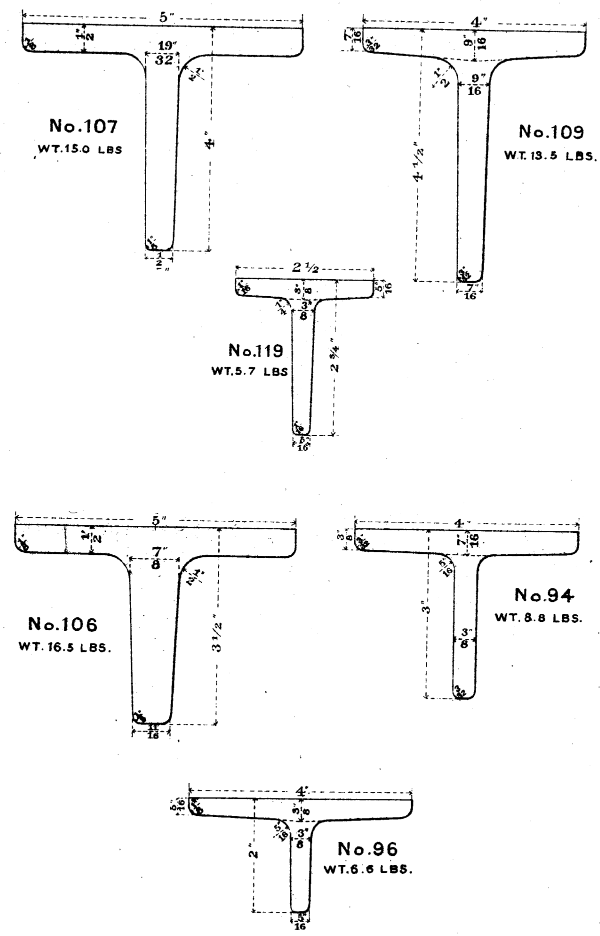


Plate No. 21

All weights given in pounds per foot.

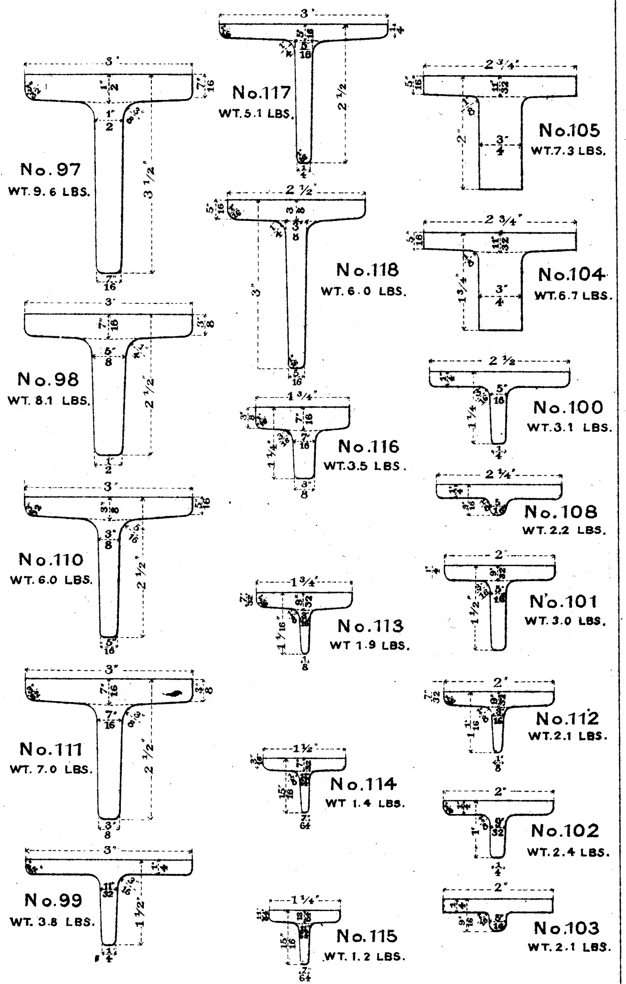


Plate No. 22.

All weights given in Lbs. per ft.

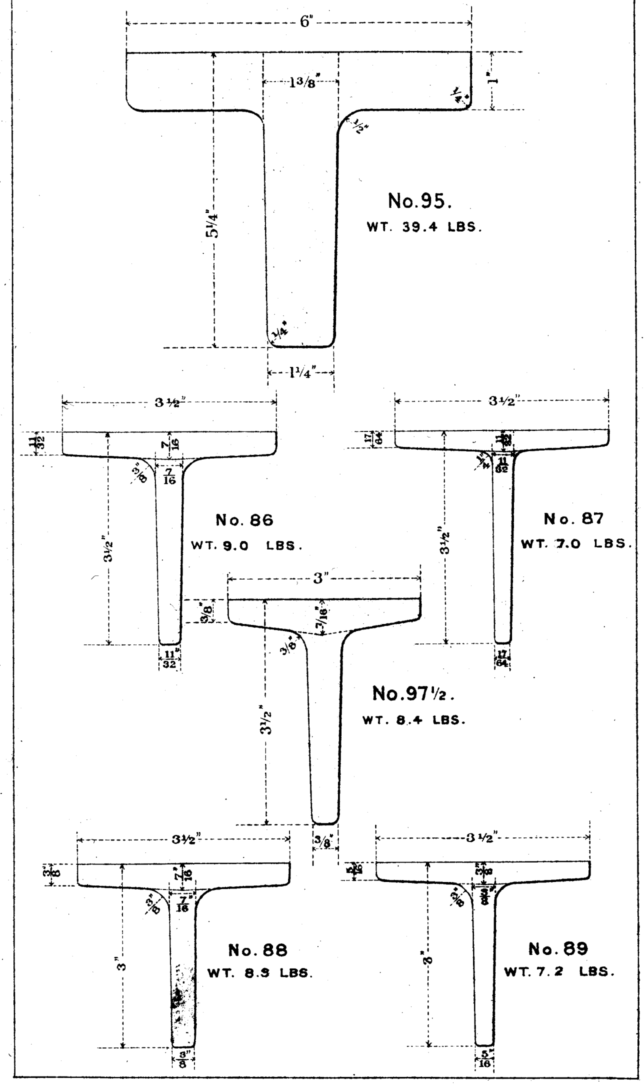


Plate No.23.

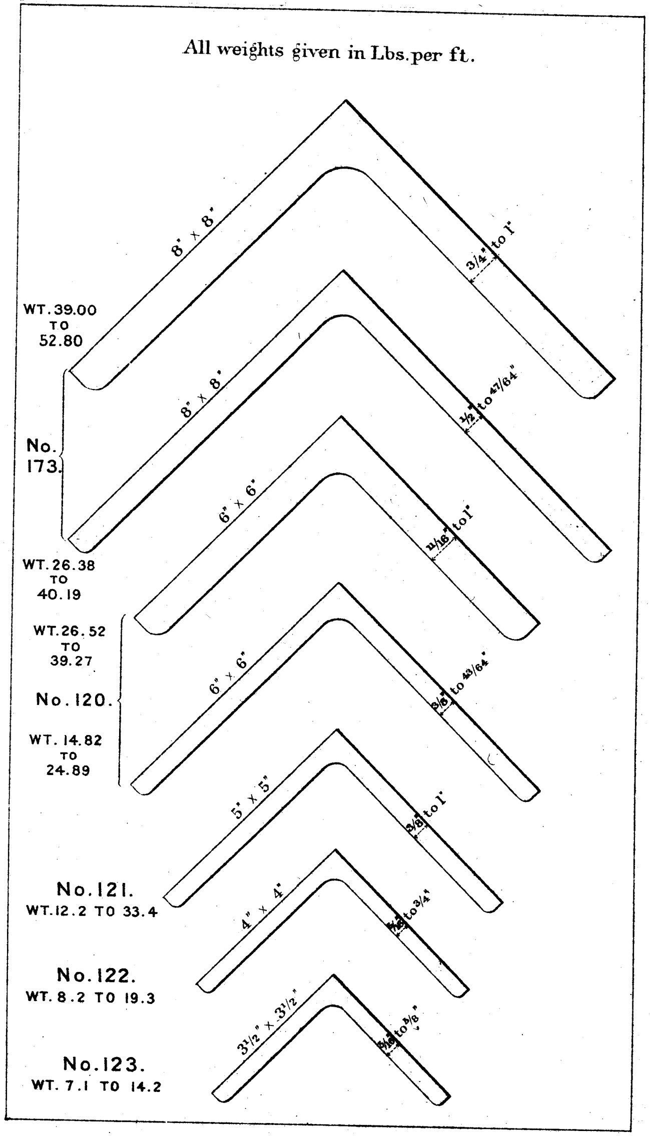


Plate No. 24.

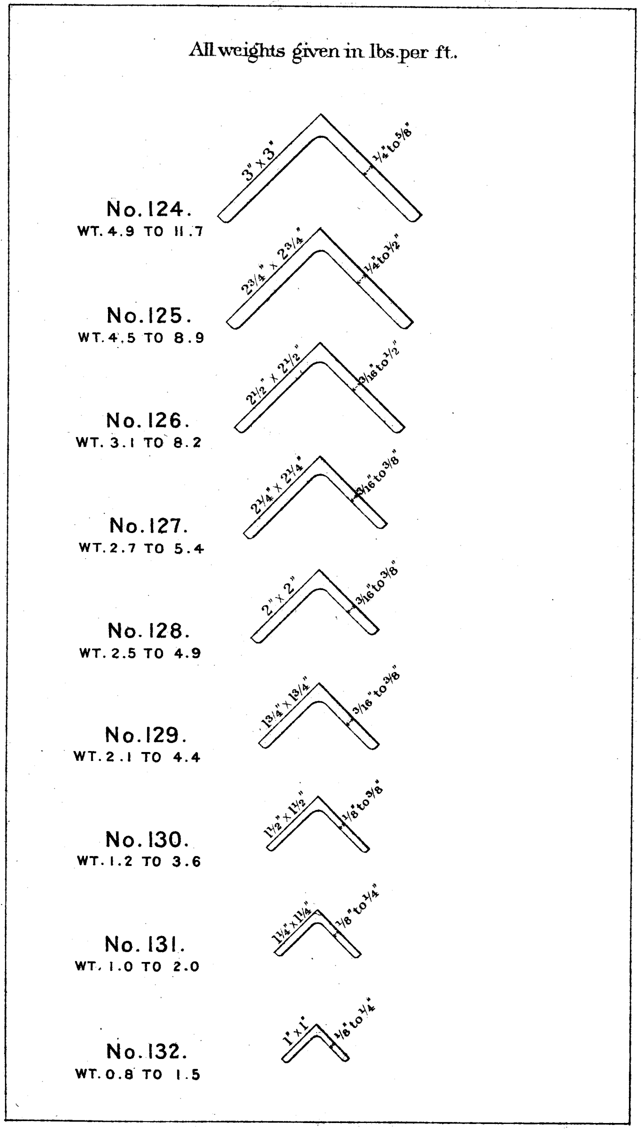


Plate No. 25.

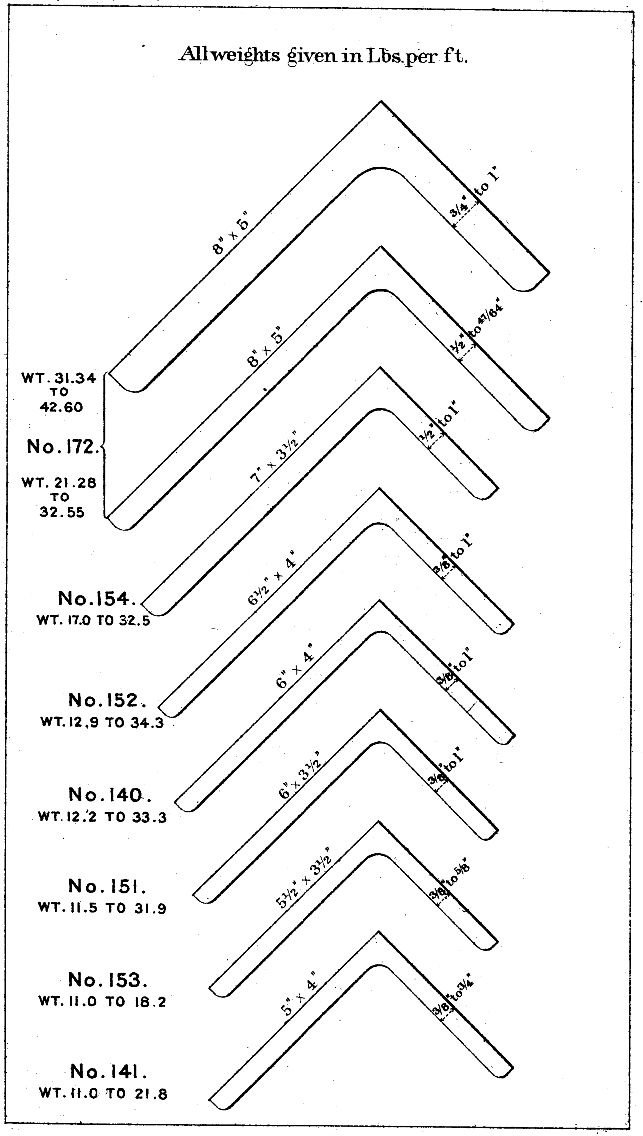


Plate No. 26.

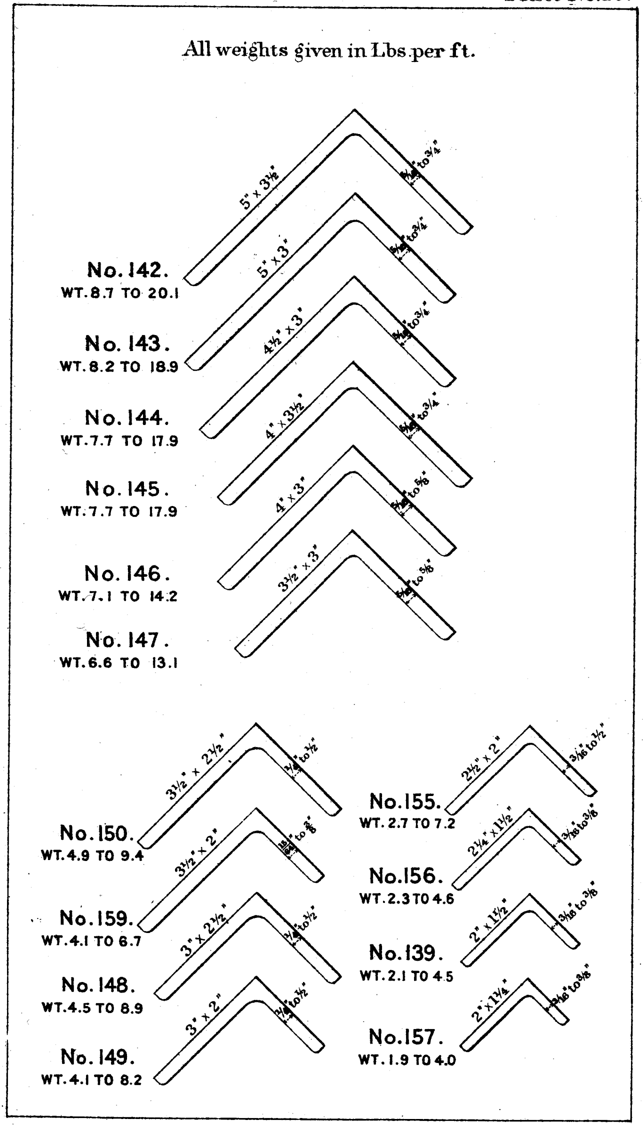


Plate No. 27.

All weights given in Lbs. per ft.

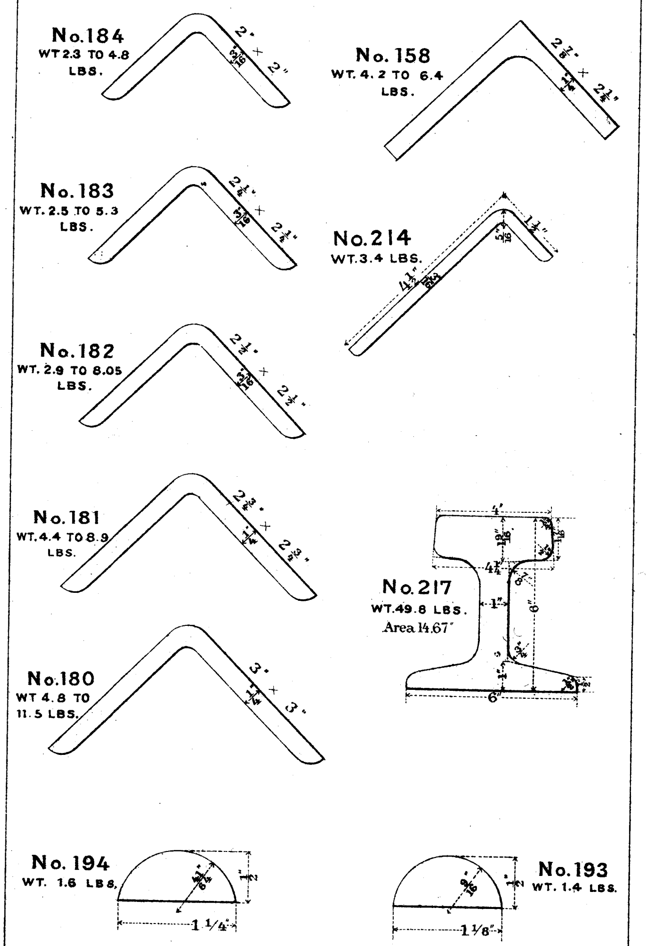
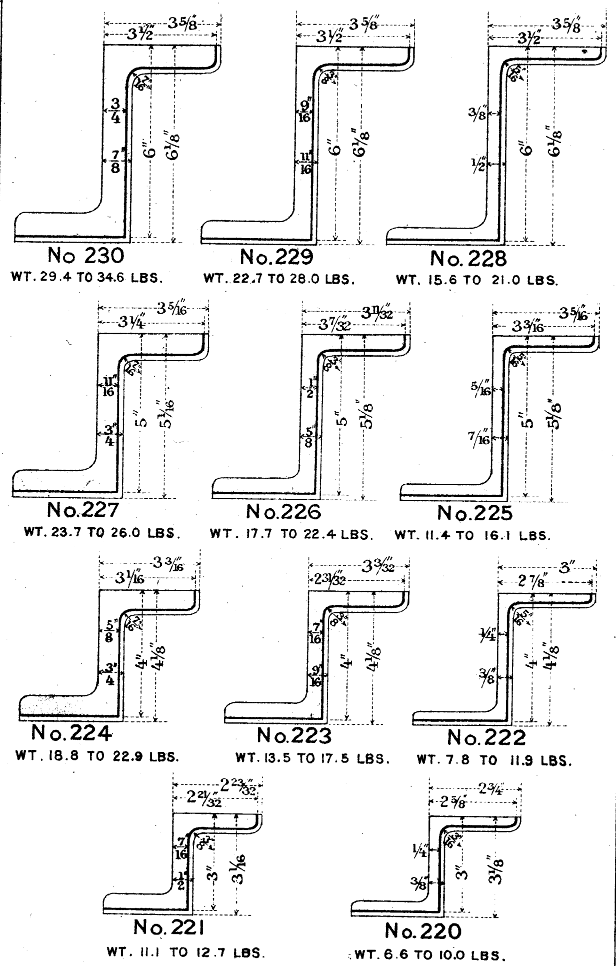


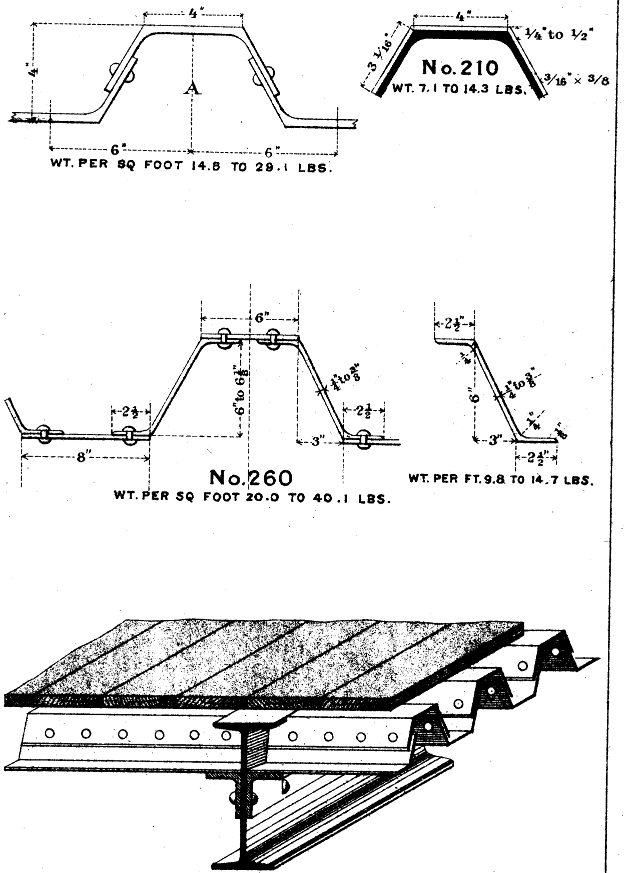
Plate No. 28.

All weights given in lbs. per ft.



Trough Shaped Sections for Corrugated Flooring

All weights given in Lbs.per ft.



METHOD OF INCREASING SECTIONAL AREAS.

Cross hatched portions represent the minimum sections and the blank portions the added areas.

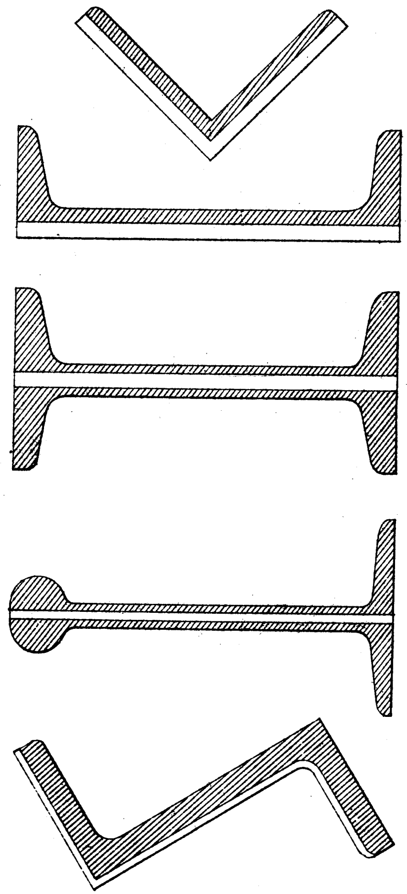


Table of Standard Wire Gauges

With Equivalents in Decimal Parts of an Inch and Weights.

Number of Wire Gauge.	Birmingham or Stubbs.	Weight per Lineal Foot, 1-inch wide, by Stubbs Gauge.	American or Brown & Sharp.	Washburn & Moen Mfg. Co.	Weight per 100 feet in lbs., W. & M. Gauge.	Music Wire.	Fractions of an Inch with Decimal Equivalents.
0000	.454	1.512	.460	.393	40 94	.	1-32 = .031
000	.425	1.415	.410	.362	34 73	. .	1-16 = .062
00	.380	1.265	.365	.331	29.04	. .	3-32 = .094
0	.340	1.132	.325	.307	27 66	.0095	1-8 = .125
1	.300	1.000	.289	.283	21.23	.0100	5-32 = .156
2	.284	.946	.258	.263	18 34	.0105	3-16 = .187
3	.259	.863	.229	.244	15.78	.0115	7-32 = .219
4	.238	.793	.204	.225	13.39	.0125	1-4 = .250
5	.220	.733	.182	.207	11 35	.0135	9-32 = .281
6	.203	.676	.162	.192	9 73	.015	5-16 = .312
7	.180	.600	.144	.177	8.03	.0175	11-32 = .344
8	.165	.550	.128	162	6 96	.019	3-8 = .375
9	.148	.493	.114	.148	5.08	.022	13-32 = .406
10	.134	.446	.102	.135	4.83	.0245	7-16 = .437
11	.120	.400	.091	.120	3.82	.027	15-32 = .469
12	.109	.363	081	.105	2.92	0285	1-2 = .500
13	.095	.316	.072	.092	2.24	.0305	17-32 = .531
14	.083	.276	.064	.080	1.69	.032	9-16 = .562
15	.072	.240	.057	.072	1.37	.035	19-32 = .594
16	.065	.217	.051	.063	1.05	.036	5-8 = .625
17	.058	.193	.045	.054	.77	.038	21-32 = .656
18	.049	.165	.040	.047	.58	.040	11-16 = .688
19	.042	.140	.036	.041	.45	.042	23-32 = .718
20	.035	.117	.032	.035	.32	.043	3-4 = .750
21	.032	.107	.028	.032	.27	.0445	25-32 = .781
22	.028	.093	.025	.028	.21	.047	13-16 = .812
23	.025	.083	.023	.025	.175	.049	27-32 = .844
24	.022	.073	.020	.023	.140	.053	7-8 = .875
25	.020	.067	.018	.020	.116	.056	29-32 = .906
26	.018	.060	.016	.018	.093	.060	15-16 = .937
27	.016	.053	.014	.017	.083	.064	31-32 = 969
28	.014	.047	.0125	.016	.074	.0685	. . . . .
29	.013	.044	.011	.015	.061	.0715	. . . . .
30	.012	.040	.010	.014	.054	.076	. . . . .
31	.010	.0333	.009	0135	.050	.080	. . . . .
32	.009	.0300	.008	.013	.046	.085	. . . . .
33	.008	.0266	.007	.011	.037	.090	. . . . .
34	.007	.0233	.0063	.010	030	.095	. . . . .
35	.005	.0167	.0056	.095	.025	.100	. . . . .
36	.004	.0133	.005	.009	.021	.105	. . . . .

For Stubbs Drill Rod Gauge, see page 9.

Cold Rolled Steel Squares.

For Keys, Splines and Square Shafts.

Size.	Weight per ft.	Price per lb.	Size.	Weight per ft.	Price per lb.
1/8		14 cts.	1 9/16	8.26	
3/16			1 5/8	8.93	
1/4	.211		1 11/16	9.63	
5/16	.332	12 cts.	1 3/4	10.34	
3/8	.475		1 13/16	11.11	
7/16	.652		1 7/8	11.88	
1/2	.845		1 15/16	12.70	
9/16	1.08	10 cts.	2	13.52	
5/8	1.32		2 1/16	14.39	
11/16	1.61		2 1/8	15.26	
3/4	1.90		2 3/16	16.18	8 cts.
13/16	2.25		2 1/4	17.11	
7/8	2 59		2 5/16	18.09	
15/16	2.96		2 3/8	19.07	
1	3.38		2 7/16	20.09	
1 1/16	3.85		2 1/2	21.12	
1 1/8	4.28	8 cts.	2 5/8	23.59	
1 3/16	4 78		2 3/4	25.56	
1 1/4	5.28		2 15/16	29.18	
1 5/16	5.84		3	30.42	
1 3/8	6.39				
1 7/16	6.99				
1 1/2	7.60				

In stock 1/8″ to 1 1/4″.

We have a large stock of Cold Rolled Flats for keys, etc