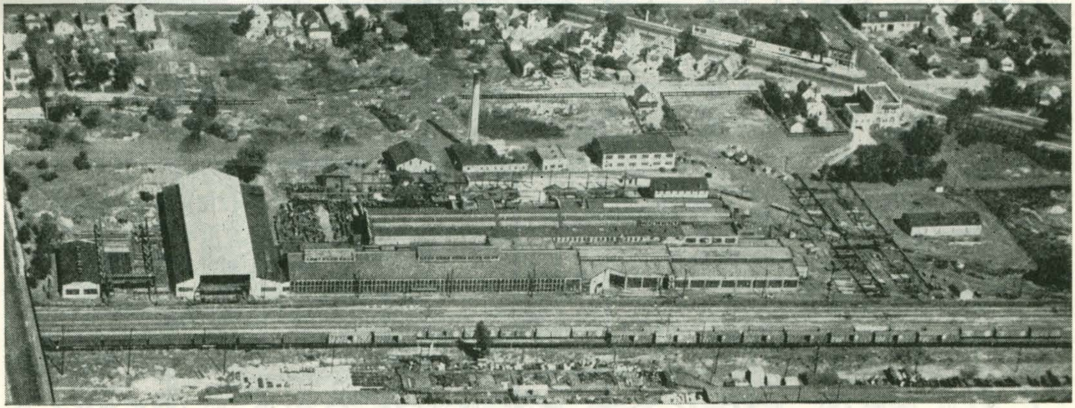
ST. PAUL FOUNDRY & MANUFACTURING COMPANY

ST. PAUL, U. S. A.

1948



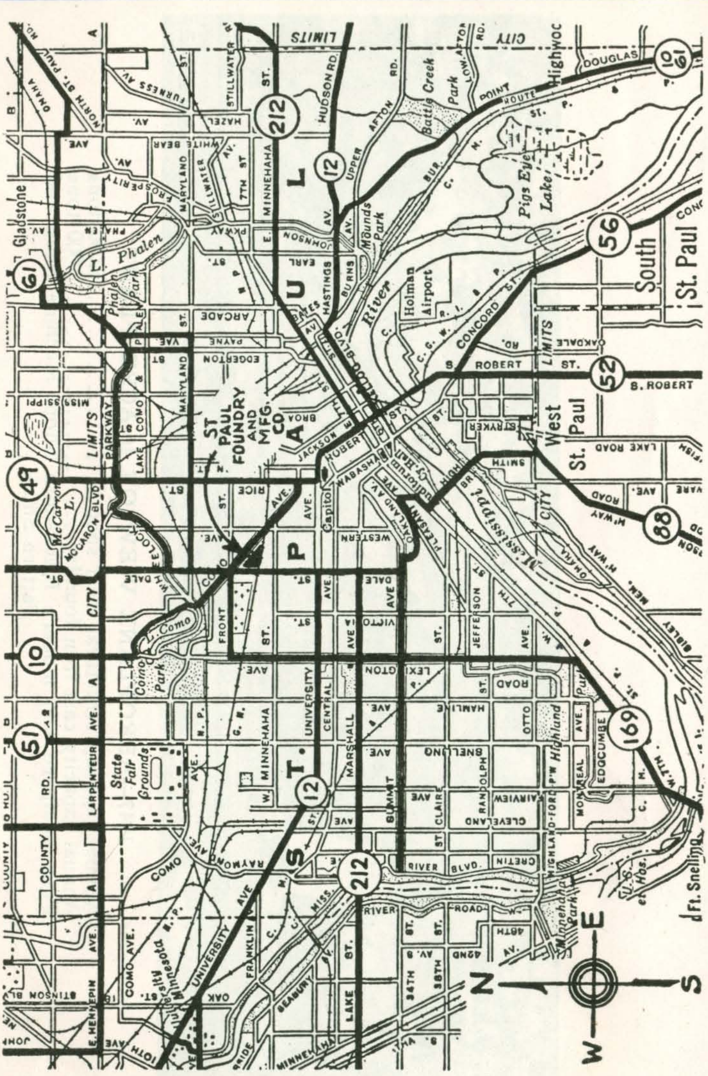
1947—AEROPLANE VIEW OF 16-ACRE PLANT

Annual capacity structural steel shop ....15,000 tons
Annual capacity cast iron foundry ....12,000 tons
Fully equipped and modern Blacksmith Shop, Machine Shop and Pattern Shop.

ST. PAUL FOUNDRY & MANUFACTURING CO.

MAIN STREETS AND HIGHWAYS TO ST. PAUL FOUNDRY & MFG. CO.

Use Como-Harriet or Como Hopkins car and get off at Mackubin Street



B332

HANDBOOK

of

Tables and Information

(In three parts)

Appertaining to the use of

Alloy Cast Iron, Structural Steel

and of

This Company's Products

for

Engineers-Architects-Builders

ST. PAUL FOUNDRY & MANUFACTURING CO.

MANUFACTURERS AND ENGINEERS

St. Paul, Minnesota

Established 1863

HESTON & ANDERSON

(Subsidiary)

MANUFACTURERS OF WOODWORKING MACHINES

Fairfield, Iowa

The St. Paul Foundry & Manufacturing Co., 500 Como Avenue, was established in 1863. The St. Paul plant covers an area of sixteen acres and consists of a Steel Fabricating Plant, Foundry, and Machine Shop.

On August 12, 1944, the Company purchased Heston & Anderson, Fairfield, Iowa, which is operated as Heston & Anderson Division of the St. Paul Foundry & Manufacturing Co. This plant manufactures a complete line of industrial and homecraft woodworking machinery.

Ralph H. Maxson, President
A. Lehr, Executive Vice-President
Thomas J. Rowe—Vice-President in charge of Heston & Anderson Division
Joseph B. Klemp, Secretary & Treasurer
William Snyker, Works Manager
John Brendel, Assistant Works Manager

Contracting Dept.	George E. Cook, Contract Manager Thor L. Dosen, Structural Engineer C. I. Carter, Estimating Engineer William R. Zuber, Sales Manager, Foundry & Machine Shop Arthur J. Hoff, Design Engineer Edward W. Hoff, Estimating Engineer
Warehouse Sales	Russell Gunther
Engineering Dept.	Edgar A. Goetz, Chief Engineer
Purchasing Dept.	Charles S. Long, Director of Purchasing John H. Gunther, Purchasing Agent Robert L. Nord, Asst. Purchasing Agent
Order Dept.	Stanley J. Janecek, Manager
Accounting Dept.	Harry C. Johnson, Chief Accountant Credit Manager George H. Gardner, Chief Cost Accountant Henry Giefer, Cashier
Traffic Dept.	Andrew Mieloch, Traffic & Shipping
Personnel Dept.	E. Dale Anderson, Personnel Manager

PREFACE TO EIGHTH EDITION

THIS handbook is written to give detailed and general information to the architect, contractor, and structural engineer on the products of our various shops and on the allied materials of the building industry. The book contains data, details, and tables for the design of steel structures and for the castings, forgings, and machinery made by this Company.

PART I consists of four sections (1) properties and detail dimensions of rolled structural shapes, angles, bars, plates, etc. now rolled (2) safe load tables of beams, channels, angles, etc. used as beams, (3) of rolled shapes and angles used as struts and columns, and of angles and bars used in tension, and (4) detailed information on standard connections, rivet values, bolts and various items.

Unless noted, all tables of properties, detail dimensions, and safe loads of beams and columns for wide flange and other shapes are those of the American Institute of Steel Construction. These tables are based on a unit tensile strength of 20,000 pounds per square inch to conform to the specifications of the A. I. S. C. and of the St. Paul Building Code, pertaining to structural steel.

PART II contains information principally on the products of our foundry and machine shop. Tables on the strength of our cast iron columns, their details and connections.

Our complete line of standard sewer and miscellaneous castings is illustrated. We show a wide variety of castings and other items pertaining to building construction.

PART III comprises various engineering data and information on some of the products of other companies allied to those of our Company. The St. Paul Building Code, portions of the Code of Standard Practice of the American Institute of Steel Construction, and excerpts from the Specifications of the American Society for Testing Materials, all with particular reference to structural steel for buildings, are quoted.

Permission to use the new A.I.S.C. tables is gratefully acknowledged.

PART I

TABLES ON STRUCTURAL STEEL

SIZES OF STEEL SECTIONS USUALLY IN STOCK IN OUR WAREHOUSE.

In designing steel sections, especially when delivery is important, the Engineer should use sections from the list below whenever they meet his requirements.

WIDE FLANGE BEAMS

Size	Weights			
33"	130			
30"	108			
27"	94			
24"	76	84		
21"	59	73		
18"	50	55		
16"	36	40		
14"	30	34	43	
12"	27	31	36	40
10"	21	25	33	49
8"	17	24	31	34.3
8"	40	48		

AMERICAN STANDARD CHANNELS

Size	Weights			
15"	33.9			
12"	20.7	25.0		
10"	15.3	20.0	25	
9"	13.4			
8"	11.5			
7"	9.8			
6"	8.2	10.5		
5"	6.7			
4"	5.4			
3"	4.1			

AMERICAN STANDARD BEAMS

Size	Weights		
24"	79.9		
20"	65.4		
18"	54.7		
15"	42.9		
12"	31.8	40.8	
10"	25.4		
8"	18.4		
7"	15.3		
6"	12.5		
5"	10.0		
4"	7.7		
3"	5.7		

H-BEAMS OR COLUMNS

Size	Weights		
6"	20	25	
5"	18.9		
4"	10	13	

LIGHT BEAMS

Size	Weights		
12"	16.5		
10"	11.5	15	
8"	10	13	
6"	8.5	12	15.5

ANGLES

Size	Thickness				
1½" x 1½"	3/16	1/4			
1¾" x 1¾"	3/16	1/4			
2 " x 2 "	3/16	1/4	5/16		
2½" x 2 "	3/16	1/4	5/16		
2½" x 2½"	3/16	1/4	5/16	3/8	
3 " x 2 "		1/4	5/16	3/8	
3 " x 2½"		1/4	5/16	3/8	

ANGLES—Continued

Size	Thickness							
3 " x 3 "	1/4	5/16	3/8	.....	.....	.....	.....	.....
3½" x 2½"	1/4	5/16	3/8	.....	.....	.....	.....	.....
3½" x 3 "	1/4	5/16	3/8	.....	.....	.....	.....	.....
3½" x 3½"	1/4	5/16	3/8	.....	.....	.....	.....	.....
4 " x 3 "	1/4	5/16	3/8	.....	1/2	.....	.....	.....
4 " x 3½"	1/4	5/16	3/8	7/16	1/2	.....	.....	.....
4 " x 4 "	1/4	5/16	3/8	7/16	1/2	.....	.....	.....
5 " x 3 "	.....	5/16	3/8	.....	1/2	.....	.....	.....
5 " x 3½"	.....	5/16	3/8	.....	1/2	.....	.....	.....
5 " x 5 "	.....	.....	3/8	.....	.....	.....	.....	.....
6 " x 3½"	.....	5/16	3/8	7/16	1/2	.....	.....	.....
6 " x 4 "	.....	.....	3/8	7/16	1/2	5/8	.....	.....
6 " x 6 "	.....	.....	3/8	7/16	1/2	.....	.....	.....
7 " x 4 "	.....	.....	3/8	7/16	1/2	.....	.....	.....
8 " x 4 "	.....	.....	.....	7/16	1/2	.....	.....	.....
8 " x 6 "	.....	.....	.....	.....	1/2	.....	3/4	.....
8 " x 8 "	.....	.....	.....	.....	1/2	.....	3/4	.....

STRUCTURAL TEES

Size	Weight Per Foot				
4	6.5	8.5	12		
5	10.5	24.5	....	....	....
6	13.5	15.5	20	32.5	....

SHEETS (Hot Rolled)

Thickness	Width	Length
#10	36" 48" 60".....	12'-0"
#12	36" 48" 60".....	12'-0"
#14	36" 48" 60".....	12'-0"
#16	36" 48" 60".....	12'-0"

PLATES

Thickness	Width	Length
3/16"	36" 48" 60" 72"	20'-0"
1/4"	6⅛" to 72".....	40'-0"
5/16"	6⅛" to 72".....	40'-0"
3/8"	6⅛" to 72".....	40'-0"
1/2"	6⅛" to 72".....	40'-0"
5/8"	6⅛" to 48".....	40'-0"

PLATES—Continued

Thickness	Width	Length
3/4"	6⅛" to 48"...	40'-0"
1 "	6⅛" to 48"...	40'-0"
1⅛"	48"...........	20'-0"
1¼"	48"...........	20'-0"
1½"	48"...........	20'-0"
2 "	48"...........	10'-0"
2½"	48"...........	10'-0"
3 "	48"...........	10'-0"

FLOOR PLATES

Thickness	Width	Length
3/16"	48" 60"........	20'-0"
1/4"	48" 60"........	20'-0"
5/16"	48" 60"........	20'-0"
3/8"	48" 60"........	20'-0"
1/2"	48" 60"........	20'-0"

DIMENSIONS, WEIGHTS AND PROPERTIES
OF
ROLLED STEEL STRUCTURAL SHAPES

Structural Shapes are presented in Part I in two groupings, namely "Regular" and "Special." Under the grouping "Regular" Shapes are shown the popular sizes for which there is a constant demand, and such sizes are readily procurable in any size lots.

Under the grouping "Special" Shapes are shown sizes and sections for which there is a fluctuating demand and, therefore, are rolled at irregular intervals, and then only by special arrangement. Consequently the use of "Special" Shapes should generally be avoided, unless the quantity of any one size is sufficient to warrant a rolling.

"Regular" WF (Wide Flange) Shapes can be furnished promptly from Bethlehem Steel Company or Carnegie-Illinois Steel Corporation Mills. "Regular" American Standard Beams, Channels and Angles are readily procurable from all mills rolling these products. The same is true of the Miscellaneous "Regular" Shapes rolled by the various mills.

All WF Shapes produced by Carnegie-Illinois Steel Corporation have parallel face flanges. WF Shapes produced by Bethlehem Steel Company have parallel face flanges with the following exceptions: All sizes with nominal depths from 36 to 16 inches, inclusive; 14 WF 38 to 30; 12 WF 36 to 27; 10 WF 29 to 21; 8 WF 20 and 17. These shapes have a 5 per cent slope on the inside face of flange.

Due to this difference in rolling practice the properties of certain WF Shapes produced by the different mills are not precisely identical, but the difference is so small as to be practically negligible. In the interest of standardization the tables of properties show only the lesser values and are thus a trifle on the side of safety.

When WF Shapes are available either with sloping flanges or parallel flanges, the dimensions such as T, k, and g_1 (see page 11), are given for the sloping flange shapes and therefore may be used for all shapes. Where thickness of flange is given in the tables, it is, in the case of shapes with sloping flanges, the mean thickness. If necessary, additional dimensions may be obtained from mill catalogs.

All American Standard Beam and Channel Shapes have a slope on the inside face of flange of 16⅔ per cent. The Miscellaneous Column and Beam Shapes in the Regular Series, as well as the Channels and the Tees in the Special Series, have various flange slopes whose amounts may be ascertained from the respective mill catalogs.

It is the practice of the rolling mills to use the terms "Sections" or "Shapes" when referring to their finished flanged product. The term "Shapes" is used throughout this Manual as being the standard practice of the Fabricating Industry.

When designating rolled steel shapes on drawings it is desirable that a standard method of abbreviating be followed that will identify the group without reference to the manufacturer, and without the use of inch and pound marks. To this end it is recommended that the nominal depth of shape, its group symbol, and its weight in pounds per linear foot, be abbreviated in the manner exemplified below. For completeness a convenient method of abbreviating the sizes of plates and bars is included.

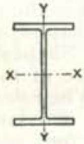
Group	Page Nos. of Part I of Manual
Wide Flange Shapes	10-21
Miscellaneous Light Beams	24-25
Miscellaneous Light Columns	26-27
Miscellaneous Light Beams	26-27
Junior Beams	24-25
Junior Channels	26-27
American Standard Beams	22-23
American Standard Channels	28-29
Equal Leg Angles	30-31
Unequal Leg Angles	32-39
Structural Tees	40-47
" "	48
Bearing Piles	50
Zees	49
Rails	51
Plates	55-60
Square Bars, Round Bars	52-53

The abbreviations exemplified above are intended only for use on design drawings. When lists of material are being prepared for ordering from the mills, the requirements of the respective mills from which the material in question is to be ordered should be observed.

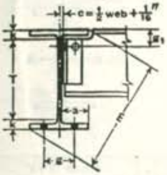
Space does not permit of the inclusion in this Manual of data on every rolled steel product occasionally useful in building construction. For products herein omitted, reference should be made to the various mill catalogs.

WF SHAPES

PROPERTIES FOR DESIGNING



Nominal Size	Weight per Foot	Area	Depth	Flange Width	Flange Thickness	Web Thickness	Axis X-X I	Axis X-X S	Axis X-X r	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r
In.	Lb.	$In.^2$	In.	In.	In.	In.	$In.^4$	$In.^3$	In.	$In.^4$	$In.^3$	In.
36 x 16½	300	88.17	36.72	16.655	1.680	.945	20290.2	1105.1	15.17	1225.2	147.1	3.73
	280	82.32	36.50	16.595	1.570	.885	18819.3	1031.2	15.12	1127.5	135.9	3.70
	260	76.56	36.24	16.555	1.440	.845	17233.8	951.1	15.00	1020.6	123.3	3.65
	245	72.03	36.06	16.512	1.350	.802	16092.2	892.5	14.95	944.7	114.4	3.62
	230	67.73	35.88	16.475	1.260	.765	14988.4	835.5	14.88	870.9	105.7	3.59
36 x 12	194	57.11	36.48	12.117	1.260	.770	12103.4	663.6	14.56	355.4	58.7	2.49
	182	53.54	36.32	12.072	1.180	.725	11281.5	621.2	14.52	327.7	54.3	2.47
	170	49.98	36.16	12.027	1.100	.680	10470.0	579.1	14.47	300.6	50.0	2.45
	160	47.09	36.00	12.000	1.020	.653	9738.8	541.0	14.38	275.4	45.9	2.42
	150	44.16	35.84	11.972	.940	.625	9012.1	502.9	14.29	250.4	41.8	2.38
33 x 15¾	240	70.52	33.50	15.865	1.400	.830	13585.1	811.1	13.88	874.3	110.2	3.52
	220	64.73	33.25	15.810	1.275	.775	12312.1	740.6	13.79	782.4	99.0	3.48
	200	58.79	33.00	15.750	1.150	.715	11048.2	669.6	13.71	691.7	87.8	3.43
33 x 11½	152	44.71	33.50	11.565	1.055	.635	8147.6	486.4	13.50	256.1	44.3	2.39
	141	41.51	33.31	11.535	.960	.605	7442.2	446.8	13.39	229.7	39.8	2.35
	130	38.26	33.10	11.510	.855	.580	6699.0	404.8	13.23	201.4	35.0	2.29
30 x 15	210	61.78	30.38	15.105	1.315	.775	9872.4	649.9	12.64	707.9	93.7	3.38
	190	55.90	30.12	15.040	1.185	.710	8825.9	586.1	12.57	624.6	83.1	3.34
	172	50.65	29.88	14.985	1.065	.655	7891.5	528.2	12.48	550.1	73.4	3.30
30 x 10½	132	38.83	30.30	10.551	1.000	.615	5753.1	379.7	12.17	185.0	35.1	2.18
	124	36.45	30.16	10.521	.930	.585	5347.1	354.6	12.11	169.7	32.3	2.16
	116	34.13	30.00	10.500	.850	.564	4919.1	327.9	12.00	153.2	29.2	2.12
	108	31.77	29.82	10.484	.760	.548	4461.0	299.2	11.85	135.1	25.8	2.06



WF SHAPES

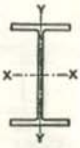
DIMENSIONS FOR DETAILING

Nominal Size	Weight per Foot	Depth	Flange Width	Flange Thickness	Web Thickness	Web Half Thickness	a	T	k	m	g_1	c	Usual Gage g
In.	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
36 x 16 1/2	300	36 3/4	16 5/8	1 11/16	15/16	1/2	7 7/8	31 1/8	2 13/16	40 3/8	4	9/16	5 1/2
	280	36 1/2	16 5/8	1 9/16	7/8	7/16	7 7/8	31 1/8	2 11/16	40 1/8	4	1/2	5 1/2
	260	36 1/4	16 1/2	1 7/16	7/8	7/16	7 7/8	31 1/8	2 9/16	39 7/8	3 3/4	1/2	5 1/2
	245	36	16 1/2	1 3/8	13/16	3/8	7 7/8	31 1/8	2 7/16	39 3/4	3 3/4	7/16	5 1/2
	230	35 7/8	16 1/2	1 1/4	3/4	3/8	7 7/8	31 1/8	2 3/8	39 1/2	3 1/2	7/16	5 1/2
36 x 12	194	36 1/2	12 1/8	1 1/4	13/16	3/8	5 5/8	32 1/4	2 1/8	38 1/2	3 1/4	7/16	5 1/2
	182	36 3/8	12 1/8	1 3/16	3/4	3/8	5 5/8	32 1/4	2 1/16	38 3/8	3 1/4	7/16	5 1/2
	170	36 1/8	12	1 1/8	11/16	3/8	5 5/8	32 1/4	1 15/16	38 1/8	3 1/4	7/16	5 1/2
	160	36	12	1	11/16	5/16	5 5/8	32 1/4	1 7/8	38	3	3/8	5 1/2
	150	35 7/8	12	15/16	5/8	5/16	5 5/8	32 1/4	1 13/16	37 7/8	3	3/8	5 1/2
33 x 15 3/4	240	33 1/2	15 7/8	1 3/8	7/8	7/16	7 1/2	28 5/8	2 7/16	37 1/8	3 3/4	1/2	5 1/2
	220	33 1/4	15 3/4	1 1/4	13/16	3/8	7 1/2	28 5/8	2 5/16	36 7/8	3 1/2	7/16	5 1/2
	200	33	15 3/4	1 1/8	3/4	3/8	7 1/2	28 5/8	2 3/16	36 5/8	3 1/2	7/16	5 1/2
33 x 11 1/2	152	33 1/2	11 5/8	1 1/16	5/8	5/16	5 1/2	29 3/4	1 7/8	35 1/2	3	3/8	5 1/2
	141	33 1/4	11 1/2	15/16	5/8	5/16	5 1/2	29 3/4	1 3/4	35 1/4	3	3/8	5 1/2
	130	33 1/8	11 1/2	7/8	9/16	5/16	5 1/2	29 3/4	1 11/16	35 1/8	3	3/8	5 1/2
30 x 15	210	30 3/8	15 1/8	1 5/16	13/16	3/8	7 1/8	25 3/4	2 5/16	34	3 1/2	7/16	5 1/2
	190	30 1/8	15	1 3/16	3/4	3/8	7 1/8	25 3/4	2 3/16	33 3/4	3 1/2	7/16	5 1/2
	172	29 7/8	15	1 1/16	11/16	5/16	7 1/8	25 3/4	2 1/16	33 1/2	3 1/4	3/8	5 1/2
30 x 10 1/2	132	30 1/4	10 1/2	1	5/8	5/16	5	26 7/8	1 11/16	32 1/8	3	3/8	5 1/2
	124	30 1/8	10 1/2	15/16	5/8	5/16	5	26 7/8	1 5/8	31 7/8	3	3/8	5 1/2
	116	30	10 1/2	7/8	9/16	5/16	5	26 7/8	1 9/16	31 3/4	2 3/4	3/8	5 1/2
	108	29 7/8	10 1/2	3/4	9/16	5/16	5	26 7/8	1 1/2	31 5/8	2 3/4	3/8	5 1/2

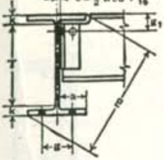
Gage g_1 is based on k + 1 1/4", to nearest 1/4".

WF SHAPES

PROPERTIES FOR DESIGNING



Nominal Size	Weight per Foot	Area	Depth	Flange		Web Thickness	Axis X-X			Axis Y-Y		
				Width	Thickness		I	S	r	I	S	r
In.	Lb.	In.^{2}	In.	In.	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
27 x 14	177	52.10	27.31	14.090	1.190	.725	6728.6	492.8	11.36	518.9	73.7	3.16
	160	47.04	27.08	14.023	1.075	.658	6018.6	444.5	11.31	458.0	65.3	3.12
	145	42.68	26.88	13.965	.975	.600	5414.3	402.9	11.26	406.9	58.3	3.09
27 x 10	114	33.53	27.28	10.070	.932	.570	4080.5	299.2	11.03	149.6	29.7	2.11
	102	30.01	27.07	10.018	.827	.518	3604.1	266.3	10.96	129.5	25.9	2.08
	94	27.65	26.91	9.990	.747	.490	3266.7	242.8	10.87	115.1	23.0	2.04
24 x 14	160	47.04	24.72	14.091	1.135	.656	5110.3	413.5	10.42	492.6	69.9	3.23
	145	42.62	24.49	14.043	1.020	.608	4561.0	372.5	10.34	434.3	61.8	3.19
	130	38.21	24.25	14.000	.900	.565	4009.5	330.7	10.24	375.2	53.6	3.13
24 x 12	120	35.29	24.31	12.088	.930	.556	3635.3	299.1	10.15	254.0	42.0	2.68
	110	32.36	24.16	12.042	.855	.510	3315.0	274.4	10.12	229.1	38.0	2.66
	100	29.43	24.00	12.000	.775	.468	2987.3	248.9	10.08	203.5	33.9	2.63
24 x 9	94	27.63	24.29	9.061	.872	.516	2683.0	220.9	9.85	102.2	22.6	1.92
	84	24.71	24.09	9.015	.772	.470	2364.3	196.3	9.78	88.3	19.6	1.89
	76	22.37	23.91	8.985	.682	.440	2096.4	175.4	9.68	76.5	17.0	1.85
21 x 13	142	41.76	21.46	13.132	1.095	.659	3403.1	317.2	9.03	385.9	58.8	3.04
	127	37.34	21.24	13.061	.985	.588	3017.2	284.1	8.99	338.6	51.8	3.01
	112	32.93	21.00	13.000	.865	.527	2620.6	249.6	8.92	289.7	44.6	2.96
21 x 9	96	28.21	21.14	9.038	.935	.575	2088.9	197.6	8.60	109.3	24.2	1.97
	82	24.10	20.86	8.962	.795	.499	1752.4	168.0	8.53	89.6	20.0	1.93
21 x 8¼	73	21.46	21.24	8.295	.740	.455	1600.3	150.7	8.64	66.2	16.0	1.76
	68	20.02	21.13	8.270	.685	.430	1478.3	139.9	8.59	60.4	14.6	1.74
	62	18.23	20.99	8.240	.615	.400	1326.8	126.4	8.53	53.1	12.9	1.71



WF SHAPES

DIMENSIONS FOR DETAILING

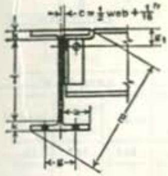
Nominal Size	Weight per Foot	Depth	Flange Width	Flange Thickness	Web Thickness	Web Half Thickness	Distance a	Distance T	Distance k	Distance m	Distance g1	Distance c	Usual Gage g
In.	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
27 x 14	177	27 1/4	14 1/8	1 3/16	3/4	3/8	6 3/4	23	2 1/8	30 3/4	3 1/4	7/16	5 1/2
	160	27 1/8	14	1 1/16	11/16	5/16	6 3/4	23	2 1/16	30 1/2	3 1/4	3/8	5 1/2
	145	26 7/8	14	1	5/8	5/16	6 3/4	23	1 15/16	30 3/8	3 1/4	3/8	5 1/2
27 x 10	114	27 1/4	10 1/8	15/16	9/16	5/16	4 3/4	24	1 5/8	29 1/8	2 3/4	3/8	5 1/2
	102	27 1/8	10	13/16	1/2	1/4	4 3/4	24	1 9/16	28 7/8	2 3/4	5/16	5 1/2
	94	26 7/8	10	3/4	1/2	1/4	4 3/4	24	1 7/16	28 3/4	2 3/4	5/16	5 1/2
24 x 14	160	24 3/4	14 1/8	1 1/8	11/16	5/16	6 3/4	20 3/4	2	28 1/2	3 1/4	3/8	5 1/2
	145	24 1/2	14	1	5/8	5/16	6 3/4	20 3/4	1 7/8	28 1/4	3 1/4	3/8	5 1/2
	130	24 1/4	14	7/8	9/16	5/16	6 3/4	20 3/4	1 3/4	28	3	3/8	5 1/2
24 x 12	120	24 1/4	12 1/8	15/16	9/16	5/16	5 3/4	20 7/8	1 11/16	27 1/8	3	3/8	5 1/2
	110	24 1/8	12	7/8	1/2	1/4	5 3/4	20 7/8	1 5/8	27	2 3/4	5/16	5 1/2
	100	24	12	3/4	1/2	1/4	5 3/4	20 7/8	1 9/16	26 7/8	2 3/4	5/16	5 1/2
24 x 9	94	24 1/4	9	7/8	1/2	1/4	4 1/4	21 3/8	1 7/16	25 7/8	2 3/4	5/16	5 1/2
	84	24 1/8	9	3/4	1/2	1/4	4 1/4	21 3/8	1 3/8	25 3/4	2 3/4	5/16	5 1/2
	76	23 7/8	9	11/16	7/16	1/4	4 1/4	21 3/8	1 1/4	25 5/8	2 1/2	5/16	5 1/2
21 x 13	142	21 1/2	13 1/8	1 1/8	11/16	3/8	6 1/4	17 3/4	1 7/8	25 1/4	3	7/16	5 1/2
	127	21 1/4	13	1	9/16	5/16	6 1/4	17 3/4	1 3/4	25	3	3/8	5 1/2
	112	21	13	7/8	9/16	1/4	6 1/4	17 3/4	1 5/8	24 3/4	3	5/16	5 1/2
21 x 9	96	21 1/8	9	15/16	9/16	5/16	4 1/4	18	1 9/16	23	2 3/4	3/8	5 1/2
	82	20 7/8	9	13/16	1/2	1/4	4 1/4	18	1 7/16	22 3/4	2 3/4	5/16	5 1/2
21 x 8 1/4	73	21 1/4	8 1/4	3/4	1/2	1/4	4	18 5/8	1 5/16	22 7/8	2 1/2	5/16	5 1/2
	68	21 1/8	8 1/4	11/16	7/16	1/4	4	18 5/8	1 1/4	22 3/4	2 1/2	5/16	5 1/2
	62	21	8 1/4	5/8	3/8	3/16	4	18 5/8	1 3/16	22 5/8	2 1/2	1/4	5 1/2

Gage g_1 is based on k + 1 1/4", to nearest 1/4".

WF SHAPES

PROPERTIES FOR DESIGNING

Nominal Size	Weight per Foot	Area	Depth	Flange Width	Flange Thick-ness	Web Thick-ness	Axis X-X I	Axis X-X S	Axis X-X r	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r
In.	Lb.	In.²	In.	In.	In.	In.	In.⁴	In.³	In.	In.⁴	In.³	In.
18 x 11¾	114	33.51	18.48	11.833	.991	.595	2033.8	220.1	7.79	255.6	43.2	2.76
	105	30.86	18.32	11.792	.911	.554	1852.5	202.2	7.75	231.0	39.2	2.73
	96	28.22	18.16	11.750	.831	.512	1674.7	184.4	7.70	206.8	35.2	2.71
18 x 8¾	85	24.97	18.32	8.838	.911	.526	1429.9	156.1	7.57	99.4	22.5	2.00
	77	22.63	18.16	8.787	.831	.475	1286.8	141.7	7.54	88.6	20.2	1.98
	70	20.56	18.00	8.750	.751	.438	1153.9	128.2	7.49	78.5	17.9	1.95
	64	18.80	17.87	8.715	.686	.403	1045.8	117.0	7.46	70.3	16.1	1.93
18 x 7½	60	17.64	18.25	7.558	.695	.416	984.0	107.8	7.47	47.1	12.5	1.63
	55	16.19	18.12	7.532	.630	.390	889.9	98.2	7.41	42.0	11.1	1.61
	50	14.71	18.00	7.500	.570	.358	800.6	89.0	7.38	37.2	9.9	1.59
16 x 11½	96	28.22	16.32	11.533	.875	.535	1355.1	166.1	6.93	207.2	35.9	2.71
	88	25.87	16.16	11.502	.795	.504	1222.6	151.3	6.87	185.2	32.2	2.67
16 x 8½	78	22.92	16.32	8.586	.875	.529	1042.6	127.8	6.74	87.5	20.4	1.95
	71	20.86	16.16	8.543	.795	.486	936.9	115.9	6.70	77.9	18.2	1.93
	64	18.80	16.00	8.500	.715	.443	833.8	104.2	6.66	68.4	16.1	1.91
	58	17.04	15.86	8.464	.645	.407	746.4	94.1	6.62	60.5	14.3	1.88
16 x 7	50	14.70	16.25	7.073	.628	.380	655.4	80.7	6.68	34.8	9.8	1.54
	45	13.24	16.12	7.039	.563	.346	583.3	72.4	6.64	30.5	8.7	1.52
	40	11.77	16.00	7.000	.503	.307	515.5	64.4	6.62	26.5	7.6	1.50
	36	10.59	15.85	6.992	.428	.299	446.3	56.3	6.49	22.1	6.3	1.45



WF SHAPES

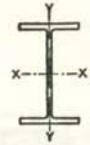
DIMENSIONS FOR DETAILING

Nominal Size	Weight per Foot	Depth	Flange Width	Flange Thickness	Web Thickness	Web Half Thickness	Distance a	Distance T	Distance k	Distance m	Distance g_1	Distance c	Usual Gage g
In.	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
18 x 11 3/4	114	18 1/2	11 7/8	1	5/8	5/16	5 5/8	15 1/8	1 11/16	22	3	3/8	5 1/2
	105	18 3/8	11 3/4	15/16	9/16	5/16	5 5/8	15 1/8	1 5/8	21 7/8	2 3/4	3/8	5 1/2
	96	18 1/8	11 3/4	13/16	1/2	1/4	5 5/8	15 1/8	1 1/2	21 3/4	2 3/4	5/16	5 1/2
18 x 8 3/4	85	18 3/8	8 7/8	15/16	9/16	1/4	4 1/8	15 5/8	1 1/2	20 5/8	2 3/4	5/16	5 1/2
	77	18 1/8	8 3/4	13/16	1/2	1/4	4 1/8	15 5/8	1 3/8	20 1/8	2 3/4	5/16	5 1/2
	70	18	8 3/4	3/4	7/16	1/4	4 1/8	15 5/8	1 5/16	20	2 3/4	5/16	5 1/2
	64	17 7/8	8 3/4	11/16	7/16	3/16	4 1/8	15 5/8	1 1/4	20	2 1/2	1/4	5 1/2
18 x 7 1/2	60	18 1/4	7 1/2	11/16	7/16	3/16	3 5/8	15 7/8	1 3/16	19 7/8	2 1/2	1/4	3 1/2
	55	18 1/8	7 1/2	5/8	3/8	3/16	3 5/8	15 7/8	1 1/8	19 5/8	2 1/2	1/4	3 1/2
	50	18	7 1/2	9/16	3/8	3/16	3 5/8	15 7/8	1 1/16	19 1/2	2 1/4	1/4	3 1/2
16 x 11 1/2	96	16 3/8	11 1/2	7/8	9/16	5/16	5 1/2	13 1/8	1 5/8	20	2 3/4	3/8	5 1/2
	88	16 1/8	11 1/2	13/16	1/2	1/4	5 1/2	13 1/8	1 1/2	19 7/8	2 3/4	5/16	5 1/2
16 x 8 1/2	78	16 3/8	8 5/8	7/8	9/16	1/4	4	13 5/8	1 1/2	18 1/2	2 3/4	5/16	5 1/2
	71	16 1/8	8 1/2	13/16	1/2	1/4	4	13 5/8	1 3/8	18 1/4	2 3/4	5/16	5 1/2
	64	16	8 1/2	11/16	7/16	1/4	4	13 5/8	1 5/16	18 1/8	2 1/2	5/16	5 1/2
	58	15 7/8	8 1/2	5/8	7/16	1/4	4	13 5/8	1 1/4	18	2 1/2	5/16	5 1/2
16 x 7	50	16 1/4	7 1/8	5/8	3/8	3/16	3 3/8	14	1 1/8	17 3/4	2 1/2	1/4	3 1/2
	45	16 1/8	7	9/16	3/8	3/16	3 3/8	14	1 1/16	17 5/8	2 1/4	1/4	3 1/2
	40	16	7	1/2	5/16	3/16	3 3/8	14	1	17 1/2	2 1/4	1/4	3 1/2
	36	15 7/8	7	7/16	5/16	3/16	3 3/8	14	15/16	17 5/8	2 1/4	1/4	3 1/2

Gage g_1 is based on k + 1 1/4", to nearest 1/4"

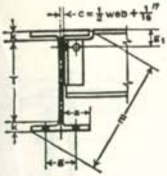
WF SHAPES

PROPERTIES FOR DESIGNING



Nominal Size	Weight per Foot	Area	Depth	Flange		Web Thickness	AXIS X-X			AXIS Y-Y		
				Width	Thickness		I	S	r	I	S	r
In.	Lb.	In.²	In.	In.	In.	In.	In.⁴	In.³	In.	In.⁴	In.³	In.
14 x 16	426	125.25	18.69	16.695	3.033	1.875	6610.3	707.4	7.26	2359.5	282.7	4.34
	398	116.98	18.31	16.590	2.843	1.770	6013.7	656.9	7.17	2169.7	261.6	4.31
	370	108.78	17.94	16.475	2.658	1.655	5454.2	608.1	7.08	1986.0	241.1	4.27
	342	100.59	17.56	16.365	2.468	1.545	4911.5	559.4	6.99	1806.9	220.8	4.24
	314	92.30	17.19	16.235	2.283	1.415	4399.4	511.9	6.90	1631.4	201.0	4.20
	287	84.37	16.81	16.130	2.093	1.310	3912.1	465.5	6.81	1466.5	181.8	4.17
	264	77.63	16.50	16.025	1.938	1.205	3526.0	427.4	6.74	1331.2	166.1	4.14
	246	72.33	16.25	15.945	1.813	1.125	3228.9	397.4	6.68	1226.6	153.9	4.12
	237	69.69	16.12	15.910	1.748	1.090	3080.9	382.2	6.65	1174.8	147.7	4.11
	228	67.06	16.00	15.865	1.688	1.045	2942.4	367.8	6.62	1124.8	141.8	4.10
	219	64.36	15.87	15.825	1.623	1.005	2798.2	352.6	6.59	1073.2	135.6	4.08
	211	62.07	15.75	15.800	1.563	.980	2671.4	339.2	6.56	1028.6	130.2	4.07
	202	59.39	15.63	15.750	1.503	.930	2538.8	324.9	6.54	979.7	124.4	4.06
	193	56.73	15.50	15.710	1.438	.890	2402.4	310.0	6.51	930.1	118.4	4.05
	184	54.07	15.38	15.660	1.378	.840	2274.8	295.8	6.49	882.7	112.7	4.04
	176	51.73	15.25	15.640	1.313	.820	2149.6	281.9	6.45	837.9	107.1	4.02
	167	49.09	15.12	15.600	1.248	.780	2020.8	267.3	6.42	790.2	101.3	4.01
	158	46.47	15.00	15.550	1.188	.730	1900.6	253.4	6.40	745.0	95.8	4.00
	150	44.08	14.88	15.515	1.128	.695	1786.9	240.2	6.37	702.5	90.6	3.99
	142	41.85	14.75	15.500	1.063	.680	1672.2	226.7	6.32	660.1	85.2	3.97
	*320	94.12	16.81	16.710	2.093	1.890	4141.7	492.8	6.63	1635.1	195.7	4.17
14 x 14½	136	39.98	14.75	14.740	1.063	.660	1593.0	216.0	6.31	567.7	77.0	3.77
	127	37.33	14.62	14.690	.998	.610	1476.7	202.0	6.29	527.6	71.8	3.76
	119	34.99	14.50	14.650	.938	.570	1373.1	189.4	6.26	491.8	67.1	3.75
	111	32.65	14.37	14.620	.873	.540	1266.5	176.3	6.23	454.9	62.2	3.73
	103	30.26	14.25	14.575	.813	.495	1165.8	163.6	6.21	419.7	57.6	3.72
	95	27.94	14.12	14.545	.748	.465	1063.5	150.6	6.17	383.7	52.8	3.71
	87	25.56	14.00	14.500	.688	.420	966.9	138.1	6.15	349.7	48.2	3.70
14 x 12	84	24.71	14.18	12.023	.778	.451	928.4	130.9	6.13	225.5	37.5	3.02
	78	22.94	14.06	12.000	.718	.428	851.2	121.1	6.09	206.9	34.5	3.00
14 x 10	74	21.76	14.19	10.072	.783	.450	796.8	112.3	6.05	133.5	26.5	2.48
	68	20.00	14.06	10.040	.718	.418	724.1	103.0	6.02	121.2	24.1	2.46
	61	17.94	13.91	10.000	.643	.378	641.5	92.2	5.98	107.3	21.5	2.45

*Column core section.



WF SHAPES

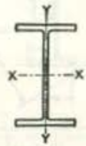
DIMENSIONS FOR DETAILING

Nominal Size	Weight per Foot	Depth	Flange Width	Flange Thickness	Web Thickness	Web Half Thickness	Distance a	Distance T	Distance k	Distance m	Distance g_1	Distance c	Usual Gage g
In.	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
14 x 16	426	18¾	16¾	3 1/16	1⅞	15/16	7⅜	11⅜	3⅝	25⅛	5	1	3—5½—3
	398	18¼	16⅝	2 13/16	1 13/16	⅞	7⅜	11⅜	3 7/16	24¾	4¾	15/16	
	370	18	16½	2 11/16	1 11/16	13/16	7⅜	11⅜	3¼	24⅜	4½	⅞	
	342	17½	16⅜	2 7/16	1 9/16	13/16	7⅜	11⅜	3 1/16	24	4¼	⅞	
	314	17¼	16¼	2 5/16	1 7/16	¾	7⅜	11⅜	2⅞	23¾	4¼	13/16	
	287	16¾	16⅛	2 1/16	1 5/16	11/16	7⅜	11⅜	2 11/16	23⅜	4	¾	
	264	16½	16	1 15/16	1¼	⅝	7⅜	11⅜	2 9/16	23	3¾	11/16	
	246	16¼	16	1 13/16	1⅛	9/16	7⅜	11⅜	2 7/16	22⅞	3¾	⅝	
	237	16⅛	15⅞	1¾	1⅛	9/16	7⅜	11⅜	2⅜	22¾	3¾	⅝	
	228	16	15⅞	1 11/16	1 1/16	9/16	7⅜	11⅜	2 5/16	22⅝	3½	⅝	
	219	15⅞	15⅞	1⅝	1	½	7⅜	11⅜	2¼	22½	3½	9/16	
	211	15¾	15¾	1 9/16	1	½	7⅜	11⅜	2 3/16	22⅜	3½	9/16	
	202	15⅝	15¾	1½	15/16	½	7⅜	11⅜	2⅛	22¼	3½	9/16	
	193	15½	15¾	1 7/16	⅞	7/16	7⅜	11⅜	2 1/16	22⅛	3¼	½	
	184	15⅜	15⅝	1⅜	⅞	7/16	7⅜	11⅜	2	22	3¼	½	
	176	15¼	15⅝	1 5/16	13/16	7/16	7⅜	11⅜	1 15/16	21⅞	3¼	½	
	167	15⅛	15⅝	1¼	13/16	⅜	7⅜	11⅜	1⅞	21¾	3¼	7/16	
	158	15	15½	1 3/16	¾	⅜	7⅜	11⅜	1 13/16	21⅝	3	7/16	
	150	14⅞	15½	1⅛	11/16	⅜	7⅜	11⅜	1¾	21½	3	7/16	
	142	14¾	15½	1 1/16	11/16	⅜	7⅜	11⅜	1 11/16	21½	3	7/16	
	*320	16¾	16¾	2 1/16	1⅞	15/16	7⅜	11⅜	2 11/16	23¾	4	1	
14 x 14½	136	14¾	14¾	1 1/16	11/16	⅜	7	11⅜	1 11/16	20⅞	3	7/16	5½
	127	14⅝	14¾	1	⅝	5/16	7	11⅜	1⅝	20¾	3	⅜	5½
	119	14½	14⅝	15/16	9/16	5/16	7	11⅜	1 9/16	20⅝	2¾	⅜	5½
	111	14⅜	14⅝	⅞	9/16	5/16	7	11⅜	1½	20½	2¾	⅜	5½
	103	14¼	14⅝	13/16	½	¼	7	11⅜	1 7/16	20½	2¾	5/16	5½
	95	14⅛	14½	¾	½	¼	7	11⅜	1⅜	20¼	2¾	5/16	5½
	87	14	14½	11/16	7/16	¼	7	11⅜	1 5/16	20¼	2½	5/16	5½
14 x 12	84	14⅛	12	¾	7/16	¼	5¾	11⅜	1⅜	18⅝	2¾	5/16	5½
	78	14	12	11/16	7/16	¼	5¾	11⅜	1 5/16	18½	2½	5/16	5½
14 x 10	74	14¼	10⅛	13/16	7/16	¼	4¾	11⅜	1⅜	17½	2¾	5/16	5½
	68	14	10	11/16	7/16	¼	4¾	11⅜	1 5/16	17¼	2½	5/16	5½
	61	13⅞	10	⅝	⅜	3/16	4¾	11⅜	1¼	17⅛	2½	¼	5½

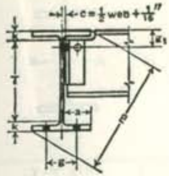
*Column Core Section.
Gage g_1 is based on k + 1¼", to nearest ¼".

WF SHAPES

PROPERTIES FOR DESIGNING



Nominal Size	Weight per Foot	Area	Depth	Flange Width	Flange Thickness	Web Thickness	Axis X-X I	Axis X-X S	Axis X-X r	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r
In.	Lb.	In.²	In.	In.	In.	In.	In.⁴	In.³	In.	In.⁴	In.³	In.
14 x 8	53	15.59	13.94	8.062	.658	.370	542.1	77.8	5.90	57.5	14.3	1.92
	48	14.11	13.81	8.031	.593	.339	484.9	70.2	5.86	51.3	12.8	1.91
	43	12.65	13.68	8.000	.528	.308	429.0	62.7	5.82	45.1	11.3	1.89
14 x 6¾	38	11.17	14.12	6.776	.513	.313	385.3	54.6	5.87	24.6	7.3	1.49
	34	10.00	14.00	6.750	.453	.287	339.2	48.5	5.83	21.3	6.3	1.46
	30	8.81	13.86	6.733	.383	.270	289.6	41.8	5.73	17.5	5.2	1.41
12 x 12	190	55.86	14.38	12.670	1.736	1.060	1892.5	263.2	5.82	589.7	93.1	3.25
	161	47.38	13.88	12.515	1.486	.905	1541.8	222.2	5.70	486.2	77.7	3.20
	133	39.11	13.38	12.365	1.236	.755	1221.2	182.5	5.59	389.9	63.1	3.16
	120	35.31	13.12	12.320	1.106	.710	1071.7	163.4	5.51	345.1	56.0	3.13
	106	31.19	12.88	12.230	.986	.620	930.7	144.5	5.46	300.9	49.2	3.11
	99	29.09	12.75	12.190	.921	.580	858.5	134.7	5.43	278.2	45.7	3.09
	92	27.06	12.62	12.155	.856	.545	788.9	125.0	5.40	256.4	42.2	3.08
	85	24.98	12.50	12.105	.796	.495	723.3	115.7	5.38	235.5	38.9	3.07
	79	23.22	12.38	12.080	.736	.470	663.0	107.1	5.34	216.4	35.8	3.05
	72	21.16	12.25	12.040	.671	.430	597.4	97.5	5.31	195.3	32.4	3.04
	65	19.11	12.12	12.000	.606	.390	533.4	88.0	5.28	174.6	29.1	3.02
12 x 10	58	17.06	12.19	10.014	.641	.359	476.1	78.1	5.28	107.4	21.4	2.51
	53	15.59	12.06	10.000	.576	.345	426.2	70.7	5.23	96.1	19.2	2.48
12 x 8	50	14.71	12.19	8.077	.641	.371	394.5	64.7	5.18	56.4	14.0	1.96
	45	13.24	12.06	8.042	.576	.336	350.8	58.2	5.15	50.0	12.4	1.94
	40	11.77	11.94	8.000	.516	.294	310.1	51.9	5.13	44.1	11.0	1.94
12 x 6½	36	10.59	12.24	6.565	.540	.305	280.8	45.9	5.15	23.7	7.2	1.50
	31	9.12	12.09	6.525	.465	.265	238.4	39.4	5.11	19.8	6.1	1.47
	27	7.97	11.95	6.500	.400	.240	204.1	34.1	5.06	16.6	5.1	1.44



WF SHAPES

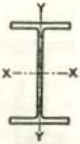
DIMENSIONS FOR DETAILING

Nominal Size	Weight per Foot	Depth	Flange		Web		Distance						Usual Gage
			Width	Thickness	Thickness	Half Thickness	a	T	k	m	g_1	c	g
In.	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
14 x 8	53	14	8	11/16	3/8	3/16	3 7/8	11 3/8	1 1/4	16 1/8	2 1/2	1/4	5 1/2
	48	13 3/4	8	9/16	3/8	3/16	3 7/8	11 3/8	1 3/16	16	2 1/2	1/4	5 1/2
	43	13 5/8	8	1/2	5/16	3/16	3 7/8	11 3/8	1 1/8	15 7/8	2 1/2	1/4	5 1/2
14 x 6 3/4	38	14 1/8	6 3/4	1/2	5/16	3/16	3 1/4	12 1/8	1	15 3/4	2 1/4	1/4	3 1/2
	34	14	6 3/4	7/16	5/16	3/16	3 1/4	12 1/8	15/16	15 5/8	2 1/4	1/4	3 1/2
	30	13 7/8	6 3/4	3/8	5/16	1/8	3 1/4	12 1/8	7/8	15 1/2	2 1/4	3/16	3 1/2
12 x 12	190	14 3/8	12 5/8	1 3/4	1 1/16	9/16	5 3/4	9 3/4	2 3/16	19 1/4	3 3/4	5/8	5 1/2
	161	13 7/8	12 1/2	1 1/2	15/16	7/16	5 3/4	9 3/4	2 1/16	18 3/4	3 1/2	1/2	5 1/2
	133	13 3/8	12 3/8	1 1/4	3/4	3/8	5 3/4	9 3/4	1 13/16	18 1/4	3 1/4	7/16	5 1/2
	120	13 1/8	12 3/8	1 1/8	3/4	3/8	5 3/4	9 3/4	1 11/16	18	3	7/16	5 1/2
	106	12 7/8	12 1/4	1	5/8	5/16	5 3/4	9 3/4	1 9/16	17 7/8	3	3/8	5 1/2
	99	12 3/4	12 1/4	15/16	5/8	5/16	5 3/4	9 3/4	1 1/2	17 3/4	2 3/4	3/8	5 1/2
	92	12 5/8	12 1/8	7/8	9/16	5/16	5 3/4	9 3/4	1 7/16	17 1/2	2 3/4	3/8	5 1/2
	85	12 1/2	12 1/8	13/16	1/2	1/4	5 3/4	9 3/4	1 3/8	17 1/2	2 3/4	5/16	5 1/2
	79	12 3/8	12 1/8	3/4	1/2	1/4	5 3/4	9 3/4	1 5/16	17 3/8	2 3/4	5/16	5 1/2
	72	12 1/4	12	11/16	7/16	1/4	5 3/4	9 3/4	1 1/4	17 1/4	2 1/2	5/16	5 1/2
	65	12 1/8	12	5/8	3/8	3/16	5 3/4	9 3/4	1 3/16	17 1/8	2 1/2	1/4	5 1/2
12 x 10	58	12 1/4	10	5/8	3/8	3/16	4 7/8	9 3/4	1 1/4	15 7/8	2 1/2	1/4	5 1/2
	53	12	10	9/16	3/8	3/16	4 7/8	9 3/4	1 3/16	15 5/8	2 1/2	1/4	5 1/2
12 x 8	50	12 1/4	8 1/8	5/8	3/8	3/16	3 7/8	9 3/4	1 1/4	14 5/8	2 1/2	1/4	5 1/2
	45	12	8	9/16	3/8	3/16	3 7/8	9 3/4	1 3/16	14 1/2	2 1/2	1/4	5 1/2
	40	12	8	1/2	5/16	3/16	3 7/8	9 3/4	1 1/8	14 3/8	2 1/2	1/4	5 1/2
12 x 6 1/2	36	12 1/4	6 5/8	9/16	5/16	3/16	3 1/8	10 3/8	15/16	14	2 1/4	1/4	3 1/2
	31	12 1/8	6 1/2	7/16	1/4	1/8	3 1/8	10 3/8	7/8	13 3/4	2 1/4	3/16	3 1/2
	27	12	6 1/2	3/8	1/4	1/8	3 1/8	10 3/8	13/16	13 5/8	2 1/4	3/16	3 1/2

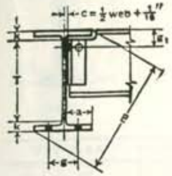
Gage g_1 is based on k + 1¼", to nearest ¼".

W= SHAPES

PROPERTIES FOR DESIGNING



Nominal Size	Weight per Foot	Area	Depth	Flange Width	Flange Thickness	Web Thickness	Axis X-X I	Axis X-X S	Axis X-X r	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r
In.	Lb.	In.^{2}	In.	In.	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
10 x 10	112	32.92	11.38	10.415	1.248	.755	718.7	126.3	4.67	235.4	45.2	2.67
	100	29.43	11.12	10.345	1.118	.685	625.0	112.4	4.61	206.6	39.9	2.65
	89	26.19	10.88	10.275	.998	.615	542.4	99.7	4.55	180.6	35.2	2.63
	77	22.67	10.62	10.195	.868	.535	457.2	86.1	4.49	153.4	30.1	2.60
	72	21.18	10.50	10.170	.808	.510	420.7	80.1	4.46	141.8	27.9	2.59
	66	19.41	10.38	10.117	.748	.457	382.5	73.7	4.44	129.2	25.5	2.58
	60	17.66	10.25	10.075	.683	.415	343.7	67.1	4.41	116.5	23.1	2.57
	54	15.88	10.12	10.028	.618	.368	305.7	60.4	4.39	103.9	20.7	2.56
	49	14.40	10.00	10.000	.558	.340	272.9	54.6	4.35	93.0	18.6	2.54
10 x 8	45	13.24	10.12	8.022	.618	.350	248.6	49.1	4.33	53.2	13.3	2.00
	39	11.48	9.94	7.990	.528	.318	209.7	42.2	4.27	44.9	11.2	1.98
	33	9.71	9.75	7.964	.433	.292	170.9	35.0	4.20	36.5	9.2	1.94
10 x 5¾	29	8.53	10.22	5.799	.500	.289	157.3	30.8	4.29	15.2	5.2	1.34
	25	7.35	10.08	5.762	.430	.252	133.2	26.4	4.26	12.7	4.4	1.31
	21	6.19	9.90	5.750	.340	.240	106.3	21.5	4.14	9.7	3.4	1.25
8 x 8	67	19.70	9.00	8.287	.933	.575	271.8	60.4	3.71	88.6	21.4	2.12
	58	17.06	8.75	8.222	.808	.510	227.3	52.0	3.65	74.9	18.2	2.10
	48	14.11	8.50	8.117	.683	.405	183.7	43.2	3.61	60.9	15.0	2.08
	40	11.76	8.25	8.077	.558	.365	146.3	35.5	3.53	49.0	12.1	2.04
	35	10.30	8.12	8.027	.493	.315	126.5	31.1	3.50	42.5	10.6	2.03
	31	9.12	8.00	8.000	.433	.288	109.7	27.4	3.47	37.0	9.2	2.01
8 x 6½	28	8.23	8.06	6.540	.463	.285	97.8	24.3	3.45	21.6	6.6	1.62
	24	7.06	7.93	6.500	.398	.245	82.5	20.8	3.42	18.2	5.6	1.61
8 x 5¼	20	5.88	8.14	5.268	.378	.248	69.2	17.0	3.43	8.5	3.2	1.20
	17	5.00	8.00	5.250	.308	.230	56.4	14.1	3.36	6.7	2.6	1.16



WF SHAPES

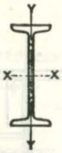
DIMENSIONS FOR DETAILING

Nominal Size	Weight per Foot	Depth	Flange Width	Flange Thickness	Web Thickness	Web Half Thickness	Distance a	Distance T	Distance k	Distance m	Distance g_1	Distance c	Usual Gage g
In.	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
10 x 10	112	11⅜	10⅜	1¼	¾	⅜	4⅞	7⅞	1¾	15½	3	7/16	5½
	100	11⅛	10⅜	1⅛	11/16	⅜	4⅞	7⅞	1⅝	15¼	3	7/16	5½
	89	10⅞	10¼	1	⅝	5/16	4⅞	7⅞	1½	15	2¾	⅜	5½
	77	10⅝	10¼	⅞	9/16	5/16	4⅞	7⅞	1⅜	14¾	2¾	⅜	5½
	72	10½	10⅛	13/16	½	¼	4⅞	7⅞	1 5/16	14⅝	2¾	5/16	5½
	66	10⅜	10⅛	¾	7/16	¼	4⅞	7⅞	1¼	14½	2½	5/16	5½
	60	10¼	10⅛	11/16	7/16	¼	4⅞	7⅞	1 3/16	14⅜	2½	5/16	5½
	54	10⅛	10	⅝	⅜	3/16	4⅞	7⅞	1⅛	14¼	2½	¼	5½
	49	10	10	9/16	⅜	3/16	4⅞	7⅞	1 1/16	14⅛	2½	¼	5½
10 x 8	45	10⅛	8	⅝	⅜	3/16	3⅞	7⅞	1⅛	13	2½	¼	5½
	39	10	8	½	5/16	3/16	3⅞	7⅞	1 1/16	12⅞	2½	¼	5½
	33	9¾	8	7/16	5/16	3/16	3⅞	7⅞	15/16	12⅝	2¼	¼	5½
10 x 5¾	29	10¼	5¾	½	5/16	3/16	2¾	8½	⅞	11¾	2¼	¼	2¾
	25	10⅛	5¾	7/16	¼	⅛	2¾	8½	13/16	11⅝	2¼	3/16	2¾
	21	9⅞	5¾	5/16	¼	⅛	2¾	8½	11/16	11½	2	3/16	2¾
8 x 8	67	9	8¼	15/16	9/16	5/16	3⅞	6⅜	1 5/16	12¼	2¾	⅜	5½
	58	8¾	8¼	13/16	½	¼	3⅞	6⅜	1 3/16	12	2½	5/16	5½
	48	8½	8⅛	11/16	7/16	3/16	3⅞	6⅜	1 1/16	11⅞	2½	¼	5½
	40	8¼	8⅛	9/16	⅜	3/16	3⅞	6⅜	15/16	11⅝	2¼	¼	5½
	35	8⅛	8	½	5/16	3/16	3⅞	6⅜	⅞	11½	2¼	¼	5½
	31	8	8	7/16	5/16	3/16	3⅞	6⅜	13/16	11⅜	2¼	¼	5½
8 x 6½	28	8	6½	7/16	5/16	⅛	3⅛	6⅜	13/16	10½	2¼	3/16	3½
	24	7⅞	6½	⅜	¼	⅛	3⅛	6⅜	¾	10¼	2¼	3/16	3½
8 x 5¼	20	8⅛	5¼	⅜	¼	⅛	2½	6¾	11/16	9¾	2¼	3/16	2¾
	17	8	5¼	5/16	¼	⅛	2½	6¾	⅝	9⅝	2¼	3/16	2¾

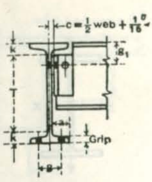
Gage g_1 is based on k + 1¼″, to nearest ¼″.

AMERICAN STANDARD BEAMS

PROPERTIES FOR DESIGNING



Nominal Size	Weight per Foot	Area	Depth	Flange Width	Flange Thickness	Web Thickness	Axis X-X I	Axis X-X S	Axis X-X r	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r
In.	Lb.	In.^{2}	In.	In.	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
24 x 7⅞	120.0	35.13	24.00	8.048	1.102	.798	3010.8	250.9	9.26	84.9	21.1	1.56
	105.9	30.98	24.00	7.875	1.102	.625	2811.5	234.3	9.53	78.9	20.0	1.60
24 x 7	100.0	29.25	24.00	7.247	.871	.747	2371.8	197.6	9.05	48.4	13.4	1.29
	90.0	26.30	24.00	7.124	.871	.624	2230.1	185.8	9.21	45.5	12.8	1.32
	79.9	23.33	24.00	7.000	.871	.500	2087.2	173.9	9.46	42.9	12.2	1.36
20 x 7	95.0	27.74	20.00	7.200	.916	.800	1599.7	160.0	7.59	50.5	14.0	1.35
	85.0	24.80	20.00	7.053	.916	.653	1501.7	150.2	7.78	47.0	13.3	1.38
20 x 6¼	75.0	21.90	20.00	6.391	.789	.641	1263.5	126.3	7.60	30.1	9.4	1.17
	65.4	19.08	20.00	6.250	.789	.500	1169.5	116.9	7.83	27.9	8.9	1.21
18 x 6	70.0	20.46	18.00	6.251	.691	.711	917.5	101.9	6.70	24.5	7.8	1.09
	54.7	15.94	18.00	6.000	.691	.460	795.5	88.4	7.07	21.2	7.1	1.15
15 x 5½	50.0	14.59	15.00	5.640	.622	.550	481.1	64.2	5.74	16.0	5.7	1.05
	42.9	12.49	15.00	5.500	.622	.410	441.8	58.9	5.95	14.6	5.3	1.08
12 x 5¼	50.0	14.57	12.00	5.477	.659	.687	301.6	50.3	4.55	16.0	5.8	1.05
	40.8	11.84	12.00	5.250	.659	.460	268.9	44.8	4.77	13.8	5.3	1.08
12 x 5	35.0	10.20	12.00	5.078	.544	.428	227.0	37.8	4.72	10.0	3.9	.99
	31.8	9.26	12.00	5.000	.544	.350	215.8	36.0	4.83	9.5	3.8	1.01
10 x 4⅝	35.0	10.22	10.00	4.944	.491	.594	145.8	29.2	3.78	8.5	3.4	.91
	25.4	7.38	10.00	4.660	.491	.310	122.1	24.4	4.07	6.9	3.0	.97
8 x 4	23.0	6.71	8.00	4.171	.425	.441	64.2	16.0	3.09	4.4	2.1	.81
	18.4	5.34	8.00	4.000	.425	.270	56.9	14.2	3.26	3.8	1.9	.84
7 x 3⅝	20.0	5.83	7.00	3.860	.392	.450	41.9	12.0	2.68	3.1	1.6	.74
	15.3	4.43	7.00	3.660	.392	.250	36.2	10.4	2.86	2.7	1.5	.78
6 x 3⅜	17.25	5.02	6.00	3.565	.359	.465	26.0	8.7	2.28	2.3	1.3	.68
	12.5	3.61	6.00	3.330	.359	.230	21.8	7.3	2.46	1.8	1.1	.72
5 x 3	14.75	4.29	5.00	3.284	.326	.494	15.0	6.0	1.87	1.7	1.0	.63
	10.0	2.87	5.00	3.000	.326	.210	12.1	4.8	2.05	1.2	.82	.65
4 x 2⅝	9.5	2.76	4.00	2.796	.293	.326	6.7	3.3	1.56	.91	.65	.58
	7.7	2.21	4.00	2.660	.293	.190	6.0	3.0	1.64	.77	.58	.59
3 x 2⅜	7.5	2.17	3.00	2.509	.260	.349	2.9	1.9	1.15	.59	.47	.52
	5.7	1.64	3.00	2.330	.260	.170	2.5	1.7	1.23	.46	.40	.53



AMERICAN STANDARD BEAMS

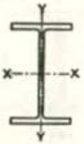
DIMENSIONS FOR DETAILING

Depth of Section	Weight per Foot	Flange: Width	Flange: Mean Thickness	Web: Thickness	Web: Half Thickness	Distance: a	Distance: T	Distance: k	Distance: g_1	Distance: c	Grip	Max. Flange Rivet	Usual Gage g
In.	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
24	120.0	8	1 1/8	13/16	7/16	3 5/8	20 1/8	1 15/16	3 1/4	1/2	1 1/8	1	4
	105.9	7 7/8	1 1/8	5/8	5/16	3 5/8	20 1/8	1 15/16	3 1/4	3/8	1 1/8	1	4
24	100.0	7 1/4	7/8	3/4	3/8	3 1/4	20 3/4	1 5/8	3	7/16	7/8	1	4
	90.0	7 1/8	7/8	5/8	5/16	3 1/4	20 3/4	1 5/8	3	3/8	7/8	1	4
	79.9	7	7/8	1/2	1/4	3 1/4	20 3/4	1 5/8	3	5/16	7/8	1	4
20	95.0	7 1/4	15/16	13/16	7/16	3 1/4	16 1/2	1 3/4	3 1/4	1/2	15/16	1	4
	85.0	7	15/16	11/16	5/16	3 1/4	16 1/2	1 3/4	3 1/4	3/8	7/8	1	4
20	75.0	6 3/8	13/16	5/8	5/16	2 7/8	16 7/8	1 9/16	3	3/8	13/16	7/8	3 1/2
	65.4	6 1/4	13/16	1/2	1/4	2 7/8	16 7/8	1 9/16	3	5/16	3/4	7/8	3 1/2
18	70.0	6 1/4	11/16	3/4	3/8	2 3/4	15 1/4	1 3/8	2 3/4	7/16	11/16	7/8	3 1/2
	54.7	6	11/16	1/2	1/4	2 3/4	15 1/4	1 3/8	2 3/4	5/16	11/16	7/8	3 1/2
15	50.0	5 5/8	5/8	9/16	5/16	2 1/2	12 1/2	1 1/4	2 3/4	3/8	9/16	3/4	3 1/2
	42.9	5 1/2	5/8	7/16	1/4	2 1/2	12 1/2	1 1/4	2 3/4	5/16	9/16	3/4	3 1/2
12	50.0	5 1/2	11/16	11/16	3/8	2 3/8	9 3/8	1 5/16	2 3/4	7/16	11/16	3/4	3
	40.8	5 1/4	11/16	1/2	1/4	2 3/8	9 3/8	1 5/16	2 3/4	5/16	5/8	3/4	3
12	35.0	5 1/8	9/16	7/16	1/4	2 3/8	9 3/4	1 1/8	2 1/2	5/16	1/2	3/4	3
	31.8	5	9/16	3/8	3/16	2 3/8	9 3/4	1 1/8	2 1/2	1/4	1/2	3/4	3
10	35.0	5	1/2	5/8	5/16	2 1/8	8	1	2 1/2	3/8	1/2	3/4	2 3/4
	25.4	4 5/8	1/2	5/16	3/16	2 1/8	8	1	2 1/2	1/4	1/2	3/4	2 3/4
8	23.0	4 1/8	7/16	7/16	1/4	1 7/8	6 1/4	7/8	2 1/4	5/16	7/16	3/4	2 1/4
	18.4	4	7/16	5/16	1/8	1 7/8	6 1/4	7/8	2 1/4	3/16	7/16	3/4	2 1/4
7	20.0	3 7/8	3/8	7/16	1/4	1 3/4	5 3/8	13/16	2	5/16	3/8	5/8	2 1/4
	15.3	3 5/8	3/8	1/4	1/8	1 3/4	5 3/8	13/16	2	3/16	3/8	5/8	2 1/4
6	17.25	3 5/8	3/8	1/2	1/4	1 1/2	4 1/2	3/4	2	5/16	3/8	5/8	2
	12.5	3 3/8	3/8	1/4	1/8	1 1/2	4 1/2	3/4	2	3/16	5/16		
5	14.75	3 1/4	5/16	1/2	1/4	1 3/8	3 5/8	11/16	2	5/16	5/16	1/2	1 3/4
	10.0	3	5/16	1/4	1/8	1 3/8	3 5/8	11/16	2	3/16	5/16	1/2	1 3/4
4	9.5	2 3/4	5/16	5/16	3/16	1 1/4	2 3/4	5/8	2	1/4	5/16	1/2	1 1/2
	7.7	2 5/8	5/16	3/16	1/8	1 1/4	2 3/4	5/8	2	3/16	5/16		
3	7.5	2 1/2	1/4	3/8	3/16	1 1/8	1 7/8	9/16		1/4	1/4	3/8	1 1/2
	5.7	2 3/8	1/4	3/16	1/8	1 1/8	1 7/8	9/16		3/16	1/4	3/8	1 1/2

Gage g_1 is based on k + 1 1/4", to nearest 1/4".
Gage g is permissible near ends of beam; elsewhere Specification may require reduction in rivet size.

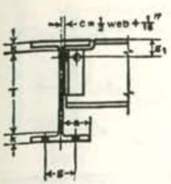
WF SHAPES
MISCELLANEOUS (B)
COLUMNS AND BEAMS

PROPERTIES FOR DESIGNING



Nominal Size	Weight per Foot	Area	Depth	Flange		Web Thickness	AXIS X-X			AXIS Y-Y		
				Width	Thickness		I	S	r	I	S	r
In.	Lb.	In.²	In.	In.	In.	In.	In.⁴	In.³	In.	In.⁴	In.³	In.
WF SHAPES AND LIGHT COLUMNS												
6 WF 6 x 6	25	7.37	6.37	6.080	.456	.320	53.5	16.8	2.69	17.1	5.6	1.52
	20	5.90	6.20	6.018	.367	.258	41.7	13.4	2.66	13.3	4.4	1.50
	15.5	4.62	6.00	6.000	.269	.240	30.3	10.1	2.56	9.69	3.2	1.45
5 WF 5 x 5	18.5	5.45	5.12	5.025	.420	.265	25.4	9.94	2.16	8.89	3.54	1.28
	16	4.70	5.00	5.000	.360	.240	21.3	8.53	2.13	7.51	3.00	1.26
4 WF 4 x 4	13	3.82	4.16	4.060	.345	.280	11.3	5.45	1.72	3.76	1.85	.99
	10	2.93	4.00	4.000	.265	.220	8.31	4.16	1.68	2.74	1.37	.97
LIGHT BEAMS												
12 x 4	22	6.47	12.31	4.030	.424	.260	155.7	25.3	4.91	4.55	2.26	.84
	19	5.62	12.16	4.010	.349	.240	130.1	21.4	4.81	3.67	1.83	.81
	16½	4.86	12.00	4.000	.269	.230	105.3	17.5	4.65	2.79	1.39	.76
10 x 4	19	5.61	10.25	4.020	.394	.250	96.2	18.8	4.14	4.19	2.08	.86
	17	4.98	10.12	4.010	.329	.240	81.8	16.2	4.05	3.45	1.72	.83
	15	4.40	10.00	4.000	.269	.230	68.8	13.8	3.95	2.79	1.39	.80
8 x 4	15	4.43	8.12	4.015	.314	.245	48.0	11.8	3.29	3.30	1.65	.86
	13	3.83	8.00	4.000	.254	.230	39.5	9.88	3.21	2.62	1.31	.83
6 x 4	16	4.72	6.25	4.030	.404	.260	31.7	10.1	2.59	4.32	2.14	.96
	12	3.53	6.00	4.000	.279	.230	21.7	7.24	2.48	2.89	1.44	.90
JOISTS												
12 x 4	14	4.14	11.91	3.970	.224	.200	88.2	14.8	4.61	2.25	1.13	.74
10 x 4	11½	3.39	9.87	3.950	.204	.180	51.9	10.5	3.92	2.01	1.02	.77
8 x 4	10	2.95	7.90	3.940	.204	.170	30.8	7.79	3.23	1.99	1.01	.82
6 x 4	8½	2.50	5.83	3.940	.194	.170	14.8	5.07	2.43	1.89	.96	.87

Above shapes all rolled by Bethlehem Steel Co. and Carnegie-Illinois Steel Corp., except 4 WF 13 by Bethlehem Steel Co. only.



WF SHAPES
MISCELLANEOUS (B)
COLUMNS AND BEAMS

DIMENSIONS FOR DETAILING

Nominal Size	Weight per Foot	Depth	Flange		Web		Distance					Max. Flg. Rivet	Usual Gage
			Width	Thickness	Thickness	Half Thickness	a	T	k	g_1	c		g
In.	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
WF SHAPES AND LIGHT COLUMNS													
6 WF 6 x 6	25	6⅜	6	½	5/16	3/16	2⅞	4⅞	¾	2¼	¼	⅞	3½
	20	6¼	6	⅜	¼	3/16	2⅞	4⅞	11/16	2	3/16	⅞	3½
	15.5	6	6	¼	¼	⅛	2⅞	4⅞	9/16	2	3/16	⅞	3½
5 WF 5 x 5	18.5	5⅛	5	7/16	¼	⅛	2⅜	3 11/16	¾	2	3/16	⅞	2¾
	16	5	5	⅜	¼	⅛	2⅜	3 11/16	⅝	2	3/16	⅞	2¾
4 WF 4 x 4	13	4⅛	4	⅜	5/16	⅛	1⅞	2⅞	⅝	1¾	3/16	⅝	2¼
	10	4	4	¼	¼	⅛	1⅞	2⅞	9/16	1¾	3/16	⅝	2¼
LIGHT BEAMS													
12 x 4	22	12¼	4	7/16	¼	⅛	1⅞	10¾	¾	2	3/16	¾	2¼
	19	12⅛	4	⅜	¼	⅛	1⅞	10¾	11/16	2	3/16	¾	2¼
	16½	12	4	¼	¼	⅛	1⅞	10¾	⅝	1¾	3/16	¾	2¼
10 x 4	19	10¼	4	⅜	¼	⅛	1⅞	8⅞	11/16	2	3/16	¾	2¼
	17	10⅛	4	5/16	¼	⅛	1⅞	8⅞	⅝	2	3/16	¾	2¼
	15	10	4	¼	¼	⅛	1⅞	8⅞	9/16	1¾	3/16	¾	2¼
8 x 4	15	8⅛	4	5/16	¼	⅛	1⅞	6⅞	⅝	2	3/16	¾	2¼
	13	8	4	¼	¼	⅛	1⅞	6⅞	9/16	1¾	3/16	¾	2¼
6 x 4	16	6¼	4	⅜	¼	⅛	1⅞	4⅞	11/16	2	3/16	¾	2¼
	12	6	4	¼	¼	⅛	1⅞	4⅞	9/16	1¾	3/16	¾	2¼
JOISTS													
12 x 4	14	11⅞	4	¼	3/16	⅛	1⅞	10¾	9/16	1¾	3/16	⅝	2¼
10 x 4	11½	9⅞	4	3/16	3/16	⅛	1⅞	8⅞	½	1¾	3/16	⅝	2¼
8 x 4	10	7⅞	4	3/16	3/16	⅛	1⅞	6⅞	½	1¾	3/16	⅝	2¼
6 x 4	8½	5⅞	4	3/16	3/16	⅛	1⅞	5	7/16	1¾	3/16	⅝	2¼

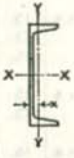
Above shapes all rolled by Bethlehem Steel Co. and Carnegie-Illinois Steel Corp., except 4 WF 13 by Bethlehem Steel Co. only.
Gage g_1 is based on k + 1¼″, to nearest ¼″.
Gage g is permissible near ends of beam; elsewhere Specification may require reduction in rivet size.

MISCELLANEOUS SHAPES

PROPERTIES FOR DESIGNING

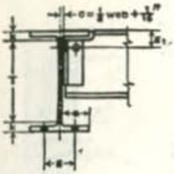
Nominal Size	Weight per Foot	Area	Depth	Width of Flange	Web Thickness	AXIS X-X			AXIS Y-Y		
						I	S	r	I	S	r
In.	Lb.	In.²	In.	In.	In.	In.⁴	In.³	In.	In.⁴	In.³	In.
LIGHT COLUMNS											
*8 x 8	34.3	10.09	8.00	8.000	.375	115.5	28.9	3.40	35.1	8.8	1.87
*6 x 6	25.0	7.35	6.00	5.938	.313	47.0	15.7	2.53	14.9	5.0	1.43
	20.0	5.88	6.00	5.938	.250	38.8	12.9	2.57	11.4	3.8	1.39
§5 x 5	18.9	5.56	5.00	5.000	.313	23.8	9.5	2.08	7.8	3.1	1.20
†4 x 4	13.0	3.82	4.00	3.937	.250	10.4	5.2	1.65	3.4	1.7	.94
STANDARD MILL BEAMS											
‡10 x 5¾	25	7.35	9.90	5.86	.35	117.0	23.6	3.99	9.84	3.36	1.16
	21	6.18	9.90	5.74	.24	107.5	21.7	4.17	9.30	3.24	1.22
‡8 x 6½	28	8.23	8.00	6.65	.39	90.1	22.5	3.31	17.73	5.33	1.47
	24	7.06	8.00	6.50	.24	83.8	21.0	3.45	16.52	5.08	1.53
‡8 x 5¼	20	5.88	8.00	5.36	.35	60.7	15.2	3.22	6.60	2.46	1.06
	17	5.00	8.00	5.25	.24	56.0	14.0	3.35	6.16	2.35	1.11
JUNIOR BEAMS											
●12 x 3	11.8	3.45	12.00	3.063	.175	72.2	12.0	4.57	.98	.64	.53
●11 x 2⅞	10.3	3.01	11.00	2.844	.165	53.1	9.6	4.20	.75	.52	.50
●10 x 2¾	9.0	2.64	10.00	2.688	.155	39.0	7.8	3.85	.61	.45	.48
● 9 x 2⅜	7.5	2.20	9.00	2.375	.145	26.2	5.8	3.45	.39	.33	.42
● 8 x 2¼	6.5	1.92	8.00	2.281	.135	18.7	4.7	3.12	.34	.30	.42
● 7 x 2⅛	5.5	1.61	7.00	2.078	.126	12.1	3.5	2.74	.25	.24	.39
● 6 x 1⅞	4.4	1.30	6.00	1.844	.114	7.3	2.4	2.37	.17	.18	.36

JUNIOR CHANNELS



Nominal Size	Weight per Foot	Area	Depth	Width of Flange	Web Thickness	AXIS X-X			AXIS Y-Y			
						I	S	r	I	S	r	x
In.	Lb.	In.²	In.	In.	In.	In.⁴	In.³	In.	In.⁴	In.³	In.	In.
●12 x 1½	10.6	3.12	12.00	1.500	.190	55.8	9.3	4.23	.39	.32	.35	.27
●10 x 1½	8.4	2.47	10.00	1.500	.170	32.3	6.5	3.61	.33	.28	.37	.29
●10 x 1⅛	6.5	1.91	10.00	1.125	.150	22.1	4.4	3.47	.12	.13	.25	.19

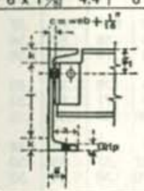
*Rolled by Carnegie-Illinois Steel Corp., Inland Steel Co. and The Phoenix Iron Co.-M.
§Rolled by Carnegie-Illinois Steel Corp. and Bethlehem Steel Co.-B.
†Rolled by Carnegie-Illinois Steel Corp.-B.
‡Rolled by The Phoenix Iron Co.-M.
●Rolled by Jones & Laughlin Steel Corp.-Jr.



MISCELLANEOUS SHAPES

DIMENSIONS FOR DETAILING

Nominal Size	Weight per Foot	Depth	Flange Width	Flange Mean Thickness	Web Thickness	Web Half Thickness	Distance a	Distance T	Distance k	Distance g_1	Distance c	Max. Flg. Rivet	Usual Gage g
In.	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
LIGHT COLUMNS													
*8 x 8	34.3	8	8	7/16	3/8	3/16	3 7/8	6 1/4	7/8	2 1/2	1/4	7/8	5 1/2
*6 x 6	25.0	6	6	1/2	5/16	3/16	2 7/8	4 1/4	7/8	2 1/2	1/4	7/8	3 1/2
	20.0	6	6	3/8	1/4	1/8	2 7/8	4 3/8	13/16	2 1/4	3/16	7/8	3 1/2
§5 x 5	18.9	5	5	7/16	5/16	3/16	2 3/8	3 3/8	13/16	2 1/4	1/4	3/4	2 3/4
†4 x 4	13.0	4	4	3/8	1/4	1/8	1 7/8	2 1/2	3/4	2	3/16	5/8	2 1/4
STANDARD MILL BEAMS													
‡10 x 5 3/4	25	9 15/16	5 7/8	3/8	3/8	3/16	2 3/4	8 3/8	3/4	2	1/4	3/4	2 3/4
	21	9 15/16	5 3/4	3/8	1/4	1/8	2 3/4	8 3/8	3/4	2	3/16	3/4	2 3/4
‡ 8 x 6 1/2	28	8	6 5/8	3/8	3/8	3/16	3 1/8	6 1/4	7/8	2 1/4	1/4	7/8	3 1/2
	24	8	6 1/2	3/8	1/4	1/8	3 1/8	6 1/4	7/8	2 1/4	3/16	7/8	3 1/2
‡ 8 x 5 1/4	20	8	5 3/8	5/16	3/8	3/16	2 1/2	6 5/8	11/16	2	1/4	7/8	2 3/4
	17	8	5 1/4	5/16	1/4	1/8	2 1/2	6 5/8	11/16	2	3/16	7/8	2 3/4
JUNIOR BEAMS													
●12 x 3	11.8	12	3	1/4	3/16	1/8	1 1/2	11	1/2	1 3/4	3/16		
●11 x 2 7/8	10.3	11	2 7/8	3/16	3/16	1/8	1 3/8	10	1/2	1 3/4	3/16		
●10 x 2 3/4	9.0	10	2 3/4	3/16	3/16	1/16	1 1/4	9 1/8	7/16	1 3/4	1/8		
● 9 x 2 5/8	7.5	9	2 5/8	3/16	3/16	1/16	1 1/8	8 1/8	7/16	1 1/2	1/8		
● 8 x 2 1/4	6.5	8	2 1/4	3/16	1/8	1/16	1 1/8	7 1/4	3/8	1 1/2	1/8		
● 7 x 2 1/8	5.5	7	2 1/8	3/16	1/8	1/16	1	6 1/4	3/8	1 1/2	1/8		
● 6 x 1 7/8	4.4	6	1 7/8	3/16	1/8	1/16	7/8	5 1/4	3/8	1 1/2	1/8		



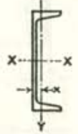
JUNIOR CHANNELS

Depth of Section	Weight per Foot	Flange Width	Flange Mean Thickness	Web Thickness	Web Half Thickness	Distance a	Distance T	Distance k	Distance g_1	Distance c
In.	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.
●12 x 1 1/2	10.6	1 1/2	5/16	3/16	1/8	1 1/4	10 3/4	5/8	2	1/4
●10 x 1 1/2	8.4	1 1/2	1/4	3/16	1/8	1 3/8	9	1/2	1 3/4	1/4
●10 x 1 1/8	6.5	1 1/8	13/32	5/32	3/32	1 3/32	9 1/4	3/8	1 1/2	1/4

*Rolled by Carnegie-Illinois Steel Corp., Inland Steel Co. and The Phoenix Iron Co.-M.
§Rolled by Carnegie-Illinois Steel Corp. and Bethlehem Steel Co.-B.
†Rolled by Carnegie-Illinois Steel Corp.-B.
‡Rolled by The Phoenix Iron Co.-M.
●Rolled by Jones & Laughlin Steel Corp.-Jr.
Gage g_1 is based on k + 1 1/4", to nearest 1/4".
Gage g is permissible near ends of beam; elsewhere Specification may require reduction in rivet size.

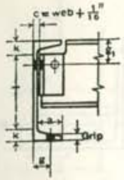
AMERICAN STANDARD CHANNELS

PROPERTIES FOR DESIGNING



Nominal Size	Weight per Foot	Area	Depth	Flange Width	Flange Average Thickness	Web Thickness	Axis X-X I	Axis X-X S	Axis X-X r	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r	Axis Y-Y x
In.	Lb.	$In.^2$	In.	In.	In.	In.	$In.^4$	$In.^3$	In.	$In.^4$	$In.^3$	In.	In.
*18 x 4	58.0	16.98	18.00	4.200	.625	.700	670.7	74.5	6.29	18.5	5.6	1.04	.88
	51.9	15.18	18.00	4.100	.625	.600	622.1	69.1	6.40	17.1	5.3	1.06	.87
	45.8	13.38	18.00	4.000	.625	.500	573.5	63.7	6.55	15.8	5.1	1.09	.89
	42.7	12.48	18.00	3.950	.625	.450	549.2	61.0	6.64	15.0	4.9	1.10	.90
15 x 3⅜	50.0	14.64	15.00	3.716	.650	.716	401.4	53.6	5.24	11.2	3.8	.87	.80
	40.0	11.70	15.00	3.520	.650	.520	346.3	46.2	5.44	9.3	3.4	.89	.78
	33.9	9.90	15.00	3.400	.650	.400	312.6	41.7	5.62	8.2	3.2	.91	.79
12 x 3	30.0	8.79	12.00	3.170	.501	.510	161.2	26.9	4.28	5.2	2.1	.77	.68
	25.0	7.32	12.00	3.047	.501	.387	143.5	23.9	4.43	4.5	1.9	.79	.68
	20.7	6.03	12.00	2.940	.501	.280	128.1	21.4	4.61	3.9	1.7	.81	.70
10 x 2⅝	30.0	8.80	10.00	3.033	.436	.673	103.0	20.6	3.42	4.0	1.7	.67	.65
	25.0	7.33	10.00	2.886	.436	.526	90.7	18.1	3.52	3.4	1.5	.68	.62
	20.0	5.86	10.00	2.739	.436	.379	78.5	15.7	3.66	2.8	1.3	.70	.61
	15.3	4.47	10.00	2.600	.436	240	66.9	13.4	3.87	2.3	1.2	.72	.64
9 x 2½	20.0	5.86	9.00	2.648	.413	.448	60.6	13.5	3.22	2.4	1.2	.65	.59
	15.0	4.39	9.00	2.485	.413	.285	50.7	11.3	3.40	1.9	1.0	.67	.59
	13.4	3.89	9.00	2.430	.413	.230	47.3	10.5	3.49	1.8	.97	.67	.61
8 x 2¼	18.75	5.49	8.00	2.527	.390	.487	43.7	10.9	2.82	2.0	1.0	.60	.57
	13.75	4.02	8.00	2.343	.390	.303	35.8	9.0	2.99	1.5	.86	.62	.56
	11.5	3.36	8.00	2.260	.390	.220	32.3	8.1	3.10	1.3	.79	.63	.58
7 x 2⅛	14.75	4.32	7.00	2.299	.366	.419	27.1	7.7	2.51	1.4	.79	.57	.53
	12.25	3.58	7.00	2.194	.366	.314	24.1	6.9	2.59	1.2	.71	.58	.53
	9.8	2.85	7.00	2.090	.366	.210	21.1	6.0	2.72	.98	.63	.59	.55
6 x 2	13.0	3.81	6.00	2.157	.343	.437	17.3	5.8	2.13	1.1	.65	.53	.52
	10.5	3.07	6.00	2.034	.343	.314	15.1	5.0	2.22	.87	.57	.53	.50
	8.2	2.39	6.00	1.920	.343	.200	13.0	4.3	2.34	.70	.50	.54	.52
5 x 1¾	9.0	2.63	5.00	1.885	.320	.325	8.8	3.5	1.83	.64	.45	.49	.48
	6.7	1.95	5.00	1.750	.320	.190	7.4	3.0	1.95	.48	.38	.50	.49
4 x 1⅝	7.25	2.12	4.00	1.720	.296	.320	4.5	2.3	1.47	.44	.35	.46	.46
	5.4	1.56	4.00	1.580	.296	.180	3.8	1.9	1.56	.32	.29	.45	.46
3 x 1½	6.0	1.75	3.00	1.596	.273	.356	2.1	1.4	1.08	.31	.27	.42	.46
	5.0	1.46	3.00	1.498	.273	.258	1.8	1.2	1.12	.25	.24	.41	.44
	4.1	1.19	3.00	1.410	.273	.170	1.6	1.1	1.17	.20	.21	.41	.44

*Car and Shipbuilding Channel; not an American Standard.



AMERICAN STANDARD

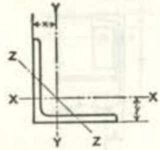
CHANNELS

DIMENSIONS FOR DETAILING

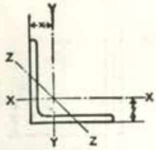
Depth of Section	Weight per Foot	Flange: Width	Flange: Mean Thickness	Web: Thickness	Web: Half Thickness	Distance: a	Distance: T	Distance: k	Distance: g_1	Distance: c	Grip	Max. Flange Rivet	Usual Gage g
In.	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
*18	58.0	4 1/4	5/8	11/16	3/8	3 1/2	15 3/8	1 5/16	2 3/4	3/4	5/8	1	2 1/2
	51.9	4 1/8	5/8	5/8	5/16	3 1/2	15 3/8	1 5/16	2 3/4	11/16	5/8	1	2 1/2
	45.8	4	5/8	1/2	1/4	3 1/2	15 3/8	1 5/16	2 3/4	9/16	5/8	1	2 1/2
	42.7	4	5/8	7/16	1/4	3 1/2	15 3/8	1 5/16	2 3/4	1/2	5/8	1	2 1/2
15	50.0	3 3/4	5/8	3/4	3/8	3	12 3/8	1 5/16	2 3/4	13/16	5/8	1	2 1/4
	40.0	3 1/2	5/8	9/16	1/4	3	12 3/8	1 5/16	2 3/4	5/8	5/8	1	2
	33.9	3 3/8	5/8	7/16	3/16	3	12 3/8	1 5/16	2 3/4	1/2	5/8	1	2
12	30.0	3 1/8	1/2	1/2	1/4	2 5/8	9 7/8	1 1/16	2 1/2	9/16	1/2	7/8	1 3/4
	25.0	3	1/2	3/8	3/16	2 5/8	9 7/8	1 1/16	2 1/2	7/16	1/2	7/8	1 3/4
	20.7	3	1/2	5/16	1/8	2 5/8	9 7/8	1 1/16	2 1/2	3/8	1/2	7/8	1 3/4
10	30.0	3	7/16	11/16	3/8	2 3/8	8 1/8	15/16	2 1/2	3/4	7/16	3/4	1 3/4
	25.0	2 7/8	7/16	9/16	1/4	2 3/8	8 1/8	15/16	2 1/2	5/8	7/16	3/4	1 3/4
	20.0	2 3/4	7/16	3/8	3/16	2 3/8	8 1/8	15/16	2 1/2	7/16	7/16	3/4	1 1/2
	15.3	2 5/8	7/16	1/4	1/8	2 3/8	8 1/8	15/16	2 1/2	5/16	7/16	3/4	1 1/2
9	20.0	2 5/8	7/16	7/16	1/4	2 1/4	7 1/4	7/8	2 1/2	1/2	7/16	3/4	1 1/2
	15.0	2 1/2	7/16	5/16	3/16	2 1/4	7 1/4	7/8	2 1/2	3/8	7/16	3/4	1 3/8
	13.4	2 3/8	7/16	1/4	1/8	2 1/4	7 1/4	7/8	2 1/2	5/16	3/8	3/4	1 3/8
8	18.75	2 1/2	3/8	1/2	1/4	2	6 3/8	13/16	2 1/4	9/16	3/8	3/4	1 1/2
	13.75	2 3/8	3/8	5/16	3/16	2	6 3/8	13/16	2 1/4	3/8	3/8	3/4	1 3/8
	11.5	2 1/4	3/8	1/4	1/8	2	6 3/8	13/16	2 1/4	5/16	3/8	3/4	1 3/8
7	14.75	2 1/4	3/8	7/16	1/4	1 7/8	5 3/8	13/16	2	1/2	3/8	5/8	1 1/4
	12.25	2 1/4	3/8	5/16	3/16	1 7/8	5 3/8	13/16	2	3/8	3/8	5/8	1 1/4
	9.8	2 1/8	3/8	1/4	1/8	1 7/8	5 3/8	13/16	2	5/16	3/8	5/8	1 1/4
6	13.0	2 1/8	3/8	7/16	1/4	1 3/4	4 1/2	3/4	2	1/2	5/16	5/8	1 3/8
	10.5	2	3/8	5/16	3/16	1 3/4	4 1/2	3/4	2	3/8	3/8	5/8	1 1/8
	8.2	1 7/8	3/8	3/16	1/8	1 3/4	4 1/2	3/4	2	1/4	5/16	5/8	1 1/8
5	9.0	1 7/8	5/16	5/16	3/16	1 1/2	3 5/8	11/16	2	3/8	5/16	1/2	1 1/8
	6.7	1 3/4	5/16	3/16	1/8	1 1/2	3 5/8	11/16	2	1/4	5/16	1/2	1 1/8
4	7.25	1 3/4	5/16	5/16	3/16	1 3/8	2 3/4	5/8	2	3/8	5/16	1/2	1
	5.4	1 5/8	5/16	3/16	1/8	1 3/8	2 3/4	5/8	2	1/4	1/4	1/2	1
3	6.0	1 5/8	1/4	3/8	3/16	1 1/4	1 3/4	5/8		7/16	5/16	1/2	7/8
	5.0	1 1/2	1/4	1/4	1/8	1 1/4	1 3/4	5/8		5/16	1/4	1/2	7/8
	4.1	1 3/8	1/4	3/16	1/8	1 1/4	1 3/4	5/8		1/4	1/4		

*Car and Shipbuilding Channel; not an American Standard.
Gage g_1 is based on $k + 1\frac{1}{4}''$, to nearest $\frac{1}{4}''$.
Gage g is permissible near ends of channel; elsewhere Specification may require reduction in rivet size.

ANGLES
EQUAL LEGS
PROPERTIES FOR DESIGNING



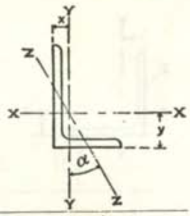
Size	Thickness	Weight per Foot	Area	AXIS X-X AND AXIS Y-Y I	S	r	x or y	AXIS Z-Z r
In.	In.	Lb.	In.²	In.⁴	In.³	In.	In.	In.
8 x 8	1⅛	56.9	16.73	98.0	17.5	2.42	2.41	1.56
	1	51.0	15.00	89.0	15.8	2.44	2.37	1.56
	⅞	45.0	13.23	79.6	14.0	2.45	2.32	1.57
	¾	38.9	11.44	69.7	12.2	2.47	2.28	1.57
	⅝	32.7	9.61	59.4	10.3	2.49	2.23	1.58
	9/16	29.6	8.68	54.1	9.3	2.50	2.21	1.58
	½	26.4	7.75	48.6	8.4	2.50	2.19	1.59
6 x 6	1	37.4	11.00	35.5	8.6	1.80	1.86	1.17
	⅞	33.1	9.73	31.9	7.6	1.81	1.82	1.17
	¾	28.7	8.44	28.2	6.7	1.83	1.78	1.17
	⅝	24.2	7.11	24.2	5.7	1.84	1.73	1.18
	9/16	21.9	6.43	22.1	5.1	1.85	1.71	1.18
	½	19.6	5.75	19.9	4.6	1.86	1.68	1.18
	7/16	17.2	5.06	17.7	4.1	1.87	1.66	1.19
	⅜	14.9	4.36	15.4	3.5	1.88	1.64	1.19
	5/16	12.5	3.66	13.0	3.0	1.89	1.61	1.19
5 x 5	⅞	27.2	7.98	17.8	5.2	1.49	1.57	.97
	¾	23.6	6.94	15.7	4.5	1.51	1.52	.97
	⅝	20.0	5.86	13.6	3.9	1.52	1.48	.98
	½	16.2	4.75	11.3	3.2	1.54	1.43	.98
	7/16	14.3	4.18	10.0	2.8	1.55	1.41	.98
	⅜	12.3	3.61	8.7	2.4	1.56	1.39	.99
	5/16	10.3	3.03	7.4	2.0	1.57	1.37	.99
4 x 4	¾	18.5	5.44	7.7	2.8	1.19	1.27	.78
	⅝	15.7	4.61	6.7	2.4	1.20	1.23	.78
	½	12.8	3.75	5.6	2.0	1.22	1.18	.78
	7/16	11.3	3.31	5.0	1.8	1.23	1.16	.78
	⅜	9.8	2.86	4.4	1.5	1.23	1.14	.79
	5/16	8.2	2.40	3.7	1.3	1.24	1.12	.79
	¼	6.6	1.94	3.0	1.1	1.25	1.09	.80



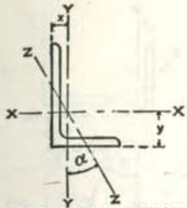
ANGLES
EQUAL LEGS
PROPERTIES FOR DESIGNING

Size	Thickness	Weight per Foot	Area	AXIS X-X AND AXIS Y-Y				AXIS Z-Z
				I	S	r	x or y	r
In.	In.	Lb.	In.²	In.⁴	In.³	In.	In.	In.
3½ x 3½	½	11.1	3.25	3.6	1.5	1.06	1.06	.68
	7/16	9.8	2.87	3.3	1.3	1.07	1.04	.68
	3/8	8.5	2.48	2.9	1.2	1.07	1.01	.69
	5/16	7.2	2.09	2.5	.98	1.08	.99	.69
	¼	5.8	1.69	2.0	.79	1.09	.97	.69
3 x 3	½	9.4	2.75	2.2	1.1	.90	.93	.58
	7/16	8.3	2.43	2.0	.95	.91	.91	.58
	3/8	7.2	2.11	1.8	.83	.91	.89	.58
	5/16	6.1	1.78	1.5	.71	.92	.87	.59
	¼	4.9	1.44	1.2	.58	.93	.84	.59
	3/16	3.71	1.09	.96	.44	.94	.82	.59
2½ x 2½	½	7.7	2.25	1.2	.72	.74	.81	.49
	3/8	5.9	1.73	.98	.57	.75	.76	.49
	5/16	5.0	1.47	.85	.48	.76	.74	.49
	¼	4.1	1.19	.70	.39	.77	.72	.49
	3/16	3.07	.90	.55	.30	.78	.69	.49
2 x 2	3/8	4.7	1.36	.48	.35	.59	.64	.39
	5/16	3.92	1.15	.42	.30	.60	.61	.39
	¼	3.19	.94	.35	.25	.61	.59	.39
	3/16	2.44	.71	.27	.19	.62	.57	.39
	⅛	1.65	.48	.19	.13	.63	.55	.40
1¾ x 1¾	¼	2.77	.81	.23	.19	.53	.53	.34
	3/16	2.12	.62	.18	.14	.54	.51	.34
	⅛	1.44	.42	.13	.10	.55	.48	.35
1½ x 1½	¼	2.34	.69	.14	.13	.45	.47	.29
	3/16	1.80	.53	.11	.10	.46	.44	.29
	⅛	1.23	.36	.08	.07	.47	.42	.30
1¼ x 1¼	¼	1.92	.56	.08	.09	.37	.40	.24
	3/16	1.48	.43	.06	.07	.38	.38	.24
	⅛	1.01	.30	.04	.05	.38	.36	.25
1 x 1	¼	1.49	.44	.04	.06	.29	.34	.20
	3/16	1.16	.34	.03	.04	.30	.32	.19
	⅛	.80	.23	.02	.03	.30	.30	.20

ANGLES
UNEQUAL LEGS
PROPERTIES FOR DESIGNING



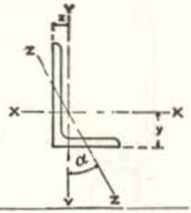
Size	Thickness	Weight per Foot	Area	AXIS X-X I	AXIS X-X S	AXIS X-X r	AXIS X-X y	AXIS Y-Y I	AXIS Y-Y S	AXIS Y-Y r	AXIS Y-Y x	AXIS Z-Z r	AXIS Z-Z Tan α
In.	In.	Lb.	In.²	In.⁴	In.³	In.	In.	In.⁴	In.³	In.	In.	In.	
9 x 4	1	40.8	12.00	97.0	17.6	2.84	3.50	12.0	4.0	1.00	1.00	.83	.203
	⅞	36.1	10.61	86.8	15.7	2.86	3.45	10.8	3.6	1.01	.95	.84	.208
	¾	31.3	9.19	76.1	13.6	2.88	3.41	9.6	3.1	1.02	.91	.84	.212
	⅝	26.3	7.73	64.9	11.5	2.90	3.36	8.3	2.6	1.04	.86	.85	.216
	9/16	23.8	7.00	59.1	10.4	2.91	3.33	7.6	2.4	1.04	.83	.85	.218
	½	21.3	6.25	53.2	9.3	2.92	3.31	6.9	2.2	1.05	.81	.85	.220
8 x 6	1	44.2	13.00	80.8	15.1	2.49	2.65	38.8	8.9	1.73	1.65	1.28	.543
	⅞	39.1	11.48	72.3	13.4	2.51	2.61	34.9	7.9	1.74	1.61	1.28	.547
	¾	33.8	9.94	63.4	11.7	2.53	2.56	30.7	6.9	1.76	1.56	1.29	.551
	⅝	28.5	8.36	54.1	9.9	2.54	2.52	26.3	5.9	1.77	1.52	1.29	.554
	9/16	25.7	7.56	49.3	9.0	2.55	2.50	24.0	5.3	1.78	1.50	1.30	.556
	½	23.0	6.75	44.3	8.0	2.56	2.47	21.7	4.8	1.79	1.47	1.30	.558
	7/16	20.2	5.93	39.2	7.1	2.57	2.45	19.3	4.2	1.80	1.45	1.31	.560
8 x 4	1	37.4	11.00	69.6	14.1	2.52	3.05	11.6	3.9	1.03	1.05	.85	.247
	⅞	33.1	9.73	62.5	12.5	2.53	3.00	10.5	3.5	1.04	1.00	.85	.253
	¾	28.7	8.44	54.9	10.9	2.55	2.95	9.4	3.1	1.05	.95	.85	.258
	⅝	24.2	7.11	46.9	9.2	2.57	2.91	8.1	2.6	1.07	.91	.86	.262
	9/16	21.9	6.43	42.8	8.4	2.58	2.88	7.4	2.4	1.07	.88	.86	.265
	½	19.6	5.75	38.5	7.5	2.59	2.86	6.7	2.2	1.08	.86	.86	.267
	7/16	17.2	5.06	34.1	6.6	2.60	2.83	6.0	1.9	1.09	.83	.87	.269
7 x 4	⅞	30.2	8.86	42.9	9.7	2.20	2.55	10.2	3.5	1.07	1.05	.86	.318
	¾	26.2	7.69	37.8	8.4	2.22	2.51	9.1	3.0	1.09	1.01	.86	.324
	⅝	22.1	6.48	32.4	7.1	2.24	2.46	7.8	2.6	1.10	.96	.86	.329
	9/16	20.0	5.87	29.6	6.5	2.24	2.44	7.2	2.4	1.11	.94	.87	.332
	½	17.9	5.25	26.7	5.8	2.25	2.42	6.5	2.1	1.11	.92	.87	.335
	7/16	15.8	4.62	23.7	5.1	2.26	2.39	5.8	1.9	1.12	.89	.88	.337
	⅜	13.6	3.98	20.6	4.4	2.27	2.37	5.1	1.6	1.13	.87	.88	.339



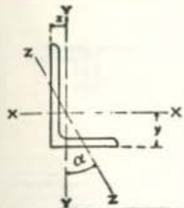
ANGLES
UNEQUAL LEGS
PROPERTIES FOR DESIGNING

Size	Thick-ness	Weight per Foot	Area	AXIS X-X				AXIS Y-Y				AXIS Z-Z	
				I	S	r	y	I	S	r	x	r	Tan α
In.	In.	Lb.	In.²	In.⁴	In.³	In.	In.	In.⁴	In.³	In.	In.	In.	
6 x 4	7/8	27.2	7.98	27.7	7.2	1.86	2.12	9.8	3.4	1.11	1.12	.86	.421
	3/4	23.6	6.94	24.5	6.3	1.88	2.08	8.7	3.0	1.12	1.08	.86	.428
	5/8	20.0	5.86	21.1	5.3	1.90	2.03	7.5	2.5	1.13	1.03	.86	.435
	9/16	18.1	5.31	19.3	4.8	1.90	2.01	6.9	2.3	1.14	1.01	.87	.438
	1/2	16.2	4.75	17.4	4.3	1.91	1.99	6.3	2.1	1.15	.99	.87	.440
	7/16	14.3	4.18	15.5	3.8	1.92	1.96	5.6	1.9	1.16	.96	.87	.443
	3/8	12.3	3.61	13.5	3.3	1.93	1.94	4.9	1.6	1.17	.94	.88	.446
	5/16	10.3	3.03	11.4	2.8	1.94	1.92	4.2	1.4	1.17	.92	.88	.449
6 x 3½	1/2	15.3	4.50	16.6	4.2	1.92	2.08	4.3	1.6	.97	.83	.76	.344
	3/8	11.7	3.42	12.9	3.2	1.94	2.04	3.3	1.2	.99	.79	.77	.350
	5/16	9.8	2.87	10.9	2.7	1.95	2.01	2.9	1.0	1.00	.76	.77	.352
	1/4	7.9	2.31	8.9	2.2	1.96	1.99	2.3	0.85	1.01	.74	.78	.355
5 x 3½	3/4	19.8	5.81	13.9	4.3	1.55	1.75	5.6	2.2	.98	1.00	.75	.464
	5/8	16.8	4.92	12.0	3.7	1.56	1.70	4.8	1.9	.99	.95	.75	.472
	1/2	13.6	4.00	10.0	3.0	1.58	1.66	4.1	1.6	1.01	.91	.75	.479
	7/16	12.0	3.53	8.9	2.6	1.59	1.63	3.6	1.4	1.01	.88	.76	.482
	3/8	10.4	3.05	7.8	2.3	1.60	1.61	3.2	1.2	1.02	.86	.76	.486
	5/16	8.7	2.56	6.6	1.9	1.61	1.59	2.7	1.0	1.03	.84	.76	.489
	1/4	7.0	2.06	5.4	1.6	1.61	1.56	2.2	.83	1.04	.81	.76	.492
5 x 3	1/2	12.8	3.75	9.5	2.9	1.59	1.75	2.6	1.1	.83	.75	.65	.357
	7/16	11.3	3.31	8.4	2.6	1.60	1.73	2.3	1.0	.84	.73	.65	.361
	3/8	9.8	2.86	7.4	2.2	1.61	1.70	2.0	.89	.84	.70	.65	.364
	5/16	8.2	2.40	6.3	1.9	1.61	1.68	1.8	.75	85	.68	.66	.368
	1/4	6.6	1.94	5.1	1.5	1.62	1.66	1.4	.61	.86	.66	.66	.371

ANGLES
UNEQUAL LEGS
PROPERTIES FOR DESIGNING

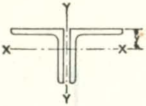


Size	Thickness	Weight per Foot	Area	AXIS X-X				AXIS Y-Y				AXIS Z-Z	
				I	S	r	y	I	S	r	x	r	Tan α
In.	In.	Lb.	$In.^2$	$In.^4$	$In.^3$	In.	In.	$In.^4$	$In.^3$	In.	In.	In.	—
4 x 3½	⅝	14.7	4.30	6.4	2.4	1.22	1.29	4.5	1.8	1.03	1.04	.72	.745
	½	11.9	3.50	5.3	1.9	1.23	1.25	3.8	1.5	1.04	1.00	.72	.750
	7/16	10.6	3.09	4.8	1.7	1.24	1.23	3.4	1.4	1.05	.98	.72	.753
	⅜	9.1	2.67	4.2	1.5	1.25	1.21	3.0	1.2	1.06	.96	.73	.755
	5/16	7.7	2.25	3.6	1.3	1.26	1.18	2.6	1.0	1.07	.93	.73	.757
	¼	6.2	1.81	2.9	1.0	1.27	1.16	2.1	.81	1.07	.91	.73	.759
4 x 3	⅝	13.6	3.98	6.0	2.3	1.23	1.37	2.9	1.4	.85	.87	.64	.534
	½	11.1	3.25	5.1	1.9	1.25	1.33	2.4	1.1	.86	.83	.64	.543
	7/16	9.8	2.87	4.5	1.7	1.25	1.30	2.2	1.0	.87	.80	.64	.547
	⅜	8.5	2.48	4.0	1.5	1.26	1.28	1.9	.87	.88	.78	.64	.551
	5/16	7.2	2.09	3.4	1.2	1.27	1.26	1.7	.73	.89	.76	.65	.554
	¼	5.8	1.69	2.8	1.0	1.28	1.24	1.4	.60	.90	.74	.65	.558
3½ x 3	½	10.2	3.00	3.5	1.5	1.07	1.13	2.3	1.1	.88	.88	.62	.714
	7/16	9.1	2.65	3.1	1.3	1.08	1.10	2.1	.98	.89	.85	.62	.718
	⅜	7.9	2.30	2.7	1.1	1.09	1.08	1.9	.85	.90	.83	.62	.721
	5/16	6.6	1.93	2.3	.95	1.10	1.06	1.6	.72	.90	.81	.63	.724
	¼	5.4	1.56	1.9	.78	1.11	1.04	1.3	.59	.91	.79	.63	.727
3½x2½	½	9.4	2.75	3.2	1.4	1.09	1.20	1.4	.76	.70	.70	.53	.486
	7/16	8.3	2.43	2.9	1.3	1.09	1.18	1.2	.68	.71	.68	.54	.491
	⅜	7.2	2.11	2.6	1.1	1.10	1.16	1.1	.59	.72	.66	.54	.496
	5/16	6.1	1.78	2.2	.93	1.11	1.14	.94	.50	.73	.64	.54	.501
	¼	4.9	1.44	1.8	.75	1.12	1.11	.78	.41	.74	.61	.54	.506



ANGLES
UNEQUAL LEGS
PROPERTIES FOR DESIGNING

Size	Thick-ness	Weight per Foot	Area	AXIS X-X				AXIS Y-Y				AXIS Z-Z	
				I	S	r	y	I	S	r	x	r	Tan α
In.	In.	Lb.	In.^{2}	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.	In.	In.	
3 x 2½	½	8.5	2.50	2.1	1.0	.91	1.00	1.3	.74	.72	.75	.52	.667
	7/16	7.6	2.21	1.9	.93	.92	.98	1.2	.66	.73	.73	.52	.672
	3/8	6.6	1.92	1.7	.81	.93	.96	1.0	.58	.74	.71	.52	.676
	5/16	5.6	1.62	1.4	.69	.94	.93	.90	.49	.74	.68	.53	.680
	¼	4.5	1.31	1.2	.56	.95	.91	.74	.40	.75	.66	.53	.684
3 x 2	½	7.7	2.25	1.9	1.0	.92	1.08	.67	.47	.55	.58	.43	.414
	7/16	6.8	2.00	1.7	.89	.93	1.06	.61	.42	.55	.56	.43	.421
	3/8	5.9	1.73	1.5	.78	.94	1.04	.54	.37	.56	.54	.43	.428
	5/16	5.0	1.47	1.3	.66	.95	1.02	.47	.32	.57	.52	.43	.435
	¼	4.1	1.19	1.1	.54	.95	.99	.39	.26	.57	.49	.43	.440
	3/16	3.07	.90	.84	.41	.97	.97	.31	.20	.58	.47	.44	.446
2½ x 2	3/8	5.3	1.55	.91	.55	.77	.83	.51	.36	.58	.58	.42	.614
	5/16	4.5	1.31	.79	.47	.78	.81	.45	.31	.58	.56	.42	.620
	¼	3.62	1.06	.65	.38	.78	.79	.37	.25	.59	.54	.42	.626
	3/16	2.75	.81	.51	.29	.79	.76	.29	.20	.60	.51	.43	.631
2½x1½	3/8	4.7	1.36	.82	.52	.78	.92	.22	.20	.40	.42	.32	.340
	5/16	3.92	1.15	.71	.44	.79	.90	.19	.17	.41	.40	.32	.349
	¼	3.19	.94	.59	.36	.79	.88	.16	.14	.41	.38	.32	.357
	3/16	2.44	.72	.46	.28	.80	.85	.13	.11	.42	.35	.33	.364
2 x 1½	¼	2.77	.81	.32	.24	.62	.66	.15	.14	.43	.41	.32	.543
	3/16	2.12	.62	.25	.18	.63	.64	.12	.11	.44	.39	.32	.551
	1/8	1.44	.42	.17	.13	.64	.62	.09	.08	.45	.37	.33	.558
1¾x1¼	¼	2.34	.69	.20	.18	.54	.60	.09	.10	.35	.35	.27	.486
	3/16	1.80	.53	.16	.14	.55	.58	.07	.08	.36	.33	.27	.496
	1/8	1.23	.36	.11	.09	.56	.56	.05	.05	.37	.31	.27	.506



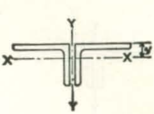
TWO EQUAL ANGLES

PROPERTIES OF SECTIONS

Size	Thickness	Weight per Ft. 2 Angles	Area of 2 Angles	AXIS X-X I	S	r	y	RADII OF GYRATION ABOUT AXIS Y-Y Back to Back of Angles, Inches 0	¼	⅜	½	⅝	¾
In.	In.	Lb.	In.²	In.⁴	In.³	In.	In.						
8 x 8	1⅛	113.8	33.46	195.9	35.1	2.42	2.41	3.42	3.50	3.55	3.60	3.64	3.69
	1	102.0	30.00	178.0	31.6	2.44	2.37	3.40	3.49	3.53	3.58	3.62	3.67
	⅞	90.0	26.46	159.2	28.0	2.45	2.32	3.38	3.46	3.51	3.55	3.60	3.64
	¾	77.8	22.88	139.5	24.4	2.47	2.28	3.36	3.45	3.49	3.54	3.58	3.63
	⅝	65.4	19.22	118.9	20.6	2.49	2.23	3.34	3.42	3.47	3.51	3.56	3.60
	9/16	59.2	17.36	108.2	18.7	2.50	2.21	3.33	3.41	3.46	3.50	3.55	3.59
	½	52.8	15.50	97.3	16.7	2.50	2.19	3.33	3.41	3.45	3.50	3.54	3.59
6 x 6	1	74.8	22.00	70.9	17.1	1.80	1.86	2.59	2.68	2.72	2.77	2.82	2.87
	⅞	66.2	19.46	63.8	15.3	1.81	1.82	2.57	2.66	2.70	2.75	2.80	2.85
	¾	57.4	16.88	56.3	13.3	1.83	1.78	2.55	2.64	2.68	2.73	2.78	2.82
	⅝	48.4	14.22	48.3	11.3	1.84	1.73	2.53	2.62	2.66	2.71	2.75	2.80
	9/16	43.8	12.86	44.1	10.3	1.85	1.71	2.52	2.60	2.65	2.69	2.74	2.78
	½	39.2	11.50	39.8	9.2	1.86	1.68	2.51	2.59	2.64	2.68	2.73	2.77
	7/16	34.4	10.12	35.4	8.1	1.87	1.66	2.50	2.58	2.63	2.67	2.72	2.76
	⅜	29.8	8.72	30.8	7.1	1.88	1.64	2.49	2.58	2.62	2.66	2.71	2.76
5 x 5	⅞	54.4	15.96	35.5	10.3	1.49	1.57	2.17	2.26	2.31	2.35	2.40	2.45
	¾	47.2	13.88	31.5	9.1	1.51	1.52	2.14	2.23	2.28	2.32	2.37	2.42
	⅝	40.0	11.72	27.2	7.7	1.52	1.48	2.12	2.21	2.26	2.30	2.35	2.40
	½	32.4	9.50	22.5	6.3	1.54	1.43	2.10	2.19	2.23	2.28	2.32	2.37
	7/16	28.6	8.36	20.0	5.6	1.55	1.41	2.09	2.18	2.22	2.27	2.31	2.36
	⅜	24.6	7.22	17.5	4.8	1.56	1.39	2.09	2.17	2.22	2.26	2.31	2.35
4 x 4	¾	37.0	10.88	15.3	5.6	1.19	1.27	1.74	1.83	1.88	1.93	1.98	2.03
	⅝	31.4	9.22	13.3	4.8	1.20	1.23	1.72	1.81	1.86	1.91	1.96	2.01
	½	25.6	7.50	11.12	3.9	1.22	1.18	1.70	1.78	1.83	1.88	1.93	1.98
	7/16	22.6	6.62	9.9	3.5	1.23	1.16	1.69	1.77	1.82	1.87	1.92	1.96
	⅜	19.6	5.72	8.7	3.0	1.23	1.14	1.68	1.77	1.81	1.86	1.91	1.95
	5/16	16.4	4.80	7.4	2.6	1.24	1.12	1.67	1.75	1.80	1.84	1.89	1.94
	¼	13.2	3.88	6.1	2.1	1.25	1.09	1.66	1.74	1.79	1.83	1.88	1.93
3½x3½	½	22.2	6.50	7.3	3.0	1.06	1.06	1.50	1.59	1.64	1.68	1.73	1.78
	7/16	19.6	5.74	6.5	2.6	1.07	1.04	1.49	1.57	1.62	1.67	1.71	1.76
	⅜	17.0	4.96	5.7	2.3	1.07	1.01	1.48	1.56	1.61	1.66	1.70	1.75
	5/16	14.4	4.18	4.9	2.0	1.08	.99	1.47	1.55	1.60	1.65	1.69	1.74
	¼	11.6	3.38	4.0	1.6	1.09	.97	1.46	1.55	1.59	1.64	1.68	1.73
3 x 3	½	18.8	5.50	4.4	2.1	.90	.93	1.29	1.39	1.43	1.48	1.53	1.58
	7/16	16.6	4.86	4.0	1.9	.91	.91	1.28	1.38	1.42	1.47	1.52	1.57
	⅜	14.4	4.22	3.5	1.7	.91	.89	1.28	1.37	1.41	1.46	1.51	1.56
	5/16	12.2	3.56	3.0	1.4	.92	.87	1.26	1.35	1.40	1.44	1.49	1.54
	¼	9.8	2.88	2.5	1.2	.93	.84	1.25	1.34	1.38	1.43	1.48	1.53
2½x2½	½	15.4	4.50	2.5	1.4	.74	.81	1.10	1.19	1.24	1.29	1.34	1.40
	⅜	11.8	3.46	2.0	1.1	.75	.76	1.07	1.16	1.21	1.26	1.31	1.36
	5/16	10.0	2.94	1.7	1.0	.76	.74	1.06	1.15	1.20	1.25	1.30	1.35
	¼	8.2	2.38	1.4	0.8	.77	.72	1.05	1.14	1.19	1.24	1.29	1.34
2 x 2	⅜	9.4	2.72	1.0	0.7	.59	.64	.87	.97	1.02	1.07	1.12	1.18
	5/16	7.84	2.30	0.8	0.6	.60	.61	.86	.95	1.00	1.05	1.10	1.16
	¼	6.38	1.88	0.7	0.5	.61	.59	.85	.94	.99	1.04	1.09	1.14

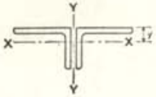
TWO UNEQUAL ANGLES

PROPERTIES OF SECTIONS



SHORT LEGS BACK TO BACK

Size	Thick-ness	Weight per Ft. 2 Angles	Area of 2 Angles	AXIS X-X				RADII OF GYRATION ABOUT AXIS Y-Y Back to Back of Angles, Inches					
				I	S	r	y	0	¼	⅜	½	⅝	¾
In.	In.	Lb.	In.²	In.⁴	In.³	In.	In.						
9 x 4	1	81.6	24.00	24.0	8.0	1.00	1.00	4.51	4.61	4.66	4.71	4.76	4.80
	⅞	72.2	21.22	21.6	7.2	1.01	.95	4.48	4.58	4.63	4.68	4.73	4.78
	¾	62.6	18.38	19.2	6.2	1.02	.91	4.46	4.56	4.61	4.65	4.70	4.75
	⅝	52.6	15.46	16.6	5.2	1.04	.86	4.43	4.53	4.58	4.63	4.68	4.73
	9/16	47.6	14.00	15.2	4.8	1.04	.83	4.42	4.51	4.56	4.61	4.66	4.71
	½	42.6	12.50	13.8	4.4	1.05	.81	4.41	4.51	4.55	4.60	4.65	4.70
8 x 6	1	88.4	26.00	77.6	17.8	1.73	1.65	3.64	3.73	3.78	3.82	3.87	3.92
	⅞	78.2	22.96	69.7	15.9	1.74	1.61	3.62	3.71	3.76	3.81	3.85	3.90
	¾	67.6	19.88	61.4	13.8	1.76	1.56	3.60	3.69	3.73	3.78	3.83	3.87
	⅝	57.0	16.72	52.7	11.8	1.77	1.52	3.58	3.67	3.72	3.76	3.81	3.85
	9/16	51.4	15.12	48.1	10.7	1.78	1.50	3.57	3.66	3.70	3.75	3.79	3.84
	½	46.0	13.50	43.4	9.6	1.79	1.47	3.56	3.65	3.69	3.74	3.78	3.83
	7/16	40.4	11.86	38.5	8.5	1.80	1.45	3.55	3.64	3.68	3.73	3.77	3.82
8 x 4	1	74.8	22.00	23.3	7.9	1.03	1.05	3.95	4.05	4.10	4.15	4.20	4.25
	⅞	66.2	19.46	21.1	7.0	1.04	1.00	3.93	4.02	4.07	4.12	4.17	4.22
	¾	57.4	16.88	18.7	6.1	1.05	.95	3.90	3.99	4.04	4.09	4.14	4.19
	⅝	48.4	14.22	16.2	5.2	1.07	.91	3.88	3.98	4.02	4.07	4.12	4.17
	9/16	43.8	12.86	14.8	4.8	1.07	.88	3.87	3.96	4.01	4.06	4.10	4.15
	½	39.2	11.50	13.5	4.3	1.08	.86	3.86	3.95	4.00	4.05	4.09	4.14
	7/16	34.4	10.12	12.0	3.8	1.09	.83	3.85	3.94	3.99	4.04	4.07	4.12
7 x 4	⅞	60.4	17.72	20.4	6.9	1.07	1.05	3.37	3.46	3.51	3.56	3.61	3.66
	¾	52.4	15.38	18.1	6.1	1.09	1.01	3.35	3.44	3.49	3.54	3.59	3.64
	⅝	44.2	12.96	15.7	5.2	1.10	.96	3.32	3.42	3.47	3.51	3.56	3.61
	9/16	40.0	11.74	14.4	4.8	1.11	.94	3.32	3.41	3.46	3.50	3.55	3.60
	½	35.8	10.50	13.0	4.2	1.11	.92	3.31	3.40	3.45	3.49	3.54	3.59
	7/16	31.6	9.24	11.6	3.8	1.12	.89	3.29	3.39	3.43	3.48	3.53	3.57
	⅜	27.2	7.96	10.2	3.3	1.13	.87	3.28	3.38	3.42	3.47	3.52	3.56
6 x 4	⅞	54.4	15.96	19.5	6.8	1.11	1.12	2.82	2.92	2.97	3.02	3.06	3.11
	¾	47.2	13.88	17.4	5.9	1.12	1.08	2.80	2.90	2.95	2.99	3.04	3.09
	⅝	40.0	11.72	15.0	5.1	1.13	1.03	2.78	2.87	2.92	2.97	3.01	3.06
	9/16	36.2	10.62	13.8	4.6	1.14	1.01	2.77	2.86	2.91	2.96	3.00	3.05
	½	32.4	9.50	12.5	4.2	1.15	.99	2.76	2.85	2.90	2.95	2.99	3.04
	7/16	28.6	8.36	11.2	3.7	1.16	.96	2.75	2.84	2.88	2.93	2.98	3.03
	⅜	24.6	7.22	9.8	3.2	1.17	.94	2.74	2.83	2.87	2.92	2.97	3.02
6 x 3½	½	30.6	9.00	8.5	3.2	.97	.83	2.83	2.92	2.97	3.02	3.07	3.12
	⅜	23.4	6.84	6.7	2.5	.99	.79	2.81	2.90	2.95	3.00	3.05	3.09
	5/16	19.6	5.74	5.7	2.1	1.00	.76	2.80	2.89	2.94	2.99	3.03	3.08
5 x 3½	¾	39.6	11.62	11.1	4.4	.98	1.00	2.34	2.43	2.48	2.53	2.58	2.63
	⅝	33.6	9.84	9.7	3.8	.99	.95	2.31	2.40	2.45	2.50	2.55	2.60
	½	27.2	8.00	8.1	3.1	1.01	.91	2.29	2.38	2.43	2.48	2.53	2.58
	7/16	24.0	7.06	7.3	2.8	1.01	.88	2.28	2.37	2.41	2.46	2.51	2.56
	⅜	20.8	6.10	6.4	2.4	1.02	.86	2.27	2.36	2.40	2.45	2.50	2.55
	5/16	17.4	5.12	5.4	2.0	1.03	.84	2.26	2.35	2.38	2.43	2.48	2.53
5 x 3	½	25.6	7.50	5.2	2.3	.83	.75	2.36	2.46	2.50	2.55	2.60	2.65
	⅜	19.6	5.72	4.1	1.8	.84	.70	2.34	2.43	2.48	2.53	2.58	2.63
	5/16	16.4	4.80	3.5	1.5	.85	.68	2.33	2.42	2.47	2.52	2.57	2.62



TWO UNEQUAL ANGLES

PROPERTIES OF SECTIONS

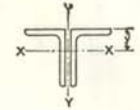
SHORT LEGS BACK TO BACK

Size	Thickness	Weight per Ft. 2 Angles	Area of 2 Angles	AXIS X-X				RADII OF GYRATION ABOUT AXIS Y-Y Back to Back of Angles, Inches					
				I	S	r	y	0	¼	⅜	½	⅝	¾
In.	In.	Lb.	In.²	In.⁴	In.³	In.	In.						
4 x 3½	⅝	29.4	8.60	9.0	3.7	1.03	1.04	1.77	1.87	1.91	1.96	2.01	2.06
	½	23.8	7.00	7.6	3.0	1.04	1.00	1.76	1.85	1.89	1.94	1.99	2.04
	7/16	21.2	6.18	6.8	2.7	1.05	.98	1.75	1.84	1.89	1.94	1.98	2.03
	⅜	18.2	5.34	6.0	2.3	1.06	.96	1.74	1.83	1.88	1.92	1.97	2.02
	5/16	15.4	4.50	5.1	2.0	1.07	.93	1.73	1.81	1.86	1.91	1.96	2.00
	¼	12.4	3.62	4.2	1.6	1.07	.91	1.72	1.80	1.85	1.90	1.94	1.99
4 x 3	⅝	27.2	7.96	5.7	2.7	.85	.87	1.84	1.94	1.99	2.03	2.08	2.14
	½	22.2	6.50	4.8	2.2	.86	.83	1.82	1.92	1.96	2.01	2.06	2.11
	7/16	19.6	5.74	4.4	2.0	.87	.80	1.81	1.90	1.95	1.99	2.04	2.09
	⅜	17.0	4.96	3.8	1.7	.88	.78	1.80	1.89	1.94	1.98	2.03	2.08
	5/16	14.4	4.18	3.3	1.5	.89	.76	1.79	1.88	1.93	1.97	2.02	2.07
	¼	11.6	3.38	2.7	1.2	.90	.74	1.78	1.87	1.92	1.96	2.01	2.06
3½ x 3	½	20.4	6.00	4.7	2.2	.88	.88	1.56	1.65	1.70	1.75	1.80	1.85
	7/16	18.2	5.30	4.2	2.0	.89	.85	1.54	1.63	1.68	1.73	1.78	1.83
	⅜	15.8	4.60	3.7	1.7	.90	.83	1.53	1.62	1.67	1.72	1.77	1.82
	5/16	13.2	3.86	3.2	1.4	.90	.81	1.52	1.61	1.66	1.71	1.76	1.81
	¼	10.8	3.12	2.6	1.2	.91	.79	1.52	1.61	1.65	1.70	1.75	1.80
3½x2½	½	18.8	5.50	2.7	1.5	.70	.70	1.62	1.71	1.76	1.81	1.86	1.91
	7/16	16.6	4.86	2.5	1.4	.71	.68	1.61	1.70	1.75	1.80	1.85	1.90
	⅜	14.4	4.22	2.2	1.2	.72	.66	1.61	1.69	1.74	1.79	1.84	1.89
	5/16	12.2	3.56	1.9	1.0	.73	.64	1.60	1.68	1.73	1.77	1.82	1.88
	¼	9.8	2.88	1.6	0.8	.74	.61	1.58	1.67	1.71	1.76	1.81	1.86
3 x 2½	½	17.0	5.00	2.6	1.5	.72	.75	1.35	1.45	1.50	1.55	1.60	1.65
	7/16	15.2	4.42	2.4	1.3	.73	.73	1.34	1.44	1.49	1.54	1.59	1.64
	⅜	13.2	3.84	2.1	1.2	.74	.71	1.34	1.43	1.48	1.53	1.58	1.63
	5/16	11.2	3.24	1.8	1.0	.74	.68	1.32	1.41	1.46	1.51	1.56	1.60
	¼	9.0	2.62	1.5	0.8	.75	.66	1.31	1.40	1.45	1.50	1.55	1.60
3 x 2	½	15.4	4.50	1.3	0.9	.55	.58	1.42	1.52	1.57	1.62	1.67	1.73
	7/16	13.6	4.00	1.2	0.8	.55	.56	1.41	1.51	1.56	1.61	1.65	1.71
	⅜	11.8	3.46	1.1	0.7	.56	.54	1.40	1.49	1.54	1.59	1.64	1.69
	5/16	10.0	2.94	0.9	0.6	.57	.52	1.39	1.48	1.53	1.58	1.63	1.68
	¼	8.2	2.38	0.8	0.5	.57	.49	1.38	1.47	1.52	1.57	1.62	1.67
	3/16	6.1	1.80	0.6	0.4	.58	.47	1.37	1.46	1.51	1.56	1.61	1.66
2½ x 2	⅜	10.6	3.10	1.0	0.7	.58	.58	1.13	1.22	1.27	1.32	1.38	1.43
	5/16	9.0	2.62	0.9	0.6	.58	.56	1.12	1.21	1.26	1.31	1.37	1.42
	¼	7.2	2.12	0.7	0.5	.59	.54	1.11	1.20	1.25	1.30	1.35	1.40
	3/16	5.5	1.62	0.6	0.4	.60	.51	1.10	1.19	1.24	1.29	1.34	1.38

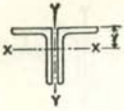
TWO UNEQUAL ANGLES

PROPERTIES OF SECTIONS

LONG LEGS BACK TO BACK



Size	Thickness	Weight per Ft. 2 Angles	Area of 2 Angles	Axis X-X I	Axis X-X S	Axis X-X r	Axis X-X y	Radii of Gyration about Axis Y-Y, Back to Back of Angles, Inches: 0	1/4	3/8	1/2	5/8	3/4
In.	In.	Lb.	In.²	In.⁴	In.³	In.	In.						
9 x 4	1	81.6	24.00	194.0	35.2	2.84	3.50	1.41	1.50	1.55	1.60	1.65	1.70
	7/8	72.2	21.22	173.6	31.4	2.86	3.45	1.39	1.47	1.52	1.57	1.62	1.67
	3/4	62.6	18.38	152.2	27.2	2.88	3.41	1.37	1.45	1.50	1.55	1.59	1.64
	5/8	52.6	15.46	129.8	23.0	2.90	3.36	1.35	1.43	1.47	1.52	1.56	1.61
	9/16	47.6	14.00	118.2	20.8	2.91	3.33	1.33	1.41	1.46	1.50	1.55	1.59
	1/2	42.6	12.50	106.4	18.6	2.92	3.31	1.33	1.41	1.45	1.49	1.54	1.58
8 x 6	1	88.4	26.00	161.6	30.2	2.49	2.65	2.39	2.48	2.52	2.57	2.61	2.66
	7/8	78.2	22.96	144.6	26.8	2.51	2.61	2.37	2.46	2.50	2.55	2.59	2.64
	3/4	67.6	19.88	126.8	23.3	2.53	2.56	2.35	2.44	2.48	2.52	2.57	2.61
	5/8	57.0	16.72	108.2	19.7	2.54	2.52	2.34	2.42	2.46	2.51	2.55	2.60
	9/16	51.4	15.12	98.5	17.9	2.55	2.50	2.33	2.41	2.46	2.50	2.54	2.59
	1/2	46.0	13.50	88.6	16.0	2.56	2.47	2.32	2.40	2.44	2.48	2.53	2.57
	7/16	40.4	11.86	78.4	14.1	2.57	2.45	2.31	2.39	2.43	2.47	2.52	2.56
8 x 4	1	74.8	22.00	139.3	28.1	2.52	3.05	1.47	1.56	1.61	1.66	1.71	1.76
	7/8	66.2	19.46	124.9	25.0	2.53	3.00	1.44	1.53	1.58	1.63	1.68	1.72
	3/4	57.4	16.88	109.8	21.8	2.55	2.95	1.42	1.50	1.55	1.60	1.64	1.69
	5/8	48.4	14.22	93.8	18.4	2.57	2.91	1.40	1.49	1.53	1.58	1.62	1.67
	9/16	43.8	12.86	85.6	16.8	2.58	2.88	1.39	1.47	1.51	1.56	1.60	1.65
	1/2	39.2	11.50	77.0	15.0	2.59	2.86	1.38	1.46	1.51	1.55	1.60	1.64
	7/16	34.4	10.12	68.2	13.2	2.60	2.83	1.37	1.45	1.49	1.53	1.58	1.62
7 x 4	7/8	60.4	17.72	85.8	19.3	2.20	2.55	1.50	1.59	1.64	1.68	1.73	1.78
	3/4	52.4	15.38	75.6	16.8	2.22	2.51	1.48	1.57	1.62	1.66	1.71	1.76
	5/8	44.2	12.96	64.8	14.3	2.24	2.46	1.46	1.55	1.59	1.64	1.68	1.73
	9/16	40.0	11.74	59.2	13.0	2.24	2.44	1.45	1.54	1.58	1.62	1.67	1.72
	1/2	35.8	10.50	53.3	11.6	2.25	2.42	1.45	1.53	1.57	1.62	1.66	1.71
	7/16	31.6	9.24	47.4	10.2	2.26	2.39	1.43	1.51	1.55	1.60	1.65	1.69
	3/8	27.2	7.96	41.1	8.9	2.27	2.37	1.43	1.51	1.55	1.59	1.64	1.68
6 x 4	7/8	54.4	15.96	55.5	14.3	1.86	2.12	1.57	1.66	1.71	1.76	1.81	1.86
	3/4	47.2	13.88	49.0	12.5	1.88	2.08	1.55	1.64	1.69	1.74	1.79	1.84
	5/8	40.0	11.72	42.1	10.6	1.90	2.03	1.53	1.62	1.66	1.71	1.76	1.80
	9/16	36.2	10.62	38.5	9.7	1.90	2.01	1.52	1.61	1.66	1.70	1.75	1.79
	1/2	32.4	9.50	34.8	8.7	1.91	1.99	1.52	1.60	1.65	1.69	1.74	1.78
	7/16	28.6	8.36	31.0	7.7	1.92	1.96	1.50	1.59	1.63	1.68	1.72	1.77
	3/8	24.6	7.22	26.9	6.6	1.93	1.94	1.50	1.58	1.62	1.67	1.71	1.76
6 x 3½	1/2	30.6	9.00	33.2	8.5	1.92	2.08	1.27	1.36	1.40	1.45	1.49	1.55
	3/8	23.4	6.84	25.7	6.5	1.94	2.04	1.26	1.34	1.39	1.43	1.48	1.53
	5/16	19.6	5.74	21.8	5.5	1.95	2.01	1.26	1.33	1.38	1.42	1.46	1.51
5 x 3½	3/4	39.6	11.62	27.8	8.6	1.55	1.75	1.40	1.49	1.54	1.59	1.64	1.69
	5/8	33.6	9.84	24.1	7.3	1.56	1.70	1.37	1.46	1.51	1.56	1.60	1.65
	1/2	27.2	8.00	20.0	6.0	1.58	1.66	1.36	1.44	1.49	1.54	1.58	1.63
	7/16	24.0	7.06	17.8	5.3	1.59	1.63	1.35	1.43	1.47	1.52	1.57	1.62
	3/8	20.8	6.10	15.6	4.6	1.60	1.61	1.34	1.42	1.46	1.51	1.55	1.60
	5/16	17.4	5.12	13.2	3.9	1.61	1.59	1.33	1.41	1.45	1.50	1.54	1.59
5 x 3	1/2	25.6	7.50	18.9	5.8	1.59	1.75	1.11	1.21	1.25	1.30	1.35	1.40
	3/8	19.6	.5.72	14.7	4.5	1.61	1.70	1.09	1.18	1.23	1.27	1.32	1.37
	5/16	16.4	4.80	12.5	3.8	1.61	1.68	1.09	1.17	1.22	1.26	1.31	1.36

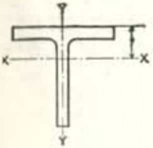


TWO UNEQUAL ANGLES

PROPERTIES OF SECTIONS

LONG LEGS BACK TO BACK

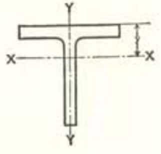
Size	Thick-ness	Weight per Ft. 2 Angles	Area of 2 Angles	AXIS X-X				RADII OF GYRATION ABOUT AXIS Y-Y Back to Back of Angles, Inches					
				I	S	r	y	0	1/4	3/8	1/2	5/8	3/4
In.	In.	Lb.	In.²	In.⁴	In.³	In.	In.						
4 x 3½	5/8	29.4	8.60	12.7	4.7	1.22	1.29	1.46	1.55	1.60	1.65	1.70	1.75
	1/2	23.8	7.00	10.6	3.9	1.23	1.25	1.44	1.53	1.58	1.63	1.67	1.72
	7/16	21.2	6.18	9.5	3.4	1.24	1.23	1.44	1.52	1.57	1.62	1.66	1.71
	3/8	18.2	5.34	8.4	3.0	1.25	1.21	1.43	1.52	1.56	1.61	1.66	1.70
	5/16	15.4	4.50	7.1	2.5	1.26	1.18	1.42	1.50	1.55	1.59	1.64	1.69
	1/4	12.4	3.62	5.8	2.1	1.27	1.16	1.41	1.49	1.54	1.58	1.63	1.67
4 x 3	5/8	27.2	7.96	12.1	4.6	1.23	1.37	1.22	1.31	1.36	1.41	1.46	1.51
	1/2	22.2	6.50	10.1	3.8	1.25	1.33	1.20	1.29	1.33	1.38	1.43	1.48
	7/16	19.6	5.74	9.0	3.4	1.25	1.30	1.18	1.27	1.32	1.36	1.41	1.46
	3/8	17.0	4.96	7.9	2.9	1.26	1.28	1.18	1.26	1.31	1.35	1.40	1.45
	5/16	14.4	4.18	6.8	2.5	1.27	1.26	1.17	1.25	1.30	1.35	1.39	1.44
	1/4	11.6	3.38	5.5	2.0	1.28	1.24	1.16	1.25	1.29	1.34	1.38	1.43
3½ x 3	1/2	20.4	6.00	6.9	2.9	1.07	1.13	1.25	1.34	1.38	1.43	1.48	1.53
	7/16	18.2	5.30	6.2	2.6	1.08	1.10	1.23	1.32	1.37	1.41	1.46	1.51
	3/8	15.8	4.60	5.4	2.3	1.09	1.08	1.22	1.31	1.36	1.40	1.45	1.50
	5/16	13.2	3.86	4.7	1.9	1.10	1.06	1.22	1.30	1.35	1.39	1.44	1.49
	1/4	10.8	3.12	3.8	1.6	1.11	1.04	1.21	1.29	1.34	1.38	1.43	1.48
3½x2½	1/2	18.8	5.50	6.5	2.8	1.09	1.20	.99	1.08	1.13	1.18	1.23	1.29
	7/16	16.6	4.86	5.8	2.5	1.09	1.18	.98	1.07	1.12	1.17	1.22	1.27
	3/8	14.4	4.22	5.1	2.2	1.10	1.16	.97	1.07	1.11	1.16	1.21	1.26
	5/16	12.2	3.56	4.4	1.9	1.11	1.14	.96	1.05	1.10	1.15	1.20	1.24
	1/4	9.8	2.88	3.6	1.5	1.12	1.11	.95	1.04	1.09	1.13	1.18	1.23
3 x 2½	1/2	17.0	5.00	4.2	2.1	.91	1.00	1.04	1.14	1.18	1.23	1.28	1.34
	7/16	15.2	4.42	3.8	1.9	.92	.98	1.03	1.12	1.17	1.22	1.27	1.33
	3/8	13.2	3.84	3.3	1.6	.93	.96	1.02	1.11	1.16	1.21	1.26	1.31
	5/16	11.2	3.24	2.8	1.4	.94	.93	1.01	1.10	1.14	1.19	1.24	1.29
	1/4	9.0	2.62	2.3	1.1	.95	.91	1.00	1.09	1.13	1.18	1.23	1.28
3 x 2	1/2	15.4	4.50	3.8	2.0	.92	1.08	.80	.89	.94	1.00	1.04	1.10
	7/16	13.6	4.00	3.5	1.8	.93	1.06	.79	.88	.93	.98	1.03	1.09
	3/8	11.8	3.46	3.1	1.6	.94	1.04	.78	.87	.92	.97	1.02	1.07
	5/16	10.0	2.94	2.6	1.3	.95	1.02	.77	.86	.90	.95	1.00	1.06
	1/4	8.2	2.38	2.2	1.1	.96	.99	.75	.84	.89	.93	.99	1.04
	3/16	6.14	1.80	1.7	0.8	.97	.97	.75	.83	.88	.93	.98	1.03
2½ x 2	3/8	10.6	3.10	1.8	1.1	.77	.83	.82	.91	.96	1.01	1.06	1.11
	5/16	9.0	2.62	1.6	0.9	.78	.81	.81	.91	.95	1.00	1.05	1.10
	1/4	7.2	2.12	1.3	0.8	.78	.79	.80	.89	.94	.99	1.04	1.09
	3/16	5.5	1.62	1.0	0.6	.79	.76	.79	.88	.92	.96	1.02	1.07



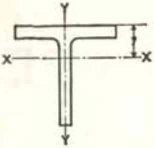
STRUCTURAL TEES
CUT FROM WF BEAMS
DIMENSIONS AND PROPERTIES FOR DESIGNING

Section Number	Weight per Foot	Area	Depth of Tee	Flange		Stem Thickness	Axis X-X				Axis Y-Y		
				Width	Average Thickness		I	S	r	y	I	S	r
	Lb.	In.²	In.	In.	In.	In.	In.⁴	In.³	In.	In.	In.⁴	In.³	In.
ST 18 WF	150	44.09	18.36	16.655	1.680	.945	1222.7	85.9	5.27	4.13	612.6	73.6	3.73
	140	41.16	18.25	16.595	1.570	.885	1133.3	79.9	5.25	4.07	563.7	67.9	3.70
	130	38.28	18.12	16.555	1.440	.845	1059.2	75.4	5.26	4.07	510.3	61.6	3.65
	122.5	36.01	18.03	16.512	1.350	.802	994.3	71.1	5.25	4.04	472.3	57.2	3.62
	115	33.86	17.94	16.475	1.260	.765	935.8	67.2	5.26	4.02	435.5	52.9	3.59
ST 18 WF	97	28.56	18.24	12.117	1.260	.770	904.0	67.3	5.63	4.81	177.7	29.3	2.49
	91	26.77	18.16	12.072	1.180	.725	844.0	63.0	5.61	4.77	163.9	27.1	2.47
	85	24.99	18.08	12.027	1.100	.680	784.7	58.8	5.60	4.74	150.3	25.0	2.45
	80	23.54	18.00	12.000	1.020	.653	741.0	56.0	5.61	4.76	137.7	22.9	2.42
	75	22.08	17.92	11.972	.940	.625	696.7	53.0	5.62	4.79	125.2	20.9	2.38
ST 16 WF	120	35.26	16.75	15.865	1.400	.830	822.5	63.2	4.83	3.73	437.2	55.1	3.52
	110	32.36	16.63	15.810	1.275	.775	754.1	58.4	4.83	3.71	391.2	49.5	3.48
	100	29.40	16.50	15.750	1.150	.715	683.6	53.3	4.82	3.67	345.8	43.9	3.43
ST 16 WF	76	22.35	16.75	11.565	1.055	.635	591.9	47.4	5.15	4.26	128.1	22.1	2.39
	70.5	20.76	16.66	11.535	.960	.603	551.8	44.7	5.16	4.30	114.9	19.9	2.35
	65	19.13	16.55	11.510	.855	.580	513.0	42.1	5.18	4.37	100.7	17.5	2.29
ST 15 WF	105	30.89	15.19	15.105	1.315	.775	578.0	48.7	4.33	3.31	354.0	46.9	3.38
	95	27.95	15.06	15.040	1.185	.710	520.4	44.1	4.31	3.26	312.3	41.5	3.34
	86	25.32	14.94	14.985	1.065	.655	471.0	40.2	4.31	3.23	275.1	36.7	3.30
ST 15 WF	66	19.41	15.15	10.551	1.000	.615	420.7	37.4	4.66	3.90	92.5	17.5	2.18
	62	18.22	15.08	10.521	.930	.585	394.8	35.3	4.65	3.90	84.8	16.1	2.16
	58.0	17.07	15.00	10.500	.850	.564	371.8	33.6	4.67	3.94	76.6	14.6	2.12
	54.0	15.88	14.91	10.484	.760	.548	349.5	32.1	4.69	4.03	67.6	12.9	2.06
ST 13 WF	88.5	26.05	13.66	14.090	1.190	.725	391.8	36.7	3.88	2.97	259.4	36.8	3.16
	80	23.72	13.54	14.023	1.075	.658	351.4	33.1	3.87	2.91	229.0	32.7	3.12
	72.5	21.34	13.44	13.965	.975	.600	316.3	29.9	3.85	2.85	203.5	29.1	3.09
ST 13 WF	57	16.77	13.64	10.070	.932	.570	288.9	28.3	4.15	3.42	74.8	14.9	2.11
	51	15.01	13.53	10.018	.827	.518	257.7	25.4	4.14	3.39	64.8	12.9	2.08
	47	13.83	13.45	9.990	.747	.490	238.5	23.7	4.15	3.41	57.5	11.5	2.04

STRUCTURAL TEES
CUT FROM WF BEAMS
DIMENSIONS AND PROPERTIES FOR DESIGNING



Section Number	Weight per Foot	Area	Depth of Tee	Flange		Stem Thickness	AXIS X-X				AXIS Y-Y		
				Width	Average Thickness		I	S	r	y	I	S	r
	Lb.	In.²	In.	In.	In.	In.	In.⁴	In.³	In.	In.	In.⁴	In.³	In.
ST 12 WF	80	23.54	12.36	14.091	1.135	.656	271.6	27.6	3.40	2.51	246.3	35.0	3.23
	72.5	21.31	12.24	14.043	1.020	.608	246.2	25.2	3.40	2.48	217.1	30.9	3.19
	65	19.11	12.13	14.000	.900	.565	222.6	23.1	3.41	2.47	187.6	26.8	3.13
ST 12 WF	60	17.64	12.16	12.088	.930	.556	213.6	22.4	3.48	2.62	127.0	21.0	2.68
	55	16.18	12.08	12.042	.855	.510	195.2	20.5	3.47	2.57	114.5	19.0	2.66
	50	14.71	12.00	12.000	.775	.468	176.7	18.7	3.46	2.54	101.8	17.0	2.63
ST 12 WF	47	13.81	12.15	9.061	.872	.516	185.9	20.3	3.67	2.99	51.1	11.3	1.92
	42	12.35	12.04	9.015	.772	.470	165.9	18.3	3.66	2.97	44.2	9.8	1.89
	38	11.18	11.95	8.985	.682	.440	151.1	16.9	3.68	3.00	38.3	8.5	1.85
ST 10 WF	71	20.88	10.73	13.132	1.095	.659	177.3	20.8	2.91	2.18	193.0	29.4	3.04
	63.5	18.67	10.62	13.061	.985	.588	155.8	18.3	2.89	2.11	169.3	25.9	3.01
	56	16.47	10.50	13.000	.865	.527	136.4	16.2	2.88	2.06	144.8	22.3	2.96
ST 10 WF	48	14.11	10.57	9.038	.935	.575	137.1	17.1	3.11	2.55	54.7	12.1	1.97
	41	12.05	10.43	8.962	.795	.499	115.4	14.5	3.09	2.48	44.8	10.0	1.93
ST 10 WF	36.5	10.73	10.62	8.295	.740	.455	110.2	13.7	3.21	2.60	33.1	7.98	1.76
	34	10.01	10.57	8.270	.685	.430	102.8	12.9	3.20	2.59	30.2	7.30	1.74
	31	9.12	10.49	8.240	.615	.400	93.7	11.9	3.21	2.59	26.6	6.45	1.71
ST 9 WF	57	16.77	9.24	11.833	.991	.595	102.6	13.9	2.47	1.85	127.8	21.6	2.76
	52.5	15.43	9.16	11.792	.911	.554	93.9	12.8	2.47	1.82	115.5	19.6	2.73
	48	14.11	9.08	11.750	.831	.512	85.3	11.7	2.46	1.78	103.4	17.6	2.71
ST 9 WF	42.5	12.49	9.16	8.838	.911	.526	84.4	11.9	2.60	2.05	49.7	11.3	2.00
	38.5	11.32	9.08	8.787	.831	.475	75.3	10.6	2.58	1.99	44.3	10.1	1.98
	35	10.28	9.00	8.750	.751	.438	68.1	9.67	2.57	1.96	39.2	8.97	1.95
	32	9.40	8.94	8.715	.686	.403	61.8	8.82	2.56	1.93	35.2	8.07	1.93
ST 9 WF	30	8.82	9.12	7.558	.695	.416	64.8	9.32	2.71	2.17	23.5	6.23	1.63
	27.5	8.09	9.06	7.532	.630	.390	59.6	8.63	2.71	2.16	21.0	5.57	1.61
	25	7.35	9.00	7.500	.570	.358	53.9	7.85	2.71	2.14	18.6	4.96	1.59
ST 8 WF	48	14.11	8.16	11.533	.875	.535	64.7	9.82	2.14	1.57	103.6	18.0	2.71
	44	12.94	8.08	11.502	.795	.504	59.5	9.11	2.14	1.55	92.6	16.1	2.67



STRUCTURAL TEES

CUT FROM WF BEAMS

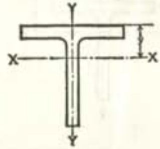
DIMENSIONS AND PROPERTIES FOR DESIGNING

Section Number	Weight per Foot	Area	Depth of Tee	Flange		Stem Thickness	AXIS X-X				AXIS Y-Y		
				Width	Average Thickness		I	S	r	y	I	S	r
	Lb.	In.²	In.	In.	In.	In.	In.⁴	In.³	In.	In.	In.⁴	In.³	In.
ST 8 WF	39	11.46	8.16	8.586	.875	.529	60.0	9.45	2.28	1.81	43.8	10.2	1.95
	35.5	10.43	8.08	8.543	.795	.486	54.0	8.57	2.28	1.77	38.9	9.11	1.93
	32	9.40	8.00	8.500	.715	.443	48.3	7.71	2.27	1.73	34.2	8.05	1.91
	29	8.52	7.93	8.464	.645	.407	43.6	7.00	2.26	1.70	30.2	7.14	1.88
ST 8 WF	25	7.35	8.13	7.073	.628	.380	42.2	6.77	2.40	1.89	17.4	4.92	1.54
	22.5	6.62	8.06	7.039	.563	.346	37.8	6.10	2.39	1.87	15.2	4.33	1.52
	20	5.88	8.00	7.000	.503	.307	33.2	5.37	2.37	1.82	13.3	3.79	1.50
	18	5.30	7.93	6.992	.428	.299	30.7	5.10	2.41	1.90	11.1	3.17	1.45
ST 7 WF	105.5	31.04	7.88	15.800	1.563	.980	102.2	16.2	1.81	1.57	514.3	65.1	4.07
	101	29.70	7.82	15.750	1.503	.930	95.7	15.2	1.80	1.53	489.8	62.2	4.06
	96.5	28.36	7.75	15.710	1.438	.890	90.1	14.4	1.78	1.49	465.1	59.2	4.05
	92	27.04	7.69	15.660	1.378	.840	83.9	13.4	1.76	1.45	441.4	56.4	4.04
	88	25.87	7.63	15.640	1.313	.820	80.2	12.9	1.76	1.42	418.9	53.6	4.02
	83.5	24.55	7.56	15.600	1.248	.780	75.0	12.1	1.75	1.39	395.1	50.7	4.01
	79	23.24	7.50	15.550	1.188	.730	69.3	11.3	1.73	1.34	372.5	47.9	4.00
	75	22.04	7.44	15.515	1.128	.695	64.9	10.6	1.72	1.31	351.3	45.3	3.99
	71	20.92	7.38	15.500	1.063	.680	62.1	10.2	1.72	1.29	330.1	42.6	3.97
ST 7 WF	68	19.99	7.38	14.740	1.063	.660	60.0	9.89	1.73	1.31	283.9	38.5	3.77
	63.5	18.67	7.31	14.690	.998	.610	54.7	9.04	1.71	1.26	263.8	35.9	3.76
	59.5	17.49	7.25	14.650	.938	.570	50.4	8.36	1.70	1.22	245.9	33.6	3.75
	55.5	16.33	7.19	14.620	.873	.540	46.7	7.80	1.69	1.19	227.4	31.1	3.73
	51.5	15.13	7.13	14.575	.813	.495	42.4	7.10	1.67	1.15	209.9	28.8	3.72
	47.5	13.97	7.06	14.545	.748	.465	39.1	6.58	1.67	1.12	191.9	26.4	3.71
	43.5	12.78	7.00	14.5	.688	.420	34.9	5.88	1.65	1.08	174.8	24.1	3.70
ST 7 WF	42	12.36	7.09	12.023	.778	.451	37.4	6.36	1.74	1.21	112.7	18.8	3.02
	39	11.47	7.03	12.000	.718	.428	34.8	5.96	1.74	1.19	103.5	17.2	3.00
ST 7 WF	37	10.88	7.10	10.072	.783	.450	36.1	6.26	1.82	1.32	66.7	13.3	2.48
	34	10.00	7.03	10.040	.718	.418	33.0	5.74	1.81	1.29	60.6	12.1	2.46
	30.5	8.97	6.96	10.000	.643	.378	29.2	5.13	1.80	1.25	53.6	10.7	2.45
ST 7 WF	26.5	7.79	6.97	8.062	.658	.370	27.7	4.95	1.88	1.38	28.8	7.14	1.92
	24	7.06	6.91	8.031	.593	.339	24.9	4.49	1.88	1.35	25.6	6.38	1.91
	21.5	6.32	6.84	8.000	.528	.308	22.2	4.02	1.87	1.33	22.6	5.64	1.89

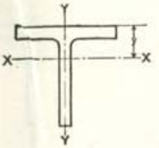
STRUCTURAL TEES

CUT FROM WF BEAMS

DIMENSIONS AND PROPERTIES FOR DESIGNING



Section Number	Weight per Foot	Area	Depth of Tee	Flange		Stem Thickness	AXIS X-X				AXIS Y-Y		
				Width	Average Thickness		I	S	r	y	I	S	r
	Lb.	In.²	In.	In.	In.	In.	In.⁴	In.³	In.	In.	In.⁴	In.³	In.
ST 7 WF	19	5.59	7.06	6.776	.513	.313	23.5	4.27	2.05	1.56	12.3	3.64	1.49
	17	5.00	7.00	6.750	.453	.287	21.1	3.86	2.05	1.55	10.6	3.15	1.46
	15	4.41	6.93	6.733	.383	.270	19.0	3.55	2.08	1.59	8.77	2.61	1.41
ST 6 WF	80.5	23.69	6.94	12.515	1.486	.905	62.6	11.5	1.63	1.47	243.1	38.9	3.20
	66.5	19.56	6.69	12.365	1.236	.755	48.4	9.03	1.57	1.33	195.0	31.5	3.16
	60	17.65	6.56	12.320	1.106	.710	43.4	8.22	1.57	1.28	172.5	28.0	3.13
	53	15.59	6.44	12.230	.986	.620	36.7	7.01	1.53	1.20	150.4	24.6	3.11
	49.5	14.54	6.38	12.190	.921	.580	33.7	6.46	1.52	1.16	139.1	22.8	3.09
	46	13.53	6.31	12.155	.856	.545	31.0	5.98	1.51	1.13	128.2	21.1	3.08
	42.5	12.49	6.25	12.105	.796	.495	27.8	5.38	1.49	1.08	117.7	19.5	3.07
	39.5	11.61	6.19	12.080	.736	.470	25.8	5.02	1.48	1.06	108.2	17.9	3.05
	36	10.58	6.13	12.040	.671	.430	23.1	4.53	1.48	1.02	97.6	16.2	3.04
	32.5	9.55	6.06	12.000	.606	.390	20.6	4.06	1.47	.98	87.3	14.6	3.02
ST 6 WF	29	8.53	6.10	10.014	.641	.359	19.0	3.75	1.49	1.03	53.7	10.7	2.51
	26.5	7.80	6.03	10.000	.576	.345	17.7	3.54	1.51	1.02	48.0	9.60	2.48
ST 6 WF	25	7.36	6.10	8.077	.641	.371	18.7	3.80	1.60	1.17	28.2	6.98	1.96
	22.5	6.62	6.03	8.042	.576	.336	16.6	3.40	1.59	1.13	25.0	6.20	1.94
	20	5.89	5.97	8.000	.516	.294	14.4	2.94	1.56	1.08	22.0	5.50	1.94
ST 6 WF	18	5.29	6.12	6.565	.540	.305	15.3	3.14	1.70	1.26	11.9	3.62	1.50
	15.5	4.56	6.04	6.525	.465	.265	13.0	2.69	1.69	1.22	9.9	3.04	1.47
	13.5	3.98	5.98	6.500	.400	.240	11.4	2.39	1.69	1.21	8.3	2.55	1.44
ST 6 WF	7	2.07	5.96	3.970	.224	.200	7.66	1.83	1.92	1.76	1.13	.57	.74



STRUCTURAL TEES

CUT FROM WF BEAMS

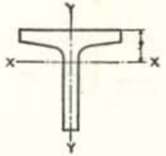
DIMENSIONS AND

PROPERTIES FOR DESIGNING

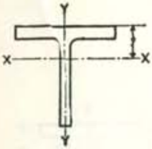
Section Number	Weight per Foot	Area	Depth of Tee	Flange Width	Flange Average Thickness	Stem Thickness	Axis X-X I	Axis X-X S	Axis X-X r	Axis X-X y	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r
	Lb.	$In.^2$	In.	In.	In.	In.	$In.^4$	$In.^3$	In.	In.	$In.^4$	$In.^3$	In.
ST 5 WF	56	16.46	5.69	10.415	1.248	.755	28.8	6.42	1.32	1.21	117.7	22.6	2.67
	50	14.72	5.56	10.345	1.118	.685	24.8	5.62	1.30	1.14	103.3	20.0	2.65
	44.5	13.09	5.44	10.275	.998	.615	21.3	4.88	1.28	1.07	90.3	17.6	2.63
	38.5	11.33	5.31	10.195	.868	.535	17.7	4.10	1.25	1.00	76.7	15.1	2.60
	36	10.59	5.25	10.170	.808	.510	16.4	3.83	1.24	.97	70.9	13.9	2.59
	33	9.70	5.19	10.117	.748	.457	14.5	3.39	1.22	.92	64.6	12.8	2.58
	30	8.83	5.13	10.075	.683	.415	12.8	3.02	1.21	.88	58.2	11.6	2.57
	27	7.94	5.06	10.028	.618	.368	11.2	2.64	1.18	.84	51.95	10.4	2.56
	24.5	7.20	5.00	10.000	.558	.340	10.1	2.40	1.18	.81	46.5	9.30	2.54
ST 5 WF	22.5	6.62	5.06	8.022	.618	.350	10.3	2.48	1.25	.91	26.6	6.63	2.00
	19.5	5.74	4.97	7.990	.528	.318	8.96	2.19	1.25	.88	22.5	5.62	1.98
	16.5	4.85	4.88	7.964	.433	.292	7.80	1.95	1.27	.88	18.2	4.58	1.94
ST 5 WF	14.5	4.27	5.11	5.799	.500	.289	8.38	2.07	1.40	1.05	7.61	2.62	1.34
	12.5	3.67	5.04	5.762	.430	.252	7.12	1.77	1.39	1.02	6.34	2.20	1.31
	10.5	3.10	4.95	5.750	.340	.240	6.31	1.62	1.43	1.06	4.87	1.69	1.25
ST 4 WF	33.5	9.85	4.50	8.287	.933	.575	10.94	3.07	1.05	.94	44.3	10.7	2.12
	29	8.53	4.38	8.222	.808	.510	9.11	2.60	1.03	.87	37.5	9.10	2.10
	24	7.06	4.25	8.117	.683	.405	6.92	2.00	.99	.78	30.45	7.50	2.08
	20	5.88	4.13	8.077	.558	.365	5.80	1.71	.99	.74	24.5	6.05	2.04
	17.5	5.15	4.06	8.027	.493	.315	4.88	1.45	.97	.69	21.25	5.30	2.03
	15.5	4.56	4.00	8.000	.433	.288	4.31	1.30	.97	.67	18.5	4.60	2.01
ST 4 WF	14	4.11	4.03	6.540	.463	.285	4.22	1.28	1.01	.73	10.8	3.30	1.62
	12	3.53	3.97	6.500	.398	.245	3.53	1.08	1.00	.70	9.10	2.80	1.61
ST 4 WF	10	2.94	4.07	5.268	.378	.248	3.66	1.13	1.12	.83	4.25	1.61	1.20
	8.5	2.50	4.00	5.250	.308	.230	3.21	1.01	1.13	.84	3.36	1.28	1.16

STRUCTURAL TEES

CUT FROM STANDARD BEAMS
DIMENSIONS AND
PROPERTIES FOR DESIGNING



Section Number	Weight per Foot	Area	Depth of Tee	Flange Width	Flange Average Thickness	Stem Thickness	Axis X-X I	Axis X-X S	Axis X-X r	Axis X-X y	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r
	Lb.	In.^{2}	In.	In.	In.	In.	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.
ST 6 I	25	7.29	6.00	5.477	.660	.687	25.2	6.05	1.85	1.84	7.85	2.87	1.03
	20.4	5.92	6.00	5.250	.660	.460	18.8	4.26	1.77	1.57	6.77	2.58	1.06
ST 6 I	17.5	5.10	6.00	5.078	.544	.428	17.2	3.95	1.83	1.65	4.93	1.94	.98
	15.9	4.63	6.00	5.000	.544	.350	14.9	3.31	1.78	1.51	4.68	1.87	1.00
ST 5 I	17.5	5.11	5.00	4.944	.491	.594	12.5	3.63	1.56	1.56	4.18	1.69	.90
	12.7	3.69	5.00	4.660	.491	.310	7.81	2.05	1.45	1.20	3.39	1.46	.95
ST 4 I	11.5	3.36	4.00	4.171	.425	.441	5.03	1.77	1.22	1.15	2.15	1.03	.80
	9.2	2.67	4.00	4.000	.425	.270	3.50	1.14	1.14	.94	1.86	.93	.83
ST 3.5 I	10	2.92	3.50	3.860	.392	.450	3.36	1.36	1.07	1.04	1.58	.82	.73
	7.65	2.22	3.50	3.660	.392	.250	2.18	.81	.99	.81	1.32	.72	.77
ST 3 I	8.625	2.51	3.00	3.565	.359	.465	2.13	1.02	.92	.91	1.15	.65	.67
	6.25	1.81	3.00	3.330	.359	.230	1.27	.55	.83	.69	.93	.56	.71



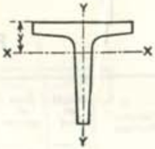
STRUCTURAL TEES
CUT FROM MISCELLANEOUS BEAMS

DIMENSIONS AND PROPERTIES FOR DESIGNING

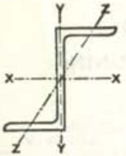
Section Number	Weight per Foot	Area of Section	Depth of Tee	Flange		Stem Thickness	AXIS X-X				AXIS Y-Y		
				Width	Average Thickness		I	S	r	y	I	S	r
	Lb.	In.^{2}	In.	In.	In.	In.	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.
MISCELLANEOUS													
ST 6 B	11.00	3.24	6.16	4.030	.424	.260	11.7	2.58	1.90	1.63	2.27	1.13	.84
	9.5	2.81	6.08	4.010	.349	.240	10.2	2.32	1.91	1.67	1.84	.92	.81
	8.25	2.43	6.00	4.000	.269	.230	9.02	2.13	1.93	1.76	1.39	.70	.76
ST 5 B	9.5	2.80	5.13	4.020	.394	.250	6.70	1.74	1.55	1.28	2.09	1.04	.86
	8.5	2.49	5.06	4.010	.329	.240	6.07	1.62	1.56	1.32	1.73	.86	.83
	7.5	2.20	5.00	4.000	.269	.230	5.46	1.50	1.57	1.37	1.39	.70	.80
ST 5 B	5.75	1.69	4.94	3.950	.204	.180	4.15	1.16	1.57	1.35	1.00	.51	.77
ST 4 B	7.50	2.22	4.06	4.015	.314	.245	3.29	1.07	1.22	1.00	1.65	.82	.86
	6.50	1.91	4.00	4.000	.254	.230	2.90	.98	1.23	1.03	1.31	.66	.83
ST 4 B	5.00	1.48	3.95	3.940	.204	.170	2.15	.72	1.21	.96	1.00	.51	.82
ST 3 B	8.00	2.36	3.13	4.030	.404	.260	1.66	.68	.84	.67	2.16	1.07	.96
	6.00	1.77	3.00	4.000	.279	.230	1.30	.56	.86	.67	1.44	.72	.90
ST 3 B	4.25	1.25	2.92	3.940	.194	.170	.90	.40	.85	.64	.94	.48	.87
JUNIOR													
ST 6 Jr.	5.90	1.72	6.00	3.06	.225	.175	6.59	1.60	1.96	1.88	.49	.32	.53
ST 5.5 Jr.	5.15	1.50	5.50	2.84	.214	.165	4.81	1.27	1.79	1.72	.37	.26	.50
ST 5 Jr.	4.50	1.32	5.00	2.69	.206	.155	3.46	.99	1.62	1.53	.30	.23	.48
ST 4.5 Jr.	3.75	1.10	4.50	2.38	.193	.145	2.34	.75	1.46	1.38	.20	.17	.42
ST 4 Jr.	3.25	.96	4.00	2.28	.189	.135	1.59	.56	1.29	1.18	.17	.15	.42
ST 3.5 Jr.	2.75	.80	3.50	2.08	.180	.126	1.01	.40	1.12	1.01	.12	.12	.39
ST 3 Jr.	2.20	.65	3.00	1.84	.171	.114	.58	.27	.95	.84	.082	.089	.36

TEES

DIMENSIONS AND PROPERTIES FOR DESIGNING



Nominal Size	Weight per Foot	Area	DIMENSIONS: Depth	DIMENSIONS: Width of Flange	DIMENSIONS: Minimum Thickness: Flange	DIMENSIONS: Minimum Thickness: Stem	AXIS X-X: I	AXIS X-X: S	AXIS X-X: r	AXIS X-X: y	AXIS Y-Y: I	AXIS Y-Y: S	AXIS Y-Y: r
In.	Lb.	In.²	In.	In.	In.	In.	In.⁴	In.³	In.	In.	In.⁴	In.³	In.
5 x 3⅛	13.6	4.00	3⅛	5	½	13/32	2.7	1.1	.82	.76	5.2	2.1	1.14
5 x 3	11.5	3.37	3	5	⅜	13/32	2.4	1.1	.84	.76	3.9	1.6	1.10
4 x 4½	11.2	3.29	4½	4	⅜	⅜	6.3	2.0	1.39	1.31	2.1	1.1	.80
4 x 4	13.5	3.97	4	4	½	½	5.7	2.0	1.20	1.18	2.8	1.4	.84
4 x 3	9.2	2.68	3	4	⅜	⅜	2.0	.90	.86	.78	2.1	1.1	.89
4 x 2½	8.5	2.48	2½	4	⅜	⅜	1.2	.62	.69	.62	2.1	1.0	.92
3 x 3	7.8	2.29	3	3	⅜	⅜	1.84	.86	.89	.88	.89	.60	.63
3 x 3	6.7	1.97	3	3	5/16	5/16	1.61	.74	.90	.85	.75	.50	.62
3 x 2½	6.1	1.77	2½	3	5/16	5/16	.94	.51	.73	.68	.75	.50	.65
2½x2½	6.4	1.87	2½	2½	⅜	⅜	1.0	.59	.74	.76	.52	.42	.53
2½x2½	4.6	1.33	2½	2½	¼	¼	.74	.42	.75	.71	.34	.27	.51
2¼x2¼	4.1	1.19	2¼	2¼	¼	¼	.52	.32	.66	.65	.25	.22	.46
2 x 2	4.4	1.26	2	2	5/16	5/16	.44	.31	.59	.61	.23	.23	.43
2 x 2	3.62	1.05	2	2	¼	¼	.37	.26	.59	.59	.18	.18	.42

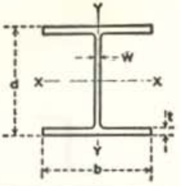


ZEES

DIMENSIONS AND PROPERTIES FOR DESIGNING

Nominal Size	Weight per Foot	Area	DIMENSIONS			AXIS X-X			AXIS Y-Y			AXIS Z-Z
			Depth	Width of Flange	Thick-ness	I	S	r	I	S	r	r
In.	Lb.	In.²	In.	In.	In.	In.⁴	In.³	In.	In.⁴	In.³	In.	In.
6 x 3½	21.1	6.19	6⅛	3⅝	½	34.4	11.2	2.36	12.9	3.8	1.44	.84
	15.7	4.59	6	3½	⅜	25.3	8.4	2.35	9.1	2.8	1.41	.83
5 x 3¼	17.9	5.25	5	3¼	½	19.2	7.7	1.91	9.1	3.0	1.31	.74
	16.4	4.81	5⅛	3⅜	7/16	19.1	7.4	1.99	9.2	2.9	1.38	.77
	14.0	4.10	5 1/16	3 5/16	⅜	16.2	6.4	1.99	7.7	2.5	1.37	.76
	11.6	3.40	5	3¼	5/16	13.4	5.3	1.98	6.2	2.0	1.35	.75
4 x 3 1/16	15.9	4.66	4 1/16	3⅛	½	11.2	5.5	1.55	8.0	2.8	1.31	.67
	12.5	3.66	4⅛	3 3/16	⅜	9.6	4.7	1.62	6.8	2.3	1.36	.69
	10.3	3.03	4 1/16	3⅛	5/16	7.9	3.9	1.62	5.5	1.8	1.34	.68
	8.2	2.41	4	3 1/16	¼	6.3	3.1	1.62	4.2	1.4	1.33	.67
3 x 2 11/16	12.6	3.69	3	2 11/16	½	4.6	3.1	1.12	4.9	2.0	1.15	.53
	9.8	2.86	3	2 11/16	⅜	3.9	2.6	1.16	3.9	1.6	1.17	.54
	6.7	1.97	3	2 11/16	¼	2.9	1.9	1.21	2.8	1.1	1.19	.55

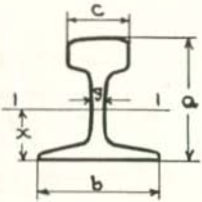
Tees and Zees are seldom used as structural framing members. When so used they are generally employed on short spans in flexure.



H BEARING PILES

DIMENSIONS AND PROPERTIES FOR DESIGNING

Section Number and Nominal Size	Weight per Foot	Area A	Depth d	Flange Width b	Flange Thickness t	Web Thickness W	Axis X-X I	Axis X-X S	Axis X-X r	Axis Y-Y I′	Axis Y-Y S′	Axis Y-Y r′
	Lb.	In.²	In.	In.	In.	In.	In.⁴	In.³	In.	In.⁴	In.³	In.
	117	34.44	14.234	14.885	.805	.805	1228.5	172.6	5.97	443.1	59.5	3.59
BP 14	102	30.01	14.032	14.784	.704	.704	1055.1	150.4	5.93	379.6	51.3	3.56
14x14½	89	26.19	13.856	14.696	.616	.616	909.1	131.2	5.89	326.2	44.4	3.53
	73	21.46	13.636	14.586	.506	.506	733.1	107.5	5.85	261.9	35.9	3.49
BP 12	74	21.76	12.122	12.217	.607	.607	566.5	93.5	5.10	184.7	30.2	2.91
12 x 12	53	15.58	11.780	12.046	.436	.436	394.8	67.0	5.03	127.3	21.2	2.86
BP 10	57	16.76	10.012	10.224	.564	.564	294.7	58.9	4.19	100.6	19.7	2.45
10 x 10	42	12.35	9.720	10.078	.418	.418	210.8	43.4	4.13	71.4	14.2	2.40
BP 8 8 x 8	36	10.60	8.026	8.158	.446	.446	119.8	29.9	3.36	40.4	9.9	1.95



WEIGHTS AND DIMENSIONS RAILROAD RAILS

Design	Weight Per Yard Pounds	Area of Section Sq. In.	Dimensions a In.	Dimensions b In.	Dimensions c In.	Dimensions g In.	Axis 1-1 I In.	Axis 1-1 r In.	Axis 1-1 x Ins.
ASCE	**30**	3.00	3 1/8	3 1/8	1 11/16	21/64	4.1	1.16	1.52
ASCE	**40**	3.94	3 1/2	3 1/2	1 7/8	25/64	6.6	1.29	1.68
ASCE	**60**	5.93	4 1/4	4 1/4	2 3/8	31/64	14.6	1.57	2.05
ASCE	**65**	6.33	4 7/16	4 7/16	2 27/64	1/2	16.9	1.63	2.14
ASCE	**70**	6.81	4 5/8	4 5/8	2 7/16	33/64	19.7	1.70	2.22
ASCE	**75**	7.33	4 13/16	4 13/16	2 15/32	17/32	22.9	1.77	2.30
ASCE	**80**	7.86	5	5	2 1/2	35/64	26.4	1.83	2.38
ASCE	**85**	8.33	5 3/16	5 3/16	2 9/16	9/16	30.1	1.90	2.47
ARA-A	**90**	8.82	5 5/8	5 1/8	2 9/16	9/16	38.7	2.09	2.54
ARA-B	**90**	8.87	5 17/64	4 49/64	2 9/16	9/16	32.3	1.91	2.44
ASCE	**90**	8.83	5 3/8	5 3/8	2 5/8	9/16	34.4	1.97	2.55
ARA-A	**100**	9.84	6	5 1/2	2 3/4	9/16	48.9	2.23	2.75
ARA-B	**100**	9.85	5 41/64	5 9/64	2 21/32	9/16	41.3	2.05	2.63
ASCE	**100**	9.84	5 3/4	5 3/4	2 3/4	9/16	44.0	2.11	2.73
Carn. Ill.	**105**	10.30	5 3/16	5 3/16	2 9/16	11/16	34.4	1.82	2.41
AREA	**115**	11.25	6 5/8	5 1/2	2 23/32	5/8	65.6	2.42	2.98
AREA	**132**	12.95	7 1/8	6	3	21/32	88.2	2.61	3.20
Carn. Ill.	**135**	13.32	5 3/4	5 3/16	3 1/16	1 1/4	50.6	1.95	2.81

Courtesy Carnegie Illinois Steel Co.

PROPERTIES FOR SMALL CHANNELS

Depth, Inches	Flange Width, Ins.	Web Thickness, Inches	Weight Per Foot, Lbs.	Depth, Inches	Flange Width, Ins.	Web Thickness, Inches	Weight Per Foot, Lbs.	Depth, Inches	Flange Width, Ins.	Web Thickness, Inches	Weight Per Foot, Lbs.	Depth, Inches	Flange Width, Ins.	Web Thickness, Inches	Weight Per Foot, Lbs.
1/2	1/4	1/8	0.28	7/8	3/8	1/8	0.61	1 1/2	1/2	1/8	1.12	2	1/2	1/8	1.26
5/8	5/16	1/8	0.41	1	3/8	1/8	0.68	1 1/2	1/2	1/4	1.53	2	9/16	3/16	1.76
3/4	3/8	5/64	0.40	1	1/2	1/8	0.84	1 1/2	9/16	1/4	1.68	2	5/8	1/4	2.28
3/4	21/64	7/64	0.52	1 1/4	1/2	1/8	0.99	1 1/2	3/4	1/8	1.17	2	1	3/16	2.32
3/4	3/8	1/8	0.56	1 1/4	1/2	3/16	1.18	1 3/4	1/2	3/16	1.55	2 1/2	5/8	3/16	2.27

WEIGHTS AND AREAS OF ■ AND ● BARS

ONE CUBIC FOOT OF STEEL WEIGHING 489.6 POUNDS

Diameter of ● or Side of ■	Weight of ■ Bar per Lin. Foot	Weight of ● Bar per Lin. Foot	Area of ■ Bar	Area of ● Bar	Diameter of ● or Side of ■	Weight of ■ Bar per Lin. Foot	Weight of ● Bar per Lin. Foot	Area of ■ Bar	Area of ● Bar
Inches	Pounds	Pounds	Sq. Ins.	Sq. Ins.	Inches	Pounds	Pounds	Sq. Ins.	Sq. Ins.
0	......	......	......	......	**3**	30.60	24.03	9.0000	7.0686
1/16	.013	.010	.0039	.0031	1/16	31.89	25.04	9.3789	7.3662
1/8	.053	.042	.0156	.0123	1/8	33.20	26.08	9.7656	7.6699
3/16	.119	.094	.0352	.0276	3/16	34.55	27.13	10.160	7.9798
1/4	.212	.167	.0625	.0491	1/4	35.92	28.20	10.563	8.2958
5/16	.333	.261	.0977	.0767	5/16	37.31	29.30	10.973	8.6179
3/8	.478	.375	.1406	.1104	3/8	38.73	30.42	11.391	8.9462
7/16	.651	.511	.1914	.1503	7/16	40.18	31.56	11.816	9.2806
1/2	.850	.667	.2500	.1963	1/2	41.65	32.71	12.250	9.6211
9/16	1.076	.845	.3164	.2485	9/16	43.14	33.90	12.691	9.9678
5/8	1.328	1.043	.3906	.3068	5/8	44.68	35.09	13.141	10.321
11/16	1.608	1.262	.4727	.3712	11/16	46.24	36.31	13.598	10.680
3/4	1.913	1.502	.5625	.4418	3/4	47.82	37.56	14.063	11.045
13/16	2.245	1.763	.6602	.5185	13/16	49.42	38.81	14.535	11.416
7/8	2.603	2.044	.7656	.6013	7/8	51.05	40.10	15.016	11.793
15/16	2.989	2.347	.8789	.6903	15/16	52.71	41.40	15.504	12.177
1	3.400	2.670	1.0000	.7854	**4**	54.40	42.73	16.000	12.566
1/16	3.838	3.014	1.1289	.8866	1/16	56.11	44.07	16.504	16.962
1/8	4.303	3.379	1.2656	.9940	1/8	57.85	45.44	17.016	13.364
3/16	4.795	3.766	1.4102	1.1075	3/16	59.62	46.83	17.535	13.772
1/4	5.312	4.173	1.5625	1.2272	1/4	61.41	48.24	18.063	14.186
5/16	5.857	4.600	1.7227	1.3530	5/16	63.23	49.66	18.598	14.607
3/8	6.428	5.049	1.8906	1.4849	3/8	65.08	51.11	19.141	15.033
7/16	7.026	5.518	2.0664	1.6230	7/16	66.95	52.58	19.691	15.466
1/2	7.650	6.008	2.2500	1.7671	1/2	68.85	54.07	20.250	15.904
9/16	8.301	6.520	2.4414	1.9175	9/16	70.78	55.59	20.816	16.349
5/8	8.978	7.051	2.6406	2.0739	5/8	72.73	57.12	21.391	16.800
11/16	9.682	7.604	2.8477	2.2365	11/16	74.70	58.67	21.973	17.257
3/4	10.41	8.178	3.0625	2.4053	3/4	76.71	60.25	22.563	17.721
13/16	11.17	8.773	3.2852	2.5802	13/16	78.74	61.84	23.160	18.190
7/8	11.95	9.388	3.5156	2.7612	7/8	80.81	63.46	23.766	18.665
15/16	12.76	10.02	3.7539	2.9483	15/16	82.89	65.10	24.379	19.147
2	13.60	10.68	4.0000	3.1416	**5**	85.00	66.76	25.000	19.635
1/16	14.46	11.36	4.2539	3.3410	1/16	87.14	68.44	25.629	20.129
1/8	15.35	12.06	4.5156	3.5466	1/8	89.30	70.14	26.266	20.629
3/16	16.27	12.78	4.7852	3.7583	3/16	91.49	71.86	26.910	21.135
1/4	17.22	13.52	5.0625	3.9761	1/4	93.72	73.60	27.563	21.648
5/16	18.19	14.28	5.3477	4.2000	5/16	95.96	75.37	28.223	22.166
3/8	19.18	15.07	5.6406	4.4301	3/8	98.23	77.15	28.891	22.691
7/16	20.20	15.86	5.9414	4.6664	7/16	100.5	78.95	29.566	23.221
1/2	21.25	16.69	6.2500	4.9087	1/2	102.8	80.77	30.250	23.758
9/16	22.33	17.53	6.5664	5.1572	9/16	105.2	82.62	30.941	24.301
5/8	23.43	18.40	6.8906	5.4119	5/8	107.6	84.49	31.641	24.850
11/16	24.56	19.29	7.2227	5.6727	11/16	110.0	86.38	32.348	25.406
3/4	25.71	20.20	7.5625	5.9396	3/4	112.4	88.29	33.063	25.967
13/16	26.90	21.12	7.9102	6.2126	13/16	114.9	90.22	33.785	26.535
7/8	28.10	22.07	8.2656	6.4918	7/8	117.4	92.17	34.516	27.109
15/16	29.34	23.04	8.6289	6.7771	15/16	119.9	94.14	35.254	27.688

WEIGHTS AND AREAS OF ■ AND ● BARS

ONE CUBIC FOOT OF STEEL WEIGHING 489.6 POUNDS

Diameter of ● or Side of ■	Weight of ■ Bar per Lin. Foot	Weight of ● Bar per Lin. Foot	Area of ■ Bar	Area of ● Bar	Diameter of ● or Side of ■	Weight of ■ Bar per Lin. Foot	Weight of ● Bar per Lin. Foot	Area of ■ Bar	Area of ● Bar
Inches	Pounds	Pounds	Sq. Ins.	Sq. Ins.	Inches	Pounds	Pounds	Sq. Ins.	Sq. Ins.
6	122.4	96.14	36.000	28.274	**9**	275.4	216.3	81.000	63.617
1/16	125.0	98.14	36.754	28.866	1/16	279.2	219.3	82.129	64.504
1/8	127.6	100.2	37.516	29.465	1/8	283.1	222.3	83.266	65.397
3/16	130.2	102.2	38.285	30.069	3/16	287.0	225.4	84.410	66.296
1/4	132.8	104.3	39.063	30.680	1/4	290.9	228.5	85.563	67.201
5/16	135.5	106.4	39.848	31.296	5/16	294.9	231.6	86.723	68.112
3/8	138.2	108.5	40.641	31.919	3/8	298.8	234.7	87.891	69.029
7/16	140.9	110.7	41.441	32.548	7/16	302.8	237.8	89.066	69.953
1/2	143.6	112.8	42.250	33.183	1/2	306.9	241.0	90.250	70.882
9/16	146.5	114.9	43.066	33.824	9/16	310.9	244.2	91.441	71.818
5/8	149.2	117.2	43.891	34.472	5/8	315.0	247.4	92.641	72.760
11/16	152.1	119.4	44.723	35.125	11/16	319.1	250.6	93.848	73.708
3/4	154.9	121.7	45.563	35.785	3/4	323.2	253.8	95.063	74.662
13/16	157.8	123.9	46.410	36.450	13/16	327.4	257.1	96.285	75.622
7/8	160.8	126.2	47.266	37.122	7/8	331.6	260.4	97.516	76.589
15/16	163.6	128.5	48.129	37.800	15/16	335.8	263.7	98.754	77.561
7	166.6	130.9	49.000	38.485	**10**	340.0	267.0	100.00	78.540
1/16	169.6	133.2	49.879	39.175	1/16	344.3	270.4	101.25	79.525
1/8	172.6	135.6	50.766	39.871	1/8	348.6	273.8	102.52	80.516
3/16	175.6	137.9	51.660	40.574	3/16	352.9	277.1	103.79	81.513
1/4	178.7	140.4	52.563	41.282	1/4	357.2	280.6	105.06	82.516
5/16	181.8	142.8	53.473	41.997	5/16	361.6	284.0	106.35	83.525
3/8	184.9	145.3	54.391	42.718	3/8	366.0	287.4	107.64	84.541
7/16	188.1	147.7	55.316	43.445	7/16	370.4	290.9	108.94	85.563
1/2	191.3	150.2	56.250	44.179	1/2	374.9	294.4	110.25	86.590
9/16	194.4	152.7	57.191	44.918	9/16	379.3	297.9	111.57	87.624
5/8	197.7	155.2	58.141	45.664	5/8	383.8	301.5	112.89	88.664
11/16	200.9	157.8	59.098	46.415	11/16	388.4	305.0	114.22	89.710
3/4	204.2	160.3	60.063	47.173	3/4	392.9	308.6	115.56	90.763
13/16	207.6	163.0	61.035	47.937	13/16	397.5	312.2	116.91	91.821
7/8	210.8	165.6	62.016	48.707	7/8	402.1	315.8	118.27	92.886
15/16	214.2	168.2	63.004	49.483	15/16	406.7	319.5	119.63	93.957
8	217.6	170.9	64.000	50.266	**11**	411.4	323.1	121.00	95.033
1/16	221.0	173.6	65.004	51.054	1/16	416.1	326.8	122.38	96.116
1/8	224.5	176.3	66.016	51.849	1/8	420.8	330.5	123.77	97.206
3/16	227.9	179.0	67.035	52.649	3/16	425.5	334.3	125.16	98.301
1/4	231.4	181.8	68.063	53.456	1/4	430.3	338.0	126.56	99.402
5/16	234.9	184.5	69.098	54.269	5/16	435.1	341.7	127.97	100.51
3/8	238.5	187.3	70.141	55.088	3/8	439.9	345.5	129.39	101.62
7/16	242.1	190.1	71.191	55.914	7/16	444.8	349.3	130.82	102.74
1/2	245.7	192.9	72.250	56.745	1/2	449.7	353.2	132.25	103.87
9/16	249.3	195.8	73.316	57.583	9/16	454.6	357.0	133.69	105.00
5/8	252.9	198.6	74.391	58.426	5/8	459.5	360.9	135.14	106.14
11/16	256.6	201.5	75.473	59.276	11/16	464.4	364.8	136.60	107.28
3/4	260.3	204.4	76.563	60.132	3/4	469.4	368.7	138.06	108.43
13/16	264.0	207.4	77.660	60.994	13/16	474.4	372.6	139.54	109.59
7/8	267.8	210.3	78.766	61.863	7/8	479.5	376.6	141.02	110.75
15/16	271.6	213.3	79.879	62.737	15/16	484.5	380.5	142.50	111.92

WEIGHTS OF STEEL ANGLES.

Size in inches	1/8″	3/16″	1/4″	5/16″	3/8″	7/16″	1/2″	9/16″	5/8″	11/16″	3/4″	13/16″	7/8″	15/16″	1″
8 x 8	....	....	....	....	....	....	26.4	29.6	32.7	....	38.9	....	45.0	....	51.0
8 x 6	....	....	....	....	....	20.2	23.0	25.7	28.5	....	33.8	....	39.1	....	44.2
8 x 4	....	....	....	....	....	17.2	19.6	21.9	24.2	....	28.7	....	33.1	....	37.4
7 x 4	....	....	....	....	13.6	15.8	17.9	20.0	22.1	....	26.2	....	30.2	....	....
6 x 6	....	....	....	12.5	14.9	17.2	19.6	21.9	24.2	....	28.7	....	33.1	....	37.4
6 x 4	....	....	....	10.8	12.3	14.3	16.2	18.1	20.0	....	23.6	....	27.2	....	....
6 x 3½	....	....	7.9	9.8	11.7	....	15.3	....	....	....	....	....	....	....	....
5 x 5	....	....	....	10.3	12.3	14.3	16.2	....	20.0	....	23.6	....	27.2	....	....
5 x 3½	....	....	7.0	8.7	10.4	12.0	13.6	....	16.8	....	19.8	....	....	....	....
5 x 3	....	....	6.6	8.2	9.8	11.3	12.8	....	....	....	....	....	....	....	....
4 x 4	....	....	6.6	8.2	9.8	11.3	12.8	....	15.7	....	18.5	....	....	....	....
4 x 3½	....	....	6.3	7.7	9.1	10.6	11.9	....	14.7	....	....	....	....	....	....
4 x 3	....	....	5.8	7.2	8.5	9.8	11.1	....	13.6	....	....	....	....	....	....
3½ x 3½	....	....	5.8	7.2	8.5	9.8	11.1	....	....	....	....	....	....	....	....
3½ x 3	....	....	5.4	6.6	7.9	9.1	10.2	....	....	....	....	....	....	....	....
3½ x 2½	....	....	4.9	6.1	7.2	8.3	9.4	....	....	....	....	....	....	....	....
3 x 3	....	3.71	4.9	6.1	7.2	8.3	9.4	....	....	....	....	....	....	....	....
3 x 2½	....	....	4.5	5.6	6.6	7.6	8.5	....	....	....	....	....	....	....	....
3 x 2	....	3.07	4.1	5.0	5.9	6.8	7.7	....	....	....	....	....	....	....	....
2½ x 2½	2.08	3.07	4.1	5.0	5.9	....	7.7	....	....	....	....	....	....	....	....
2½ x 2	....	2.75	3.62	4.5	5.3	....	....	....	....	....	....	....	....	....	....
2½ x 1½	....	2.44	3.19	3.92	4.7	....	....	....	....	....	....	....	....	....	....
2 x 2	1.65	2.44	3.19	3.92	4.7	....	....	....	....	....	....	....	....	....	....
2 x 1½	1.44	2.12	2.77	....	....	....	....	....	....	....	....	....	....	....	....
1¾ x 1¾	1.44	2.12	2.77	....	....	....	....	....	....	....	....	....	....	....	....
1¾ x 1¼	1.23	1.80	2.34	....	....	....	....	....	....	....	....	....	....	....	....
1½ x 1½	1.23	1.80	2.34	....	....	....	....	....	....	....	....	....	....	....	....
1¼ x 1¼	1.01	1.48	1.92	....	....	....	....	....	....	....	....	....	....	....	....
1 x 1	0.80	1.16	1.49	....	....	....	....	....	....	....	....	....	....	....	....
¾ x ¾	.59	....	....	....	....	....	....	....	....	....	....	....	....	....	....

WEIGHT OF SHEET STEEL

POUNDS PER LINEAL FOOT

United States Standard Gauge

Number of Gauge	Approximate Thickness in Fractions of an Inch	Approximate Thickness in Decimals of an Inch	Weight Per Sq. Foot Pounds	WIDTH IN INCHES											
				20	**22**	**24**	**26**	**28**	**30**	**36**	**42**	**48**	**50**	**54**	**60**
7	$\frac{3}{16}$	.1793	7.50	12.50	13.75	15.00	16.25	17.50	18.75	22.50	26.25	30.00	31.25	33.75	37.50
8	$\frac{11}{64}$	.1644	6.875	11.46	12.60	13.75	14.90	16.04	17.19	20.62	24.06	27.50	28.65	30.94	34.37
10	$\frac{9}{64}$	.1345	5.625	9.37	10.31	11.25	12.19	13.12	14.06	16.87	19.69	22.50	23.44	25.31	28.12
12	$\frac{7}{64}$	1046	4.375	7.29	8.02	8.75	9.48	10.21	10.94	13.12	15.31	17.50	18.23	19.69	21.87
14	$\frac{5}{64}$	.0747	3.125	5.21	5.73	6.25	6.77	7.29	7.81	9.37	10.94	12.50	13.02	14.06	15.62
16	$\frac{1}{16}$	.0598	2.50	4.17	4.58	5.00	5.42	5.83	6.25	7.50	8.75	10.00	10.42	11.25	12.50
18	$\frac{1}{20}$	.0478	2.00	3.33	3.67	4.00	4.33	4.67	5.00	6.00	7.00	8.00	8.33	9.00	10.00
20	$\frac{3}{80}$	.0359	1.50	2.50	2.75	3.00	3.25	3.50	3.75	4.50	5.25	6.00	6.25	6.75	7.50
22	$\frac{1}{32}$	.0299	1.25	2.08	2.29	2.50	2.71	2.92	3.12	3.75	4.37	5.00	5.21	5.62	6.25
24	$\frac{1}{40}$	.0239	1.00	1.67	1.83	2.00	2.17	2.33	2.50	3.00	3.50	4.00	4.17	4.50	5.00
26	$\frac{3}{160}$	.0179	.75	1.25	1.37	1.50	1.62	1.75	1.87	2.25	2.62	3.00	3.12	3.37	3.75
28	$\frac{1}{64}$	.0149	.625	1.04	1.14	1.25	1.35	1.46	1.56	1.87	2.19	2.50	2.60	2.81	3.12
30	$\frac{1}{80}$	.0120	.50	.83	.92	1.00	1.08	1.17	1.25	1.50	1.75	2.00	2.08	2.25	2.50

AREA OF STEEL PLATE.

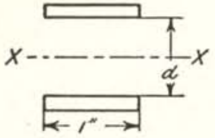
Width in Inches	THICKNESS IN INCHES. $\frac{3}{16}''$	$\frac{1}{4}''$	$\frac{5}{16}''$	$\frac{3}{8}''$	$\frac{7}{16}''$	$\frac{1}{2}''$	$\frac{9}{16}''$	$\frac{5}{8}''$	$\frac{11}{16}''$	$\frac{3}{4}''$	$\frac{13}{16}''$	$\frac{7}{8}''$	$\frac{15}{16}''$	1″
1	.188	.250	.313	.375	.438	.500	.563	.625	.688	.750	.813	.875	.938	1.00
1¼	.234	.313	.391	.469	.547	.625	.703	.781	.859	.938	1.02	1.09	1.17	1.25
1½	.281	.375	.469	.563	.656	.750	.844	.938	1.03	1.13	1.22	1.31	1.41	1.50
1¾	.328	.438	.547	.656	.766	.875	.984	1.09	1.20	1.31	1.42	1.53	1.64	1.75
2	.375	.500	.625	.750	.875	1.00	1.13	1.25	1.38	1.50	1.63	1.75	1.88	2.00
2¼	.422	.563	.703	.844	.984	1.13	1.27	1.41	1.55	1.69	1.83	1 97	2.11	2.25
2½	.469	.625	.781	.938	1.09	1.25	1.41	1.56	1.72	1.88	2.03	2.19	2.34	2.50
2¾	.516	.688	.859	1.03	1.20	1.38	1.55	1.72	1.89	2.06	2.23	2.41	2.58	2.75
3	.563	.750	938	1.13	1.31	1.50	1.69	1.88	2.06	2.25	2.44	2.63	2.81	3.00
3¼	.609	.813	1.02	1.22	1.42	1.63	1.83	2.03	2.23	2.44	2.64	2.84	3.05	3.25
3½	.656	.875	1.09	1.31	1.53	1.75	1 97	2.19	2.41	2.63	2.84	3.06	3.28	3.50
3¾	.703	.938	1.17	1.41	1.64	1.88	2.11	2.34	2.58	2.81	3.05	3.28	3.52	3.75
4	.750	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00
4½	.844	1.13	1.41	1.69	1.97	2.25	2.53	2.81	3.09	3.38	3.66	3.94	4.22	4.50
5	.938	1.25	1.56	1.88	2.19	2.50	2.81	3.13	3.44	3.75	4.06	4.38	4.69	5.00
5½	1.03	1.38	1.72	2.06	2.41	2.75	3.09	3.44	3.78	4.13	4.47	4.81	5.16	5.50
6	1.13	1.50	1.88	2.25	2.63	3.00	3.38	3.75	4.13	4.50	4.88	5.25	5.63	6.00
6½	1.22	1.63	2.03	2.44	2.84	3.25	3.66	4.06	4.47	4.88	5.28	5.69	6.09	6.50
7	1.31	1.75	2.19	2.63	3.06	3.50	3.94	4.38	4.81	5.25	5.69	6.13	6.56	7.00
7½	1.41	1.88	2.34	2.81	3.28	3.75	4.22	4.69	5.16	5.63	6.09	6.56	7.03	7.50
8	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
9	1.69	2 25	2.81	3.38	3.94	4.50	5.06	5.63	6.19	6.75	7.31	7.88	8.44	9.00
10	1.88	2.50	3.13	3.75	4.38	5.00	5.63	6 25	6.88	7.50	8.13	8.75	9.38	10.00
11	2.06	2.75	3.44	4.13	4.81	5.50	6.19	6.88	7.56	8.25	8.94	9.63	10.31	11.00
12	2.25	3.00	3 75	4.50	5.25	6.00	6.75	7.50	8.25	9.00	9.75	10.50	11.25	12.00
13	2.44	3.25	4.06	4.88	5.69	6.50	7.31	8.13	8.94	9.75	10.56	11.38	12.19	13.00
14	2.63	3.50	4.38	5.25	6.13	7.00	7.88	8.75	9.63	10.50	11.38	12.25	13.13	14.00
15	2.81	3.75	4.69	5.63	6.56	7.50	8 44	9.38	10.31	11.25	12.19	13.13	14.06	15.00
16	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00
17	3.19	4.25	5.31	6.38	7.44	8.50	9.56	10.63	11.69	12.75	13.81	14.88	15 94	17.00
18	3.38	4.50	5.63	6.75	7.88	9.00	10.13	11.25	12.38	13.50	14.63	15.75	16.88	18.00
19	3.56	4.75	5.94	7.13	8.31	9.50	10.69	11.88	13.06	14.25	15.44	16.63	17.81	19.00
20	3.75	5.00	6.25	7.50	8.75	10.00	11.25	12.50	13.75	15.00	16.25	17.50	18.75	20.00
21	3.94	5.25	6.56	7.88	9.19	10.50	11.81	13.13	14.44	15.75	17 06	18.38	19.69	21.00
22	4.13	5.50	6.88	8.25	9.63	11.00	12.38	13.75	15.13	16.50	17.88	19.25	20.63	22.00
23	4.31	5 75	7.19	8.63	10.06	11.50	12.94	14.38	15.81	17.25	18.69	20.13	21.56	23.00
24	4.50	6.00	7.50	9.00	10.50	12.00	13.50	15.00	16.50	18.00	19.50	21.00	22.50	24.00
26	4.88	6.50	8.13	9.75	11.38	13.00	14.63	16.25	17.88	19.50	21.13	22 75	24.38	26.00
28	5.25	7.00	8.75	10.50	12.25	14.00	15.75	17.50	19.25	21.00	22.75	24.50	26.25	28.00
30	5.63	7.50	9.38	11.25	13.13	15.00	16.88	18.75	20.63	22.50	24.38	26.25	28.13	30.00
36	6.75	9.00	11.25	13.50	15.75	18.00	20.25	22.50	24.75	27.00	29.25	31.50	33.75	36.00
42	7.88	10.50	13.13	15.75	18.38	21.00	23.63	26.25	28.88	31.50	34.13	36.75	39.38	42.00

WEIGHT OF STEEL PLATE.

Pounds per Lineal Foot.

Width in Inches	THICKNESS IN INCHES													
	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	.638	.850	1.06	1.28	1.49	1.70	1.91	2.13	2.34	2.55	2.76	2.98	3.19	3.40
1¼	.797	1.06	1.33	1.59	1.86	2.13	2.39	2.66	2.92	3.19	3.45	3.72	3.98	4.25
1½	.957	1.28	1.59	1.91	2.23	2.55	2.87	3.19	3.51	3.83	4.14	4.46	4.78	5.10
1¾	1.12	1.49	1.86	2.23	2.60	2.98	3.35	3.72	4.09	4.46	4.83	5.21	5.58	5.95
2	1.28	1.70	2.13	2.55	2.98	3.40	3.83	4.25	4.68	5.10	5.53	5.95	6.38	6.80
2¼	1.43	1.91	2.39	2.87	3.35	3.83	4.30	4.78	5.26	5.74	6.22	6.69	7.17	7.65
2½	1.59	2.13	2.66	3.19	3.72	4.25	4.78	5.31	5.84	6.38	6.91	7.44	7.97	8.50
2¾	1.75	2.34	2.92	3.51	4.09	4.68	5.26	5.84	6.43	7.01	7.60	8.18	8.77	9.35
3	1.91	2.55	3.19	3.83	4.46	5.10	5.74	6.38	7.01	7.65	8.29	8.93	9.56	10.20
3¼	2.07	2.76	3.45	4.14	4.83	5.53	6.22	6.91	7.60	8.29	8.98	9.67	10.36	11.05
3½	2.23	2.98	3.72	4.46	5.21	5.95	6.69	7.44	8.18	8.93	9.67	10.41	11.16	11.90
3¾	2.39	3.19	3.98	4.78	5.58	6.38	7.17	7.97	8.77	9.56	10.36	11.16	11.95	12.75
4	2.55	3.40	4.25	5.10	5.95	6.80	7.65	8.50	9.35	10.20	11.05	11.90	12.75	13.60
4½	2.87	3.83	4.78	5.74	6.69	7.65	8.61	9.56	10.52	11.48	12.43	13.39	14.34	15.30
5	3.19	4.25	5.31	6.38	7.44	8.50	9.56	10.63	11.69	12.75	13.81	14.88	15.94	17.00
5½	3.51	4.68	5.84	7.01	8.18	9.35	10.52	11.69	12.86	14.03	15.19	16.36	17.53	18.70
6	3.83	5.10	6.38	7.65	8.93	10.20	11.48	12.75	14.03	15.30	16.58	17.85	19.13	20.40
6½	4.14	5.53	6.91	8.29	9.67	11.05	12.43	13.81	15.19	16.58	17.96	19.34	20.72	22.10
7	4.46	5.95	7.44	8.93	10.41	11.90	13.39	14.88	16.36	17.85	19.34	20.83	22.31	23.80
7½	4.78	6.38	7.97	9.56	11.16	12.75	14.34	15.94	17.53	19.13	20.72	22.31	23.91	25.50
8	5.10	6.80	8.50	10.20	11.90	13.60	15.30	17.00	18.70	20.40	22.10	23.80	25.50	27.20
9	5.74	7.65	9.56	11.48	13.39	15.30	17.21	19.13	21.04	22.95	24.86	26.78	28.69	30.60
10	6.38	8.50	10.63	12.75	14.88	17.00	19.13	21.25	23.38	25.50	27.63	29.75	31.88	34.00
11	7.01	9.35	11.69	14.03	16.36	18.70	21.04	23.38	25.71	28.05	30.39	32.72	35.06	37.40
12	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	8.29	11.05	13.81	16.58	19.34	22.10	24.86	27.63	30.40	33.20	35.91	38.68	41.44	44.20
14	8.93	11.90	14.88	17.85	20.83	23.80	26.78	29.75	32.72	35.71	38.67	41.65	44.63	47.60
15	9.56	12.75	15.94	19.13	22.31	25.50	28.69	31.88	35.06	38.26	41.43	44.62	47.82	51.00
16	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	10.84	14.45	18.06	21.68	25.29	28.90	32.51	36.13	39.74	43.36	46.96	50.58	54.20	57.80
18	11.48	15.30	19.13	22.95	26.78	30.60	34.43	38.25	42.08	45.90	49.72	53.56	57.38	61.20
19	12.11	16.15	20.19	24.23	28.26	32.30	36.34	40.38	44.42	48.46	52.48	56.52	60.57	64.60
20	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	13.39	17.85	22.31	26.78	31.24	35.70	40.16	44.63	49.08	53.56	58.01	62.49	66.94	71.40
22	14.03	18.70	23.38	28.05	32.73	37.40	42.08	46.75	51.43	56.10	60.79	65.44	70.13	74.80
23	14.66	19.55	24.44	29.33	34.21	39.10	43.99	48.88	53.76	58.66	63.53	68.43	73.32	78.20
24	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
26	16.58	22.10	27.63	33.15	38.68	44.20	49.73	55.25	60.78	66.30	71.82	77.36	82.88	88.40
28	17.85	23.80	29.75	35.70	41.65	47.60	53.56	59.50	65.44	71.40	77.34	83.30	89.26	95.20
30	19.13	25.50	31.88	38.25	44.63	51.00	57.38	63.75	70.13	76.50	82.86	89.24	95.64	102.00
36	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
42	26.78	35.70	44.63	53.55	62.48	71.40	80.33	89.25	98.18	107.10	116.03	124.95	133.88	142.80

MOMENTS OF INERTIA OF TWO PLATES



Moments of Inertia of Two Plates

ONE INCH WIDE

About Axis X-X

Distances Measured from Inside to Inside

For Moments of Inertia, deducting for rivet holes, multiply tabular value by net width.

d Ins.	Thickness of Plates in Inches.													
	1/8	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
6	2.3	4.9	6.2	7.6	9.1	10.6	12.1	13.8	15.4	17.2	18.9	20.7	22.7	24.7
6¼	2.5	5.3	6.7	8.2	9.8	11.4	13.1	14.8	16.6	18.5	20.4	22.3	24.4	26.5
6½	2.7	5.7	7.3	8.9	10.5	12.3	14.1	15.9	17.8	19.8	21.8	23.9	26.1	28.3
6¾	3.0	6.1	7.8	9.5	11.3	13.2	15.1	17.0	19.1	21.2	23.3	25.5	27.8	30.2
8	4.1	8.5	10.8	13.2	15.6	18.1	20.6	23.3	26.0	28.8	31.6	34.6	37.6	40.7
8¼	4.4	9.0	11.5	14.0	16.5	19.2	21.9	24.7	27.5	30.5	33.5	36.5	39.7	43.0
8½	4.6	9.6	12.1	14.8	17.5	20.3	23.1	26.1	29.1	32.2	35.3	38.6	41.9	45.3
8¾	4.9	10.1	12.8	15.6	18.5	21.4	24.4	27.5	30.7	33.9	37.2	40.6	44.1	47.7
9	5.2	10.7	13.6	16.5	19.5	22.6	25.7	29.0	32.3	35.7	39.2	42.8	46.4	50.2
9¼	5.5	11.3	14.3	17.4	20.5	23.8	27.1	30.5	34.0	37.6	41.2	45.0	48.8	52.7
9½	5.8	11.9	15.0	18.3	21.6	25.0	28.5	32.1	35.7	39.5	43.3	47.2	51.2	55.3
9¾	6.1	12.5	15.8	19.2	22.7	26.3	29.9	33.7	37.5	41.4	45.4	49.5	53.7	57.9
10	6.4	13.1	16.6	20.2	23.8	27.6	31.4	35.3	39.3	43.4	47.6	51.9	56.2	60.7
10¼	6.7	13.8	17.4	21.2	25.0	28.9	32.9	37.0	41.2	45.5	49.8	54.3	58.8	63.5
10½	7.1	14.5	18.3	22.2	26.2	30.3	34.5	38.7	43.1	47.5	52.1	56.7	61.5	66.3
10¾	7.4	15.1	19.1	23.2	27.4	31.7	36.0	40.5	45.0	49.7	54.4	59.2	64.2	69.2
12	9.2	18.8	23.7	28.7	33.9	39.1	44.2	49.8	55.4	61.0	66.8	72.6	76.8	84.7
12¼	9.6	19.5	24.7	29.9	35.2	40.7	46.2	51.8	57.6	63.5	69.4	75.5	81.7	88.0
12½	10.0	20.3	25.7	31.1	36.6	42.3	48.0	53.9	59.8	65.9	72.1	78.4	84.8	91.3
12¾	10.4	21.1	26.7	32.3	38.1	43.9	49.9	55.9	62.1	68.4	74.8	81.3	88.0	94.7
14	12.5	25.4	32.0	38.8	45.6	52.6	59.7	66.9	74.2	81.7	89.2	96.9	104.7	112.7
14¼	12.9	26.3	33.1	40.1	47.2	54.4	61.7	69.2	76.8	84.5	92.3	100.2	108.3	116.5
14½	13.4	27.2	34.3	41.5	48.8	56.3	63.8	71.5	79.4	87.3	95.3	103.5	111.9	120.3
14¾	13.8	28.1	35.5	42.9	50.5	58.2	66.0	73.9	82.0	90.2	98.4	106.9	115.5	124.2
15	14.3	29.1	36.7	44.3	52.1	60.1	68.1	76.3	84.7	93.1	101.7	110.4	119.2	128.2
15¼	14.8	30.0	37.9	45.8	53.9	62.0	70.4	78.8	87.4	96.1	104.9	113.9	123.0	132.2
15½	15.3	31.0	39.1	47.3	55.6	64.0	72.6	81.3	90.1	99.1	108.2	117.4	126.8	136.3
15¾	15.7	32.0	40.3	48.7	57.3	66.0	74.9	83.8	92.9	102.2	111.5	121.0	130.7	140.4
16	16.2	33.0	41.6	50.2	59.1	68.1	77.2	86.4	95.8	105.3	114.9	124.7	134.6	144.7
16¼	16.8	34.0	42.9	51.8	60.9	70.2	79.5	89.0	98.7	108.5	118.4	128.4	138.6	149.0
16½	17.3	35.1	44.2	53.4	62.8	72.3	81.9	91.7	101.6	111.7	121.9	132.2	142.7	153.3
16¾	17.8	36.1	45.5	55.0	64.6	74.4	84.3	94.4	104.6	114.9	125.4	136.0	146.8	157.7
18¼	21.1	42.8	53.9	65.1	76.4	87.9	99.6	111.4	123.3	135.5	147.7	160.1	172.7	185.0
18½	21.7	43.9	55.3	66.8	78.5	90.3	102.2	114.3	126.6	139.0	151.6	164.3	177.2	190.5
20¼	26.0	52.5	66.1	79.8	93.6	107.7	121.9	136.2	150.8	165.5	180.3	195.4	210.6	226.3
20½	26.6	53.8	67.7	81.7	95.9	110.3	124.8	139.5	154.4	169.4	184.6	200.0	215.6	231.3
22¼	31.3	63.3	79.6	96.0	112.6	129.4	146.4	163.6	180.9	198.5	216.2	234.1	252.2	270.5
22½	32.0	64.7	81.3	98.1	115.1	132.3	149.6	167.2	184.9	202.8	220.9	239.2	257.6	276.3
24¼	37.1	75.0	94.3	113.7	133.3	153.2	173.2	193.4	213.8	234.5	255.3	276.3	297.5	319.0
24½	37.9	76.6	96.2	116.0	136.0	156.3	176.7	197.3	218.1	239.2	260.4	281.8	303.5	325.3
26¼	43.5	87.8	110.3	132.9	155.8	178.9	202.2	225.8	249.5	273.5	297.6	322.0	346.6	371.5
26½	44.3	89.4	112.3	135.4	158.7	182.3	206.0	230.0	254.1	278.5	303.1	328.0	353.0	378.0
28¼	50.3	101.5	127.5	153.7	180.0	206.7	233.5	260.6	287.9	315.5	343.2	371.2	399.5	428.3
28½	51.2	103.3	129.7	156.3	183.2	210.3	237.6	265.1	292.9	320.9	349.2	377.6	406.3	435.3

MOMENTS OF INERTIA OF TWO PLATES

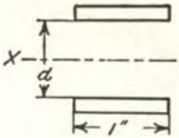
Moments of Inertia of Two Plates

ONE INCH WIDE

About Axis X-X

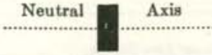
Distances Measured from Inside to Inside

For Moments of Inertia, deducting for rivet holes, multiply tabular value by net width.



d Ins.	Thickness of Plates in Inches. 1/8	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
30¼	57.7	116.3	146.0	175.9	206.0	236.4	267.1	297.9	329.1	360.5	392.1	424.0	456.1	488.5
30½	58.6	118.2	148.4	178.7	209.4	240.3	271.4	302.8	334.4	366.3	398.4	430.8	463.4	496.3
32½	66.5	134.1	168.2	202.7	237.3	272.3	307.5	342.9	378.7	414.7	450.9	487.4	524.2	561.3
34½	74.9	150.9	189.4	228.1	267.0	306.3	345.8	385.6	425,7	466.0	506.7	547.6	588.8	630.3
36¼	82.7	166.5	208.9	251.5	294.5	337.7	381.2	425.0	469.1	513.5	558.1	603.1	648.3	694.0
36½	83.8	168.8	211.7	255.0	298.5	342.3	386.4	430.7	475.4	520.4	565.7	611.2	657.1	703.3
38½	93.2	187.7	235.4	283.4	331.7	380.3	429.2	478.4	527.9	577.8	627.9	678.4	729.2	780.3
40½	103.1	207.6	260.3	313.3	366.6	420.3	474.3	528.6	583.2	638.2	693.4	749.1	805.0	861.3
42¼	112.2	225.8	283.1	340.7	398.6	456.9	515.5	574.5	633.8	693.5	753.4	813.8	874.4	935.5
42½	113.6	228.4	286.4	344.7	403.3	462.3	521.6	581.2	641.2	701.5	762.2	823.2	884.6	946.3
44½	124.6	250.3	313.8	377.6	441.7	506.3	571.1	636.4	702.0	767.9	834.2	900.9	967.9	1035.3
46½	135.9	273.2	342.4	412.0	481.9	552.3	623.0	694.0	765.5	837.3	909.5	982.9	1055.0	1128.3
48¼	146.3	294.0	368.5	443.4	518.6	594.2	670.2	746.5	823.3	900.5	978.0	1055.9	1134.3	1213.0
48½	147.8	297.1	372.3	447.9	523.9	600.3	677.0	754.2	831.7	909.7	988.0	1066.7	1145.8	1225.3
50½	160.2	321.9	403.4	485.3	567.6	650.3	733.4	816.8	900.7	985.0	1069.7	1154.8	1240.4	1326.3
52½	173.1	347.8	435.8	524.2	613.0	702.3	791.9	882.0	972.5	1063.4	1154.7	1246.5	1338.7	1431.3
54¼	184.8	371.3	465.2	559.5	654.3	749.4	845.0	941.1	1037.5	1134.5	1231.8	1329.6	1427.8	1526.5
54½	186.5	374.7	469.4	564.6	660.2	756.3	852.7	949.7	1047.0	1144.8	1243.0	1341.7	1440.8	1540.3
56½	200.4	402.6	504.3	606.5	709.2	812.3	915.8	1019.8	1124.3	1229.2	1334.5	1440.3	1546.6	1653.3
58½	214.8	431.4	540.5	649.9	759.9	870.3	981.1	1092.5	1204.3	1316.5	1429.3	1542.5	1656.1	1770.3
60½	229.7	461.3	577.8	694.8	812.3	930.3	1048.7	1167.6	1287.0	1406.9	1527.3	1648.1	1769.5	1891.3
62½	245.1	492.2	616.5	741.2	866.5	992.3	1118.5	1245.3	1372.5	1500.3	1628.5	1757.3	1886.5	2016.3
64½	261.0	524.1	656.4	789.1	922.4	1056.3	1190.6	1325.4	1460.8	1596.7	1733.0	1869.9	2007.4	2145.3
66½	277.4	556.9	697.5	838.6	980.1	1122.3	1264.9	1408.1	1551.8	1696.0	1840.8	1986.1	2131.9	2278.3
68½	294.3	590.8	739.9	889.5	1039.6	1190.3	1341.5	1493.2	1645.6	1798.4	1951.8	2105.7	2260.2	2415.3
70½	311.7	625.7	783.5	941.9	1100.8	1260.3	1420.3	1580.9	1742.1	1903.8	2066.1	2228.9	2392.3	2556.3
72½	329.6	661.6	828.4	995.8	1163.7	1332.3	1501.4	1671.1	1841.3	2012.2	2183.6	2355.5	2528.1	2701.3
74½	348.0	698.4	874.5	1051.2	1228.4	1406.3	1584.7	1763.7	1943.3	2123.5	2304.3	2485.7	2667.7	2850.3
76½	367.0	736.3	921.9	1108.1	1294.9	1482.3	1670.3	1858.9	2048.1	2237.9	2428.3	2619.4	2811.0	3003.3
78½	386.4	775.2	970.5	1166.5	1363.1	1560.3	1758.1	1956.5	2155.6	2355.3	2555.6	2756.5	2958.1	3160.3
80½	406.3	815.1	1020.4	1226.4	1433.0	1640.3	1848.2	2056.7	2265.9	2475.7	2686.1	2897.2	3108.9	3321.3
82½	426.7	855.9	1071.6	1287.8	1504.7	1722.3	1940.5	2159.3	2378.9	2599.0	2819.9	3041.3	3263.5	3486.3
84½	447.6	897.8	1123.9	1350.7	1578.1	1806.3	2035.0	2264.5	2494.6	2725.4	2956.9	3189.0	3421.8	3655.3
86½	469.0	940.7	1177.6	1415.1	1653.3	1892.3	2131.9	2372.1	2613.1	2854.8	3097.1	3340.1	3583.9	3828.3
88½	490.9	984.6	1232.5	1481.0	1730.3	1980.3	2230.9	2482.3	2734.4	2987.2	3240.6	3494.8	3749.7	4005.3
90½	513.3	1029.4	1288.6	1548.4	1809.0	2070.3	2332.3	2595.0	2858.4	3122.5	3387.4	3653.0	3919.3	4186.3
92½	536.2	1075.3	1346.0	1617.4	1889.4	2162.3	2435.8	2710.1	2985.2	3260.9	3537.4	3814.6	4092.6	4371.3
94½	559.6	1122.2	1404.6	1687.7	1971.6	2256.3	2541.6	2827.8	3114.7	3402.3	3690.7	3979.8	4269.7	4560.3
96½	583.5	1170.1	1464.5	1759.6	2055.6	2352.3	2649.7	2947.9	3246.9	3546.7	3847.2	4148.4	4450.5	4753.3
98½	607.9	1218.9	1525.6	1833.0	2141.3	2450.3	2760.0	3070.6	3381.9	3694.0	4006.9	4320.6	4635.0	4950.3
100¼	632.8	1268.8	1588.0	1908.0	2228.7	2550.3	2872.6	3195.7	3519.7	3844.4	4169.9	4496.2	4823.4	5151.3
108½	737.5	1478.3	1850.0	2222.6	2596.0	2970.3	3345.4	3721.4	4098.2	4475.9	4854.5	5233.9	5614.1	5995.3
112½	792.8	1589.1	1988.6	2388.9	2790.1	3192.3	3595.3	3999.2	4404.0	4809.7	5216.2	5623.7	6032.0	6441.3
120½	909.4	1822.6	2280.6	2739.5	3199.4	3660.3	4122.1	4584.8	5048.5	5513.2	5978.8	6445.3	6912.8	7381.3

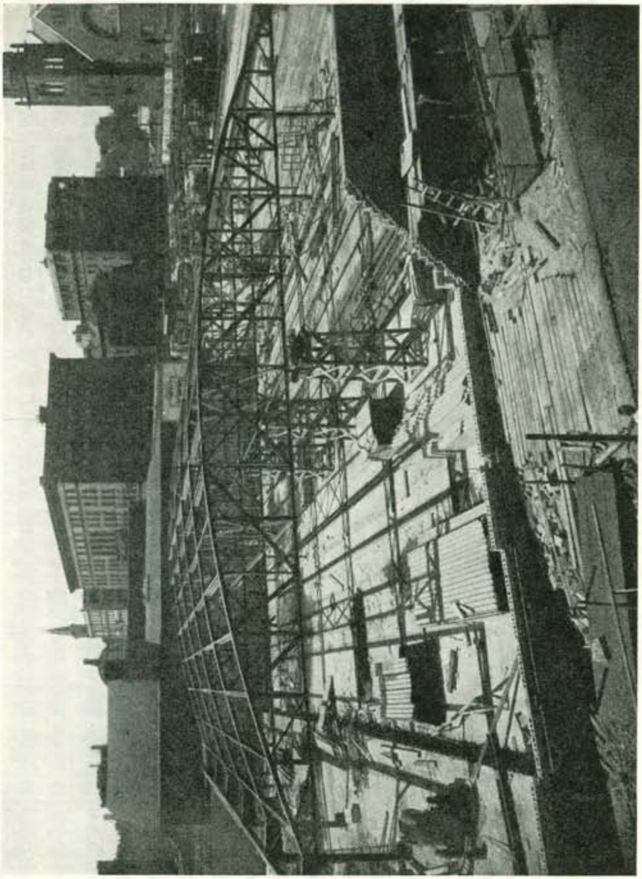
MOMENTS OF INERTIA OF RECTANGLES



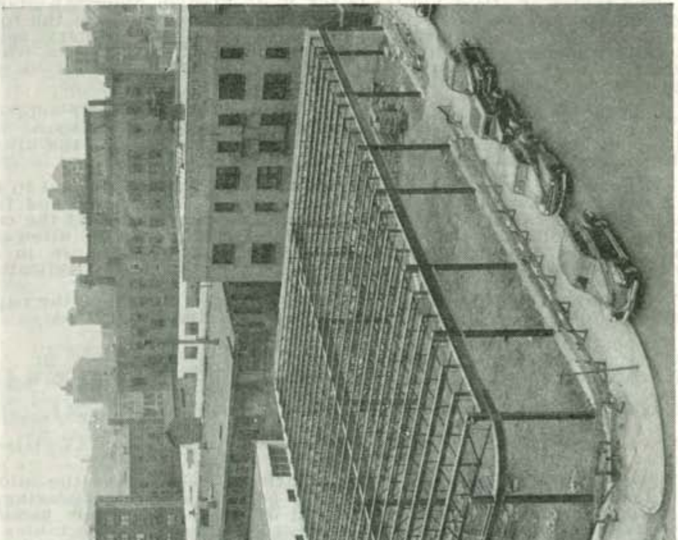
Depth In Inches	THICKNESS IN INCHES									
	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1
2	.17	.21	.25	.29	.33	.38	.42	.50	.58	.67
3	.56	.70	.84	.98	1.13	1.27	1.41	1.69	1.97	2.25
4	1.33	1.67	2.00	2.33	2.67	3.00	3.33	4.00	4.67	5.33
5	2.60	3.26	3.91	4.56	5.21	5.86	6.51	7.81	9.11	10.42
6	4.50	5.63	6.75	7.88	9.00	10.13	11.25	13.50	15.75	18.00
7	7.15	8.93	10.72	12.51	14.29	16.08	17.86	21.44	25.01	28.58
8	10.67	13.33	16.00	18.67	21.33	24.00	26.67	32.00	37.33	42.67
9	15.19	18.98	22.78	26.58	30.38	34.17	37.97	45.56	53.16	60.75
10	20.83	26.04	31.25	36.46	41.67	46.87	52.08	62.50	72.92	83.33
11	27.73	34.66	41.59	48.53	55.46	62.39	69.32	83.19	97.05	110.92
12	36.00	45.00	54.00	63.00	72.00	81.00	90.00	108.00	126.00	144.00
13	45.77	57.21	68.66	80.10	91.54	102.98	114.43	137.31	160.20	183.08
14	57.17	71.46	85.75	100.04	114.33	128.63	142.92	171.50	200.08	228.67
15	70.31	87.89	105.47	123.05	140.63	158.20	175.78	210.94	246.09	281.25
16	85.33	106.67	128.00	149.33	170.67	192.00	213.33	256.00	298.67	341.33
17	102.35	127.94	153.53	179.12	204.71	230.30	255.89	307.06	358.24	409.42
18	121.50	151.88	182.25	212.63	243.00	273.38	303.75	364.50	425.25	486.00
19	142.90	178.62	214.34	250.07	285.79	321.52	357.24	428.69	500.14	571.58
20	166.67	208.33	250.00	291.67	333.33	375.00	416.67	500.00	583.33	666.67
21	192.94	241.17	289.41	337.64	385.88	434.11	482.34	578.81	675.28	771.75
22	221.83	277.29	332.75	388.21	443.67	499.13	554.58	665.50	776.42	887.33
23	253.48	316.85	380.22	443.59	506.96	570.33	633.70	760.44	887.18	1013.92
24	288.00	360.00	432.00	504.00	576.00	648.00	720.00	864.00	1008.00	1152.00
25	325.52	406.90	488.28	569.66	651.04	732.42	813.80	976.56	1139.32	1302.08
26	366.17	457.71	549.25	640.79	732.33	823.88	915.42	1098.50	1281.58	1464.67
27	410.06	512.58	615.09	717.61	820.13	922.64	1025.16	1230.19	1435.22	1640.25
28	457.33	571.67	686.00	800.33	914.67	1029.00	1143.33	1372.00	1600.67	1829.33
29	508.10	635.13	762.16	889.18	1016.21	1143.23	1270.26	1524.31	1778.36	2032.42
30	562.50	703.13	843.75	984.38	1125.00	1265.63	1406.25	1687.50	1968.75	2250.00
32	682.67	853.33	1024.00	1194.67	1365.33	1536.00	1706.67	2048.00	2389.33	2730.67
34	818.83	1023.54	1228.25	1432.96	1637.67	1842.38	2047.08	2456.50	2865.92	3275.33
36	972.00	1215.00	1458.00	1701.00	1944.00	2187.00	2430.00	2916.00	3402.00	3888.00
38	1143.17	1428.96	1714.75	2000.54	2286.33	2572.13	2857.92	3429.50	4001.08	4572.67
40	1333.33	1666.67	2000.00	2333.33	2666.67	3000.00	3333.33	4000.00	4666.67	5333.33
42	1543.50	1929.38	2315.25	2701.13	3087.00	3472.88	3858.75	4630.50	5402.25	6174.00
44	1774.67	2218.33	2662.00	3105.67	3549.33	3993.00	4436.67	5324.00	6211.33	7098.67
46	2027.83	2534.79	3041.75	3548.71	4055.67	4562.63	5069.58	6083.50	7097.42	8111.33
48	2304.00	2880.00	3456.00	4032.00	4608.00	5184.00	5760.00	6912.00	8064.00	9216.00
50	2604.17	3255.21	3906.25	4557.29	5208.33	5859.38	6510.42	7812.50	9114.58	10416.67
52	2929.33	3661.67	4394.00	5126.33	5858.67	6591.00	7323.33	8788.00	10252.67	11717.33
54	3280.50	4100.63	4920.75	5740.88	6561.00	7381.13	8201.25	9841.50	11481.75	13122.00
56	3658.67	4573.33	5488.00	6402.67	7317.33	8232.00	9146.67	10976.00	12805.33	14634.67
58	4064.83	5081.04	6097.25	7113.46	8129.67	9145.87	10162.08	12194.50	14226.92	16259.33
60	4500.00	5625.00	6750.00	7875.00	9000.00	10125.00	11250.00	13500.00	15750.00	18000.00

PROPERTIES OF GAS PIPE

Nom. Size	STANDARD						EXTRA STRONG						DOUBLE EXTRA STRONG					
	Actual Outside Diam.	Inside Diam.	Thickness in ins.	Wt. Per Foot	Area Sq. ins.	Rad. of Gyration	Actual Outside Diam.	Inside Diam.	Thickness In Ins.	Wt. Per Foot.	Area Sq. ins.	Rad. of Gyration	Actual Outside Diam.	Inside Diam.	Thickness in ins.	Wt. per Foot	Area Sq. Ins.	Rad. of Gyration
¾	1.050	0.824	0.113	1.130	0.333	0.328	1.050	0.742	0.154	1.473	0.433	0.313	1.050	0.434	0.308	2.44	0.718	0.259
1	1.315	1.049	0.133	1.678	0.494	0.420	1.315	0.957	0.179	2.17	0.639	0.407	1.315	0.599	0.358	3.66	1.076	0.361
1¼	1.660	1.380	0.140	2.272	0.668	0.540	1.660	1.278	0.191	3.00	0.881	0.524	1.660	0.896	0.382	5.21	1.534	0.472
1½	1.900	1.610	0.145	2.717	0.800	0.623	1.900	1.500	0.200	3.63	1.068	0.605	1.900	1.100	0.400	6.41	1.885	0.549
2	2.375	2.067	0.154	3.652	1.075	0.787	2.375	1.939	0.218	5.02	1.477	0.766	2.375	1.503	0.436	9.03	2.656	0.703
2½	2.875	2.469	0.203	5.793	1.704	0.947	2.875	2.323	0.276	7.66	2.254	0.924	2.875	1.771	0.552	13.69	4.028	0.844
3	3.500	3.068	0.216	7.575	2.228	1.164	3.500	2.900	0.300	10.25	3.016	1.136	3.500	2.300	0.600	18.58	5.466	1.047
3½	4.000	3.548	0.226	9.109	2.680	1.337	4.000	3.364	0.318	12.50	3.678	1.307	4.000	2.728	0.636	22.85	6.721	1.210
4	4.500	4.026	0.237	10.790	3.174	1.510	4.500	3.826	0.337	14.98	4.407	1.477	4.500	3.152	0.674	27.54	8.101	1.374
4½	5.000	4.506	0.247	12.538	3.688	1.683	5.000	4.290	0.355	17.61	5.180	1.647	5.000	3.580	0.710	32.53	9.569	1.537
5	5.563	5.047	0.258	14.617	4.300	1.878	5.563	4.813	0.375	20.78	6.112	1.839	5.563	4.063	0.750	38.55	11.34	1.722
6	6.625	6.065	0.280	18.974	5.581	2.245	6.625	5.761	0.432	28.57	8.405	2.195	6.625	4.897	0.864	53.16	15.64	2.060
7	7.625	7.023	0.301	23.544	6.926	2.592	7.625	6.625	0.500	38.05	11.19	2.525	7.625	5.875	0.875	63.08	18.56	2.406
8	8.625	8.071	0.277	24.696	7.265	2.953	8.625	7.625	0.500	43.39	12.76	2.878	8.625	6.875	0.875	72.42	21.30	2.757



112′ SPAN BOWSTRING TRUSSES
Harkins Recreation Palace
St. Paul, Minnesota



TYPICAL STEEL FLOOR JOIST INSTALLATION
Minneapolis, Minnesota

ALLOWABLE LOADS ON BEAMS

The tables of allowable loads for Wide Flange, American Standard, and Miscellaneous Sections used as simple beams, give the total allowable uniformly distributed loads in kips, for ordinary spans laterally supported. The loads include the weight of the beam, which should be deducted to arrive at the net load which the beam will support.

The tables are also applicable to simple beams laterally supported, carrying a single concentrated load at the center of the span. For this condition the allowable concentrated load is one-half the allowable uniformly distributed load for the same span.

It is assumed in all cases that the loads are applied normal to the X-X axis as shown in the tables of properties of sections, and that the beam deflects vertically in the plane of bending only. If the conditions of loading involve forces outside of this plane, the allowable loads must be determined from the general theory of flexure, in accordance with the character of the load and its mode of application.

SYMBOLS USED IN BEAM TABLES. At the bottom of the pages giving safe loads on beams the following values are tabulated:

S = Section modulus, in inches^3	
V = Maximum web shear, in kips	$= 13\ dt$
R = Maximum end reaction, in kips, for 3½ inch bearing	$= G\ (3\tfrac{1}{2} + k)$
G = Increase in R, in kips, for each additional inch of bearing	$= 24\ t$
N = Length of bearing, in inches, to develop V	$= (V \div G) - k$

SHEARING STRESSES. With relatively short spans the allowable loads for beams and channels may be limited by the shearing or buckling strength of the web, instead of by the maximum bending stress allowed in the flanges. This limit is indicated in the tables by solid cross lines. Loads above these lines will produce the maximum allowable shear on the beam webs.

CRIPPLING VALUES OF BEAM WEBS. Beams should be designed so the compression stress in the web at the toe of the fillet, resulting from reactions or concentrated loads, shall not exceed 24 kips per square inch figured as follows, for webs without stiffeners:

Maximum end reaction $= 24t\ (a + k)$

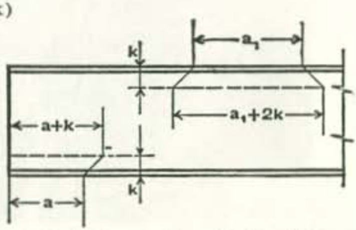
Maximum interior load $= 24t\ (a_1 + 2k)$

where t = thickness of web in inches.

k = distance from outer face of flange to web toe of fillet in inches.

a = length of bearing in inches.

a_1 = length of concentrated load in inches.



When the above values are exceeded the webs of the beams should be reinforced, or the length of bearing increased. Lack of proper lateral support for the top flanges of beams at the reaction point so decreases the crippling strength of the webs as to render such practice inadmissible.

LATERAL DEFLECTION OF BEAMS. The allowable loads given in the tables are calculated on the assumption that the compression flanges of the beams are properly secured against yielding.

These loads are however also allowable on the same spans, without side support, provided that the quantity ld/bt does not exceed 600. Therefore the function d/bt, which is a beam property, is tabulated under each beam weight, and immediately below is tabulated, as L_u, the greatest span in feet for which ld/bt does not exceed 600.*

When ld/bt exceeds 600, the permissible unit stress must be reduced below 20,000 p.s.i., in accordance with the formula

$$*f = \frac{12{,}000{,}000}{\frac{ld}{bt}}$$

This formula may be solved by the aid of the tabulated values of d/bt. The allowable load must then be reduced below that tabulated for the span, in the same ratio as the value of f thus calculated bears to 20,000.

VERTICAL DEFLECTION. The deflection of floor beams carrying plastered ceilings should be limited to not more than 1/360 of the span length. This limit is indicated in the allowable load tables by the horizontal dotted lines; loads below these lines produce greater deflection.

In the column at the right of each page of allowable loads are given the deflections for beams of various spans carrying the tabulated allowable loads These deflections are based on the nominal depth of beam. The following formula may be used for calculating the maximum deflection of any symmetrical beam or girder uniformly loaded:

$$\Delta = \frac{5Wl^3}{384EI} = \frac{0.02069\,L^2}{d}$$

where Δ=deflection in inches, W = total uniform load including weight of beam in pounds, and l=span in inches, E=29,000,000 pounds per square inch and flexural stress 20000 pounds per square inch, L= span in feet, and d=depth of beam or girder in inches.

To determine the span L in feet which will have a deflection of 1/360 of the span for a beam uniformly loaded and a flange stress of 20 kips per square inch.

$$L = 1.6111d$$

NOTATION

$$\frac{d}{bt} = \frac{\text{depth of beam}}{\text{breadth} \times \text{thickness of flange}}, \text{ all in inches.}$$

L_u = length of span, in ft., up to which the tabulated loads are safe with or without lateral support.

HORIZONTAL LINES

———————— Load next above is maximum allowable shear on web.

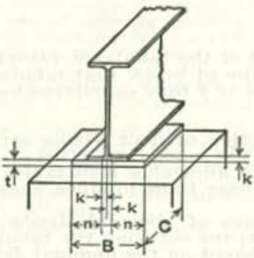
—— —— —— Load next below is maximum for Standard "A" Series beam connection.

— — — — — Load next below is maximum for Standard "B" Series beam connection.

BEAM BEARING PLATES

When a beam is supported by a masonry wall or pier it is essential that the beam reaction be distributed over an area sufficient to keep the average pressure on the masonry within the allowable limits. Steel bearing plates are generally used for this purpose.

The following method of design, using a maximum bending stress of 20,000 pounds per square inch, is recommended.



R = Reaction of beam, in kips.

A = B×C = Area of plate, in square inches.

t = Thickness of plate, in inches.

p = Bearing pressure on masonry, in kips per square inch.

k = Distance from outer face of beam flange to web toe of fillet in inches.

1. Determine the required area A=R/p.

P is given in the building code table on page 236.

2. Determine C and solve for B.

The length of bearing, C, is usually governed by the available wall thickness or some other structural consideration.

3. Determine n, and solve for t^2 by substituting in the formula $t^2 = .15pn^2$.

EQUIVALENT UNIFORM LOADS.

The size of beam necessary to carry a uniformly distributed load and one or more concentrated loads, or several concentrated loads alone can be readily obtained from the tables of safe loads of beams, by first obtaining a total uniformly distributed load which is equivalent to the various loads on the beam. The table at the right gives the equivalent uniformly distributed load of a concentrated load of 1,000 pounds located at different points on the beam.

1/2	2,000
1/3	1,780
1/4	1,500
1/5	1,280
1/6	1,100
1/7	980
1/8	875
1/9	790
1/10	720

BEAMS

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WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot										Deflection Inches
	36 x 16½					36 x 12					
	300	280	260	245	230	194	182	170	160	150	
d/bt	1.31	1.40	1.52	1.62	1.73	2.39	2.55	2.73	2.94	3.19	
L_u	38	35.5	32.5	30.5	28.5	20.5	19.5	18	17.0	15.5	
11									612	582	.07
12						730	684	640	601	559	.08
13						681	637	594	555	516	.10
14						632	592	552	515	479	.11
15			796	752	714	590	552	515	481	447	.13
16	902	840	793	744	696	553	518	483	451	419	.15
17	867	809	746	700	655	521	487	454	424	394	.17
18	819	764	705	661	619	492	460	429	401	373	.19
19	776	724	668	627	586	466	436	406	380	353	.21
20	737	688	634	595	557	442	414	386	361	335	.23
21	702	655	604	566	531	421	394	368	344	319	.25
22	670	625	577	540	506	402	377	351	328	305	.28
23	641	598	551	517	484	385	360	336	314	292	.30
24	614	573	528	496	464	369	345	322	301	279	.33
25	589	550	507	476	446	354	331	309	289	268	.36
26	567	529	488	458	428	340	319	297	277	258	.39
27	546	509	470	441	413	328	307	286	267	248	.42
28	526	491	453	425	398	316	296	276	258	240	.45
29	508	474	437	410	384	305	286	266	249	231	.48
30	491	458	423	397	371	295	276	257	240	224	.52
32	461	430	396	372	348	277	259	241	225	210	.59
34	433	404	373	350	328	260	244	227	212	197	.66
36	409	382	352	331	310	246	230	215	200	186	.75
38	388	362	334	313	293	233	218	203	190	177	.83
40	368	344	317	298	279	221	207	193	180	168	.92
42	351	327	302	283	265	211	197	184	172	160	1.01
44	335	313	288	271	253	201	188	176	164	152	1.11
46	320	299	276	259	242	192	180	168	157	146	1.22
48	307	287	264	248	232	184	173	161	150	140	1.32
50	295	275	254	238	223	177	166	154	144	134	1.44
52	283	264	244	229	214	170	159	149	139	129	1.55
54	273	255	235	220	206	164	153	143	134	124	1.68
56	263	246	227	213	199	158	148	138	129	120	1.80
58	254	237	219	205	192	153	143	133	124	116	1.93
60	246	229	211	197	186	148	138	129	120	112	2.07
62	238	222	205	192	180	143	134	125	116	108	2.21
64	230	215	198	186	174	138	129	121	113	105	2.35
66	223	208	192	181	169	134	126	117	109	102	2.50
68	217	202	187	175	164	130	122	114	106	99	2.66
70	211	196	181	170	159	126	118	110	103	96	2.82
72	205	191	176	165	155	123	115	107	100	93	2.98
PROPERTIES AND REACTION VALUES											
S in.³	1105.1	1031.2	951.1	892.5	835.5	663.6	621.2	579.1	541.0	502.9	
V kips	451	420	398	376	357	365	342	320	306	291	
R kips	143	132	123	114	108	104	97	89	84	80	
G kips	22.7	21.2	20.3	19.2	18.4	18.5	17.4	16.3	15.7	15.0	
N in.	17.1	17.1	17.1	17.1	17.1	17.6	17.6	17.7	17.6	17.6	

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BEAMS

WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS
FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot						Deflection Inches
	33 x 15¾			33 x 11½			
	240	220	200	152	141	130	
d/bt	1.51	1.65	1.82	2.74	3.01	3.36	
L_u	33	30	27	18	16.5	15	
10						498	.06
11				554	524	490	.08
12				540	496	449	.09
13				499	458	415	.11
14	724	670	614	463	426	385	.12
15	721	658	595	432	397	359	.14
16	676	617	558	405	372	337	.16
17	636	581	525	382	350	317	.18
18	601	549	496	360	331	300	.20
19	569	520	470	341	314	284	.23
20	541	494	446	324	298	269	.25
21	515	470	425	309	284	257	.28
22	492	449	406	295	271	245	.30
23	470	429	388	282	259	234	.33
24	451	412	372	270	248	225	.36
25	433	395	357	259	238	216	.39
26	416	380	343	249	229	207	.42
27	401	366	331	240	221	199	.46
28	386	353	319	232	213	193	.49
29	373	341	308	224	205	186	.53
30	361	329	298	216	199	179	.56
32	338	309	279	203	186	168	.64
34	318	291	263	191	175	159	.73
36	300	274	248	180	166	150	.81
38	285	260	235	171	157	142	.91
40	270	247	223	162	149	135	1.00
42	258	235	213	154	142	128	1.11
44	246	224	203	147	135	122	1.21
46	235	215	194	141	130	117	1.33
48	225	206	186	135	124	112	1.45
50	216	198	179	130	119	108	1.57
52	208	190	172	125	115	104	1.70
54	200	183	165	120	110	100	1.83
56	193	176	159	116	106	96	1.97
58	187	170	154	112	103	93	2 11
60	180	165	149	108	99	90	2.26
62	175	159	144	105	96	87	2.41
64	169	154	140	101	93	84	2.57
66	164	150	135	98	90	82	2.73
68	159	145	131	95	88	79	2.90

PROPERTIES AND REACTION VALUES

	240	220	200	152	141	130	
S in.³	811.1	740.6	669.6	486.4	446.8	404.8	
V kips	362	335	307	277	262	249	
R kips	118	108	98	82	76	72	
G kips	19.9	18.6	17.2	15.2	14.5	13.9	
N in.	15.7	15.7	15.7	16.3	16.3	16.3	

BEAMS

30

WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot							Deflection Inches
	30 x 15			30 x 10½				
	210	190	172	132	124	116	108	
d/bt	1.53	1.69	1.87	2.87	3.08	3.36	3.74	
L_u	32.5	29.5	26.5	17.5	16	15	13	
9						440	424	.06
10						437	399	.07
				484	458			
11				460	430	397	363	.08
12				422	394	364	332	.10
13			508	389	364	336	307	.12
14	612	556	503	362	338	312	285	.14
15	578	521	470	338	315	292	266	.16
16	542	488	440	316	296	273	249	.18
17	510	460	414	298	278	257	235	.20
18	481	434	391	281	263	243	222	.22
19	456	411	371	267	249	230	210	.25
20	433	391	352	253	236	219	200	.28
21	413	372	335	241	225	208	190	.30
22	394	355	320	230	215	199	181	.33
23	377	340	306	220	206	190	173	.37
24	361	326	294	211	197	182	166	.40
25	347	313	282	203	189	175	160	.43
26	333	301	271	195	182	168	153	.47
27	321	289	261	188	175	162	148	.50
28	310	279	252	181	169	156	143	.54
29	299	270	243	175	163	151	138	.58
30	289	261	235	169	158	146	133	.62
32	271	244	220	158	148	137	125	.71
34	255	230	207	149	139	129	117	.80
36	241	217	196	141	131	122	111	.89
38	228	206	185	133	124	115	105	1.00
40	217	195	176	127	118	109	100	1.10
42	206	186	168	121	113	104	95	1.22
44	197	178	160	115	107	99	91	1.34
46	188	170	153	110	103	95	87	1.46
48	181	163	147	106	99	91	83	1.59
50	173	156	141	101	95	88	80	1.72
52	167	150	135	97	91	84	77	1.87
54	161	145	130	94	88	81	74	2.01
56	155	140	126	90	84	78	71	2.16
58	149	135	121	87	82	75	69	2.32
60	144	130	117	84	79	73	67	2.48
62	140	126	114	82	76	71	64	2.65
PROPERTIES AND REACTION VALUES								
S $in.^3$	649.9	586.1	528.2	379.7	354.6	327.9	299.2	
V kips	306	278	254	242	229	220	212	
R kips	108	97	87	77	72	69	66	
G kips	18.6	17.0	15.7	14.8	14.0	13.5	13.2	
N in.	14.2	14.1	14.1	14.7	14.7	14.7	14.7	

27

BEAMS

WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot						Deflection Inches
	27 x 14			27 x 10			
	177	160	145	114	102	94	
d/bt	1.63	1.80	1.97	2.91	3.27	3.61	
L_u	30.5	27.5	25	17	15	13.5	
9				404	364	344	.06
10				399	356	324	.08
11				363	323	294	.09
12	514	464	420	332	296	270	.11
13	505	455	413	307	274	249	.13
14	469	423	384	285	254	231	.15
15	438	395	358	266	237	216	.17
16	411	370	336	249	222	202	.20
17	387	348	316	235	209	190	.22
18	365	329	298	222	197	180	.25
19	346	312	283	210	187	170	.28
20	329	296	269	200	178	162	.31
21	313	282	256	190	169	154	.34
22	299	269	244	181	162	147	.37
23	286	257	234	173	154	141	.41
24	274	247	224	166	148	135	.44
25	263	237	215	160	142	129	.48
26	253	228	207	153	137	125	.52
27	243	219	199	148	132	120	.56
28	235	211	192	143	127	116	.60
29	227	204	185	138	123	112	.64
30	219	197	179	133	119	108	.69
31	212	191	173	129	115	104	.74
32	205	185	168	125	111	101	.79
33	199	179	163	121	108	98	.83
34	193	174	158	117	104	95	.89
35	188	169	154	114	101	92	.94
36	183	164	149	111	99	90	.99
37	178	160	145	108	96	87	1.05
38	173	156	141	105	93	85	1.11
39	169	152	138	102	91	83	1.17
40	164	148	134	100	89	81	1.23
42	157	141	128	95	85	77	1.35
44	149	135	122	91	81	74	1.48
46	143	129	117	87	77	70	1.62
48	137	123	112	83	74	67	1.77
50	131	118	108	80	71	65	1.92
52	126	114	103	77	68	62	2.07
54	122	110	100	74	66	60	2.24
56	117	106	96	71	63	58	2.40

PROPERTIES AND REACTION VALUES

	177	160	145	114	102	94
S in.^{3}	492.8	444.5	402.9	299.2	266.3	242.8
V kips	257	232	210	202	182	172
R kips	98	88	78	70	63	58
G kips	17.4	15.8	14.4	13.7	12.4	11.8
N in.	12.7	12.6	12.6	13.1	13.1	13.1

BEAMS

24

WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot									Deflection Inches
	24 x 14			24 x 12			24 x 9			
	160	145	130	120	110	100	94	84	76	
d/bt	1.55	1.71	1.93	2.16	2.34	2.58	3.07	3.47	3.90	
L_u	32	29	26	23	21	19	16	14.5	12.5	
8								294	274	.06
9							326	291	260	.07
10							295	262	234	.09
11				352	320	292	268	238	213	.10
12		388	356	332	305	277	245	218	195	.12
13	422	382	339	307	281	255	227	202	180	.15
14	394	355	315	285	261	237	210	187	167	.17
15	368	331	294	266	244	221	196	174	156	.19
16	345	311	276	249	229	207	184	164	146	.22
17	324	292	259	235	215	195	173	154	138	.25
18	306	276	245	222	203	184	164	145	130	.28
19	290	261	232	210	193	175	155	138	123	.31
20	276	248	221	199	183	166	147	131	117	.35
21	263	236	210	190	174	158	140	125	112	.38
22	251	226	200	181	166	151	134	119	106	.42
23	240	216	192	173	159	144	128	114	102	.46
24	230	207	184	166	153	138	123	109	98	.50
25	221	199	176	160	146	133	118	105	94	.54
26	212	191	170	153	141	128	113	101	90	.58
27	204	184	163	148	136	123	109	97	87	.63
28	197	177	158	142	131	119	105	93	84	.68
29	190	171	152	138	126	114	102	90	81	.73
30	184	166	147	133	122	111	98	87	78	.78
31	178	160	142	129	118	107	95	84	75	.83
32	172	155	138	125	114	104	92	82	73	.88
33	167	151	134	121	111	101	89	79	71	.94
34	162	146	130	117	108	98	87	77	69	1.00
35	158	142	126	114	105	95	84	75	67	1.06
36	153	138	123	111	102	92	82	73	65	1.12
37	149	134	119	108	99	90	80	71	63	1.18
38	145	131	116	105	96	87	78	69	61	1.25
39	141	127	113	102	94	85	76	67	60	1.31
40	138	124	110	100	92	83	74	65	58	1.38
42	131	118	105	95	87	79	70	62	56	1.52
44	125	113	100	91	83	75	67	59	53	1.67
46	120	108	96	87	80	72	64	57	51	1.82
48	115	104	92	83	76	69	61	55	49	1.99
50	110	99	88	80	73	66	59	52	47	2.16

PROPERTIES AND REACTION VALUES

S $in.^3$	413.5	372.5	330.7	299.1	274.4	248.9	220.9	196.3	175.4	
V kips	211	194	178	176	160	146	163	147	137	
R kips	87	78	71	69	63	57	61	55	50	
G kips	15.7	14.6	13.6	13.3	12.2	11.2	12.4	11.3	10.6	
N in.	11.4	11.4	11.4	11.5	11.5	11.4	11.7	11.7	11.7	

21

BEAMS

WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot								Deflection Inches
	21 x 13			21 x 9		21 x 8¼			
	142	127	112	96	82	73	68	62	
d/bt	1.49	1.65	1.87	2.50	2.93	3.46	3.73	4.15	
L_u	33.5	30	27	20	17	14.5	13.5	12	
7							236	218	.05
8				316	270	202	233	211	.06
9				293	249	223	207	187	.08
10				264	224	201	187	169	.10
11	368	326	288	240	204	183	170	153	.12
12	352	316	277	220	187	167	155	141	.14
13	325	292	256	203	172	155	144	130	.17
14	302	271	238	188	160	144	133	120	.19
15	282	253	222	176	149	134	124	112	.22
16	264	237	208	165	140	126	117	105	.25
17	249	223	196	155	132	118	110	99	.29
18	235	211	185	146	124	112	104	94	.32
19	223	199	175	139	118	106	98	89	.36
20	212	189	166	132	112	101	93	84	.39
21	201	180	159	126	107	96	89	80	.43
22	192	172	151	120	102	91	85	77	.48
23	184	165	145	115	97	87	81	73	.52
24	176	158	139	110	93	84	78	70	.57
25	169	152	133	105	90	80	75	67	.62
26	163	146	128	101	86	77	72	65	.67
27	157	140	123	98	83	74	69	62	.72
28	151	135	119	94	80	72	67	60	.77
29	146	131	115	91	77	69	64	58	.83
30	141	126	111	88	75	67	62	56	.89
31	136	122	107	85	72	65	60	54	.95
32	132	118	104	82	70	63	58	53	1.01
33	128	115	101	80	68	61	57	51	1.07
34	124	111	98	78	66	59	55	50	1.14
35	121	108	95	75	64	57	53	48	1.21
36	118	105	93	73	62	56	52	47	1.28
37	114	102	90	71	61	54	50	45	1.35
38	111	100	88	69	59	53	49	44	1.42
39	109	97	85	68	57	52	48	43	1.50
40	106	95	83	66	56	50	47	42	1.58
41	103	92	81	64	55	49	46	41	1.66
42	101	90	79	63	53	48	44	40	1.74
43	98	88	77	61	52	47	43	39	1.82
44	96	86	76	60	51	46	42	38	1.91

PROPERTIES AND REACTION VALUES

	142	127	112	96	82	73	68	62	
S $in.^3$	317.2	284.1	249.6	197.6	168.0	150.7	139.9	126.4	
V kips	184	163	144	158	135	126	118	109	
R kips	85	74	65	70	59	53	49	45	
G kips	15.8	14.1	12.7	13.8	12.0	10.9	10.3	9.6	
N in.	9.7	9.8	9.8	9.9	9.9	10.2	10.2	10.2	

BEAMS 18

WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot										Deflection Inches
	18 x 11¾			18 x 8¾				18 x 7½			
	114	105	96	85	77	70	64	60	55	50	
d/bt	1.58	1.71	1.86	2.28	2.49	2.74	2.99	3.48	3.82	4.22	
L_u	31.5	29	27	22	20	18	16.5	14.5	13	12	
7								198	184	168	.06
8				250	224	206	188	179	164	148	.07
9				231	210	190	173	160	146	132	.09
10	286	264	242	208	189	171	156	144	131	119	.12
11	267	245	224	189	172	155	142	130	119	108	.14
12	245	225	205	173	157	142	130	120	109	99	.17
13	226	207	189	160	145	132	120	110	101	91	.19
14	210	193	176	149	135	122	111	102	94	85	.23
15	196	180	164	139	126	114	104	96	87	79	.26
16	183	169	154	130	118	107	98	90	82	74	.29
17	173	159	145	122	111	101	92	84	77	70	.33
18	163	150	137	116	105	95	87	80	73	66	.37
19	155	142	129	110	99	90	82	75	69	63	.42
20	147	135	123	104	95	86	78	72	66	59	.46
21	140	128	117	99	90	81	74	68	62	57	.51
22	133	123	112	95	86	78	71	65	60	54	.56
23	128	117	107	91	82	74	68	62	57	52	.61
24	122	112	103	87	79	71	65	60	55	49	.66
25	117	108	98	83	76	68	62	57	52	48	.72
26	113	104	95	80	73	66	60	55	50	46	.78
27	109	100	91	77	70	63	58	53	49	44	.84
28	105	96	88	74	68	61	56	51	47	42	.90
29	101	93	85	72	65	59	54	49	45	41	.97
30	98	90	82	69	63	57	52	48	44	40	1.03
31	95	87	79	67	61	55	50	46	42	38	1.11
32	92	84	77	65	59	53	49	45	41	37	1.18
33	89	82	75	63	57	52	47	43	40	36	1.25
34	86	79	72	61	56	50	46	42	39	35	1.33
35	84	77	70	60	54	49	45	41	37	34	1.41
36	82	75	68	58	53	48	43	40	36	33	1.49
37	79	73	67	56	51	46	42	39	35	32	1.57
38	77	71	65	55	50	45	41	38	35	31	1.66

PROPERTIES AND REACTION VALUES

	114	105	96	85	77	70	64	60	55	50
S in.³	220.1	202.2	184.4	156.1	141.7	128.2	117.0	107.8	98.2	89.0
V kips	143	132	121	125	112	103	94	99	92	84
R kips	74	68	62	63	56	51	46	47	43	39
G kips	14.3	13.3	12.3	12.6	11.4	10.5	9.7	10.0	9.4	8.6
N in.	8.3	8.3	8.3	8.4	8.5	8.4	8.4	8.7	8.7	8.7

16

BEAMS

WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot										Deflection Inches
	16 x 11½		16 x 8½				16 x 7				
	96	88	78	71	64	58	50	45	40	36	
d/bt	1.62	1.77	2.17	2.38	2.63	2.91	3.66	4.07	4.54	5.30	
L_u	31	28	23	21	19	17	13.5	12	11	9.5	
6							160	146	128	124	.05
7			224	204	184	168	154	138	123	107	.06
8			213	193	174	157	135	121	107	94	.08
9	228	212	189	172	154	139	120	107	95	83	.11
10	222	202	170	155	139	126	108	97	86	75	.13
11	201	183	155	141	126	114	98	88	78	68	.16
12	185	168	142	129	116	105	90	80	72	63	.19
13	170	155	131	119	107	97	83	74	66	58	.22
14	158	144	122	110	99	90	77	69	61	54	.25
15	148	135	114	103	93	84	72	64	57	50	.29
16	138	126	107	97	87	78	67	60	54	47	.33
17	130	119	100	91	82	74	63	57	51	44	.37
18	123	112	95	86	77	70	60	54	48	42	.42
19	117	106	90	81	73	66	57	51	45	40	.47
20	111	101	85	77	70	63	54	48	43	38	.52
21	106	96	81	74	66	60	51	46	41	36	.57
22	101	92	78	70	63	57	49	44	39	34	.63
23	96	88	74	67	60	55	47	42	37	33	.68
24	92	84	71	64	58	52	45	40	36	31	.75
25	89	81	68	62	56	50	43	39	34	30	.81
26	85	78	66	59	53	48	41	37	33	29	.87
27	82	75	63	57	52	47	40	36	32	28	.94
28	79	72	61	55	50	45	38	35	31	27	1.01
29	76	70	59	53	48	43	37	33	30	26	1.09
30	74	67	57	52	46	42	36	32	29	25	1.16
31	71	65	55	50	45	41	35	31	28	24	1.24
32	69	63	53	48	43	39	34	30	27	24	1.32
33	67	61	52	47	42	38	33	29	26	23	1.41
34	65	59	50	46	41	37	32	28	25	22	1.50

PROPERTIES AND REACTION VALUES

S $in.^3$	166.1	151.3	127.8	115.9	104.2	94.1	80.7	72.4	64.4	56.3
V kips	114	106	112	102	92	84	80	73	64	62
R kips	66	61	64	57	51	46	42	38	33	32
G kips	12.8	12.1	12.7	11.7	10.6	9.8	9.1	8.3	7.4	7.2
N in.	7.2	7.3	7.3	7.4	7.4	7.3	7.7	7.7	7.7	7.6

BEAMS

14

WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot										Deflection Inches
	14 x 14½					14 x 12		14 x 10			
	119	111	103	95	87	84	78	74	68	61	
d/bt	1.06	1.13	1.20	1.30	1.40	1.52	1.63	1.80	1.95	2.16	
L_u	47	44	41	38	35.5	33	30.5	28	25.5	23	
9								166	152	136	.12
10						166	156	150	137	123	.15
11	214	202	184	170		159	147	136	125	112	.18
12	210	196	182	167	152	145	135	125	114	102	.21
13	194	181	168	155	142	134	124	115	106	95	.25
14	180	168	156	143	132	125	115	107	98	88	.29
15	168	157	145	134	123	116	108	100	92	82	.33
16	158	147	136	126	115	109	101	94	86	77	.38
17	149	138	128	118	108	103	95	88	81	72	.43
18	140	131	121	112	102	97	90	83	76	68	.48
19	133	124	115	106	97	92	85	79	72	65	.53
20	126	118	109	100	92	87	81	75	69	62	.59
21	120	112	104	96	88	83	77	71	65	59	.65
22	115	107	99	91	84	79	73	68	62	56	.72
23	110	102	95	87	80	76	70	65	60	53	.78
24	105	98	91	84	77	73	67	62	57	51	.85
25	101	94	87	80	74	70	65	60	55	49	.92
26	97	90	84	77	71	67	62	58	53	47	1.00
27	94	87	81	74	68	65	60	56	51	46	1.08
28	90	84	78	72	66	62	58	54	49	44	1.16
29	87	81	75	69	64	60	56	52	47	42	1.24
30	84	78	73	67	61	58	54	50	46	41	1.33
31	81	76	70	65	59	56					
32	79	73	68	63	57	54					
33	76	71	66	61	56	53					
34	74	69	64	59	54						
35	72	67	62	57	53						
36	70	65	60	56	51						
37	68	63	59	54							
38	66	62	57	53							

PROPERTIES AND REACTION VALUES

	119	111	103	95	87	84	78	74	68	61
S in.^{3}	189.4	176.3	163.6	150.6	138.1	130.9	121.1	112.3	103.0	92.2
V kips	107	101	92	85	76	83	78	83	76	68
R kips	69	65	59	55	49	53	49	53	48	43
G kips	13.7	13.0	11.9	11.2	10.1	10.8	10.3	10.8	10.0	9.1
N in.	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3

14

BEAMS

WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot						Deflection Inches
	14 x 8			14 x 6¾			
	53	48	43	38	34	30	
d/bt	2.63	2.90	3.24	4.06	4.58	5.37	
L_u	19	17	15.5	12.5	11	9.5	
5						98	.04
6				116	104	93	.05
7	134	122	110	104	92	80	.07
8	130	117	105	91	81	70	.10
9	115	104	93	81	72	62	.12
10	104	94	84	73	65	56	.15
11	94	85	76	66	59	51	.18
12	86	78	70	61	54	46	.21
13	80	72	64	56	50	43	.25
14	74	67	60	52	46	40	.29
15	69	62	56	49	43	37	.33
16	65	59	52	46	40	35	.38
17	61	55	49	43	38	33	.43
18	58	52	46	40	36	31	.48
19	55	49	44	38	34	29	.53
20	52	47	42	36	32	28	.59
21	49	45	40	35	31	27	.65
22	47	43	38	33	29	25	.72
23	45	41	36	32	28	24	.78
24	43	39	35	30	27	23	.85
25	42	37	33	29	26	22	.92
26	40	36	32	28	25	21	1.00
27	38	35	31	27	24	21	1.08
28	37	33	30	26	23	19.9	1.16
29	36	32	29	25	22	19.2	1.24
30	35	31	28	24	22	18.6	1.33

PROPERTIES AND REACTION VALUES

	53	48	43	38	34	30
S $in.^3$	77.8	70.2	62.7	54.6	48.5	41.8
V kips	67	61	55	58	52	49
R kips	42	38	34	34	31	28
G kips	8.9	8.1	7.4	7.5	6.9	6.5
N in.	6.3	6.3	6.3	6.7	6.6	6.6

BEAMS

12

WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS
FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot						Deflection Inches
	12 x 12				12 x 10		
	85	79	72	65	58	53	
d/bt	1.29	1.39	1.52	1.67	1.90	2.09	
L_u	38	36	33	30	26	24	
8						108	.11
9	160	152	138	122	114	105	.14
10	154	143	130	117	104	94	.17
11	140	130	118	107	95	86	.21
12	129	119	108	98	87	79	.25
13	119	110	100	90	80	73	.29
14	110	102	93	84	74	67	.34
15	103	95	87	78	69	63	.39
16	96	89	81	73	65	59	.44
17	91	84	77	69	61	56	.50
18	86	79	72	65	58	52	.56
19	81	75	68	62	55	50	.62
20	77	71	65	59	52	47	.69
21	74	68	62	56	50	45	.76
22	70	65	59	53	47	43	.83
23	67	62	57	51	45	41	.91
24	64	60	54	49	43	39	.99
25	62	57	52	47	42	38	1.08
26	59	55	50	45			
27	57	53	48	43			
28	55	51	46	42			
29	53	49	45	40			
30	51	48	43	39			
31	50	46	42				
32	48	45	41				
33	47	43	39				
34	45	42					
35	44	41					
36	43	40					
37	42						
38	41						

PROPERTIES AND REACTION VALUES

S in.^{3}	115.7	107.1	97.5	88.0	78.1	70.7	
V kips	80	76	69	61	57	54	
R kips	58	54	49	44	41	39	
G kips	11.9	11.3	10.3	9.4	8.6	8.3	
N in.	5.4	5.4	5.4	5.4	5.4	5.3	

12

BEAMS

WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS
FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot						Deflection Inches
	12 x 8			12 x 6½			
	50	45	40	36	31	27	
d/bt	2.35	2.60	2.89	3.45	3.98	4.50	
L_u	21	19	17.5	14.5	12.5	10.5	
6				98	82	74	.06
7	118	106	92	87	75	65	.08
8	108	97	87	77	65	57	.11
9	96	86	77	68	58	50	.14
10	86	78	69	61	52	45	.17
11	78	71	63	56	48	41	.21
12	72	65	58	51	44	38	.25
13	66	60	53	47	40	35	.29
14	62	55	49	44	37	32	.34
15	58	52	46	41	35	30	.39
16	54	49	43	38	33	28	.44
17	51	46	41	36	31	27	.50
18	48	43	38	34	29	25	.56
19	45	41	36	32	27	24	.62
20	43	39	35	31	26	23	.69
21	41	37	33	29	25	22	.76
22	39	35	32	28	24	21	.83
23	38	34	30	27	23	20	.91
24	36	32	29	26	22	19	.99
25	35	31	28	25	21	18	1.08

PROPERTIES AND REACTION VALUES

S in.³	64.7	58.2	51.9	45.9	39.4	34.1
V kips	59	53	46	49	41	37
R kips	42	38	33	33	28	25
G kips	8.9	8.1	7.1	7.3	6.35	5.75
N in.	5.4	5.4	5.3	5.7	5.6	5.7

BEAMS

10

WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot										Deflection Inches
	10 x 10				10 x 8			10 x 5¾			
	66	60	54	49	45	39	33	29	25	21	
d/bt	1.37	1.49	1.63	1.79	2.04	2.36	2.83	3.52	4.08	5.07	
L_u	36	33.5	30.5	28	24.5	21	17.5	14	12	10	
4										62	.03
5								76	66	57	.05
6						82	74	68	59	48	.07
7	124				92	80	67	59	50	41	.10
8	123	110	96	88	82	70	58	51	44	36	.13
9	109	99	90	81	73	62	52	46	39	32	.17
10	98	90	81	73	66	56	47	41	35	29	.21
11	89	81	73	66	60	51	42	37	32	26	.25
12	82	75	67	61	55	47	39	34	29	24	.30
13	76	69	62	56	50	43	36	32	27	22	.35
14	70	64	58	52	47	40	33	29	25	21	.41
15	66	60	54	49	44	37	31	27	23	19.1	.47
16	61	56	50	46	41	35	29	26	22	17.9	.53
17	58	53	47	43	39	33	28	24	21	16.9	.60
18	55	50	45	40	36	31	26	23	19	15.9	.67
19	52	47	42	38	35	30	25	22	18	15.1	.75
20	49	45	40	36	33	28	23	21	17	14.3	.83
21	47	43	38	35	31	27	22	19.6	16	13.7	.91
22	44	41	36	33	30						
23	42	39	35	32	28						
24	41	37	33	30	27						
25	39	36	32	29							
26	38	34	31	28							
27	36	33	30	27							
28	35	32	29	26							
29	34	31	28								
30	32	30	27								

PROPERTIES AND REACTION VALUES

S $in.^3$	73.7	67.1	60.4	54.6	49.1	42.2	35.0	30.8	26.4	21.5
V kips	62	55	48	44	46	41	37	38	33	31
R kips	52	47	41	37	39	35	31	30	26	24
G kips	11.0	10.0	8.8	8.2	8.4	7.65	7.0	6.9	6.05	5.8
N in.	4.4	4.4	4.4	4.4	4.4	4.3	4.3	4.7	4.7	4.7

8 BEAMS

WF BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot						Deflection Inches
	8 x 8		8 x 6½		8 x 5¼		
	35	31	28	24	20	17	
d/bt	2.05	2.31	2.66	3.07	4.08	4.95	
L_u	24	21.5	18.5	16	12	10	
3						48	.02
4					52	47	.04
5			60	50	45	38	.07
6	66	60	54	46	38	31	.09
7	59	52	46	40	32	27	.13
8	52	46	40	35	28	24	.17
9	46	41	36	31	25	21	.21
10	42	37	32	28	22.6	18.8	.26
11	38	33	29	25	20.6	17.1	.31
12	35	30	27	23	18.9	15.7	.37
13	32	28	25	21	17.4	14.5	.44
14	30	26	23	19.8	16.2	13.4	.51
15	28	24	21	18.5	15.1	12.5	.58
16	26	23	20	17.3	14.2	11.7	.66
17	24	22	19	16.3	13.3	11.1	.75
18	23	20	18				
19	22	19	17				
20	21	18					
21	20	17					
22	19	16					
23	18						
24	17						

PROPERTIES AND REACTION VALUES

	35	31	28	24	20	17
S in.³	31.1	27.4	24.3	20.8	17.0	14.1
V kips	33	30	30	25	26	24
R kips	33	30	30	25	25	23
G kips	7.6	6.9	6.85	5.9	5.95	5.5
N in.	3.5	3.5	3.6	3.5	3.7	3.7

BEAMS

24-20

AMERICAN STANDARD BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot										
	24 x 7⅞		24 x 7			D	20 x 7		20 x 6¼		D
	120	105.9	100	90	79.9		95	85	75	65.4	
d/bt	2.71	2.76	3.81	3.87	3.94		3.03	3.09	3.97	4.05	
L_u	18.5	18	13	13	12.5		16.5	16	12.5	12	
5			466				416	340	334		.03
6	498		439	390		.03	356	334	281	260	.04
7	478		376	354	312	.04	303	286	241	223	.05
8	418	390	329	310	290	.06	267	250	211	195	.07
9	372	347	293	275	258	.07	237	223	187	173	.08
10	335	312	264	248	232	.09	213	200	169	156	.10
11	304	284	240	225	211	.10	194	182	153	142	.13
12	279	260	220	206	193	.12	178	167	140	130	.15
13	257	240	203	191	178	.15	164	154	130	120	.18
14	239	223	188	177	166	.17	152	143	120	111	.20
15	223	208	176	165	155	.19	142	134	112	104	.23
16	209	195	165	155	145	.22	133	125	105	97	.27
17	197	184	155	146	136	.25	126	118	99	92	.30
18	186	174	146	138	129	.28	118	111	94	87	.34
19	176	164	139	130	122	.31	112	105	89	82	.37
20	167	156	132	124	116	.35	107	100	84	78	.41
21	159	149	126	118	110	.38	102	95	80	74	.46
22	152	142	120	113	105	.42	97	91	77	71	.50
23	145	136	115	108	101	.46	93	87	73	68	.55
24	139	130	110	103	97	.50	89	84	70	65	.60
25	134	125	105	99	93	.54	85	80	67	62	.65
26	129	120	101	95	89	.58	82	77	65	60	.70
27	124	116	98	92	86	.63	79	74	62	58	.75
28	120	112	94	89	83	.68	76	72	60	56	.81
29	115	108	91	85	80	.73	74	69	58	54	.87
30	112	104	88	83	77	.78	71	67	56	52	.93
31	108	101	85	80	75	.83	69	65	54	50	.99
32	105	98	82	77	73	.88	67	63	53	49	1.06
33	101	95	80	75	70	.94	65	61	51	47	1.13
34	98	92	78	73	68	1.00	63	59	50	46	1.20
35	96	89	75	71	66	1.06	61	57	48	45	1.27
36	93	87	73	69	64	1.12	59	56	47	43	1.34
37	90	84	71	67	63	1.18	58	54	46	42	1.42
38	88	82	69	65	61	1.25	56	53	44	41	1.49
39	86	80	68	64	60	1.31	55	51	43	40	1.57
40	84	78	66	62	58	1.38	53	50	42	39	1.66
42	80	74	63	59	55	1.52	51	48	40	37	1.83
44	76	71	60	56	53	1.67					
46	73	68	57	54	50	1.82					
48	70	65	55	52	48	1.99					
50	67	63	53	50	46	2.16					

Note:
D = Deflection in Inches.

PROPERTIES AND REACTION VALUES

	120	105.9	100	90	79.9		95	85	75	65.4	
S in.³	250.9	234.3	197.6	185.8	173.9		160.0	150.2	126.3	116.9	
V kips	249	195	233	195	156		208	170	167	130	
R kips	104	82	92	77	62		101	82	78	61	
G kips	19.2	15.0	17.9	15.0	12.0		19.2	15.7	15.4	12.0	
N in.	11.1	11.1	11.4	11.4	11.4		9.1	9.1	9.3	9.3	

18-15-12

BEAMS

AMERICAN STANDARD BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot										
	18 x 6		D	15 x 5½		D	12 x 5¼		12 x 5		D
	70	54.7		50	42.9		50	40.8	35	31.8	
d/bt	4.17	4.35		4.28	4.39		3.32	3.47	4.34	4.41	
L_u	12	11.5		11.5	11		15	14.5	11.5	11.5	
3							214		134		.02
4	332			214	160	.02	168	144	126	110	.03
5	272	216	.03	171	157	.03	134	120	101	96	.04
6	226	196	.04	143	131	.05	112	100	84	80	.06
7	194	168	.06	122	112	.07	96	85	72	69	.08
8	170	147	.07	107	98	.09	84	75	63	60	.11
9	151	131	.09	95	87	.11	75	66	56	53	.14
10	136	118	.12	86	79	.14	67	60	50	48	.17
11	124	107	.14	78	71	.17	61	54	46	44	.21
12	113	98	.17	71	65	.20	56	50	42	40	.25
13	105	91	.19	66	60	.23	52	46	39	37	.29
14	97	84	.23	61	56	.27	48	43	36	34	.34
15	91	79	.26	57	52	.31	45	40	34	32	.39
16	85	74	.29	54	49	.35	42	37	32	30	.44
17	80	69	.33	50	46	.40	40	35	30	28	.50
18	76	66	.37	48	44	.45	37	33	28	27	.56
19	72	62	.42	45	41	.50	35	31	27	25	.62
20	68	59	.46	43	39	.55	34	30	25	24	.69
21	65	56	.51	41	37	.61	32	28	24	23	.76
22	62	54	.56	39	36	.67	31	27	23	22	.83
23	59	51	.61	37	34	.73	29	26	22	21	.91
24	57	49	.66	36	33	.79	28	25	21	20	.99
25	54	47	.72	34	31	.86	27	24	20	19.2	1.08
26	52	45	.78	33	30	.93					
27	50	44	.84	32	29	1.01					
28	49	42	.90	31	28	1.08					
29	47	41	.97	30	27	1.16					
30	45	39	1.03	29	26	1.24					
31	44	38	1.11	28	25	1.33					
32	43	37	1.18	27	25	1.41					
33	41	36	1.25								
34	40	35	1.33								
35	39	34	1.41								
36	38	33	1.49								
37	37	32	1.57								
38	36	31	1.66								

Note:
D = Deflection in Inches.

PROPERTIES AND REACTION VALUES

S in.^{3}	101.9	88.4		64.2	58.9		50.3	44.8	37.8	36.0	
V kips	166	108		107	80		107	72	67	55	
R kips	83	54		63	47		79	53	48	39	
G kips	17.1	11.0		13.2	9.8		16.5	11.0	10.3	8.4	
N in.	8.4	8.4		6.9	6.9		5.2	5.2	5.4	5.4	

BEAMS

10-8-7

AMERICAN STANDARD BEAMS

I

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot								
	10 x 4¾			8 x 4			7 x 3¾		
	35.0	25.4	D	23.0	18.4	D	20.0	15.3	D
d/bt	4.12	4.37		4.51	4.71		4.62	4.88	
L_u	12	11.5		11	10.5		11	10	
2	154		.01	92		.01	82		.01
3	130		.02	71	56	.02	53	46	.03
4	97	80	.03	53	47	.04	40	35	.05
5	78	65	.05	43	38	.07	32	28	.07
6	65	54	07	36	32	.09	27	23	.11
7	56	47	.10	31	27	.13	23	19.8	.15
8	49	41	.13	27	24	.17	20	17.3	.19
9	43	36	.17	24	21	.21	17.8	15.4	24
10	39	33	.21	21	18.9	.26	16.0	13.9	.30
11	35	30	.25	19.4	17.2	.31	14.5	12.6	.36
12	32	27	.30	17.8	15.8	.37	13.3	11.6	.43
13	30	25	.35	16.4	14.6	.44	12.3	10.7	.50
14	28	23	41	15.2	13.5	.51	11.4	9.9	.58
15	26	22	.47	14.2	12.6	.58	10.7	9.2	.67
16	24	20	.53	13.3	11.8	.66			
17	23	19.1	.60	12.5	11.1	.73			
18	22	18.1	.67						
19	21	17.1	.75						
20	19.5	16.3	.83						
21	18.5	15.5	.91						

Note:

D = Deflection in Inches.

PROPERTIES AND REACTION VALUES									
S in.³	29.2	24.4		16.0	14.2		12.0	10.4	
V kips	77	40		46	28		41	23	
R kips	64	34		46	28		*47*	*26*	
G kips	14.3	7.4		10.6	6.5		10.8	6.0	
N in.	4.4	4.4		3.5	3.5		3.0	3.0	

Values of R in italics exceed maximum web shear V.

6-5-4-3 BEAMS

AMERICAN STANDARD BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot											
	6 x 3⅜			5 x 3			4 x 2¾			3 x 2⅜		
	17.25	12.5	D	14.75	10.0	D	9.5	7.7	D	7.5	5.7	D
d/bt	4.69	5.02		4.67	5.11		4.89	5.13		4.60	4.95	
L_u	10.5	10		10.5	10		10	9.5		11	10	
2		36	.01		27	.02						
3	39	32	.03	27	21	.04	14.7	13.3	.05	8.4	7.6	.06
4	29	24	.06	20	16.0	.07	11.0	10.0	.08	6.3	5.7	.11
5	23	19.5	.09	16.0	12.8	.10	8.8	8.0	.13	5.1	4.5	.17
6	19.3	16.2	.12	13.3	10.7	.15	7.3	6.7	.19	4.2	3.8	.25
7	16.6	13.9	.17	11.4	9.1	.20	6.3	5.7	.25	3.6	3.2	.34
8	14.5	12.2	.22	10.0	8.0	.27	5.5	5.0	.33			
9	12.9	10.8	.28	8.9	7.1	.34	4.9	4.4	.42			
10	11.6	9.7	.35	8.0	6.4	.41						
11	10.5	8.8	.42	7.3	5.8	.50						
12	9.7	8.1	.50									
13	8.9	7.3	.58									

Note:

D = Deflection in Inches.

PROPERTIES AND REACTION VALUES

S in.^{3}	8.7	7.3		6.0	4.8		3.3	3.0		1.9	1.7	
V kips	36	17.9		32	13.7		17.0	9.9		13.6	6.6	
R kips	*47*	*24*		*30*	*21*		*32*	*18.8*		*34*	*16.6*	
G kips	11.2	6.5		11.9	5.0		7.8	4.6		8.4	4.1	
N in.	2.5	2.5		2.0	2.0		1.5	1.5		1.1	1.1	

Values of R in italics exceed maximum web shear V.

MISCELLANEOUS
LIGHT BEAMS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot									
	*12 x 4			*10 x 4			*8 x 4		*6 x 4	
	22	19	16.5	19	17	15	15	13	16	12
d/bt	7.2	8.7	11.2	6.5	7.7	9.3	6.5	7.9	3.8	5.4
L_u	7	5.5	4.5	7.5	6.5	5.5	7.5	6	13	9
2								48		36
3		76	72	66	64	60	52	44	42	32
4	84	71	58	63	54	46	39	33	34	24
5	68	57	47	50	43	37	32	26	27	19.3
6	56	48	39	42	36	31	26	22	22	16.1
7	48	41	33	36	31	26	23	18.8	19.2	13.8
8	42	36	29	31	27	23	19.7	16.5	16.8	12.1
9	38	32	26	28	24	20	17.5	14.6	15.0	10.7
10	34	29	23	25	22	18.4	15.7	13.2	13.5	9.7
11	31	26	21	23	19.6	16.7	14.3	12.0	12.2	8.8
12	28	24	19.4	21	18.0	15.3	13.1	11.0	11.2	8.0
13	26	22	17.9	19.3	16.6	14.2	12.1	10.1	10.4	7.4
14	24	20	16.7	17.9	15.4	13.1	11.2	9.4		
15	23	19.0	15.6	16.7	14.4	12.3	10.5	8.8		
16	21	17.8	14.6	15.7	13.5	11.5	9.8	8.2		
17	19.8	16.8	13.7	14.7	12.7	10.8	9.3	7.7		
18	18.7	15.9	13.0	13.9	12.0	10.2				
19	17.8	15.0	12.3	13.2	11.4	9.7				
20	16.9	14.3	11.7	12.5	10.8	9.2				
21	16.1	13.6	11.1	11.9	10.3	8.8				
22	15.3	13.0	10.6							
23	14.7	12.4	10.1							
24	14.1	11.9	9.7							
25	13.5	11.4	9.3							
PROPERTIES AND REACTION VALUES										
S in.³	25.3	21.4	17.5	18.8	16.2	13.8	11.8	9.88	10.1	7.24
V kips	42	38	36	33	32	30	26	24	21	17.9
R kips	27	24	23	25	24	22	24	22	*26*	*22*
G kips	6.2	5.8	5.5	6.0	5.8	5.5	5.9	5.5	6.2	5.5
N in.	5.9	5.9	5.9	4.9	4.9	4.9	3.8	3.8	2.7	2.7

*Rolled by Bethlehem Steel Co. and Carnegie-Illinois Steel Corp.
Values of R in italics exceed maximum web shear V

MISCELLANEOUS

LIGHT BEAMS AND JOISTS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS LATERALLY SUPPORTED

Span in Feet	Nominal Depth and Width—Weight per Foot									
	*12 x 4	*10 x 4	*8 x 4	*6 x 4	†10 x 5¾		†8 x 6½		†8 x 5¼	
	14	11.5	10	8.5	25	21	28	24	20	17
d/bt	13.4	12.3	9.8	7.7	4.5	4.6	3.2	3.3	4.8	4.9
L_u	3.5	4	5	6.5	11	11	15	15	10	10
2				26					72	
3	62	46	35	23	90		82		67	
4	49	35	26	16.9	79	62	75		51	47
5	40	28	21	13.5	63	58	60	51	41	37
6	33	23	17.3	11.3	52	48	50	46	34	31
7	28	20	14.8	9.7	45	41	43	40	29	27
8	25	17.5	13.0	8.5	39	36	38	35	25	23
9	22	15.6	11.5	7.5	35	32	33	31	23	21
10	19.7	14.0	10.4	6.8	32	29	30	28	20	18.7
11	17.9	12.7	9.4	6.1	29	26	27	25	18.4	17.0
12	16.4	11.7	8.7	5.6	26	24	25	23	16.9	15.6
13	15.2	10.8	8.0	5.2	24	22	23	21	15.6	14.4
14	14.1	10.0	7.4		23	21	21	19.9	14.5	13.3
15	13.2	9.3	6.9		21	19.3	20	18.6	13.5	12.4
16	12.3	8.7	6.5		19.7	18.1	18.7	17.4	12.7	11.7
17	11.6	8.2	6.1		18.5	17.0	17.6	16.4	11.9	11.0
18	11.0	7.8			17.5	16.1				
19	10.4	7.4			16.6	15.2				
20	9.9	7.0			15.7	14.5				
21	9.4	6.7			15.0	13.8				
22	9.0									
23	8.6									
24	8.2									
25	7.9									
PROPERTIES AND REACTION VALUES										
S in.³	14.8	10.5	7.79	5.07	23.6	21.7	22.5	20.9	15.2	14.0
V kips	31	23	17.5	12.9	45	31	41	25	36	25
R kips	19.5	17.3	16.3	*16.1*	36	25	41	26	35	24
G kips	4.8	4.3	4.1	4.1	8.4	5.8	9.4	5.9	8.4	5.8
N in.	5.9	4.9	3.8	2.7	4.6	4.6	3.5	3.5	3.6	3.6

*Rolled by Bethlehem Steel Co. and Carnegie-Illinois Steel Corp.
†Rolled by The Phoenix Iron Co.
Values of R in italics exceed maximum web shear V

⊕ JUNIOR BEAMS AND JUNIOR CHANNELS

ALLOWABLE UNIFORM LOADS IN KIPS FOR BEAMS AND CHANNELS LATERALLY SUPPORTED

For beams and channels laterally unsupported, allowable loads must be reduced.

Span in Feet	Nominal Depth and Width—Weight per Foot									
	Beams							Channels		
	12x3	11x2⅞	10x2⅝	9x2⅜	8x2¼	7x2⅛	6x1⅞	12x1½	10x1½	10x1⅛
	11.8	10.3	9.0	7.5	6.5	5.5	4.4	10.6	8.4	6.5
d/bt	16	20	20	20	19	18	17			
L_u	3	2.5	2.5	2.5	2.5	2.5	3			
2	54	48	40	34	28	23		59		
3	53	43	35	26	21	15.6	10.7	41	29	19.5
4	40	32	26	19.3	15.7	11.7	8.0	31	20.6	14.7
5	32	26	21	15.5	12.5	9.3	6.4	25	17.3	11.7
6	27	21	17.3	12.9	10.4	7.8	5.3	20.6	14.4	9.8
7	23	18.3	14.9	11.0	9.0	6.7	4.6	17.7	12.4	8.4
8	20	16.0	13.0	9.7	7.8	5.8	4.0	15.5	10.8	7.3
9	17.8	14.2	11.6	8.6	7.0	5.2	3.6	13.8	9.6	6.5
10	16.0	12.8	10.4	7.7	6.3	4.7	3.2	12.4	8.7	5.9
11	14.5	11.6	9.5	7.0	5.7	4.2	2.9	11.3	7.9	
12	13.3	10.7	8.7	6.4	5.2	3.9	2.7	10.3	7.2	
13	12.3	9.8	8.0	5.9	4.8	3.6	2.5	9.5	6.7	
14	11.4	9.1	7.4	5.5	4.5	3.3		8.8		
15	10.7	8.5	6.9	5.2	4.2	3.1		8.3		
16	10.0	8.0	6.5	4.8	3.9			7.7		
17	9.4	7.5	6.1	4.5	3.7			7.3		
18	8.9	7.1	5.8	4.3						
19	8.4	6.7	5.5	4.1						
20	8.0	6.4	5.2							
21	7.6	6.1	5.0							
22	7.3	5.8								
23	7.0	5.6								
24	6.7									
25	6.4									
PROPERTIES AND REACTION VALUES										
S in.³	12.0	9.6	7.8	5.8	4.7	3.5	2.4	9.3	6.5	4.4
V kips	27	24	20	17.0	14.0	11.5	8.9	29.6	22.1	19.5
R kips	16.8	15.8	14.7	13.7	12.6	*11.7*	*10.6*			
G kips	4.2	4.0	3.7	3.5	3.2	3.0	2.7			
N in.	6.0	5.5	5.0	4.4	4.0	3.4	2.9			

⊕ Rolled by Jones & Laughlin Steel Corp.
Values of R in italics exceed maximum web shear V.

18-15

BEAMS

AMERICAN STANDARD CHANNELS

ALLOWABLE UNIFORM LOADS IN KIPS
FOR CHANNELS LATERALLY SUPPORTED

For channels laterally unsupported, allowable loads must be reduced.

Span in Feet	Nominal Depth and Width—Weight per Foot								
	18 x 4				Deflection Inches	15 x 3½			Deflection Inches
	58	51.9	45.8	42.7		50	40	33.9	
2						280			.01
3	328	280	234	210	.01	238	202	156	.01
4	248	230	212	203	.02	178	154	139	.02
5	199	184	170	163	.03	143	123	111	.03
6	166	154	142	136	.04	119	103	93	.05
7	142	132	121	116	.06	102	88	79	.07
8	124	115	106	102	.07	89	77	70	.09
9	110	102	94	90	.09	79	68	62	.11
10	99	92	85	81	.12	71	62	56	.14
11	90	84	77	74	.14	65	56	51	.17
12	83	77	71	68	.17	59	51	46	.20
13	76	71	65	63	.19	55	47	43	.23
14	71	66	61	58	.23	51	44	40	.27
15	66	61	57	54	.26	48	41	37	.31
16	62	58	53	51	.29	45	39	35	.35
17	58	54	50	48	.33	42	36	33	.40
18	55	51	47	45	.37	40	34	31	.45
19	52	49	45	43	.42	38	32	29	.50
20	50	46	43	41	.46	36	31	28	.55
21	47	44	40	39	.51	34	29	27	.61
22	45	42	39	37	.56	32	28	25	.67
23	43	40	37	35	.61	31	27	24	.73
24	41	38	35	34	.66	30	26	23	.79
25	40	37	34	33	.72	29	25	22	.86
26	38	35	33	31	.78	27	24	21	.93
27	37	34	32	30	.84	26	23	21	1.01
28	36	33	30	29	.90	26	22	19.9	1.08
29	34	32	29	28	.97	25	21	19.2	1.16
30	33	31	28	27	1.03	24	21	18.5	1.24
31	32	30	27	26	1.11	23	19.9	17.9	1.33
32	31	29	27	25	1.18	22	19.3	17.4	1.41
33	30	28	26	25	1.25	22	18.7	16.8	1.50
34	29	27	25	24	1.33	21	18.1	16.4	1.60
35	28	26	24	23	1.41	20	17.6	15.9	1.69
36	28	26	24	23	1.49	19.8	17.1	15.4	1.79
37	27	25	23	22	1.57	19.3	16.7	15.0	1.89
38	26	24	22	21	1.66	18.7	16.2	14.6	1.99
39	25	24	22	21	1.75				
40	25	23	21	20	1.84				
42	24	22	20	19.4	2.03				
44	23	21	19.3	18.5	2.23				
PROPERTIES AND REACTION VALUES									
S in.^{3}	74.5	69.1	63.7	61.0		53.6	46.2	41.7	
V kips	164	140	117	105		140	101	78	
R kips	81	69	58	52		83	60	46	
G kips	16.8	14.4	12.0	10.8		17.2	12.5	9.6	
N in.	8.4	8.4	8.4	8.4		6.8	6.8	6.8	

BEAMS

12-10

AMERICAN STANDARD CHANNELS

ALLOWABLE UNIFORM LOADS IN KIPS FOR CHANNELS LATERALLY SUPPORTED

For channels laterally unsupported, allowable loads must be reduced.

Span in Feet	Nominal Depth and Width—Weight per Foot								
	12 x 3			Deflection Inches	10 x 2⅝				Deflection Inches
	30	25	20.7		30	25	20	15.3	
2	160	120		.01			98	62	.01
3	120	106	88	.02	92	80	70	60	.02
4	90	80	71	.03	69	60	52	45	.03
5	72	64	57	.04	55	48	42	36	.05
6	60	53	48	.06	46	40	35	30	.07
7	51	46	41	.08	39	35	30	26	.10
8	45	40	36	.11	34	30	26	22	.13
9	40	35	32	.14	31	27	23	19.9	.17
10	36	32	29	.17	28	24	21	17.9	.21
11	33	29	26	.21	25	22	19.0	16.2	.25
12	30	27	24	.25	23	20	17.4	14.9	.30
13	28	25	22	.29	21	18.6	16.1	13.7	.35
14	26	23	20	.34	19.6	17.2	15.0	12.8	.41
15	24	21	19.0	.39	18.3	16.1	14.0	11.9	.47
16	22	19.9	17.8	.44	17.2	15.1	13.1	11.2	.53
17	21	18.7	16.8	.50	16.2	14.2	12.3	10.5	.60
18	19.9	17.7	15.9	.56	15.3	13.4	11.6	9.9	.67
19	18.9	16.8	15.0	.62	14.5	12.7	11.0	9.4	.75
20	17.9	15.9	14.3	.69	13.7	12.1	10.5	8.9	.83
21	17.1	15.2	13.6	.76	13.1	11.5	10.0	8.5	.91
22	16.3	14.5	13.0	.83	12.5	11.0	9.5	8.1	1.00
23	15.6	13.9	12.4	.91	11.9	10.5	9.1	7.8	1.10
24	14.9	13.3	11.9	.99	11.4	10.1	8.7	7.4	1.19
25	14.3	12.7	11.4	1.08	11.0	9.7	8.4	7.1	1.29
26	13.8	12.3	11.0	1.17					
27	13.3	11.8	10.6	1.26					
28	12.8	11.4	10.2	1.35					
29	12.4	11.0	9.8	1.45					
30	12.0	10.6	9.5	1.55					

PROPERTIES AND REACTION VALUES

	30	25	20.7		30	25	20	15.3	
S $in.^3$	26.9	23.9	21.4		20.6	18.1	15.7	13.4	
V kips	80	60	44		88	68	49	31	
R kips	56	42	31		72	56	40	26	
G kips	12.2	9.3	6.7		16.2	12.6	9.1	5.8	
N in.	5.4	5.4	5.4		4.5	4.5	4.5	4.5	

9-8-7

BEAMS

AMERICAN STANDARD CHANNELS

ALLOWABLE UNIFORM LOADS IN KIPS FOR CHANNELS LATERALLY SUPPORTED

For channels laterally unsupported, allowable loads must be reduced.

Span in Feet	Nominal Depth and Width—Weight per Foot											
	9 x 2½			Deflection	8 x 2¼			Deflection	7 x 2⅛			Deflection
	20	15	13.4	Inches	18.75	13.75	11.5	Inches	14.75	12.25	9.8	Inches
2		66	54	.01			46	.01			38	.01
3	60	50	47	.02	48	40	36	.02	34	31	27	.03
4	45	38	35	.04	36	30	27	.04	26	23	20	.05
5	36	30	28	.06	29	24	22	.07	21	18.4	16	.07
6	30	25	23	.08	24	20	18.0	.09	17.1	15.3	13.3	.11
7	26	22	20	.11	21	17.1	15.4	.13	14.7	13.1	11.4	.15
8	23	18.8	17.5	.15	18.2	15.0	13.5	.17	12.8	11.5	10.0	.19
9	20	16.7	15.6	.19	16.1	13.3	12.0	.21	11.4	10.2	8.9	.24
10	18.0	15.1	14.0	.23	14.5	12.0	10.8	.26	10.3	9.2	8.0	.30
11	16.4	13.7	12.7	.28	13.2	10.9	9.8	.31	9.3	8.4	7.3	.36
12	15.0	12.6	11.7	.33	12.1	10.0	9.0	.37	8.6	7.7	6.7	.43
13	13.8	11.6	10.8	.39	11.2	9.2	8.3	.44	7.9	7.1	6.2	.50
14	12.9	10.8	10.0	.45	10.4	8.6	7.7	.51	7.3	6.6	5.7	.58
15	12.0	10.0	9.3	.52	9.7	8.0	7.2	.58	6.8	6.1	5.3	.67
16	11.2	9.4	8.7	.59	9.1	7.5	6.7	.66	6.4	5.7	5.0	.76
17	10.6	8.9	8.2	.66	8.5	7.1	6.4	.75	6.0	5.4	4.7	.85
18	10.0	8.4	7.8	.75	8.1	6.7	6.0	.84	5.7	5.1	4.4	.96
19	9.5	7.9	7.4	.83	7.6	6.3	5.7	.93				
20	9.0	7.5	7.0	.92	7.3	6.0	5.4	1.04				
21	8.6	7.2	6.7	1.01								
22	8.2	6.8	6.4	1.11								
23	7.8	6.6	6.1	1.22								
PROPERTIES AND REACTION VALUES												
S in.³	13.5	11.3	10.5		10.9	9.0	8.1		7.7	6.9	6.0	
V kips	52	33	27		51	32	23		38	29	19.1	
R kips	47	30	24		50	31	23		*43*	*33*	*22*	
G kips	10.8	6.8	5.5		11.7	7.3	5.3		10.1	7.5	5.0	
N in.	4.0	4.0	4.0		3.5	3.5	3.5		3.0	3.0	3.0	

* Values of R in italics exceed maximum web shear V.

BEAMS 6-5-4-3

AMERICAN STANDARD CHANNELS

ALLOWABLE UNIFORM LOADS IN KIPS FOR CHANNELS LATERALLY SUPPORTED

For channels laterally unsupported, allowable loads must be reduced.

Span in Feet	Nominal Depth and Width—Weight per Foot													
	6 x 2			Deflection Inches	5 x 1¾		Deflection Inches	4 x 1⅝		Deflection Inches	3 x 1½			Deflection Inches
	13.0	10.5	8.2		9.0	6.7		7.25	5.4		6.0	5.0	4.1	
3	26	22	19.1	.03	15.6	13.3	.04	10.2	8.4	.05	6.2	5.3	4.9	.06
4	19.3	16.7	14.3	.06	11.7	10.0	.07	7.7	6.3	.08	4.7	4.0	3.7	.11
5	15.5	13.3	11.5	.09	9.3	8.0	.10	6.1	5.1	.13	3.7	3.2	2.9	.17
6	12.9	11.1	9.6	.12	7.8	6.7	.15	5.1	4.2	.19	3.1	2.7	2.4	.25
7	11.0	9.5	8.2	.17	6.7	5.7	.20	4.4	3.6	.25	2.7	2.3	2.1	.34
8	9.7	8.3	7.2	.22	5.8	5.0	.27	3.8	3.2	.33	2.3	2.0	1.8	.44
9	8.6	7.4	6.4	.28	5.2	4.4	.34	3.4	2.8	.42				
10	7.7	6.7	5.7	.35	4.7	4.0	.41	3.1	2.5	.52				
11	7.0	6.1	5.2	.42	4.2	3.6	.50							
12	6.4	5.6	4.8	.50	3.9	3.3	.60							
13	5.9	5.1	4.4	.58	3.6	3.1	.70							
14	5.5	4.8	4.1	.68										
15	5.2	4.4	3.8	.78										
PROPERTIES AND REACTION VALUES														
S in.³	5.8	5.0	4.3		3.5	3.0		2.3	1.9		1.4	1.2	1.1	
V kips	34	25	15.6		21	12.4		16.6	9.4		13.9	10.1	6.6	
R kips	*45*	*32*	*20*		*33*	*19.1*		*32*	*17.8*		*35*	*26*	*16.9*	
G kips	10.5	7.5	4.8		7.8	4.6		7.7	4.3		8.5	6.2	4.1	
N in.	2.5	2.5	2.5		2.0	2.0		1.5	1.5		1.0	1.0	1.0	

Values of R in italics exceed maximum web shear V.

SECTION MODULUS TABLE

FOR SHAPES USED AS BEAMS

Section Modulus	Shape
1105.1	36 WF 300
1031.2	36 WF 280
951.1	36 WF 260
892.5	36 WF 245
835.5	**36 WF 230**
811.1	33 WF 240
740.6	**33 WF 220**
669.6	**33 WF 200**
663.6	**36 WF 194**
649.9	30 WF 210
621.2	**36 WF 182**
586.1	30 WF 190
579.1	**36 WF 170**
541.0	**36 WF 160**
528.2	30 WF 172
502.9	**36 WF 150**
492.8	27 WF 177
486.4	33 WF 152
446.8	**33 WF 141**
444.5	27 WF 160
404.8	**33 WF 130**
413.5	24 WF 160
402.9	27 WF 145
379.7	30 WF 132
372.5	24 WF 145
354.6	**30 WF 124**
330.7	24 WF 130
327.9	**30 WF 116**
317.2	21 WF 142
299.2	**30 WF 108**
299.2	27 WF 114
299.1	24 WF 120
284.1	21 WF 127
274.4	24 WF 110
266.3	**27 WF 102**
263.2	12 WF 190
250.9	24 I 120
249.6	21 WF 112
248.9	**24 WF 100**
242.8	27 WF 94
234.3	24 I 105.9
222.2	12 WF 161

Section Modulus	Shape
220.9	**24 WF 94**
220.1	18 WF 114
216.0	14 WF 136
202.2	18 WF 105
202.0	14 WF 127
197.6	21 WF 96
197.6	24 I 100
196.3	**24 WF 84**
189.4	14 WF 119
185.8	24 I 90
184.4	18 WF 96
182.5	12 WF 133
176.3	14 WF 111
175.4	**24 WF 76**
173.9	24 I 79.9
168.0	21 WF 82
166.1	16 WF 96
163.6	14 WF 103
163.4	12 WF 120
160.0	20 I 95
156.1	18 WF 85
151.3	16 WF 88
150.7	**21 WF 73**
150.6	14 WF 95
150.2	20 I 85
144.5	12 WF 106
141.7	18 WF 77
139.9	**21 WF 68**
138.1	14 WF 87
134.7	12 WF 99
130.9	14 WF 84
128.2	18 WF 70
127.8	16 WF 78
126.4	**21 WF 62**
126.3	20 I 75
126.3	10 WF 112
125.0	12 WF 92
121.1	14 WF 78
117.0	18 WF 64
116.9	20 I 65.4
115.9	16 WF 71
115.7	12 WF 85
112.4	10 WF 100
112.3	14 WF 74
107.8	**18 WF 60**
107.1	12 WF 79
104.2	16 WF 64
103.0	14 WF 68
101.9	18 I 70
99.7	10 WF 89

Section Modulus	Shape
98.2	**18 WF 55**
97.5	12 WF 72
94.1	16 WF 58
92.2	14 WF 61
89.0	**18 WF 50**
88.4	18 I 54.7
88.0	12 WF 65
86.1	10 WF 77
80.7	**16 WF 50**
80.1	10 WF 72
78.1	12 WF 58
77.8	14 WF 53
74.5	18 ⊔ 58
73.7	10 WF 66
72.4	**16 WF 45**
70.7	12 WF 53
70.2	14 WF 48
69.1	18 ⊔ 51.9
67.1	10 WF 60
64.7	12 WF 50
64.4	**16 WF 40**
64.2	15 I 50
63.7	18 ⊔ 45.8
62.7	14 WF 43
61.0	18 ⊔ 42.7
60.4	10 WF 54
60.4	8 WF 67
58.9	15 I 42.9
58.2	12 WF 45
56.3	**16 WF 36**
54.6	14 WF 38
54.6	10 WF 49
53.6	15 ⊔ 50
52.0	8 WF 58
51.9	12 WF 40
50.3	12 I 50
49.1	10 WF 45
48.5	**14 WF 34**
46.2	15 ⊔ 40
45.9	12 WF 36
44.8	12 I 40.8
43.2	8 WF 48
42.2	10 WF 39
41.8	**14 WF 30**
41.7	15 ⊔ 33.9
39.4	12 WF 31
37.8	12 I 35
36.0	12 I 31.8
35.5	8 WF 40
35.0	10 WF 33

SECTION MODULUS TABLE

FOR SHAPES USED AS BEAMS

Section Modulus	Shape	Source
34.1	**12 WF 27**	2
31.1	8 WF 35	2
30.8	10 WF 29	2
29.2	10 I 35	1
28.9	8 M 34.3	3
27.4	8 WF 31	2
26.9	12 ⊔ 30	1
26.4	**10 WF 25**	2
25.3	**12 B 22**	2
24.4	10 I 25.4	1
24.3	8 WF 28	2
23.9	12 ⊔ 25	1
23.6	10 M 25	6
22.5	8 M 28	6
21.7	**10 M 21**	6
21.5	**10 WF 21**	2
21.4	**12 B 19**	2
21.4	12 ⊔ 20.7	1
21.0	8 M 24	6
20.8	8 WF 24	2
20.6	10 ⊔ 30	1
18.8	**10 B 19**	2
18.1	10 ⊔ 25	1
17.5	**12 B 16.5**	2
17.0	8 WF 20	2
16.8	6 WF 25	2
16.2	10 B 17	2
16.0	8 I 23	1
15.7	10 ⊔ 20	1
15.7	6 M 25	3
15.2	8 M 20	6

Section Modulus	Shape	Source
14.8	**12 B 14**	2
14.2	8 I 18.4	1
14.1	8 WF 17	2
14.0	8 M 17	6
13.8	10 B 15	2
13.5	9 ⊔ 20	1
13.4	10 ⊔ 15.3	1
13.4	6 WF 20	2
12.9	6 M 20	3
12.0	**12 Jr 11.8**	7
12.0	7 I 20	1
11.8	8 B 15	2
11.3	9 ⊔ 15	1
10.9	8 ⊔ 18.75	1
10.5	**10 B 11.5**	2
10.5	9 ⊔ 13.4	1
10.4	7 I 15.3	1
10.1	6 WF 15.5	2
10.1	6 B 16	2
9.9	8 B 13	2
9.9	5 WF 18.5	2
9.6	**11 Jr 10.3**	7
9.5	5 M 18.9	2
9.3	12 Jr ⊔ 10.6	7
9.0	8 ⊔ 13.75	1
8.7	6 I 17.25	1
8.5	5 WF 16	2
8.1	8 ⊔ 11.5	1

Section Modulus	Shape	Source
7.8	**10 Jr 9**	7
7.8	8 B 10	2
7.7	7 ⊔ 14.75	1
7.3	6 I 12.5	1
7.2	6 B 12	2
6.9	7 ⊔ 12.25	1
6.5	**10 Jr ⊔ 8.4**	7
6.0	7 ⊔ 9.8	1
6.0	5 I 14.75	1
5.8	**9 Jr 7.5**	7
5.8	6 ⊔ 13	1
5.4	4 WF 13	5
5.2	4 M 13	4
5.1	6 B 8.5	2
5.0	6 ⊔ 10.5	1
4.8	5 I 10	1
4.7	**8 Jr 6.5**	7
4.4	10 Jr ⊔ 6.5	7
4.3	6 ⊔ 8.2	1
4.2	4 WF 10	5
3.5	**7 Jr 5.5**	7
3.5	5 ⊔ 9	1
3.3	4 I 9.5	1
3.0	5 ⊔ 6.7	1
3.0	4 I 7.7	1
2.4	**6 Jr 4.4**	7
2.3	4 ⊔ 7.25	1
1.9	4 ⊔ 5.4	1
1.9	3 I 7.5	1
1.7	3 I 5.7	1
1.4	3 ⊔ 6	1
1.2	**3 ⊔ 5**	1
1.1	**3 ⊔ 4.1**	1

Index to Source Numbers
1. All Structural Mills.
2. Carnegie-Illinois, Bethlehem.
3. Carnegie-Illinois, Inland, Phoenix.
4. Carnegie-Illinois.
5. Bethlehem.
6. Phoenix.
7. Jones and Laughlin.

NOTE: On this page, if the bold-face shape at the head of the group is one which because of its "source" is not available for the particular job, examine the adjacent upper groups for a lighter shape that is available.

BEAMS

REGULAR SERIES ANGLES

ALLOWABLE UNIFORM LOADS IN KIPS
FOR ANGLES LATERALLY SUPPORTED
NEUTRAL AXIS PARALLEL TO HORIZONTAL LEG

For angles laterally unsupported, allowable loads must be reduced.
For angles subject to torsion, make special investigation.

Horizontal Leg	Angle Size	Wt. per Ft.	Span in Feet 4	5	6	7	8	9	10	12	14	16	18
8″	8 x 8 x 1	51.0	52	42	35	30	26	23	21	17.6	15.0	13.2	11.7
	7/8	45.0	46	37	31	26	23	20	18.7	15.6	13.3	11.7	10.4
	3/4	38.9	40	32	27	23	20	18.1	16.3	13.6	11.6	10.2	9.0
	5/8	32.7	34	27	22	19.6	17.2	15.3	13.7	11.4	9.8	8.6	7.6
	1/2	26.4	28	22	18.7	16.0	14.0	12.4	11.2	9.3	8.0	7.0	6.2
	8 x 6 x 9/16	25.7	17.6	14.1	11.8	10.1	8.8	7.8	7.1	5.9	5.0		
	7/16	20.2	14.0	11.2	9.3	8.0	7.0	6.2	5.6	4.7	4.0		
	8 x 4 x 7/16	17.2	6.3	5.1	4.2	3.6	3.2	2.8	2.5				
7″	7 x 4 x 3/4	26.2	10.0	8.0	6.7	5.7	5.0	4.4					
	5/8	22.1	8.7	6.9	5.8	5.0	4.3	3.9					
	1/2	17.9	7.0	5.6	4.7	4.0	3.5	3.1					
	7/16	15.8	6.2	5.0	4.2	3.5	3.1	2.8					
6″	8 x 6 x 3/4	33.8	39	31	26	22	19.5	17.3	15.6	13.0	11.1	9.7	
	5/8	28.5	33	26	22	18.9	16.5	14.7	13.2	11.0	9.4	8.2	
	1/2	23.0	26	21	17.8	15.2	13.3	11.8	10.7	8.9	7.6	6.7	
	7/16	20.2	23	18.9	15.8	13.5	11.8	10.5	9.5	7.9	6.8	5.9	
	6 x 6 x 7/16	17.2	13.7	10.9	9.1	7.8	6.8	6.1	5.5	4.6	3.9		
	3/8	14.9	11.7	9.3	7.8	6.7	5.8	5.2	4.7	3.9	3.3		
	6 x 4 x 7/16	14.3	6.3	5.1	4.2	3.6	3.2	2.8					
5″	5 x 5 x 5/8	20.0	13.0	10.4	8.7	7.4	6.5	5.8	5.2				
	1/2	16.2	10.7	8.5	7.1	6.1	5.3	4.7	4.3				
	3/8	12.3	8.0	6.4	5.3	4.6	4.0	3.6	3.2				
	5 x 3½ x 3/8	10.4	4.0	3.2	2.7	2.3	2.0						
	5/16	8.7	3.3	2.7	2.2	1.9	1.7						
4″	9 x 4 x 1	40.8	59	47	39	33	29	26	23	19.6	16.8	14.7	
	7/8	36.1	52	42	35	30	26	23	21	17.4	14.9	13.1	
	3/4	31.2	45	36	30	26	23	20	18.1	15.1	13.0	11.3	
	5/8	26.3	38	31	26	22	19.1	17.0	15.3	12.8	10.9	9.6	
	9/16	23.8	35	28	23	19.8	17.3	15.4	13.8	11.5	9.9	8.7	
	1/2	21.3	31	25	21	17.7	15.5	13.8	12.4	10.3	9.0	7.8	
4″	8 x 4 x 5/8	24.2	30	24	20	17.5	15.3	13.6	12.3	10.2	8.8	7.7	
	1/2	19.6	25	20	16.7	14.3	12.5	11.1	10.0	8.3	7.1	6.2	
	7/16	17.2	22	17.6	14.7	12.6	11.0	9.8	8.8	7.3	6.3	5.5	

BEAMS

REGULAR SERIES ANGLES

ALLOWABLE UNIFORM LOADS IN KIPS FOR ANGLES LATERALLY SUPPORTED NEUTRAL AXIS PARALLEL TO HORIZONTAL LEG

For angles laterally unsupported, allowable loads must be reduced.
For angles subject to torsion, make special investigation.

Horizontal Leg	Angle Size	Wt. per Ft.	Span in Feet 2	3	4	5	6	7	8	9	10	12	14
4″	7 x 4 x 7/16	15.8		....	17.0	13.6	11.3	9.7	8.5	7.6	6.8	5.7	4.9
	3/8	13.6	..	....	14.7	11.7	9.8	8.4	7.3	6.5	5.9	4.9	4.2
	6 x 4 x 3/8	12.3	....	......	11.0	8.8	7.3	6.3	5.5	4.9	4.4	3.7	
	4 x 4 x 3/8	9.8	.....	......	5.0	4.0	3.3	2.9	2.5	2.2			
	5/16	8.2	.....	......	4.3	3.5	2.9	2.5	2.2	1.9			
	4 x 3½x5/16	7.7	......	......	3.3	2.7	2.2	1.9	1.7				
	4 x 3 x 5/16	7.2	......	......	2.4	1.9	1.6	1.4					
	¼	5.8	.. .	......	2.0	1.6	1.3	1.1					
3½″	5 x 3½x½	13.6	20.0	13.3	10.0	8.0	6.7	5.7	5.0	4.4	4.0		
	3/8	10.4	15.3	10.2	7.7	6.1	5.1	4.4	3.8	3.4	3.1		
	5/16	8.7	12.7	8.4	6.3	5.1	4.2	3.6	3.2	2.8	2.5		
	4 x 3½x5/16	7.7	8.7	5.8	4.3	3.5	2.9	2.5	2.2	1.9			
	3½x3½x5/16	7.2	6.5	4.4	3.3	2.6	2.2	1.9	1.6				
	¼	5.8	5.3	3.5	2.6	2.1	1.8	1.5	1.3				
	3½x3 x ¼	5.4	3.9	2.6	1.9	1.5	1.3	1.1					
3″	4 x 3 x ½	11.1	12.7	8.4	6.3	5.1	4.2	3.6	3.2				
	3/8	8 5	10.0	6.7	5.0	4.0	3.3	2.9	2.5				
	5/16	7.2	8.0	5.3	4.0	3.2	2.7	2.3	2.0				
	¼	5.8	6.7	4.4	3.3	2.7	2.2	1.9	1.7				
	3½x3 x ¼	5.4	5.2	3.5	2.6	2.1	1.7	1.5					
	3 x 3 x ¼	4.9	3.9	2.6	1.9	1.5	1.3						
	3 x 2½x¼	4.5	2.7	1.8	1.3	1.1							
2½″	3 x 2½x3/8	6.6	5.4	3.6	2.7	2.2	1.8						
	5/16	5.6	4.6	3.1	2.3	1.8	1.5						
	¼	4.5	3.7	2.5	1.9	1.5	1.2						
	2½x2½x¼	4.1	2.6	1.7	1.3	1.0							
	2½x2 x ¼	3.62	1.7	1.1	0.8								

SAFE LOADS FOR CHANNELS LAID FLAT IN THOUSANDS OF POUNDS UNIFORMLY DISTRIBUTED

Extreme fibre stress 18,000 lbs. per square inch.

Deflections shown in inches, those to right of heavy line are excessive for plaster ceiling.

Size	Weight Per Foot Pounds	Length of span in feet 3	4	5	6	7	8	9
	50.0	15.4	11.4	9.2	7.6	6.4	5.8	5.2
15″	40.0	13.2	10.2	8.0	6.6	5.6	5.0	4.6
	33.9	12.6	9.4	7.6	6.2	5.4	4.8	4.0
	Defl.	.03	.06	.09	.13	.18	.23	.29
12″	30.0	8.4	6.2	5.0	4.2	3.6	3.2	2.8
	20.7	7.0	5.2	4.4	3.4	3.0	2.8	2.4
	Defl.	.04	.07	.10	.15	.20	.27	.34
	25.0	6.0	4.6	3.6	3.0	2.6	2.4	1.80
10″	15.3	4.8	3.4	2.8	2.4	1.80	1.58	1.56
	Defl.	.04	.08	.12	.17	.23	.30	.39
	20.0	4.8	3.6	3.0	2.4	2.0	1.78	1.56
9″	13.4	3.8	3.0	2.4	1.92	1.64	1.46	1.30
	Defl.	.05	.09	.13	.18	.25	.33	.41

Size	Weight Per Foot Pounds	Length of span in feet 3	4	5	6	7	8	9
8″	11.5	3.2	2.4	1.88	1.56	1.34	1.18	1.06
	Defl.	.05	.09	.14	.20	.27	.36	.45
	14.75	3.2	2.4	1.88	1.56	1.34	1.20	1.06
7″	9.8	2.6	1.86	1.50	1.24	1.10	.96	.86
	Defl.	.05	.10	.15	.22	.29	.39	.49
	10.5	2.2	1.68	1.38	1.14	.98	.88	.80
6″	8.2	1.92	1.44	1.18	1.00	.84	.74	.64
	Defl.	.06	.11	.17	.24	.33	.42	.54
5″	6.7	1.42	1.08	.86	.74	.64	.56	.50
	Defl.	.07	.12	.18	.26	.36	.47	.59
4″	5.4	1.16	.86	.68	.60	.50	.44	.40
	Defl.	.08	.13	.21	.30	.40	.53	.67
3″	4.1	.82	.64	.50	.44	.38	.34	.28
	Defl.	.09	.15	.24	.34	.47	.61	.77

COEFFICIENTS OF DEFLECTION, UNIFORMLY DISTRIBUTED LOADS

To find the deflection in inches of a section symmetrical about the neutral axis, such as beams, channels, zees, etc., divide the coefficient in the table corresponding to given span and fibre stress by the depth of the section in inches.

For unsymmetrical sections such as channels laid flat and angles, divide the coefficient by twice the distance from the neutral axis to most extreme fibre.

For concentrated load at center use four-fifths the tabular coefficient.

Span in Feet.	Fibre Stress in Pounds Per Sq. inch 20000	18000	12500	Span in Feet.	Fibre Stress in Pounds Per Sq. inch 20000	18000	12500	Span in Feet.	Fibre Stress in Pounds Per Sq. inch 20000	18000	12500
1	.021	0.018	0.013	16	5.297	4.767	3.310	31	19.882	17.894	12.427
2	.082	0.074	0.052	17	5.979	5.381	3.737	32	21.187	19.067	13.241
3	.187	0.168	0.116	18	6.703	6.033	4.190	33	22.531	20.277	14.082
4	.331	0.298	0.207	19	7.469	6.722	4.668	34	23.918	21.525	14.948
5	.518	0.466	0.323	20	8.276	7.448	5.172	35	25.344	22.810	15.841
6	.744	0.670	0.466	21	9.124	8.211	5.703	36	26.813	24.132	16.759
7	1.013	0.912	0.634	22	10.013	9.012	6.259	37	28.324	25.491	17.703
8	1.324	1.192	0.828	23	10.944	9.850	6.841	38	29.876	26.887	18.672
9	1.675	1.508	1.047	24	11.918	10.725	7.448	39	31.469	28.321	19.668
10	2.069	1.862	1.293	25	12.931	11.638	8.082	40	33.103	29.792	20.690
11	2.503	2.253	1.565	26	13.987	12.587	8.741	41	34.779	31.300	21.737
12	2.979	2.681	1.862	27	15.082	13.574	9.427	42	36.497	32.846	22.810
13	3.497	3.147	2.185	28	16.221	14.598	10.138	43	38.256	34.428	23.909
14	4.056	3.650	2.534	29	17.400	15.659	10.875	44	40.055	36.048	25.034
15	4.656	4.190	2.909	30	18.621	16.758	11.638	45	41.897	37.706	26.185

STEEL FLOOR PLATE

Carnegie-Illinois Multigrip Plate

Inland Four-way Floor Plate

Thickness	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4
Weight	8.70	11.25	13.80	16.35	18.90	21.45	24.00	26.55	31.65

Can be obtained in varying widths and lengths, respectively from 6" to 80" and 10 feet to 50 feet. Thickness independent of projections.

ALLOWABLE UNIFORM LOAD IN POUNDS PER SQUARE FOOT. STRESS 18,000 PSI TENSILE

	SPAN								
Thickness	1'6"	2'0"	2'6"	3'0"	3'6"	4'0"	4'6"	5'0"	6'0"
3/16	375	212	135	94	69	53	......	......	......
1/4	667	375	240	167	123	93	74	60	......
5/16	1041	585	375	261	191	146	116	93	65
3/8	1502	844	540	375	276	211	166	135	95
7/16	2036	1148	737	510	375	287	229	184	127
1/2	2666	1496	959	666	489	375	297	240	166
9/16	3375	1901	1215	844	619	476	375	304	210
5/8	4162	2340	1496	1041	765	585	462	375	261
3/4	6008	3375	2160	1496	1103	844	667	540	375
Deflection Coefficient	.042	.074	.116	.168	.228	.298	.377	.466	.670

Loads shown below heavy lines will produce deflections in excess of 1/100 of span.

Loads include weight of plates. Plates supported on two sides. Safe loads for other stresses than that given in table may be obtained from values given by direct proportion of fibre stress.

Deflection in inches with maximum safe uniform load shown in table equals deflection coefficient divided by thickness of plate in inches. Deflection in inches for any uniform load within the elastic limit equals deflection coefficient times actual load per square foot divided by maximum safe load per square foot.

Thickness does not include projections which are .1" high.

ALLOWABLE LOADS ON COLUMNS

The loads given in the following column tables are based on allowable unit stresses as follows

Columns with values of l/r not greater than 120, main or secondary members;

$$f = 17{,}000 - 0.485\frac{l^2}{r^2} \text{ in p.s.i.}$$

Columns with values of l/r greater than 120;

a. Bracing and secondary members, $f = \dfrac{18{,}000}{1 + \dfrac{l^2}{18{,}000\, r^2}}$

b. Main members, $f = \dfrac{18{,}000}{1 + \dfrac{l^2}{18{,}000\, r^2}} \times \left(1.6 - \dfrac{\frac{l}{r}}{200} \right)$

For convenience in using these formulas a table of allowable unit stresses derived therefrom is given on page 100.

In the column tables which follow, allowable loads given below the horizontal heavy lines are for main members with l/r greater than 120. Allowable loads for bracing and secondary members of the same l/r may be derived therefrom.

ECCENTRIC LOADING. The allowable loads given in the column tables are for columns axially or symmetrically loaded. For columns subjected both to direct loads and to bending produced by eccentric loads, the A.I.S.C. Specification in Section 12 (a) requires that the quantity

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} \text{ shall not exceed unity.}$$

The use of Bending Factors (B_x and B_y) tabulated at the bottom of the load tables provides a convenient method of converting bending moments into equivalent direct loads in order to select a trial section from the load tables. B_x and B_y are respectively equal to the area divided by the appropriate section modulus.

EXAMPLE. A 14 WF column with an unbraced length of 12 ft. carries a concentric load of 300 kips and an eccentric load of 50 kips applied 18 inches from the major axis.* Design the column.

Assume the average bending factor of the group, say, $B_x = 0.185$, then

Bending Moment $= M = 50 \times 18 = 900$ inch kips.

Equivalent Direct Load $= MB_x = 900 \times 0.185 = 167$ kips.

Approximate column load $= 300 + 50 + 167 = 517$ kips.

A trial column section (111 pounds) is first selected from the tables as having a carrying capacity of 517 kips or more on an unbraced length of 12 feet. Since this selection is only tentative, it will be necessary to investigate the selected column as to its compliance with Section 12 (a).

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*The major and minor axes are frequently referred to in technical literature as the strong and weak axes.

Section	Allowable Column Load, Kips	Allowable Stress Axial F_a	Allowable Stress Bending F_b	Actual Stress Axial $f_a = \frac{P}{A}$	Actual Stress Bending $f_b = \frac{M}{S}$	$\frac{f_a}{F_a} + \frac{f_b}{F_b}$
		Kips per Square Inch				
14 WF 111	531	16.28	20.00	10.72	5.10	0.913
14 WF 95	455	16.27	20.00	12.53	5.98	1.069
14 WF 103	493	16.27	20.00	11.57	5.50	0.986(Use)

As shown in the above table, the 14 WF 111 column section first selected was found more than adequate. A 14 WF 95 section was next tried and found to be inadequate. A 14 WF 103 section was then investigated and found allowable. The lighter of the two adequate sections is used.

In designing columns subjected to bending about the minor axis only, F_b may be taken at 20.0 ksi. In designing columns subjected to bending about the major axis only, F_b must be limited in accordance with ld/bt, to the value permitted for unsupported beams

In designing columns subjected to bending about both axes, the expression

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} \text{ becomes } \frac{f_a}{F_a} + \left(\frac{f_b}{F_b}\right)_{xx} + \left(\frac{f_b}{20.0}\right)_{yy},$$

in which F_b for the xx term is determined in accordance with ld/bt.

RATIO r_x/r_y. Allowable loads for columns are given in the tables for various lengths unbraced along the minor axis. It may be necessary, however, to investigate the capacity of columns with reference to both major and minor axes. The Ratio r_x/r_y included in these tables provides a rapid and convenient method of investigating the strength of the column with respect to the major axis.

Selection of a column from the tables is necessarily based on the greatest unbraced length l with reference to the radius of gyration r_y about the minor axis. To obtain the maximum unbraced length with reference to the radius of gyration r_x about the major axis it is only necessary to multiply the length l by the Ratio r_x/r_y. If the actual unbraced length with reference to the major axis is equal to or less than the length thus obtained, the selected section is adequate. If, however, the actual unbraced length with reference to the major axis is greater than the length thus obtained, the section is inadequate and must be redesigned.

EXAMPLE. A 12 WF column is required to carry a concentric load of 590 kips. The greatest unbraced length along the minor axis is 16 feet. The column is unbraced along the major axis for 31 feet.

Entering the column tables we find, on page 105 that at 16 feet a 12 WF 133 will carry an allowable load of 595 kips. This section will carry 590 kips at about 16.5 feet. The Ratio r_x/r_y is 1.77. The maximum length at which the column may be unbraced along the major axis is 16.5 x 1.77 = 29.2 feet. The section is therefore inadequate.

The next heavier column is the 12 WF 161 which will carry 590 kips at about 25.8 feet. The Ratio r_x/r_y is 1.78. The maximum length at which the column may be unbraced along the major axis is 25.8 x 1.78 = 46.0 feet. The section is adequate.

ALLOWABLE STRESSES PER SQUARE INCH

FOR

COMPRESSION MEMBERS

Main and Secondary Members, l/r not over 120, $f = 17000 - 0.485\left(\frac{l}{r}\right)^2$						Secondary Members, l/r 121 to 200, $f = \frac{18000}{1 + \frac{l^2}{18000r^2}}$				Main Members, l/r 121 to 200, $\text{Do} \times \left(1.6 - \frac{l/r}{200}\right)$			
$\frac{l}{r}$	Unit Stress ksi.	$\frac{l}{r}$	Unit Stress ksi.	$\frac{l}{r}$	Unit Stress ksi.	$\frac{l}{r}$	Unit Stress ksi.	$\frac{l}{r}$	Unit Stress ksi.	$\frac{l}{r}$	Unit Stress ksi.	$\frac{l}{r}$	Unit Stress ksi.
1	17.00	41	16.19	81	13.82	121	9.93	161	7.38	121	9.88	161	5.87
2	17.00	42	16.14	82	13.74	122	9.85	162	7.32	122	9.75	162	5.78
3	17.00	43	16.10	83	13.66	123	9.78	163	7.27	123	9.63	163	5.71
4	16.99	44	16.06	84	13.58	124	9.71	164	7.22	124	9.52	164	5.63
5	16.99	45	16.02	85	13.50	125	9.64	165	7.16	125	9.40	165	5.53
6	16.98	46	15.97	86	13.41	126	9.56	166	7.11	126	9.27	166	5.47
7	16.98	47	15.93	87	13.33	127	9.49	167	7.06	127	9.16	167	5.40
8	16.97	48	15.88	88	13.24	128	9.42	168	7.01	128	9.04	168	5.33
9	16.96	49	15.84	89	13.16	129	9.35	169	6.96	129	8.93	169	5.25
10	16.95	50	15.79	90	13.07	130	9.28	170	6.91	130	8.82	170	5.18
11	16.94	51	15.74	91	12.98	131	9.22	171	6.86	131	8.71	171	5.11
12	16.93	52	15.69	92	12.90	132	9.15	172	6.81	132	8.60	172	5.04
13	16.92	53	15.64	93	12.81	133	9.08	173	6.76	133	8.49	173	4.97
14	16.91	54	15.59	94	12.72	134	9.01	174	6.71	134	8.38	174	4.90
15	16.89	55	15.53	95	12.62	135	8.94	175	6.66	135	8.27	175	4.83
16	16.88	56	15.48	96	12.53	136	8.88	176	6.62	136	8.17	176	4.77
17	16.86	57	15.42	97	12.44	137	8.81	177	6.57	137	8.06	177	4.70
18	16.84	58	15.37	98	12.34	138	8.75	178	6.52	138	7.96	178	4.63
19	16.83	59	15.31	99	12.25	139	8.68	179	6.48	139	7.86	179	4.57
20	16.81	60	15.25	100	12.15	140	8.62	180	6.43	140	7.76	180	4.50
21	16.79	61	15.20	101	12.05	141	8.55	181	6.38	141	7.65	181	4.43
22	16.77	62	15.14	102	11.95	142	8.49	182	6.34	142	7.56	182	4.37
23	16.74	63	15.08	103	11.86	143	8.43	183	6.29	143	7.46	183	4.31
24	16.72	64	15.01	104	11.75	144	8.36	184	6.25	144	7.36	184	4.25
25	16.70	65	14.95	105	11.65	145	8.30	185	6.20	145	7.26	185	4.19
26	16.67	66	14.89	106	11.55	146	8.24	186	6.16	146	7.17	186	4.13
27	16.65	67	14.82	107	11.45	147	8.18	187	6.12	147	7.08	187	4.07
28	16.62	68	14.76	108	11.34	148	8.12	188	6.07	148	6.98	188	4.01
29	16.59	69	14.69	109	11.24	149	8.06	189	6.03	149	6.89	189	3.95
30	16.56	70	14.62	110	11.13	150	8.00	190	5.99	150	6.80	190	3.89
31	16.53	71	14.56	111	11.02	151	7.94	191	5.95	151	6.71	191	3.84
32	16.50	72	14.49	112	10.92	152	7.88	192	5.91	152	6.62	192	3.78
33	16.47	73	14.42	113	10.81	153	7.82	193	5.86	153	6.53	193	3.72
34	16.44	74	14.34	114	10.70	154	7.77	194	5.82	154	6.45	194	3.67
35	16.41	75	14.27	115	10.59	155	7.71	195	5.78	155	6.36	195	3.61
36	16.37	76	14.20	116	10.47	156	7.65	196	5.74	156	6.27	196	3.56
37	16.34	77	14.12	117	10.36	157	7.60	197	5.70	157	6.19	197	3.51
38	16.30	78	14.05	118	10.25	158	7.54	198	5.66	158	6.11	198	3.45
39	16.26	79	13.97	119	10.13	159	7.49	199	5.62	159	6.03	199	3.40
40	16.22	80	13.90	120	10.02	160	7.43	200	5.59	160	5.94	200	3.35

14

COLUMNS

W SHAPES

ALLOWABLE CONCENTRIC LOADS IN KIPS

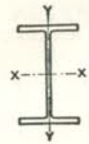
Unbraced Length Feet	Nominal Depth and Width—Weight per Foot								
	14 x 16								
	426	398	370	342	*320	314	287	264	246
6	2113	1973	1834	1696	1586	1556	1422	1308	1219
7	2107	1967	1829	1691	1582	1551	1418	1304	1215
8	2100	1960	1823	1685	1576	1546	1413	1299	1211
9	2092	1953	1816	1678	1569	1540	1407	1294	1206
10	2083	1945	1808	1671	1562	1533	1400	1288	1200
11	2073	1936	1799	1663	1554	1525	1393	1281	1194
12	2062	1925	1789	1654	1546	1516	1386	1274	1187
13	2051	1914	1779	1644	1536	1507	1377	1266	1179
14	2038	1902	1768	1633	1526	1497	1368	1258	1171
15	2025	1889	1755	1622	1515	1487	1358	1249	1163
16	2011	1876	1742	1610	1503	1476	1348	1239	1154
17	1995	1862	1729	1597	1491	1463	1337	1228	1144
18	1979	1846	1714	1584	1478	1450	1325	1217	1133
19	1962	1830	1699	1569	1464	1437	1312	1205	1122
20	1944	1813	1683	1554	1449	1423	1299	1193	1110
21	1925	1794	1666	1538	1434	1408	1285	1180	1098
22	1905	1775	1648	1521	1417	1392	1270	1166	1085
23	1884	1756	1629	1503	1400	1376	1255	1152	1072
24	1862	1736	1610	1485	1382	1359	1239	1137	1058
25	1839	1714	1589	1466	1364	1341	1223	1122	1044
26	1815	1691	1567	1446	1345	1322	1205	1106	1029
27	1790	1668	1545	1425	1324	1303	1187	1089	1013
28	1765	1643	1522	1404	1303	1283	1168	1071	996
29	1738	1619	1499	1381	1282	1261	1149	1053	979
30	1711	1593	1474	1358	1260	1240	1130	1035	962
32	1653	1538	1423	1310	1213	1195	1087	995	925
34	1593	1480	1367	1259	1163	1147	1043	954	886
36	1528	1419	1309	1203	1110	1095	995	910	844
38	1458	1354	1247	1146	1054	1041	945	863	800
40	1386	1285	1183	1085	995	984	892	814	753

Unbraced length with respect to least radius of gyration

PROPERTIES

	426	398	370	342	*320	314	287	264	246
Depth	18¾	18¼	18	17½	16¾	17¼	16¾	16½	16¼
Width	16¾	16⅝	16½	16⅜	16¾	16¼	16⅛	16	16
Ratio r_x/r_y	1.67	1.66	1.66	1.65	1.59	1.64	1.63	1.63	1.62
Bending Factors B_x	.177	.178	.179	.180	.191	.180	.181	.182	.182
Bending Factors B_y	.443	.447	.451	.456	.481	.459	.464	.467	.470

*Column Core Section.



COLUMNS

14

WF SHAPES

ALLOWABLE CONCENTRIC LOADS IN KIPS

Unbraced Length Feet	Nominal Depth and Width—Weight per Foot: 14 x 16									
	237	228	219	211	202	193	184	176	167	158
6	1174	1130	1084	1046	1001	956	911	871	827	783
7	1171	1126	1081	1042	998	953	908	868	824	780
8	1166	1122	1077	1038	994	949	904	865	821	777
9	1161	1117	1072	1034	989	945	900	861	817	774
10	1156	1112	1067	1029	984	940	896	857	813	770
11	1150	1106	1061	1024	979	935	891	852	809	766
12	1143	1100	1055	1018	973	930	886	847	804	761
13	1136	1093	1049	1011	967	924	880	842	799	756
14	1128	1086	1041	1004	960	917	874	836	793	750
15	1120	1078	1033	996	953	910	867	829	787	744
16	1111	1069	1025	988	945	903	860	822	780	738
17	1101	1060	1016	980	937	895	852	815	773	731
18	1091	1050	1007	971	928	886	844	807	765	724
19	1081	1040	997	961	919	877	836	799	757	717
20	1070	1029	986	951	909	868	827	790	749	709
21	1058	1017	975	940	899	858	817	781	741	701
22	1045	1005	963	928	888	848	807	771	731	692
23	1032	993	951	916	877	837	797	761	722	683
24	1019	980	938	904	865	825	786	751	712	673
25	1005	966	925	892	853	813	775	740	701	663
26	990	952	911	878	840	801	763	728	690	653
27	975	937	897	864	826	788	751	716	679	642
28	959	927	882	850	812	775	738	704	667	631
29	942	906	867	835	798	761	725	691	655	619
30	925	889	851	819	783	747	711	678	643	607
32	890	854	818	787	752	717	683	651	616	582
34	851	818	782	753	719	685	652	621	588	556
36	811	779	744	716	684	651	619	589	558	527
38	769	738	704	678	646	616	585	557	527	497
40	724	694	662	637	607	578	549	522	493	465

Unbraced length with respect to least radius of gyration

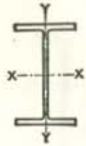
PROPERTIES

	237	228	219	211	202	193	184	176	167	158
Depth	16⅛	16	15⅞	15¾	15⅝	15½	15⅜	15¼	15⅛	15
Width	15⅞	15⅞	15⅞	15¾	15¾	15¾	15⅝	15⅝	15⅝	15½
Ratio r_x/r_y	1.62	1.61	1.62	1.61	1.61	1.61	1.61	1.60	1.60	1.60
Bending Factors B_x	.182	.182	.183	.183	.183	.183	.183	.184	.184	.183
Bending Factors B_y	.472	.473	.475	.477	.477	.479	.480	.483	.485	.485

14

COLUMNS

WF SHAPES



ALLOWABLE CONCENTRIC LOADS IN KIPS

Nominal Depth and Width—Weight per Foot

Unbraced Length Feet	14 x 16			14 x 14½						
	150	142	*320	136	127	119	111	103	95	87
6	742	705	1586	673	628	589	549	509	470	430
7	740	702	1582	670	626	587	547	507	468	428
8	737	699	1576	667	623	584	545	505	466	426
9	734	696	1569	664	620	581	542	502	464	424
10	730	693	1562	660	616	578	539	499	461	422
11	726	689	1554	656	612	574	535	496	458	419
12	722	685	1546	651	608	570	531	493	455	416
13	717	680	1536	646	603	566	527	489	451	413
14	712	675	1526	641	598	561	523	485	447	409
15	706	670	1515	635	593	556	518	480	443	405
16	700	664	1503	629	587	551	513	475	439	401
17	694	658	1491	623	581	545	508	470	434	397
18	687	652	1478	616	575	539	502	465	429	392
19	680	645	1464	609	568	532	496	459	424	387
20	672	638	1449	601	561	525	490	453	418	382
21	664	630	1434	593	553	518	483	447	412	377
22	656	622	1417	585	545	511	476	441	406	372
23	647	614	1400	576	537	503	469	434	400	366
24	638	605	1382	567	528	495	461	427	393	360
25	629	596	1364	557	519	486	453	419	386	353
26	619	586	1345	547	510	477	444	411	379	346
27	609	576	1324	537	500	468	435	403	372	339
28	598	566	1303	526	490	459	426	395	364	332
29	587	555	1282	515	480	449	417	386	356	325
30	575	544	1260	503	469	438	408	377	347	317
32	552	522	1213	478	446	417	387	358	330	301
34	526	497	1163	453	421	394	366	338	311	284
36	499	471	1110	425	396	370	343	317	291	265
38	470	443	1054	395	368	343	317	293	269	246
40	439	414	995	365	339	317	293	270	249	226

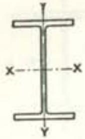
Unbraced length with respect to least radius of gyration

PROPERTIES

Depth	14⅞	14¾	16¾	14¾	14⅝	14½	14⅜	14¼	14⅛	14
Width	15½	15½	16¾	14¾	14¾	14⅝	14⅝	14⅝	14½	14½
Ratio r_x/r_y	1.60	1.59	1.59	1.67	1.67	1.67	1.67	1.67	1.66	1.66
Bending Factors B_x	.184	.185	.191	.185	.185	.185	.185	.185	.186	.185
Bending Factors B_y	.487	.491	.481	.519	.520	.521	.525	.525	.529	.530

*Column Core Section.

Loads below heavy line are for main members with l/r ratios between 120 and 200.



COLUMNS

14

WF SHAPES

ALLOWABLE CONCENTRIC LOADS IN KIPS

Unbraced Length Feet	Nominal Depth and Width—Weight per Foot							
	14 x 12		14 x 10			14 x 8		
	84	78	74	68	61	53	48	43
6	413	384	361	332	297	254	230	206
7	411	382	358	329	295	251	227	203
8	408	379	354	325	292	246	223	199
9	405	376	350	321	288	241	218	195
10	401	372	345	317	284	235	213	190
11	397	368	340	312	280	229	207	185
12	393	364	334	307	275	222	201	179
13	388	360	328	301	270	215	194	173
14	383	355	321	295	264	207	187	166
15	378	350	314	288	258	199	179	159
16	372	344	307	281	252	190	171	152
17	366	338	299	273	245	180	162	144
18	359	332	290	265	238	169	152	135
19	352	326	281	257	230	158	142	126
20	345	319	271	248	222	146	131	116
21	337	312	261	238	213	135	121	107
22	329	304	250	228	204	125	112	98
23	320	296	239	218	195	115	104	90
24	311	288	228	207	185	106	95	83
25	302	279	215	195	174	97	87	77
26	292	270	202	184	164	90	80	70
27	282	260	190	172	154	82	74	64
28	272	250	179	162	144	75	67	59
29	261	240	168	152	135	69	61	54
30	250	230	157	142	127	63	56	49
32	226	207	139	125	112	52		
34	204	188	121	109	97			
36	184	169	106	96	85			
38	166	152	93	83	74			
40	149	136	80	72	64			

Unbraced length with respect to least radius of gyration

PROPERTIES

Depth	$14\frac{1}{8}$	14	$14\frac{1}{4}$	14	$13\frac{7}{8}$	14	$13\frac{7}{8}$	$13\frac{5}{8}$
Width	12	12	$10\frac{1}{8}$	10	10	8	8	8
Ratio r_x/r_y	2.03	2.03	2.44	2.45	2.44	3.07	3.07	3.08
Bending Factors B_x	.189	.189	.194	.194	.195	.200	.201	.202
Bending Factors B_y	.659	.665	.821	.830	.834	1.090	1.102	1.119

Loads below heavy line are for main members with l/r ratios between 120 and 200.

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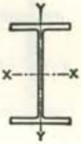
COLUMNS

WF SHAPES

ALLOWABLE CONCENTRIC LOADS IN KIPS



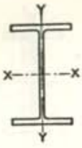
Unbraced length with respect to least radius of gyration

Unbraced Length Feet	Nominal Depth and Width—Weight per Foot										
	12 x 12										
	190	161	133	120	106	99	92	85	79	72	65
6	936	794	655	591	522	487	453	418	388	354	320
7	932	790	651	588	519	484	450	416	386	352	318
8	926	785	647	584	516	481	447	413	384	350	316
9	920	779	643	580	512	477	444	410	381	347	313
10	913	773	638	575	508	473	440	406	378	344	310
11	905	766	632	570	503	469	436	402	374	341	307
12	896	759	626	564	498	464	431	398	370	337	304
13	887	751	619	558	492	459	426	393	366	333	300
14	877	742	611	551	486	453	421	388	361	328	296
15	866	733	603	544	480	447	415	383	356	324	292
16	855	723	595	536	473	440	409	377	350	319	288
17	843	712	586	528	465	433	402	371	344	314	282
18	830	701	576	519	457	426	395	365	338	308	276
19	816	689	566	510	449	418	388	358	332	302	272
20	802	676	555	500	440	410	380	351	325	296	266
21	787	663	544	489	431	401	372	343	318	289	260
22	771	649	532	478	421	392	364	335	310	282	254
23	754	634	520	467	411	382	355	327	302	275	248
24	737	619	507	455	400	372	346	318	294	268	241
25	719	603	494	443	389	362	336	309	286	260	234
26	700	587	480	430	378	351	326	300	277	252	226
27	680	570	466	417	366	340	315	290	268	243	218
28	660	552	451	403	354	328	304	280	258	234	210
29	639	534	435	389	341	316	293	269	248	225	202
30	617	515	419	374	327	303	281	258	238	216	193
32	571	475	384	341	299	276	255	235	215	196	175
34	521	431	348	310	271	250	232	212	196	176	158
36	474	392	316	281	245	226	209	192	177	160	142
38	431	356	286	255	222	204	189	173	159	144	128
40	392	322	260	230	200	184	170	156	143	130	115

PROPERTIES

Depth	$14\frac{3}{8}$	$13\frac{7}{8}$	$13\frac{3}{8}$	$13\frac{1}{8}$	$12\frac{7}{8}$	$12\frac{3}{4}$	$12\frac{5}{8}$	$12\frac{1}{2}$	$12\frac{3}{8}$	$12\frac{1}{4}$	$12\frac{1}{8}$
Width	$12\frac{5}{8}$	$12\frac{1}{2}$	$12\frac{3}{8}$	$12\frac{3}{8}$	$12\frac{1}{4}$	$12\frac{1}{4}$	$12\frac{1}{8}$	$12\frac{1}{8}$	$12\frac{1}{8}$	12	12
Ratio r_x/r_y	1.79	1.78	1.77	1.76	1.76	1.76	1.75	1.75	1.75	1.75	1.75
Bending Factors B_x	.212	.213	.214	.216	.216	.216	.216	.216	.217	.217	.217
Bending Factors B_y	.600	.610	.620	.631	.634	.637	.641	.642	.649	.653	.657

Loads below heavy line are for main members with l/r ratios between 120 and 200.



COLUMNS

12-10

WF SHAPES

ALLOWABLE CONCENTRIC LOADS IN KIPS

Unbraced Length Feet	Nominal Depth and Width—Weight per Foot						
	12 x 10		12 x 8			10 x 10	
	58	53	50	45	40	112	100
6	283	258	240	216	192	548	490
7	281	256	237	213	189	544	486
8	278	254	233	209	186	539	482
9	275	251	228	205	182	534	477
10	271	248	223	200	178	528	471
11	267	244	218	195	174	521	465
12	263	240	212	190	169	513	458
13	258	235	205	184	163	505	451
14	253	230	198	177	157	496	443
15	247	225	190	170	151	487	434
16	241	220	182	162	144	477	425
17	235	214	173	154	137	466	416
18	229	208	163	145	129	455	406
19	222	201	154	136	121	443	395
20	214	194	142	127	113	431	383
21	206	187	132	117	104	417	371
22	198	179	122	108	96	403	359
23	190	171	113	100	89	389	346
24	181	163	104	92	81	374	332
25	172	154	96	84	75	358	317
26	161	145	88	78	69	341	302
27	152	136	81	71	63	324	286
28	143	128	75	65	58	306	270
29	134	120	68	60	53	289	256
30	126	113	63	55	49	273	241
32	111	99	53	46	41	243	214
34	98	87				216	190
36	86	76				191	168
38	75	66				169	148
40	65	58				149	131

Unbraced length with respect to least radius of gyration

PROPERTIES

	58	53	50	45	40	112	100
Depth	12¼	12	12¼	12	12	11⅜	11⅛
Width	10	10	8⅛	8	8	10⅜	10⅜
Ratio r_x/r_y	2.10	2.11	2.64	2.65	2.64	1.75	1.74
Bending Factors B_x	.218	.221	.227	.227	.227	.261	.262
Bending Factors B_y	.797	.812	1.051	1.068	1.070	.728	.738

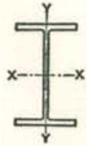
Loads below heavy line are for main members with l/r ratios between 120 and 200.

10

COLUMNS

WF SHAPES

ALLOWABLE CONCENTRIC LOADS IN KIPS



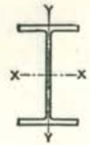
Unbraced Length Feet	Nominal Depth and Width—Weight per Foot									
	10 x 10							10 x 8		
	89	77	72	66	60	54	49	45	39	33
6	436	377	352	323	294	264	239	217	188	159
7	432	374	349	320	291	262	237	214	185	156
8	428	370	346	317	288	259	235	210	182	153
9	424	366	342	313	285	256	232	206	178	150
10	419	362	338	309	282	253	229	202	175	147
11	413	357	333	305	278	250	226	197	170	143
12	407	352	328	301	274	246	222	192	166	139
13	401	346	323	296	269	242	218	186	160	135
14	394	340	317	290	264	237	214	180	155	130
15	386	333	310	284	258	232	210	173	149	125
16	378	326	303	278	252	227	205	166	143	119
17	369	318	296	271	246	221	200	158	136	113
18	360	310	289	264	240	215	194	150	129	107
19	350	301	281	257	233	209	188	142	121	100
20	340	292	272	249	226	202	182	133	113	92
21	329	282	263	240	218	195	176	123	105	86
22	317	272	253	231	210	188	169	114	97	79
23	305	261	243	222	202	180	162	106	90	73
24	293	250	233	213	193	172	155	98	83	68
25	280	239	222	203	183	164	147	90	76	62
26	267	227	211	192	174	156	139	84	71	57
27	252	214	199	181	164	146	131	77	65	53
28	237	202	187	171	154	138	123	71	60	48
29	224	191	176	161	145	130	116	65	55	44
30	212	180	167	152	137	122	109	60	50	40
32	188	159	148	134	121	108	96	50	42	34
34	167	140	130	118	106	96	85			
36	147	124	115	105	94	84	74			
38	130	109	101	92	83	73	65			
40	113	95	88	80	72	64	57			

Unbraced length with respect to least radius of gyration

PROPERTIES

Depth	10⅞	10⅝	10½	10⅜	10¼	10⅛	10	10⅛	10	9¾
Width	10¼	10¼	10⅛	10⅛	10⅛	10	10	8	8	8
Ratio r_x/r_y	1.73	1.73	1.72	1.72	1.72	1.71	1.71	2.17	2.16	2.16
Bending Factors B_x	.263	.263	.264	.263	.263	.263	.264	.270	.275	.277
Bending Factors B_y	.744	.753	.759	.761	.765	.767	.774	.995	1.084	1.055

Loads below heavy line are for main members with l/r ratios between 120 and 200.



COLUMNS

WF SHAPES

8

ALLOWABLE CONCENTRIC LOADS IN KIPS

Unbraced Length Feet	Nominal Depth and Width—Weight per Foot							
	8 x 8						8 x 6½	
	67	58	48	40	35	31	28	24
6	324	280	232	193	169	149	132	113
7	320	277	229	190	167	147	129	111
8	315	273	225	187	164	145	126	108
9	310	268	221	184	161	142	122	105
10	304	263	217	180	158	139	118	101
11	298	257	212	176	154	136	114	97
12	291	251	207	172	150	132	108	93
13	283	244	201	167	146	128	103	88
14	275	237	195	161	141	124	96	83
15	266	229	189	155	136	120	90	77
16	256	221	182	149	131	115	83	71
17	246	212	174	143	125	110	77	65
18	236	202	166	136	119	104	69	59
19	224	192	158	129	112	98	64	54
20	212	182	149	121	105	92	58	49
21	200	171	139	112	98	86	52	44
22	186	159	129	105	91	79	47	40
23	174	148	120	97	84	73	43	36
24	161	137	112	89	78	68	39	32
25	150	128	104	83	72	62	35	29
26	139	118	96	77	67	57	31	26
27	129	109	89	71	62	53	28	
28	120	102	82	65	57	49		
29	111	94	76	61	52	46		
30	102	87	70	56	48	42		
31	95	80	64	51	44	38		
32	87	73	60	47	41	35		
33	81	68	54	43	37	32		
34	74	62	50	40				
35	68	57						

Unbraced length with respect to least radius of gyration

PROPERTIES

Depth	9	8¾	8½	8¼	8⅛	8	8 1/16	7⅞
Width	8¼	8¼	8⅛	8⅛	8	8	6½	6½
Ratio r_x/r_y	1.75	1.74	1.74	1.73	1.72	1.73	2.13	2.12
Bending Factors B_x	.326	.328	.327	.331	.331	.333	.337	.339
Bending Factors B_y	.921	.937	.941	.972	.972	.991	1.244	1.261

Loads below heavy line are for main members with *l/r* ratios between 120 and 200.

COLUMNS

AMERICAN STANDARD BEAMS

ALLOWABLE CONCENTRIC LOADS IN KIPS

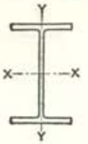
Unbraced Length Feet	Nominal Depth and Width—Weight per Foot							
	6 x 3⅜		5 x 3		4 x 2¾		3 x 2⅜	
	17.25	12.5	14.75	10.0	9.5	7.7	7.5	5.7
2	82	59	70	47	45	36	35	26
3	79	56	66	45	42	34	32	24
4	73	54	61	41	38	30	28	21
5	66	49	54	37	33	26	23	18
6	58	44	46	32	26	22	17.2	13.4
7	48	38	36	26	20	16.6	12.6	9.9
8	38	31	28	20	15.2	12.7	9.1	7.3
9	31	25	22	15.3	11.4	9.5		
10	24	20	16.8	12.1				
11	18.3	15.7						
12		12						

Unbraced length with respect to least radius of gyration

PROPERTIES

Depth	6	6	5	5	4	4	3	3
Width	3⅝	3⅜	3¼	3	2¾	2⅝	2½	2⅜
Ratio r_x/r_y	3.35	3.42	2.97	3.15	2.69	2.78	2.21	2.32
Bending Factors B_x	.579	.497	.715	.593	.824	.737	1.124	.982
Bending Factors B_y	3.862	3.282	4.290	3.500	4.246	3.810	4.617	4.100

Loads below heavy line are for main members with *l*/r ratios between 120 and 200.



MISCELLANEOUS LIGHT COLUMNS

ALLOWABLE CONCENTRIC LOADS IN KIPS

Unbraced Length Feet	Nominal Depth and Width—Weight per Foot													
	8x8	6 x 6					6 x 4		5 x 5			4 x 4		
	*34.3	*25	‡25	*20	‡20	‡15.5	‡16	‡12	‡18.9	‡18.5	‡16	†13	°13	°10
Unbraced length with respect to least radius of gyration														
4	168	121	122	97	97	76	75	55	89	89	77	60	61	46
5	166	119	120	95	96	75	71	52	86	87	75	57	58	44
6	164	116	117	92	94	73	67	49	83	84	72	54	55	42
7	162	113	114	89	91	71	63	45	80	81	70	50	52	39
8	159	109	111	86	89	69	57	41	76	78	67	46	48	36
9	155	105	107	83	85	66	51	35	71	74	63	40	43	32
10	151	100	103	79	82	63	44	29	66	69	59	34	37	27
11	147	95	98	74	78	60	37	25	61	65	55	30	32	23
12	143	89	93	69	74	56	32	20	55	59	50	25	27	20
13	138	83	88	64	69	53	27	17	48	53	44	21	23	17
14	132	76	82	58	64	48	22	14	42	47	39	17	19	14
15	126	68	75	52	59	43	19	11	37	41	35	15	16	12
16	120	61	68	46	53	39	15		32	37	30		14	10
17	113	55	61	41	48	35			28	32	27			
18	106	49	55	37	43	31			25	28	23			
19	98	43	50	33	39	28			21	25	20			
20	90	39	45	29	35	25			19	21	18			
21	83	34	40	25	31	22				19	15			
22	76	31	36	22	28	20								
23	70	27	32	20	25	17								
24	65		28		22	15								
25	59		25		19									
26	54													
27	49													
28	45													
29	41													
30	38													
31	34													

PROPERTIES

Depth	8	6	6⅜	6	6¼	6	6¼	6	5	5⅛	5	4	4⅛	4
Width	8	6	6	6	6	6	4	4	5	5	5	4	4	4
Ratio r_x/r_y	1.82	1.77	1.77	1.85	1.77	1.77	2.70	2.76	1.73	1.69	1.69	1.74	1.74	1.73
Bending Factors B_x	.346	.467	.439	.454	.440	.457	.467	.488	.576	.548	.551	.755	.701	.704
Bending Factors B_y	1.136	1.466	1.316	1.542	1.341	1.444	2.206	2.451	1.765	1.540	1.567	2.245	2.065	2.139

*Rolled by Carnegie-Illinois Steel Corp., Inland Steel Co. and The Phoenix Iron Co.
†Rolled by Carnegie-Illinois Steel Corp.
‡Rolled by Carnegie-Illinois Steel Corp. and Bethlehem Steel Co.
°Rolled by Bethlehem Steel Co.
Loads below heavy line are for main members with l/r ratios between 120 and 200.

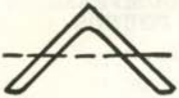
VALUES OF SINGLE ANGLES IN COMPRESSION
LOAD IN THOUSANDS OF POUNDS

Based on Formula $S = \dfrac{18000}{1 + \dfrac{l^2}{18000r^2}}$

S=Safe Fibre Stress Per Square Inch. r=Least Radius of Gyration in Inches. l=Length of Strut in Inches.

SIZE	Weight Pounds Per Foot	Area Sq. In.	Least Rad. of Gyration	LENGTH IN FEET 3	4	5	6	8	10	12	14
8 x8 x1	51.0	15.00	1.56	225.0	225.0	225.0	225.0	223.7	203.1	183.6	163.8
8 x8 x3/4	38.9	11.44	1.57	171.6	171.6	171.6	171.6	170.6	155.9	144.0	125.8
8 x8 x5/8	32.7	9.61	1.58	144.1	144.1	144.1	144.1	143.3	131.0	118.5	106.5
8 x8 x1/2	26.4	7.75	1.58	116.2	116.2	116.2	116.2	115.6	105.6	95.5	85.9
8 x6 x1	44.2	13.00	1.28	195.0	195.0	195.0	195.0	178.2	156.9	136.9	119.8
8 x6 x3/4	33.8	9.94	1.29	149.1	149.1	149.1	149.1	137.2	120.8	105.4	92.3
8 x6 x5/8	28.5	8.36	1.30	125.4	125.4	125.4	125.4	115.4	102.4	89.3	78.2
8 x6 x1/2	23.0	6.75	1.30	101.2	101.2	101.2	101.2	93.2	82.6	72.1	63.1
8 x6 x7/16	20.2	5.93	1.30	88.9	88.9	88.9	88.9	81.8	72.6	63.4	55.5
7 x4 x3/4	26.2	7.69	.86	115.3	115.3	109.0	99.6	81.8	65.5	.....	.....
7 x4 x5/8	22.1	6.48	.86	97.2	97.2	91.8	83.9	68.9	55.9	.....	.....
7 x4 x1/2	17.9	5.25	.87	78.7	78.7	74.8	68.5	56.4	46.0	.....	.....
7 x4 x3/8	13.6	3.98	.88	59.7	59.7	57.0	52.1	43.1	35.3	.....	.....
6 x6 x1	37.4	11.00	1.16	165.0	165.0	165.0	163.1	143.1	124.5	106.7	.....
6 x6 x3/4	28.7	8.44	1.17	126.6	126.6	126.6	125.9	110.6	96.2	82.5	.....
6 x6 x5/8	24.2	7.11	1.17	106.6	106.6	106.6	106.0	93.1	81.1	69.5	.....
6 x6 x1/2	19.6	5.75	1.18	86.2	86.2	86.2	85.8	75.8	65.6	56.6	.....
6 x6 x3/8	14.9	4.36	1.19	65.4	65.4	65.4	65.4	57.5	50.0	43.2	.....
6 x4 x3/4	23.6	6.94	0.86	104.1	104.1	98.2	89.7	73.6	59.8	.....	.....
6 x4 x5/8	20.0	5.86	0.86	87.9	87.9	82.9	75.7	62.1	50.5	.....	.....
6 x4 x1/2	16.2	4.75	0.87	71.2	71.2	67.6	61.8	51.1	41.5	.....	.....
6 x4 x3/8	12.3	3.61	0.88	54.1	54.1	51.7	47.3	39.1	32.0	.....	.....
6 x3 1/2 x5/8	18.9	5.55	0.75	83.2	81.3	73.7	66.0	52.3	.....	.....	.....
6 x3 1/2 x1/2	15.3	4.50	0.76	67.5	66.3	60.5	53.9	43.0	.....	.....	.....
6 x3 1/2 x3/8	11.7	3.42	0.77	51.3	50.7	46.0	41.2	32.9	.....	.....	.....
5 x5 x5/8	20.0	5.86	0.97	87.9	87.9	86.9	80.8	68.3	56.8	.....	.....
5 x5 x1/2	16.2	4.75	0.98	71.2	71.2	70.8	66.0	55.7	46.4	.....	.....
5 x5 x3/8	12.3	3.61	0.99	54.1	54.1	53.8	50.1	42.6	35.8	.....	.....
5 x3 1/2 x1/2	13.6	4.00	0.75	60.0	58.6	53.1	47.6	37.7	.....	.....	.....
5 x3 1/2 x3/8	10.4	3.05	0.76	45.7	45.0	40.8	36.5	29.2	.....	.....	.....
5 x3 1/2 x5/16	8.7	2.56	0.76	38.4	37.7	34.2	30.7	24.5	.....	.....	.....
5 x3 x1/2	12.8	3.75	0.65	56.2	51.7	45.9	40.1	.....	.....	.....	.....
5 x3 x3/8	9.8	2.86	0.65	42.9	39.5	35.0	30.6	.....	.....	.....	.....
5 x3 x5/16	8.2	2.40	0.66	36.0	33.3	29.6	26.0	.....	.....	.....	.....

To left of heavy line $\frac{l}{r}$ does not exceed 120. To right of heavy line $\frac{l}{r}$ does not exceed 140.



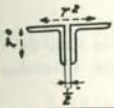
VALUES OF SINGLE ANGLES IN COMPRESSION
LOAD IN THOUSANDS OF POUNDS

Based on Formula $S = \dfrac{18000}{1 + \dfrac{l^2}{18000r^2}}$

S = Safe Fibre Stress Per Square Inch. r = Least Radius of Gyration in Inches. l = Length of Strut in Inches.

SIZE	Weight Pounds Per Foot	Area Sq. In.	Least Rad. of Gyration	LENGTH IN FEET 3	4	5	6	8	10	12	14
4 x4 x½	12.8	3.75	.78	56.3	55.6	50.8	45.9	36.7	....	....	....
4 x4 x⅜	9.8	2.86	.79	42.9	42.7	39.0	35.3	28.2	....	....	....
4 x4 x5/16	8.2	2.40	.79	36.0	35.8	32.7	29.6	23.6	....	....	....
4 x3½x½	11.9	3.50	.72	52.5	50.4	45.6	40.5	31.8	....	....	....
4 x3½x⅜	9.1	2.67	.73	40.1	38.7	35.0	31.1	24.6	....	....	....
4 x3½x5/16	7.7	2.25	.73	33.8	32.6	29.5	26.2	20.7	....	....	....
4 x3 x⅜	8.5	2.48	.64	37.2	34.0	29.9	26.1	....	....	....	....
4 x3 x5/16	7.2	2.09	.65	31.4	28.8	25.6	22.3	....	....	....	....
4 x3 x¼	5.8	1.69	.65	25.4	23.3	20.7	18.1	....	....	....	....
3½x3½x⅜	8.5	2.48	.69	37.2	35.1	31.4	27.9	21.5	....	....	....
3½x3½x5/16	7.2	2.09	.69	31.4	29.6	26.5	23.5	18.1	....	....	....
3½x3½x¼	5.8	1.69	.69	25.4	23.9	21.4	19.0	14.7	....	....	....
3½x3 x⅜	7.9	2.30	.62	34.5	31.1	27.2	23.7	....	....	....	....
3½x3 x5/16	6.6	1.93	.63	29.0	26.3	23.1	20.2	....	....	....	....
3½x3 x¼	5.4	1.56	.63	23.4	21.3	18.7	16.3	....	....	....	....
3 x3 x⅜	7.2	2.11	.58	31.3	27.5	23.7	20.5	....	....	....	....
3 x3 x5/16	6.1	1.78	.59	26.5	23.5	20.3	17.5	....	....	....	....
3 x3 x¼	4.9	1.44	.59	21.5	19.0	16.4	14.2	....	....	....	....
3 x2½x⅜	6.6	1.92	.52	27.3	23.5	19.9	16.8	....	....	....	....
3 x2½x5/16	5.6	1.62	.53	23.2	20.0	17.0	14.4	....	....	....	....
3 x2½x¼	4.5	1.31	.53	18.8	16.2	13.8	11.6	....	....	....	....
3 x2 x⅜	5.9	1.73	.43	22.4	18.4	14.9	....	....	....	....	....
3 x2 x5/16	5.0	1.47	.43	19.0	15.6	12.7	....	....	....	....	....
3 x2 x¼	4.1	1.19	.43	15.4	12.6	10.2	....	....	....	....	....
2½x2½x⅜	5.9	1.73	.48	23.7	20.0	16.7	....	....	....	....	....
2½x2½x5/16	5.0	1.47	.49	20.4	17.3	14.5	....	....	....	....	....
2½x2½x¼	4.1	1.19	.49	16.5	14.0	11.7	....	....	....	....	....
2½x2 x5/16	4.5	1.31	.42	16.7	13.7	....	....	....	....	....	....
2½x2 x¼	3.62	1.06	.43	13.7	11.2	9.1	....	....	....	....	....
2½x2 x3/16	2.75	0.81	.43	10.5	8.6	7.0	....	....	....	....	....
2 x2 x5/16	3.92	1.15	.39	14.0	11.2	....	....	....	....	....	....
2 x2 x¼	3.19	.94	.39	11.4	9.2	....	....	....	....	....	....
2 x2 x3/16	2.44	.71	.40	8.8	7.1	....	....	....	....	....	....
2 x1½x5/16	3.39	1.00	.32	10.6	....	....	....	....	....	....	....
2 x1½x¼	2.77	.81	.32	8.6	....	....	....	....	....	....	....
2 x1½x3/16	2.12	.62	.32	6.6	....	....	....	....	....	....	....

To left of heavy line $\frac{l}{r}$ does not exceed 120. To right of heavy line $\frac{l}{r}$ does not exceed 140



VALUES OF TWO ANGLES IN COMPRESSION
EQUAL LEGGED ANGLES
LOADS IN THOUSANDS OF POUNDS

See Page 98 For Formulae

SIZE OF ANGLES	Weight of One angle Lbs. per Ft.	Area of Two Angles Sq. In.	Radii of Gyration	LENGTH IN FEET							
				4	6	8	10	12	14	16	18
8 x8 x½	26.4	15.50	$r^0=2.51$	260.8	257.1	252.6	246.1	239.0	229.7	220.1	207.8
			$r^2=3.49$	262.1	260.5	257.6	254.8	250.9	246.1	240.7	234.7
6 x6 x¾	28.7	16.88	$r^0=1.83$	280.4	274.5	264.8	251.3	237.2	217.7	196.6	173.0
			$r^2=2.73$	284.3	281.4	277.0	271.1	264.0	255.6	246.8	235.8
6 x6 x½	19.6	11.50	$r^0=1.86$	191.7	187.0	180.4	172.6	162.4	150.3	136.4	120.4
			$r^2=2.68$	193.6	191.5	188.3	184.2	179.3	173.4	166.6	159.8
6 x6 x⅜	14.9	8.72	$r^0=1.87$	145.4	142.1	137.3	130.9	123.1	113.9	103.4	92.3
			$r^2=2.67$	146.8	145.2	142.7	139.7	135.9	131.5	126.3	120.5
5 x5 x½	16.2	9.50	$r^0=1.54$	157.0	151.3	146.3	133.5	121.7	106.8	91.6	81.9
			$r^2=2.28$	159.5	157.0	153.3	148.6	143.3	136.2	29.0	119.9
5 x5 x⅜	12.3	7.22	$r^0=1.56$	119.3	115.3	109.7	101.9	93.1	81.9	70.6	63.2
			$r^2=2.26$	121.2	119.1	116.5	112.9	108.4	103.5	97.5	91.1
4 x4 x½	12.8	7.50	$r^0=1.22$	121.9	114.8	105.4	91.9	76.9	65.6	......	.....
			$r^2=1.88$	125.0	122.3	118.0	112.6	106.5	98.7	89.6	79.4
4 x4 x⅜	9.8	5.72	$r^0=1.23$	93.0	87.9	80.4	70.6	58.6	50.4	......	.....
			$r^2=1.86$	95.4	93.0	89.7	85.9	80.8	74.8	67.8	59.9
4 x4 x 5/16	8.2	4.80	$r^0=1.24$	78.0	73.8	67.8	59.9	50.3	42.9	......	.....
			$r^2=1.85$	80.0	78.0	75.3	71.8	67.4	62.3	56.4	50.3
3½x3½x⅜	8.5	4.96	$r^0=1.07$	79.5	73.5	65.3	54.2	44.7	......	......	.....
			$r^2=1.67$	82.3	79.9	76.2	71.9	66.5	59.8	52.5	46.4
3½x3½x 5/16	7.2	4.18	$r^0=1.08$	67.1	61.9	55.0	46.1	37.9	......	......	.....
			$r^2=1.65$	69.3	67.1	64.2	60.3	55.7	49.9	43.8	38.5
3 x3 x⅜	7.2	4.22	$r^0=.91$	66.0	58.9	48.7	38.6	......	......	......	.....
			$r^2=1.46$	69.5	66.8	63.2	57.9	52.1	44.7	38.6	.....
3 x3 x 5/16	6.1	3.56	$r^0=.92$	55.9	50.0	41.8	33.0	......	......	......	.....
			$r^2=1.45$	58.5	56.5	53.0	48.6	43.6	37.3	32.6	.....
3 x3 x¼	4.9	2.88	$r^0=.93$	45.2	40.6	34.2	26.9	......	......	......	.....
			$r^2=1.43$	47.3	45.5	42.7	39.1	34.7	29.8	......	.....
2½x2½x⅜	5.9	3.46	$r^0=.75$	51.9	43.3	32.6	......	......	......	......	.....
			$r^2=1.26$	56.4	53.4	49.1	43.7	37.0	31.3	......	.....
2½x2½x 5/16	5.0	2.94	$r^0=.76$	44.3	37.1	28.1	......	......	......	......	.....
			$r^2=1.25$	47.9	45.2	41.5	36.8	31.1	26.5	......	.....
2½x2½x¼	4.1	2.38	$r^0=.77$	36.0	30.5	22.9	......	......	......	......	.....
			$r^2=1.24$	38.7	36.6	33.4	29.7	25.0	21.4	......	.....
2 x2 x⅜	4.7	2.72	$r^0=.59$	37.6	26.8	......	......	......	......	......	.....
			$r^2=1.07$	43.6	40.3	35.6	29.7	24.7	......	......	.....
2 x2 x 5/16	3.92	2.30	$r^0=.60$	31.9	23.0	......	......	......	......	......	.....
			$r^2=1.05$	36.7	33.8	29.8	24.6	20.3	......	......	.....
2 x2 x¼	3.19	1.88	$r^0=.61$	26.3	19.3	......	......	......	......	......	.....
			$r^2=1.04$	30.0	27.6	24.3	19.9	16.5	......	......	.....

To left of heavy line $\frac{l}{r}$ does not exceed 120. To right of heavy line $\frac{l}{r}$ does not exceed 140.

Radii of gyration correspond to direction indicated by arrowheads.

VALUES OF TWO ANGLES IN COMPRESSION
LONG LEGS TOGETHER
LOADS IN THOUSANDS OF POUNDS

See Page 98 For Formulae

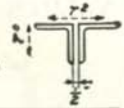
SIZE OF ANGLES	Weight of One angle Lbs. per Ft.	Area of Two Angles Sq. In.	Radii of Gyration	LENGTH IN FEET							
				4	6	8	10	12	14	16	18
7 x4 x½	17.9	10.50	$r^0=2.25$	176.3	173.3	169.0	164.2	157.6	149.8	141.8	131.6
			$r^2=1.62$	174.2	168.6	160.8	150.6	138.2	123.4	106.4	94.6
6 x4 x⅝	20.0	11.72	$r^0=1.90$	195.7	191.0	184.5	176.7	166.4	155.2	141.2	126.7
			$r^2=1.71$	194.8	189.2	181.4	171.3	159.1	144.6	128.0	112.0
6 x4 x⅜	12.3	7.22	$r^0=1.93$	120.6	118.0	114.4	108.9	103.3	96.2	88.4	78.9
			$r^2=1.67$	119.8	116.2	111.3	104.6	96.8	87.0	76.5	67.5
6 x3½x½	15.3	9.00	$r^0=1.92$	150.3	147.1	142.1	135.1	128.4	120.0	109.4	97.3
			$r^2=1.45$	148.2	142.6	134.0	123.0	110.3	94.2	82.4	.....
6 x3½x⅜	11.7	6.84	$r^0=1.94$	114.2	111.8	108.3	103.6	98.1	91.7	83.8	75.4
			$r^2=1.43$	112.4	108.0	101.4	92.9	82.4	70.9	61.6	.....
5 x3½x½	13.6	8.00	$r^0=1.58$	132.5	127.8	121.6	114.2	103.8	92.4	78.8	70.5
			$r^2=1.54$	132.2	127.4	121.1	112.4	101.8	89.9	77.1	.....
5 x3½x$\frac{5}{16}$	8.7	5.12	$r^0=1.61$	84.9	82.0	78.4	73.4	67.4	60.2	51.9	46.1
			$r^2=1.50$	84.5	81.3	76.9	71.2	64.1	55.9	48.2	.....
5 x3 x½	12.8	7.50	$r^0=1.59$	114.2	120.2	114.4	106.5	98.0	86.6	74.5	66.6
			$r^2=1.30$	122.5	116.1	107.6	96.1	82.6	70.1	......	.....
5 x3 x$\frac{5}{16}$	8.2	4.80	$r^0=1.61$	79.6	76.9	73.5	68.5	63.2	56.4	48.6	43.2
			$r^2=1.26$	78.2	74.0	68.2	60.6	51.4	43.6	......	.....
4 x3½x½	11.9	7.00	$r^0=1.23$	113.8	107.2	98.4	86.4	72.5	62.2	......	.....
			$r^2=1.63$	116.1	112.4	107.2	100.4	92.7	83.0	71.7	63.6
4 x3½x$\frac{5}{16}$	7.7	4.50	$r^0=1.26$	73.4	69.4	63.9	56.8	48.2	40.9	......	.....
			$r^2=1.59$	74.5	72.1	68.6	64.2	58.8	51.9	44.7	39.9
4 x3 x½	11.1	6.50	$r^0=1.25$	105.9	99.9	91.8	81.4	68.8	58.1	......	.....
			$r^2=1.39$	106.7	101.9	95.5	87.2	76.4	64.5	56.9	.....
4 x3 x$\frac{5}{16}$	7.2	4.18	$r^0=1.27$	68.1	64.4	59.4	53.2	45.2	38.2	......	.....
			$r^2=1.35$	68.4	65.4	60.9	55.0	47.9	40.3	......	.....
3½x3 x½	10.2	6.00	$r^0=1.08$	96.4	88.9	79.0	66.1	54.5	......	......	.....
			$r^2=1.44$	98.8	94.7	89.0	82.0	72.9	62.2	......	.....
3½x3 x$\frac{5}{16}$	6.6	3.86	$r^0=1.10$	61.5	57.5	51.4	43.4	35.6	......	......	.....
			$r^2=1.40$	63.5	60.7	57.9	51.8	45.8	38.7	......	.....
3½x2½x⅜	7.2	4.22	$r^0=1.10$	67.8	62.8	56.3	47.4	38.9	......	......	.....
			$r^2=1.15$	68.3	63.6	57.3	49.6	40.7	......	......	.....
3½x2½x¼	4.9	2.88	$r^0=1.12$	46.4	43.2	38.6	32.9	26.9	......	......	.....
			$r^2=1.13$	46.5	43.4	38.9	33.3	27.1	......	......	.....
3 x2½x⅜	6.6	3.84	$r^0=0.93$	60.2	54.2	45.5	35.9	......	......	......	.....
			$r^2=1.21$	62.4	58.8	53.6	47.0	38.9	33.3	......	.....
3 x2½x¼	4.5	2.62	$r^0=0.95$	41.4	37.2	31.6	25.0	......	......	......	.....
			$r^2=1.18$	42.5	39.8	36.2	31.3	25.8	......	......	.....
3 x2 x⅜	5.9	3.46	$r^0=0.94$	54.5	48.8	41.3	32.6	......	......	......	.....
			$r^2=0.96$	54.6	49.4	42.0	33.4	......	......	......	.....
3 x2 x¼	4.1	2.38	$r^0=0.96$	37.6	33.9	28.9	22.9	......	......	......	.....
			$r^2=0.93$	37.3	33.6	28.2	22.2	......	......	......	.....
2½x2 x⅜	5.3	3.10	$r^0=0.77$	46.9	39.4	29.9	......	......	......	......	.....
			$r^2=1.01$	49.2	45.1	39.1	31.4	......	......	......	.....
2½x2 x¼	3.6	2.12	$r^0=0.78$	32.1	27.3	20.7	......	......	......	......	.....
			$r^2=0.98$	33.6	30.6	26.4	20.9	......	......	......	.....

To left of heavy line $\frac{l}{r}$ does not exceed 120. To right of heavy line $\frac{l}{r}$ does not exceed 140.

Radii of Gyration correspond to direction indicated by arrowheads.

VALUES OF TWO ANGLES IN COMPRESSION
SHORT LEGS TOGETHER
LOAD IN THOUSANDS OF POUNDS

See Page 98 For Formulae

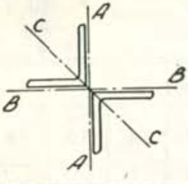


SIZE OF ANGLES	Weight of One Angle Lbs. Per Ft.	Area of Two Angles Sq. In.	Radii of Gyration	LENGTH IN FEET							
				4	6	8	10	12	14	16	18
7 x4 x½	17.9	10.50	$r^0=1.11$	169.1	156.9	140.8	119.1	97.5	....	....	....
			$r^2=3.49$	177.6	176.3	174.5	172.7	169.9	166.7	163.1	158.9
6 x4 x⅝	20.0	11.72	$r^0=1.13$	189.2	175.9	158.2	135.3	111.2	....	....	....
			$r^2=2.97$	197.8	195.9	193.4	190.1	185.6	180.7	175.2	169.0
6 x4 x⅜	12.3	7.22	$r^0=1.17$	116.9	109.5	99.2	85.9	70.6	....	....	....
			$r^2=2.92$	121.6	120.6	118.9	116.9	114.4	111.3	107.5	103.5
6 x3½x½	15.3	9.00	$r^0=0.97$	142.4	128.7	110.2	87.4	....	....	....	....
			$r^2=3.02$	151.9	150.5	148.5	146.1	143.1	139.5	135.4	130.7
6 x3½x⅜	11.7	6.84	$r^0=0.99$	108.6	98.6	85.4	67.8	....	....	....	....
			$r^2=3.00$	115.5	114.4	112.9	110.9	108.6	105.9	102.7	99.1
5 x3½x½	13.6	8.00	$r^0=1.01$	127.0	116.5	100.9	81.0	....	....	....	....
			$r^2=2.47$	134.6	132.7	130.1	126.7	122.5	117.5	111.8	106.6
5 x3½x5/16	8.7	5.12	$r^0=1.03$	81.9	75.2	65.6	53.6	44.4	....	....	....
			$r^2=2.44$	86.4	84.9	83.2	81.1	78.4	75.2	71.5	67.8
5 x3 x½	12.8	7.50	$r^0=0.83$	115.3	99.9	78.5	....	....	....	....	....
			$r^2=2.54$	126.2	124.4	122.3	119.5	115.6	111.7	106.5	101.2
5 x3 x5/16	8.2	4.80	$r^0=0.85$	74.0	64.8	51.9	....	....	....	....	....
			$r^2=2.51$	80.8	79.6	78.2	76.2	74.0	71.1	67.8	64.4
4 x3½x½	11.9	7.00	$r^0=1.04$	111.8	102.8	90.3	74.1	61.2	....	....	....
			$r^2=1.94$	116.9	114.4	110.9	105.9	100.4	93.9	85.7	77.0
4 x3½x5/16	7.7	4.50	$r^0=1.07$	72.1	66.7	59.2	49.1	40.5	....	....	....
			$r^2=1.91$	75.1	73.3	71.1	67.9	64.0	59.6	54.2	48.6
4 x3 x½	11.1	6.50	$r^0=0.87$	100.9	88.8	72.3	56.9	....	....	....	....
			$r^2=2.01$	108.7	106.4	103.2	99.5	94.2	88.3	81.4	73.7
4 x3 x5/16	7.2	4.18	$r^0=0.89$	65.2	57.8	47.4	37.4	....	....	....	....
			$r^2=1.97$	69.9	68.3	66.2	63.5	60.3	56.4	52.2	46.5
3½x3 x½	10.2	6.00	$r^0=0.88$	93.2	82.4	67.4	52.9	....	....	....	....
			$r^2=1.75$	99.9	97.1	93.2	87.7	82.4	75.2	67.4	58.7
3½x3 x5/16	6.6	3.86	$r^0=0.90$	60.4	53.6	44.6	35.0	....	....	....	....
			$r^2=1.71$	64.1	62.3	59.7	56.4	52.4	47.6	42.1	36.9
3½x2½x⅜	7.2	4.22	$r^0=0.72$	62.8	51.3	38.3	....	....	....	....	....
			$r^2=1.79$	70.3	68.4	65.8	62.5	58.6	53.7	48.3	41.9
3½x2½x¼	4.9	2.88	$r^0=0.74$	43.0	35.9	27.1	....	....	....	....	....
			$r^2=1.76$	47.9	46.6	44.7	42.5	39.6	36.3	32.4	28.1
3 x2½x⅜	6.6	3.84	$r^0=0.74$	57.4	47.4	35.9	....	....	....	....	....
			$r^2=1.52$	63.4	61.2	57.9	53.6	48.5	42.7	36.7	....
3 x2½x¼	4.5	2.62	$r^0=0.75$	39.3	32.8	24.7	....	....	....	....	....
			$r^2=1.50$	43.2	41.6	39.3	36.4	32.8	28.6	24.7	....
3 x2 x⅜	5.9	3.46	$r^0=0.56$	46.4	32.3	30.7	....	....	....	....	....
			$r^2=1.59$	57.3	55.4	52.8	49.4	44.9	39.9	34.4	30.6
3 x2 x¼	4.1	2.38	$r^0=0.58$	32.5	23.1	....	....	....	....	....	....
			$r^2=1.56$	39.3	38.0	36.2	33.6	30.7	26.9	23.3	20.8
2½x2 x⅜	5.3	3.10	$r^0=0.58$	42.3	30.1	....	....	....	....	....	....
			$r^2=1.32$	50.7	48.1	44.7	40.2	34.8	29.4	....	....
2½x2 x¼	3.62	2.12	$r^0=0.59$	29.3	20.9	....	....	....	....	....	....
			$r^2=1.29$	34.6	32.8	30.2	27.1	23.1	19.7	....	....

To left of heavy line $\frac{l}{r}$ does not exceed 120. To right of heavy line $\frac{l}{r}$ does not exceed 140.

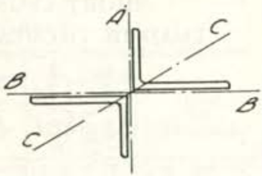
Radii of Gyration correspond to direction indicated by arrowheads.

VALUES OF TWO ANGLES STARRED IN COMPRESSION
LOADS IN THOUSANDS OF POUNDS



Formula $S = \dfrac{18000}{1 + \dfrac{l^2}{18000 r^2}}$

For unequal leg angles, the angle between axes B-B and C-C varies between 10° and 34°. Values are given for tie plates 3/8" thick. Least radii of gyration are on axes C-C.



VALUES FOR EQUAL LEG ANGLES

Size of Angles	Area 2 Ls in.²	Wt. Per Ft. Lbs.	Least r Ins.	4	6	8	10	12	14	16	18
				LENGTH IN FEET							
6 x 6 x 3/8	8.72	29.8	2.37	130.8	130.8	130.8	130.8	130.0	122.6	115.0	107.5
5 x 5 x 1/2	9.50	32.4	1.95	142.5	142.5	142.5	141.7	131.9	121.2	111.5	101.5
3/8	7.22	24.6	1.98	108.3	108.3	108.3	107.6	100.3	92.7	85.3	78.3
4 x 4 x 1/2	7.50	25.6	1.53	112.5	112.5	110.6	100.9	90.5	80.7	72.3	64.1
3/8	5.72	19.6	1.56	85.8	85.8	85.3	77.4	70.0	62.5	55.9	50.0
5/16	4.80	16.4	1.57	72.0	72.0	71.6	65.4	58.8	52.8	47.3	42.0
3½ x 3½ x 3/8	4.96	17.0	1.35	74.4	74.4	69.7	62.0	54.6	48.1	42.1	36.8
5/16	4.18	14.4	1.36	62.7	62.7	58.8	52.6	46.3	40.6	35.7	31.3
3 x 3 x 3/8	4.22	14.4	1.16	63.3	62.6	54.9	47.8	40.9	35.0	30.0	
5/16	3.56	12.2	1.16	53.4	52.8	46.3	40.3	34.6	29.5	25.3	
1/4	2.88	9.8	1.17	43.2	42.9	37.7	32.6	28.2	24.1	20.8	
2½ x 2½ x 3/8	3.46	11.8	.95	51.9	47.1	39.7	33.1	27.3	22.7		
5/16	2.94	10.0	.97	44.1	40.6	34.3	28.5	23.9	19.9		
1/4	2.38	8.1	.97	35.7	32.8	27.7	23.1	19.3	16.1		
2 x 2 x 5/16	2.30	7.8	.77	34.1	27.9	22.1	17.6				
1/4	1.88	6.4	.77	27.9	22.8	18.1	14.4				

VALUES FOR UNEQUAL LEG ANGLES

Size of Angles	Area 2 Ls in.²	Wt. Per Ft. Lbs.	Least r Ins.	4	6	8	10	12	14	16	18
				LENGTH IN FEET							
6 x 4 x 1/2	9.50	32.4	1.56	142.5	142.5	140.9	128.6	116.3	103.7	92.9	83.1
3/8	7.22	24.6	1.56	108.3	108.3	107.1	97.7	88.4	78.8	70.6	63.1
5 x 3½ x 1/2	8.00	27.2	1.35	120.0	120.0	112.5	100.0	88.0	77.6	67.9	59.4
3/8	6.10	20.8	1.37	91.5	91.5	86.3	76.7	68.1	59.6	52.5	46.0
5 x 3 x 1/2	7.50	25.6	1.16	112.5	111.2	97.6	84.9	72.8	62.3	53.7	
3/8	5.72	19.6	1.16	85.8	84.8	74.4	64.8	55.5	47.5	41.0	
4 x 3 x 3/8	4.96	17.0	1.21	74.4	74.4	66.3	57.8	49.9	43.0	37.1	32.3
1/4	3.38	11.6	1.23	50.7	50.7	45.5	39.9	34.5	29.8	25.9	22.4
3½ x 3 x 3/8	4.60	15.8	1.20	69.0	69.0	61.1	53.2	46.0	39.6	34.2	29.6
1/4	3.12	10.8	1.22	46.8	46.8	41.7	36.6	31.7	27.3	23.7	20.5
3 x 2½ x 3/8	3.84	13.2	1.00	57.6	53.6	45.7	38.4	32.1	26.9		
1/4	2.62	9.0	1.00	39.3	36.6	31.2	26.2	21.9	18.4		
2½ x 2 x 3/8	3.10	10.6	.78	46.2	37.9	30.3	24.0				
1/4	2.12	7.2	.78	31.6	25.9	20.7	16.5				

Values to left of solid **heavy** line do not exceed 140 for $\frac{l}{r}$

Values to left of dotted **heavy** line do not exceed 160 for $\frac{l}{r}$

Values for $\frac{l}{r}$ in excess of 180 are not given.

COLUMNS

STEEL PIPE

ALLOWABLE CONCENTRIC LOADS IN KIPS

STANDARD

Unbraced Length Feet	Nominal Diameter—Weight per Foot											
	12		10			8		6	5	4	3½	3
	49.56	43.77	40.48	34.24	31.20	28.55	24.70	18.97	14.62	10.79	9.11	7.58
6	246	217	200	169	154	140	121	92	70	50	42	34
8	244	216	199	168	153	138	120	90	68	48	39	30
10	243	214	196	166	151	136	118	87	65	44	35	26
12	240	212	194	164	149	133	115	84	61	40	31	22
14	237	210	190	161	147	129	112	80	56	35	26	19
16	234	207	187	158	144	125	109	75	51	30	23	16
18	231	204	182	154	141	121	105	70	46	27	20	14
20	227	200	178	151	137	116	100	64	41	24	17	
22	222	196	173	146	133	110	95	58	37	21	15	

EXTRA STRONG

Unbraced Length Feet	Nominal Diameter—Weight per Foot							
	12	10	8	6	5	4	3½	3
	65.42	54.74	43.39	28.57	20.78	14.98	12.51	10.25
6	325	271	213	139	99	70	57	45
8	323	268	210	135	96	66	53	41
10	320	265	206	131	91	61	48	35
12	317	261	201	125	86	55	41	29
14	313	257	196	119	79	47	35	25
16	309	252	189	112	72	41	30	21
18	304	246	182	104	63	36	26	18
20	299	240	174	94	57	32	23	
22	293	232	165	84	51	29		
24	286	225	155	77	47	26		

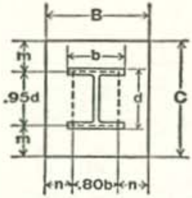
DOUBLE EXTRA STRONG

Unbraced Length Feet	Nominal Diameter—Weight per Foot					
	8	6	5	4	3½	3
	72.42	53.16	38.55	27.54	22.85	18.58
6	355	257	183	130	103	80
8	350	249	176	118	94	71
10	343	240	166	108	82	58
12	334	229	154	94	68	48
14	324	215	140	79	58	41
16	312	200	124	70	50	34
18	299	182	109	61	44	
20	284	163	98	54	38	
22	268	147	88	48		
24	250	135	80			
26	230	124	72			

Loads below heavy line are for l/r ratios between 120 and 200. Properties of steel from which pipe is made assumed to be those of A.S.T.M. A7-46. If pipe is made of other steel safe loads should be suitably modified.

COLUMN BASE PLATES

Steel base plates are generally used under columns for distributing the column loads over a sufficient area of the concrete foundations. The column base plate tables, pages 119 to 121, are for base plates on concrete foundations, for allowable bearing values of 600 and 800 pounds per square inch and the maximum values given in the column load tables. The following method of design, based on an allowable bending stress of 20,000 pounds per square inch, is recommended.



F = Total column load, in kips.

$A = B \times C$ = Area of plate, in square inches.

t = Thickness of plate, in inches.

p = Bearing pressure on foundation, in kips per square inch.

The column load, F, is assumed to be uniformly distributed within a rectangle whose dimensions are .95 d and .80 b, and the base plate is assumed to have a uniform bearing pressure, p, on the foundation.

1. Determine the required area $A = F/p$.
2. Determine B and C so that dimensions m and n are approximately equal.
3. Determine m and n, the projections of the plate beyond the assumed dotted rectangle, and use the larger value to solve for t by one of the following formulas:

$$t^2 = .15\ pm^2 \quad \text{or} \quad t^2 = .15\ pn^2$$

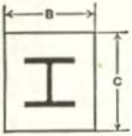
STANDARD ROLLED SIZES
All Dimensions in Inches

14 x 1¼ 14 x 1½	20 x 2 20 x 2½ 20 x 3	28 x 3 28 x 3½	36 x 4 36 x 4½	44 x 5 44 x 5½	52 x 6 52 x 6½
16 x 1½ 16 x 2	24 x 2 24 x 2½ 24 x 3	32 x 3½ 32 x 4	40 x 4½ 40 x 5	48 x 5½ 48 x 6 48 x 6½	56 x 6½ 56 x 7 56 x 8

SECTION MODULI OF BEARING PLATES 1 INCH WIDE FOR THICKNESS GREATER THAN 1 INCH

Thickness In.	S In.³	Thickness In.	S In.³	Thickness In.	S In.³	Thickness In.	S In.³
1¼	.26	3¼	1.76	5¼	4.59	7¼	8.76
1½	.38	3½	2.04	5½	5.04	7½	9.38
1¾	.51	3¾	2.34	5¾	5.51	7¾	10.01
2	.67	4	2.67	6	6.00	8	10.67
2¼	.84	4¼	3.01	6¼	6.51	8¼	11.34
2½	1.04	4½	3.38	6½	7.04	8½	12.04
2¾	1.26	4¾	3.76	6¾	7.59	8¾	12.76
3	1.50	5	4.17	7	8.17	9	13.50

Safe Loads for Column Slabs. Pages 119 to 121.



COLUMN BASE PLATES

DIMENSIONS FOR MAXIMUM COLUMN LOADS

ALLOWABLE BENDING STRESS 20000 POUNDS PER SQUARE INCH

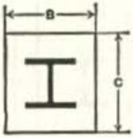
Column				Maximum Column Load	Unit Pressure on Support 600 Pounds per Sq. In.						Unit Pressure on Support 800 Pounds per Sq. In.					
Nominal Size	Weight per Foot	Depth of Column	Width of Flange		Thickness of Plate			Dimensions		Gross Wt.	Thickness of Plate			Dimensions		Gross Wt.
					Calc.	Fin.	Rol'd	B	C		Calc.	Fin.	Rol'd	B	C	
In.	Lb.	In.	In.	Kips	In.	In.	In.	In.	In.	Lb.	In.	In.	In.	In.	In.	Lb.
14 x 16	426	18.69	16.695	2113	6.83	7	7½	59	60	7522	6.51	6⅝	7	51	52	5259
	398	18.31	16.590	1973	6.40	6⅝	7	56	59	6552	5.98	6⅛	6½	48	52	4596
	370	17.94	16.475	1834	6.25	6⅜	7	55	56	6108	6.02	6⅛	6½	48	48	4243
	342	17.56	16.365	1696	5.80	6⅛	6½	52	55	5267	5.43	5¾	6	44	48	3590
	314	17.19	16.235	1556	5.55	5¾	6	50	52	4419	5.39	5¾	6	44	44	3291
	287	16.81	16.130	1422	5.23	5¼	5½	48	50	3740	4.83	5¼	5½	41	44	2811
	264	16.50	16.025	1308	4.95	5⅛	5½	46	48	3440	4.70	4¾	5	40	41	2323
	246	16.25	15.945	1219	4.70	4¾	5	44	46	2867	4.38	4¾	5	38	40	2153
	237	16.12	15.910	1174	4.67	4¾	5	44	45	2805	4.26	4¼	4½	37	40	1887
	228	16.00	15.865	1130	4.54	4¾	5	43	44	2680	4.14	4¼	4½	36	39	1790
	219	15.87	15.825	1084	4.34	4¾	5	41	44	2555	4.02	4¼	4½	36	38	1550
	211	15.75	15.800	1046	4.34	4¾	5	40	44	2493	4.01	4	4	36	37	1509
	202	15.63	15.750	1001	4.10	4¼	4½	40	42	2142	3.87	4	4	35	36	1428
	193	15.50	15.710	956	4.11	4¼	4½	40	40	2040	3.70	4	4	33	36	1346
	184	15.38	15.660	911	3.82	4¼	4½	38	40	1938	3.69	4	4	32	36	1305
	176	15.25	15.640	871	3.95	4	4	36	41	1673	3.38	3½	3½	32	34	1079
	167	15.12	15.600	827	3.66	4	4	36	39	1591	3.35	3½	3½	32	33	1047
	158	15.00	15.550	783	3.50	4	4	36	37	1509	3.19	3½	3½	31	32	984
	150	14.88	15.515	742	3.36	4	4	35	36	1428	3.09	3½	3½	29	32	920
	142	14.75	15.500	705	3.28	4	4	33	36	1346	3.09	3½	3½	28	32	888

Plates 4 inches thick, or under, may be flattened by pressing. For plates more than 4 inches thick, rolled thickness includes allowance for planing top surface. Additional allowance must be made for finishing bottom surface of base plates to be set on grillages. Structural drawings should show finished thickness. Mill orders should specify rolled thickness.

Above base plate sizes computed by method given on page 118

COLUMN BASE PLATES

DIMENSIONS FOR MAXIMUM COLUMN LOADS

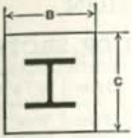


ALLOWABLE BENDING STRESS 20000 POUNDS PER SQUARE INCH

Column				Maximum Column Load	Unit Pressure on Support 600 Pounds per Sq. In.						Unit Pressure on Support 800 Pounds per Sq. In.					
Nominal Size	Weight per Foot	Depth of Column	Width of Flange		Thickness of Plate			Dimensions		Gross Wt.	Thickness of Plate			Dimensions		Gross Wt.
					Calc.	Fin.	Rol'd	B	C		Calc.	Fin.	Rol'd	B	C	
In.	Lb.	In.	In.	Kips	In.	In.	In.	In.	In.	Lb.	In.	In.	In.	In.	In.	Lb.
14 x 14½	136	14.75	14.740	673	3.15	3½	3½	32	35	1111	2.81	3	3	28	30	714
	127	14.62	14.690	628	3.03	3½	3½	32	33	1047	2.82	3	3	28	28	666
	119	14.50	14.650	589	2.88	3½	3½	31	32	984	2.61	3	3	27	28	643
	111	14.37	14.620	549	2.89	3	3	28	33	785	2.46	3	3	25	28	595
	103	14.25	14.575	509	2.59	3	3	28	31	738	2.31	2½	2½	24	27	459
	95	14.12	14.545	470	2.45	3	3	28	28	666	2.12	2½	2½	24	25	425
	87	14.00	14.500	430	2.19	3	3	26	28	619	1.95	2	2	23	24	313
14 x 12	84	14.18	12.023	413	2.32	2½	2½	24	29	493	2.12	2½	2½	22	24	374
	78	14.06	12.000	384	2.15	2½	2½	24	27	459	1.84	2	2	20	24	272
14 x 10	74	14.19	10.072	361	2.40	2½	2½	24	25	425	1.88	2	2	19	24	258
	68	14.06	10.040	332	2.25	2½	2½	23	24	391	1.81	2	2	18	24	245
	61	13.91	10.000	297	1.93	2	2	21	24	286	1.84	2	2	16	24	218
14 x 8	53	13.94	8.062	254	1.72	2	2	18	24	245	1.65	2	2	16	20	181
	48	13.81	8.031	230	1.63	2	2	16	24	218	1.46	2	2	15	20	170
	43	13.68	8.000	206	1.42	1½	1½	16	22	150	1.21	2	2	13	20	147
12 x 12	190	14.38	12.670	936	4.33	4¾	5	39	40	2210	3.93	4	4	33	36	1346
	161	13.88	12.515	794	3.89	4	4	36	37	1509	3.64	4	4	31	32	1124
	133	13.38	12.365	655	3.32	3½	3½	32	34	1079	3.15	3½	3½	28	29	805
	120	13.12	12.320	591	3.16	3½	3½	31	32	984	2.93	3	3	27	28	643
	106	12.88	12.230	522	2.82	3	3	28	31	738	2.57	3	3	24	27	551
	99	12.75	12.190	487	2.74	3	3	28	29	690	2.44	2½	2½	24	26	442
	92	12.62	12.155	453	2.59	3	3	27	28	643	2.45	2½	2½	24	24	408
	85	12.50	12.105	418	2.41	3	3	25	28	595	2.12	2½	2½	22	24	374
	79	12.38	12.080	388	2.28	2½	2½	24	27	459	2.08	2½	2½	21	24	357
	72	12.25	12.040	354	2.14	2½	2½	24	25	425	1.80	2	2	20	22	249
	65	12.12	12.000	320	1.88	2	2	22	24	299	1.80	2	2	20	20	227

Plates 4 inches thick, or under, may be flattened by pressing. For plates more than 4 inches thick, rolled thickness includes allowance for planing top surface. Additional allowance must be made for finishing bottom surface of base plates to be set on grillages. Structural drawings should show finished thickness. Mill orders should specify rolled thickness.

Above base plate sizes computed by method given on page 118.



COLUMN BASE PLATES

DIMENSIONS FOR MAXIMUM COLUMN LOADS

ALLOWABLE BENDING STRESS 20000 POUNDS PER SQUARE INCH

Column				Maximum Column Load	Unit Pressure on Support 600 Pounds per Sq. In.						Unit Pressure on Support 800 Pounds per Sq. In.					
Nominal Size	Weight per Foot	Depth of Column	Width of Flange		Thickness of Plate			Dimensions		Gross Wt.	Thickness of Plate			Dimensions		Gross Wt.
					Calc.	Fin.	Rol'd	B	C		Calc.	Fin.	Rol'd	B	C	
In.	Lb.	In.	In.	Kips	In.	In.	In.	In.	In.	Lb.	In.	In.	In.	In.	In.	Lb.
12 x 10	58	12.19	10.014	283	1.85	2	2	20	24	272	1.72	2	2	18	20	204
	53	12.06	10.000	258	1.88	2	2	18	24	245	1.52	2	2	17	20	193
12 x 8	50	12.19	8.077	240	1.84	2	2	17	24	231	1.48	2	2	15	20	170
	45	12.06	8.042	216	1.71	2	2	16	23	209	1.45	1½	1½	14	20	119
	40	11.94	8.000	192	1.44	1½	1½	16	20	136	1.28	1½	1½	14	18	107
10 x 10	112	11.38	10.415	548	3.15	3½	3½	29	32	920	2.95	3	3	25	28	595
	100	11.12	10.345	490	2.97	3	3	28	29	690	2.70	3	3	24	26	530
	89	10.88	10.275	436	2.66	3	3	26	28	619	2.54	3	3	23	24	469
	77	10.62	10.195	377	2.40	2½	2½	24	26	442	2.39	2½	2½	20	24	340
	72	10.50	10.170	352	2.50	2½	2½	25	24	425	2.08	2½	2½	20	22	312
	66	10.38	10.117	323	2.21	2½	2½	23	24	391	2.02	2½	2½	20	21	297
	60	10.25	10.075	294	2.11	2½	2½	21	24	357	1.87	2	2	19	20	215
	54	10.12	10.028	264	1.86	2	2	20	22	249	1.77	2	2	17	20	193
	49	10.00	10.000	239	1.79	2	2	20	20	227	1.63	2	2	16	19	172
10 x 8	45	10.12	8.022	217	1.74	2	2	18	20	204	1.66	2	2	16	17	154
	39	9.94	7.990	188	1.57	2	2	16	20	181	1.31	1½	1½	14	17	101
	33	9.75	7.964	159	1.43	1½	1½	16	17	116	1.14	1½	1½	13	16	88
8 x 8	67	9.00	8.287	324	2.43	2½	2½	23	24	391	2.28	2½	2½	20	21	297
	58	8.75	8.222	280	2.32	2½	2½	20	24	340	2.00	2	2	18	20	204
	48	8.50	8.117	232	2.00	2	2	20	20	227	1.72	2	2	16	18	163
	40	8.25	8.077	193	1.83	2	2	16	20	181	1.48	1½	1½	15	16	102
	35	8.12	8.027	169	1.53	2	2	16	18	163	1.40	1½	1½	14	16	95
	31	8.00	8.000	149	1.42	1½	1½	16	16	109	1.28	1½	1½	14	14	83
8 x 6½	28	8.06	6.540	132	1.30	1½	1½	14	16	95	1.16	1½	1½	12	14	71
	24	7.93	6.500	113	1.29	1½	1½	14	14	83	1.08	1½	1½	12	14	71

Plates 4 inches thick, or under, may be flattened by pressing. For plates more than 4 inches thick, rolled thickness includes allowance for planing top surface. Additional allowance must be made for finishing bottom surface of base plates to be set on grillages. Structural drawings should show finished thickness. Mill orders should specify rolled thickness.

Above base plate sizes computed by method given on page 118

VALUE OF TWO ANGLES IN TENSION

FIBRE STRESS OF 20000 LBS. PER SQUARE INCH OF SECTION

Size of Angles	Grs. area 2Ls	⅝″ Rivets		¾″ φ Rivets	
		Two Holes Ded.	Four Holes Ded.	Two Holes Ded.	Four Holes Ded.
2 x1½x 3/16	1.24	19160	......	......	......
¼	1.62	24880	......	......	......
2 x2 x 3/16	1.44	23160	......	......	......
¼	1.88	30000	......	......	......
5/16	2.30	36640	......	......	......
⅜	2.72	43160	......	......	......
2½x2 x 3/16	1.62	26760	......	25840	......
¼	2.12	34880	......	33640	......
5/16	2.62	43040	......	41480	......
⅜	3.10	50760	......	48880	......
3 x2 x¼	2.38	40080	......	38840	......
5/16	2.94	49440	......	47880	......
⅜	3.46	57960	......	56080	......
3 x2½x¼	2.62	44880	37360	43640	34880
5/16	3.24	55440	46080	53880	42960
⅜	3.84	65560	54320	63680	50560
3½x2½x¼	2.88	50080	42560	48840	40080
5/16	3.56	61840	52480	60280	49360
⅜	4.22	73160	61920	71280	58160
3½x3 x¼	3.12	54880	47360	53640	44880
5/16	3.86	67840	58480	66280	55360
⅜	4.60	80760	69520	78880	65760
½	6.00	105000	90000	102480	84960
x3 x¼	3.38	60080	52560	58840	50080
5/16	4.18	74240	64880	72680	61760
⅜	4.96	87960	76720	86080	72960
7/16	5.74	101680	88560	99480	84160
½	6.50	115000	100000	112480	94960
4 x3½x¼	3.62	64880	57360	63640	54880
5/16	4.50	80640	71280	79080	68160
⅜	5.34	95560	84320	93680	80560
7/16	6.18	110480	97360	108280	92960
½	7.00	125000	110000	122480	104960
⅝	8.60	153240	134480	150120	128240
5 x3 x 5/16	4.80	86640	77280	85080	74160
⅜	5.72	103160	91920	101280	88160
7/16	6.62	119280	106160	117080	101760
½	7.50	135000	120000	132480	114960
5 x3½x 5/16	5.12	93040	83680	91480	80560
⅜	6.10	110760	99520	108880	95760
7/16	7.06	128080	114960	125880	110560
½	8.00	145000	130000	142480	124960
⅝	9.84	178040	159280	174920	153040

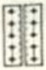
Size of Angles	Grs. area 2Ls	¾″ φ Rivets		⅞″ φ Rivets	
		Two Holes Ded.	Four Holes Ded.	Two Holes Ded.	Four Holes Ded.
6 x3½x 5/16	5.74	103880	92960	102280	89760
⅜	6.84	123680	110560	121800	106800
7/16	7.94	143480	128160	141280	123760
½	9.00	162480	144960	160000	140000
6 x4 x 5/16	6.06	110280	99360	108680	96160
⅜	7.22	131280	118160	129400	114400
7/16	8.36	151880	136560	149680	132160
½	9.50	172480	154960	170000	150000
9/16	10.62	192720	173040	189880	167360
⅝	11.72	212520	190640	209400	184400
¾	13.88	251360	225120	247600	217600
⅞	15.98	288960	258320	284600	249600
6 x6 x⅜	8.72	161280	148160	159400	144400
½	11.50	212480	194960	210000	190000
¾	16.88	311360	285120	307600	277600
7 x4 x⅜	7.96	146080	132960	144200	129200
7/16	9.24	169480	154160	167280	149760
½	10.5	192480	174960	190000	170000
9/16	11.74	215120	195440	212280	189760
⅝	12.96	237320	215440	234200	209200
¾	15.38	281360	255120	277600	247600
8 x6 x½	13.50	252480	234960	250000	230000
⅝	16.72	312520	290640	309400	284400
¾	19.88	371360	345120	367600	337600
⅞	22.96	428560	397920	424200	389200
1	26.00	485000	450000	480000	440000
8 x8 x½	15.50	292480	274960	290000	270000
⅝	19.22	362520	340640	359400	334400
¾	22.88	431360	405120	427600	397600
1	30.00	565000	530000	560000	520000

TENSILE STRENGTH OF ■ AND ● BARS

AT 18,000 LBS. PER SQUARE INCH

SQUARE						ROUND					
Side of Square	Weight Per Lineal ft.	Area at root of thread	Tensile Strength Not Upset	Area of Bar	Tensile Strength for Upset	Diameter	Weight per Lineal ft.	Area at root of thread	Tensile Strength Not Upset	Area of Bar	Tensile Strength for Upset
Ins.	Lbs.	Sq. Ins.	Lbs.	Sq. Ins.	Lbs.	Ins.	Lbs.	Sq. Ins.	Lbs.	Sq. Ins.	Lbs.
1/4	.213	.026	468	.0625	1125	1/4	.167	.026	468	.0491	884
3/8	.478	.068	1224	.1406	2531	3/8	.376	.068	1224	.1105	1989
1/2	.850	.126	2268	.2500	4500	1/2	.668	.126	2268	.1963	3533
5/8	1.328	.202	3636	.3906	7031	5/8	1.043	.202	3636	.3068	5522
3/4	1.913	.302	5436	.5625	10125	3/4	1.502	.302	5436	.4418	7952
7/8	2.603	.419	7542	.7656	13781	7/8	2.044	.419	7542	.6013	10823
1	3.400	.551	9918	1.0000	18000	1	2.670	.551	9918	.7854	14137
1 1/8	4.303	.694	12492	1.2656	22781	1 1/8	3.380	.694	12492	.9940	17892
1 1/4	5.313	.893	16074	1.5625	28125	1 1/4	4.172	.893	16074	1.2272	22090
1 3/8	6.428	1.057	19026	1.8906	34031	1 3/8	5.049	1.057	19026	1.4849	26728
1 1/2	7.650	1.295	23310	2.2500	40500	1 1/2	6.008	1.295	23310	1.7671	31808
1 5/8	8.978	1.515	27270	2.6406	47531	1 5/8	7.051	1.515	27270	2.0739	37330
1 3/4	10.41	1.746	31428	3.0625	55125	1 3/4	8.178	1.746	31428	2.4053	43295
1 7/8	11.95	2.051	36918	3.5156	63281	1 7/8	9.388	2.051	36918	2.7612	49702
2	13.60	2.302	41436	4.0000	72000	2	10.68	2.302	41436	3.1416	56549
2 1/8	15.35	2.650	47700	4.5156	81281	2 1/8	12.06	2.650	47700	3.5466	63839
2 1/4	17.21	3.023	54414	5.0625	91125	2 1/4	13.52	3.023	54414	3.9761	71570
2 3/8	19.18	3.419	61542	5.6406	101531	2 3/8	15.06	3.419	61542	4.4301	79742
2 1/2	21.25	3.719	66942	6.2500	112500	2 1/2	16.69	3.719	66942	4.9087	88357
2 5/8	23.43	4.155	74790	6.8906	124031	2 5/8	18.40	4.155	74790	5.4119	97414
2 3/4	25.71	4.620	83160	7.5625	136125	2 3/4	20.20	4.619	83160	5.9396	106913
2 7/8	28.10	5.108	91944	8.2656	148781	2 7/8	22.07	5.108	91944	6.4918	116852
3	30.60	5.428	97704	9.0000	162000	3	24.03	5.428	97704	7.0686	127235
3 1/8	33.20	5.957	107226	9.7656	175781	3 1/8	26.08	5.957	107226	7.6699	138058
3 1/4	35.91	6.510	117180	10.563	190134	3 1/4	28.21	6.510	117180	8.2958	149324
3 3/8	38.73	7.087	127566	11.391	205038	3 3/8	30.42	7.087	127566	8.9462	161030
3 1/2	41.65	7.548	135864	12.250	220500	3 1/2	32.71	7.548	135864	9.6211	173180
3 5/8	44.68	8.171	147078	13.141	236538	3 5/8	35.09	8.171	147078	10.321	185778
3 3/4	47.81	8.641	155538	14.063	253134	3 3/4	37.55	8.641	155538	11.045	198810
3 7/8	51.05	9.305	167490	15.016	270288	3 7/8	40.10	9.305	167490	11.793	212274

RIVETS 7/8" HOLES 15/16"



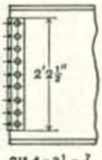
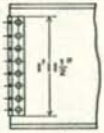
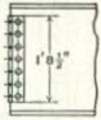
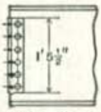
STANDARD BEAM CONNECTIONS

"A" SERIES

ALLOWABLE LOADS IN KIPS

A

These "A" Series Connections are "A.I.S.C. Standard" for the respective beams, and should in general be used for reactions not greater than those herein tabulated. For greater reactions design special connections.

	Rivets in Outstanding Legs		Rivets in Web Legs		Maximum Value	
	No.	Shear	Bearing	Shear	Section	R
A 10  2L 4×3½×7/16	20	180.4	350 t t = thickness of web	180.4	36 WF (all weights)	180.4
A 9  2L 4×3½×7/16	18	162.4	315 t	162.4	33 WF (all weights)	162.4
A 8  2L 4×3½×7/16	16	144.3	280 t	144.3	30 WF (all weights)	144.3
A 7  2L 4×3½×7/16	14	126.3	245 t	126.3	27 WF 177 to 102 94	126.3 120.0†
A 6  2L 4×3½×7/16	12	108.2	210 t	108.2	24 WF 160 to 120 110 100 94 84 76 24 I 120 to 90 79.9	108.2 107.1† 98.3† 108.4† 98.6† 92.4† 108.2 105.0†

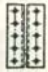
†The values tabulated for these connections have been reduced to those permitted by web bearing.

HOLES 15/16" **RIVETS 7/8"**

STANDARD BEAM CONNECTIONS

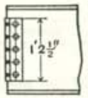
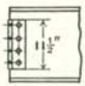
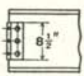
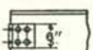
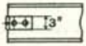
"A" SERIES

ALLOWABLE LOADS IN KIPS



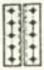
A

These "A" Series Connections are "A.I.S.C. Standard" for the respective beams, and should in general be used for reactions not greater than those herein tabulated. For greater reactions design special connections.

	Rivets in Out-standing Legs		Rivets in Web Legs		Maximum Value			
	No.	Shear	Bearing	Shear	Section	R	Section	R
A 5  2∟ 4×3½×7/16	10	90.2	175 t t = thickness of web	90.2	21WF142 to 96 82 73 68 62	90.2 87.3† 79.6† 75.3† 70.0†	20 I 95 to 75 65.4	90.2 87.5†
A 4  2∟ 4×3½×3/8	8	72.2	140 t	72.2	18WF114to105 96 85 77 70 64 60 55 50 16WF 96 88 78	72.2 71.7† 72.2† 66.5† 61.3† 56.4† 58.3† 54.6† 50.1† 72.2 70.6† 72.2†	16 WF 71 64 58 50 45 40 36 18 I 70 54.7 15 I 50 42.9	68.0† 62.0† 57.0† 53.2† 48.4† 43.0† 41.9† 72.2 64.4† 72.2 57.4†
A 3  2∟ 4×3½×3/8	6	54.1	105 t	54.1	14WF 38 34 30 12WF 36 31 27	32.9† 30.2† 28.4† 32.0† 27.8† 25.2†	12 I 50 40.8 35 31.8	54.1 48.3† 44.9† 36.8†
A 2  2∟ 6×4×3/8	4	36.1	140 t	72.2*	10WF 29 25 21 8WF 20 17	36.1 33.0† 30.9† 26.2† 23.9†	10I(35 and 25.4) 8 I 23.0 18.4	36.1 36.1 28.1†
A 1  2∟ 6×4×3/8	2	18.0	70 t	36.1*	7 I 20 15.3 6 I 17.25 12.5	18.0 17.5† 18.0 16.1†	5 I 14.75 10	18.0 13.7†

*These values are theoretical. They cannot be attained by webs of any of the listed beams.
†The values tabulated for these connections have been reduced to those permitted by web bearing or web shear, whichever governs.

RIVETS ¾" HOLES 13/16"



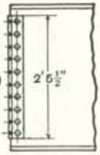
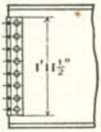
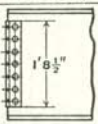
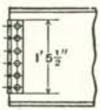
STANDARD BEAM CONNECTIONS

"B" SERIES

ALLOWABLE LOADS IN KIPS

B

These "B" Series Connections are "A.I.S.C. Standard" for the respective beams, and should in general be used for reactions not greater than those herein tabulated. For greater reactions design special connections.

Connection	Rivets in Outstanding Legs		Rivets in Web Legs		Maximum Value	
	No.	Shear	Bearing	Shear	Section	R
B 10  2L 4×3½×7/16	20	132.5	300 t (t = thickness of web)	132.5	36 WF (all weights)	132.5
B 9  2L 4×3½×7/16	18	119.3	270 t	119.3	33 WF (all weights)	119.3
B 8  2L 4×3½×7/16	16	106.0	240 t	106.0	30 WF (all weights)	106.0
B 7  2L 4×3½×7/16	14	92.8	210 t	92.8	27 WF (all weights)	92.8
B 6  2L 4×3½×7/16	12	79.5	180 t	79.5	24 WF 160 to 84 76 24 I (all weights)	79.5 79.2† 79.5

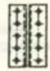
†The values tabulated for these connections have been reduced to those permitted by web bearing.

HOLES 13/16"   RIVETS ¾"

STANDARD BEAM CONNECTIONS

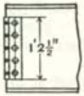
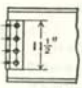
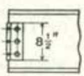
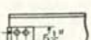
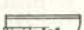
"B" SERIES

ALLOWABLE LOADS IN KIPS



B

These "B" Series Connections are "A.I.S.C. Standard" for the respective beams, and should in general be used for reactions not greater than those herein tabulated. For greater reactions design special connections.

	Rivets in Outstanding Legs		Rivets in Web Legs		Maximum Value			
	No.	Shear	Bearing	Shear	Section	R	Section	R
B 5  1'2½" 2∟ 4×3½×7/16	10	66.3	150 t (t = thickness of web)	66.3	21WF142 to 73	66.3	20I (all weights)	66.3
					68	64.5†		
					62	60.0†		
B 4  11½" 2∟ 4×3½×3/8	8	53.0	120 t	53.0	18WF114 to 77	53.0		
					70	52.6†		
					64	48.4†		
					60	49.9†		
					55	46.8†		
					50	43.0†	18I (all weights)	53.0
					16WF 96 to 64	53.0	15 I 50	53.0
					58	48.8†	42.9	49.2†
					50	45.6†		
					45	41.5†		
					40	36.8†		
					36	35.9†		
B 3  8½" 2∟ 4×3½×3/8	6	39.8	90 t	39.8	14 WF 38	28.2†		
					34	25.8†		
					30	24.3†	12 I 50 and 40.8	39.8
							35	38.5†
					12 WF 36	27.5†	31.8	31.5†
					31	23.8†		
					27	21.6†		
B 2  5½" 2∟ 6×4×3/8	4	26.5	120 t	53.0	10WF(all wts.)	26.5	10I(35 and 25.4)	26.5
					8 WF 20	26.2†	8I(23.0 & 18.4)	26.5
					17	23.9†		
B 1  3" 2∟ 6×4×3/8	2	13.3	60 t	26.5	7I(20 and 15.3)	13.3	5 I 14.75	13.3
							10	12.6
					6I(17.25 and 12.5)	13.3		

†The values tabulated for these connections have been reduced to those permitted by web bearing or web shear, whichever governs.

RIVET GROUPS UNDER ECCENTRIC APPLICATION OF LOAD

When a group of rivets carries an eccentric load, as in Fig. 1, the several rivets in such a group are not equally stressed. Each carries an equal share ($r = F/2n$) of the vertical load F, and each carries in addition a force R due to moment, which is proportional to its distance a from the center of the rivet group and acts at right angles to the line connecting the rivet in question to the center of the group. The total stress on the rivet is the resultant of the two components defined above; it is greatest for the rivet which is on the side toward the load, and farthest from the center of the group.

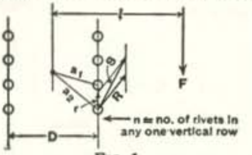


FIG. 1

Let a_1, a_2, etc., be the distances of respective rivets from center of group.

Let x = the unknown force due to moment on an imaginary rivet at unit distance from center of group.

Then, on any rivet at distance a, the force = ax, and its moment = a^2x.

Adding $(a_1)^2x + (a_2)^2x + \cdots$ etc., and equating to the moment F*l*, solve for x.

Then R (Fig. 1) = maximum ax, and S is found from R and r as shown in Fig. 1.

The group must be such in number and arrangement of rivets that S, the greatest stress on any rivet, does not exceed the value allowed by the Specification.

For any rivet group and any given lever arm of applied load a coefficient C may be found, such that C times the allowable value of one rivet equals the total load F permissible on the connection.

Thus $F = C \times S$.

Or, knowing F, and dividing by the allowable rivet value S, the necessary coefficient C is obtained, and a rivet group must be employed for which the coefficient is of that magnitude or greater.

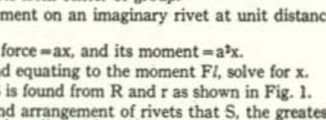


FIG. 2

General expressions for the coefficient C are very complex, and for all except simple, symmetrical cases the joint must be detailed by a cut-and-try process based on the foregoing principles and without deriving of coefficients. For the simplest cases occurring repeatedly in practice, the coefficients C are given in the Tables on page 129, in connection with Fig. 2 is given an example of the use thereof.

In the case of eccentric brackets of the type shown in Fig. 3, in which the moment produces tension on the rivets, there is no exact knowledge as to the location of the neutral axis; it probably lies somewhere below the center line of the connection. Nor is there exact knowledge of the permissible combination of tension with vertical shear on the uppermost rivets. A safe and accepted method of design for brackets of the type shown is to consider the rivets to be under an eccentric loading similar to that exemplified in Table I, page 129. The coefficient C for such cases will be twice the values tabulated in Table I to conform with the two vertical rows of rivets; the resultant stress on one extreme rivet not to exceed the A. I. S. C. Specification allowance of 15.0 kips per square inch.

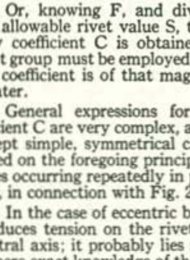


FIG. 3

Example:

F = 22 kips l = 12" ¾" rivets, 3" pitch.
Allowable stress on one rivet = $15.0 \times .4418 =$ 6.63 kips.

$$C = \frac{F}{2 \times S} = \frac{22}{2 \times 6.63} = 1.66$$

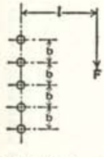
From Table I for l = 12" six rivets are required in each of two vertical rows.

The thickness of the bracket connection angles should be ample to resist the bending moment.

RIVET GROUPS UNDER ECCENTRIC APPLICATION OF LOAD

Nomenclature:
n = total number of rivets in any one vertical row.
F = permissible load, acting with lever arm l.
S = permissible load on one rivet by Specification.
C = coefficient as tabulated below.
F = C × S; or, knowing F, required minimum $C = \frac{F}{S}$

Case I

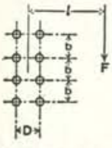


In Table, b = 3″

n \ l	1″	2″	3″	6″	9″	12″	15″	18″	21″	24″
2	1.7	1.2	.89	.49	.33	.25	.20	.17	.14	.12
3	2.7	2.1	1.7	.95	.65	.49	.40	.33	.28	.25
4	3.7	3.1	2.6	1.5	1.1	.82	.66	.55	.47	.41
5	4.7	4.2	3.5	2.2	1.6	1.2	.98	.82	.71	.62
6	5.8	5.2	4.6	3.0	2.2	1.7	1.4	1.1	.99	.87
7	6.8	6.3	5.6	3.9	2.8	2.2	1.8	1.5	1.3	1.2
8	7.8	7.3	6.7	4.8	3.6	2.8	2.3	1.9	1.7	1.5
9	8.8	8.4	7.7	5.8	4.4	3.5	2.8	2.4	2.1	1.8
10	9.8	9.4	8.8	6.8	5.2	4.2	3.4	2.9	2.5	2.2
11	10.9	10.4	9.8	7.8	6.1	4.9	4.1	3.5	3.0	2.7
12	11.9	11.5	10.9	8.8	7.0	5.7	4.8	4.1	3.5	3.1

In general, $C = \dfrac{n}{\sqrt{\left[\dfrac{6\,l}{(n+1)\,b}\right]^2 + 1}}$

Case II

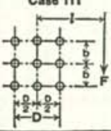


In Table, b = 3″ and D = 5½″ or 9½″

l	1″		2″		3″		6″		9″		12″		15″		18″		21″		24″	
n \ D	5½	9½	5½	9½	5½	9½	5½	9½	5½	9½	5½	9½	5½	9½	5½	9½	5½	9½	5½	9½
2	3.1	3.4	2.5	2.9	2.1	2.5	1.4	1.8	1.1	1.4	0.8	1.2	0.7	1.0	0.6	0.9	0.5	0.8	0.5	0.7
3	4.9	5.1	4.1	4.4	3.4	3.9	2.3	2.9	1.7	2.2	1.4	1.8	1.1	1.6	1.0	1.4	0.9	1.2	0.8	1.1
4	6.8	7.0	5.8	6.1	5.0	5.4	3.4	4.0	2.5	3.1	2.0	2.6	1.7	2.2	1.4	1.9	1.2	1.7	1.1	1.5
5	8.8	8.9	7.7	7.9	6.7	7.0	4.6	5.2	3.5	4.1	2.8	3.3	2.3	2.8	1.9	2.4	1.7	2.1	1.5	1.9
6	10.9	10.8	9.6	9.7	8.5	8.7	6.0	6.5	4.5	5.1	3.6	4.2	3.0	3.6	2.6	3.1	2.2	2.7	2.0	2.4
7	12.9	12.8	11.7	11.6	10.4	10.6	7.5	8.0	5.8	6.3	4.6	5.2	3.8	4.4	3.3	3.8	2.8	3.3	2.5	3.0
8	15.0	14.8	13.7	13.6	12.4	12.4	9.2	9.6	7.1	7.6	5.7	6.2	4.8	5.3	4.1	4.6	3.5	4.0	3.1	3.6
9	17.0	16.9	15.8	15.6	14.5	14.4	11.0	11.2	8.6	9.0	6.9	7.4	5.8	6.3	4.9	5.4	4.3	4.8	3.8	4.3
10	19.1	18.9	17.9	17.7	16.6	16.4	12.8	13.0	10.1	10.5	8.2	8.7	6.9	7.4	5.9	6.4	5.2	5.6	4.6	5.0
11	21.2	20.9	20.0	19.7	18.7	18.4	14.8	14.8	11.8	12.1	9.7	10.0	8.1	8.5	7.0	7.4	6.1	6.5	5.4	5.8
12	23.2	23.0	22.1	21.8	20.8	20.5	16.8	16.7	13.5	13.7	11.2	11.4	9.4	9.8	8.1	8.5	7.1	7.5	6.3	6.7

In general, $C = \dfrac{n}{\sqrt{\left[\dfrac{l(n-1)b}{D^2 + \frac{1}{3}(n^2-1)\,b^2}\right]^2 + \left[\dfrac{l\,D}{D^2 + \frac{1}{3}(n^2-1)\,b^2} + \frac{1}{2}\right]^2}}$

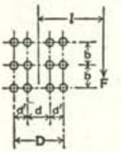
Case III



Case III, not tabulated.

In general, $C = \dfrac{n}{\sqrt{\left[\dfrac{l(n-1)b}{D^2 + \frac{1}{2}(n^2-1)\,b^2}\right]^2 + \left[\dfrac{l\,D}{D^2 + \frac{1}{2}(n^2-1)\,b^2} + \frac{1}{3}\right]^2}}$

Case IV



In Table, b = 3″

d′ = 2½″	d′ = 3″
d = 4½″	d = 5½″
d′ = 2½″	d′ = 3″
D = 9½″	D = 11½″

l	1″		2″		3″		6″		9″		12″		15″		18″		21″		24″	
n \ D	9½	11½	9½	11½	9½	11½	9½	11½	9½	11½	9½	11½	9½	11½	9½	11½	9½	11½	9½	11½
2	6.2	6.4	5.0	5.3	4.2	4.5	2.8	3.1	2.1	2.4	1.7	1.9	1.4	1.6	1.2	1.4	1.1	1.2	1.0	1.1
3	9.6	9.8	8.0	8.2	6.7	7.1	4.6	5.0	3.5	3.8	2.8	3.1	2.3	2.6	2.0	2.2	1.8	2.0	1.6	1.8
4	13.3	13.4	11.2	11.5	9.7	10.0	6.7	7.1	5.1	5.4	4.1	4.4	3.4	3.7	2.9	3.2	2.6	2.8	2.3	2.5
5	17.2	17.2	14.8	15.0	12.9	13.1	9.1	9.4	6.9	7.3	5.6	5.9	4.7	5.0	4.0	4.3	3.5	3.8	3.1	3.4
6	21.2	21.1	18.6	18.6	16.4	16.5	11.7	12.1	9.0	9.4	7.3	7.6	6.1	6.4	5.2	5.5	4.6	4.9	4.1	4.3
7	25.2	25.1	22.5	22.5	20.1	20.1	14.7	14.9	11.3	11.7	9.2	9.5	7.7	8.0	6.6	6.9	5.8	6.1	5.1	5.4
8	29.3	29.2	26.5	26.4	23.9	23.9	17.8	18.0	13.9	14.2	11.3	11.6	9.5	9.8	8.2	8.5	7.2	7.5	6.4	6.6
9	33.4	33.3	30.6	30.5	27.9	27.8	21.2	21.3	16.7	16.9	13.7	13.9	11.5	11.8	9.9	10.2	8.7	9.0	7.7	8.0
10	37.6	37.4	34.8	34.6	32.0	31.8	24.8	24.8	19.7	19.9	16.2	16.4	13.7	13.9	11.8	12.1	10.4	10.6	9.2	9.5
11	41.7	41.5	39.0	38.7	36.2	35.9	28.5	28.5	22.9	23.0	18.9	19.1	16.0	16.2	13.9	14.1	12.2	12.4	10.9	11.1
12	45.8	45.6	43.2	42.8	40.3	40.0	32.4	32.2	26.3	26.3	21.8	21.9	18.5	18.7	16.0	16.3	14.1	14.4	12.6	12.8

In general, $C = \dfrac{n}{\sqrt{\left[\dfrac{l(n-1)b}{d^2 + D^2 + \frac{2}{3}(n^2-1)\,b^2}\right]^2 + \left[\dfrac{l\,D}{d^2 + D^2 + \frac{2}{3}(n^2-1)\,b^2} + \frac{1}{4}\right]^2}}$

SHEARING AND BEARING VALUE OF RIVETS

	Single Shear		Diam. of Rivet Inches	Plate Size	Bearing Values in Pounds for Different Thickness of Plate in inches: 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"	Diam. of Rivet Inches
ROUGH BOLTS	Shear at 10000 lbs. per square inch	1100	3/8	Bearing at 20000 lbs. per square inch	1880	2340	2810	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3/8"
		1960	1/2		2500	3130	3750	4380	5000	.....	.....	.....	.....	.....	.....	.....	.....	1/2"
		3070	5/8		3130	3910	4690	5470	6250	7030	7810	.....	.....	.....	.....	.....	.....	5/8"
		4420	3/4		3750	4690	5630	6560	7500	8440	9380	10310	11250	.....	.....	.....	.....	3/4"
		6010	7/8		4380	5470	6560	7660	8750	9840	10940	12030	13130	14220	15310	16410	.....	7/8"
		7850	1		5000	6250	7500	8750	10000	11250	12500	13750	15000	16250	17500	18750	20000	1"
FIELD RIVETS	Shear at 12000 lbs. per square inch	1320	3/8	*Bearing at 24000 lbs. per square inch	2250	2800	3370	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3/8"
		2360	1/2		3000	3750	4500	5250	6000	.....	.....	.....	.....	.....	.....	.....	.....	1/2"
		3680	5/8		3750	4690	5630	6560	7500	8440	9380	.....	.....	.....	.....	.....	.....	5/8"
		5300	3/4		4500	5630	6750	7880	9000	10130	11250	12370	13500	.....	.....	.....	.....	3/4"
		7220	7/8		5250	6560	7880	9190	10500	11810	13130	14430	15750	17060	18370	19690	.....	7/8"
		9420	1		6000	7500	9000	10500	12000	13500	15000	16500	18000	19500	21000	22500	24000	1"
SHOP RIVETS	Shear at 13500 lbs. per square inch	1480	3/8	*Bearing at 30000 lbs. per square inch	2820	3510	4210	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3/8"
		2640	1/2		3750	4690	4500	6570	7500	.....	.....	.....	.....	.....	.....	.....	.....	1/2"
		4140	5/8		4690	5860	7030	8200	9370	10540	11710	.....	.....	.....	.....	.....	.....	5/8"
		5960	3/4		5630	7030	8440	9840	11250	12660	14060	15460	16870	.....	.....	.....	.....	3/4"
		8110	7/8		6570	8200	9840	11490	13120	14760	16410	18040	19690	21330	22960	24610	.....	7/8"
		10590	1		7500	9370	11250	13120	15000	16870	18750	20620	22500	24370	26250	28120	30000	1"
SHOP RIVETS	Shear at 15000 lbs. per square inch	1660	3/8	**Bearing at 40000 lbs. per square inch	3760	4680	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3/8"
		2950	1/2		5000	6260	7500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1/2"
		4600	5/8		6260	7820	9380	10940	.....	.....	.....	.....	.....	.....	.....	.....	.....	5/8"
		6630	3/4		7500	9380	11260	13120	15000	16880	.....	.....	.....	.....	.....	.....	.....	3/4"
		9030	7/8		8760	10940	13120	15320	17500	19680	21800	.....	.....	.....	.....	.....	.....	7/8"
		11780	1		10000	12500	15000	17500	20000	22500	25000	27500	.....	.....	.....	.....	.....	1"

Bearing values given above or to the right of the upper heavy lines are greater than double shear. Bearing values given between the upper and lower heavy lines are less than double shear and greater than single shear.

Bearing values given below or to the left of the lower heavy lines are less than single shear.

CAUTION
- *Use 30000 for enclosed bearing.
- *Use 24000 for single bearing.
- **Use 40000 for enclosed bearing.

REDUCTION OF AREA FOR RIVET HOLES

AREA IN SQUARE INCHES = ASSUMED DIAMETER OF HOLE BY THICKNESS OF METAL
FOR COMPUTATION PURPOSES RIVET HOLES SHALL BE TAKEN AS THE NOMINAL DIAMETER OF THE RIVET PLUS 1/8 INCH

Thickness of Metal Inches	Diameter of Hole, Inches								
	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8
3/16	.117	.141	.164	.188	.211	.234	.258	.281	.305
1/4	.156	.188	.219	.250	.281	.313	.344	.375	.406
5/16	.195	.234	.273	.313	.352	.391	.430	.469	.508
3/8	.234	.281	.328	.375	.422	.469	.516	.563	.609
7/16	.273	.328	.383	.438	.492	.547	.602	.656	.711
1/2	.313	.375	.438	.500	.563	.625	.688	.750	.813
9/16	.352	.422	.492	.563	.633	.703	.773	.844	.914
5/8	.391	.469	.547	.625	.703	.781	.859	.938	1.016
11/16	.430	.516	.602	.688	.773	.859	.945	1.031	1.117
3/4	.469	.563	.656	.750	.844	.938	1.031	1.125	1.219
13/16	.508	.609	.711	.813	.914	1.016	1.117	1.219	1.320
7/8	.547	.656	.766	.875	.984	1.094	1.203	1.313	1.422
15/16	.586	.703	.820	.938	1.055	1.172	1.289	1.406	1.523
1	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
1 1/16	.664	.797	.930	1.063	1.195	1.328	1.461	1.594	1.727
1 1/8	.703	.844	.984	1.125	1.266	1.406	1.547	1.688	1.828
1 3/16	.742	.891	1.039	1.188	1.336	1.484	1.633	1.781	1.930
1 1/4	.781	.938	1.094	1.250	1.406	1.563	1.719	1.875	2.031
1 5/16		.984	1.148	1.313	1.477	1.641	1.805	1.969	2.133
1 3/8		1.031	1.203	1.375	1.547	1.719	1.891	2.063	2.234
1 7/16		1.078	1.258	1.438	1.617	1.797	1.977	2.156	2.336
1 1/2		1.125	1.313	1.500	1.688	1.875	2.063	2.250	2.438
1 9/16		1.172	1.367	1.563	1.758	1.953	2.148	2.344	2.539
1 5/8		1.219	1.422	1.625	1.828	2.031	2.234	2.438	2.641
1 11/16		1.266	1.477	1.688	1.898	2.109	2.320	2.531	2.742
1 3/4		1.313	1.531	1.750	1.969	2.188	2.406	2.625	2.844
1 13/16			1.586	1.813	2.039	2.266	2.492	2.719	2.945
1 7/8			1.641	1.875	2.109	2.344	2.578	2.813	3.047
1 15/16			1.695	1.938	2.180	2.422	2.664	2.906	3.148
2			1.750	2.000	2.250	2.500	2.750	3.000	3.250
2 1/16			1.805	2.063	2.320	2.578	2.836	3.094	3.352
2 1/8			1.859	2.125	2.391	2.656	2.922	3.188	3.453
2 3/16			1.914	2.188	2.461	2.734	3.008	3.281	3.555
2 1/4			1.969	2.250	2.531	2.813	3.094	3.375	3.656
2 5/16			2.023	2.313	2.602	2.891	3.180	3.469	3.758
2 3/8			2.078	2.375	2.672	2.969	3.266	3.563	3.859
2 7/16			2.133	2.438	2.742	3.047	3.352	3.656	3.961
2 1/2			2.188	2.500	2.813	3.125	3.438	3.750	4.063
2 5/8			2.297	2.625	2.953	3.281	3.609	3.938	4.266
2 3/4			2.406	2.750	3.094	3.438	3.781	4.125	4.469
2 7/8			2.516	2.875	3.234	3.594	3.953	4.313	4.672
3			2.625	3.000	3.375	3.750	4.125	4.500	4.875

GENERAL INFORMATION ON RIVETS AND RIVETING.

The pitch or distance from center to center of rivets should not be less than 3 diameters of the rivet. In the flanges of beams and girders where plates more than 12 inches wide are used, an extra line of rivets with a pitch not greater than 9 inches should be driven along each edge to draw the plates together.

At the ends of compression members the pitch should not exceed 4 diameters of the rivet for a length equal to 1½ times the width or diameter of the member. In girder stiffeners the pitch should not exceed 6 inches.

In the flanges of girders and chords, carrying floors, the pitch should not exceed 6 inches.

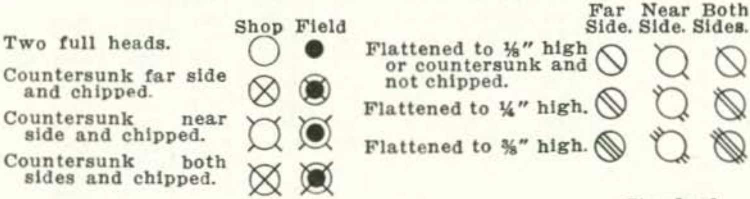
For members in compression, the pitch in the direction of the line of stress should not exceed 16 times the thinnest outside plate, nor 20 times the thinnest enclosed plate or shape with a maximum of 12 inches, and at right angles to the direction of stress the distance between lines of rivets shall not exceed 30 times the thinnest plate or shape. For angles in built sections with two gauge lines, with rivets staggered, the maximum pitch in the line of stress in each gauge line shall not exceed 24 times the thinnest plate with a maximum of 18 inches.

Generally the distance between the edge of any piece and the center of the rivet hole should not be less than 1¼ inches for ¾ and ⅞ inch rivets except in bars less than 2½ inches wide; when practicable it should, for all sizes, be at least 2 diameters of the rivet and should not exceed 12 times the thickness of plate with a maximum of 6 inches.

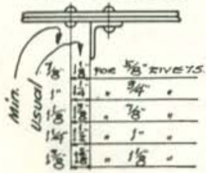
In figuring clearance of rivets for special cases, allow ⅜ inch in addition to diameter of head.

The shop cost of round and flattened head rivets is the same, while countersunk rivets entail more labor and expense. Countersunk holes should not be used in plates of less thickness than one-half the diameter of rivet.

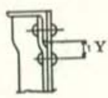
CONVENTIONAL SIGNS FOR RIVETING.



Clearance for Web Riveting.

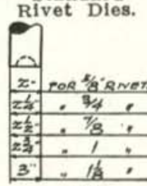


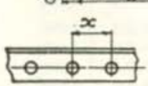
Rivets in Crimped Angles.



Distance Y should be 1⅛ in. plus thickness of chord angles, but never less than 2 in.

Standard Rivet Dies.





MINIMUM RIVET SPACING.

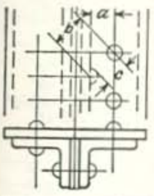
Dia. of rivet, in.	¼	⅜	½	⅝	¾	⅞	1	1⅛
x, minimum, in.	1	1¼	1¾	2	2¼	2⅝	3	3⅜

STANDARD GAUGES FOR ANGLES

Leg.	a	Max. Riv.	Leg.	b	c	Max. Riv.
4	2½	⅞	8	3	3	1
3½	2	⅞	7	2½	3	Variable
3	1¾	⅞	6	2½	2¼	"
2½	1⅜	¾	5	1¾	2	"
2	1⅛	⅝	4	1½	1¾	½
1¾	1	½				

All Dimensions in Inches

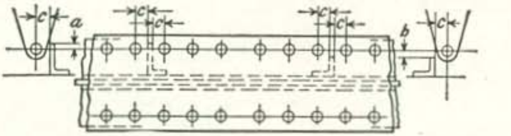
MINIMUM PITCH FOR MACHINE RIVETING



Riv. Diam. D	Std. c	Std. b	a 1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2¼	2⅜	2½	2¾
⅜	⅞	1 3/16	¼	0	...	...	...	...	...	...	...	...	...	...	...
½	1	1 5/16	¾	½	0	...	...	...	...	...	...	...	...	...	...
⅝	1⅛	1 9/16	1⅛	1	¾	⅜	0	...	...	...	...	...	...	...	...
¾	1¼	1¾	...	1¼	1⅛	1	¾	0	...	...	...	...	...	...	...
⅞	1⅜	2	...	...	1½	1⅜	1⅛	⅞	⅝	0	...	...	...	...	...
1	1½	2 3/16	...	...	...	1⅝	1½	1⅜	1⅛	⅞	½	0	...	...	...
1⅛	1⅝	2⅜	...	...	...	...	1¾	1⅝	1½	1⅜	1⅛	⅞	0	...	...
1¼	1¾	2⅝	...	...	...	...	...	2	1⅞	1¾	1½	1¼	1	⅝	0
1⅜	1⅞	2 13/16	...	...	...	...	...	...	2⅛	2	1⅞	1¾	1½	1¼	½
1½	2	3	...	...	...	...	...	...	...	2¼	2⅛	2	1⅞	1⅝	1⅛

COVER PLATE RIVETING

a	c
½	2½
1	2⅝
1½	2¾
2	2¾
2½	2⅞
3	2⅞
3½	3
4	3⅛
5	3¼
	3⅜



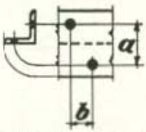
The use of hand pneumatic hammers is avoided where construction permits these clearances

b	c
...	2½
½	2⅜
¾	2¼
1	2¼
1¼	2⅛
1½	2
1¾	1¾
2	1½
2¼	1
2½	..

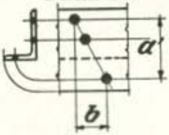
STAGGER OF RIVETS TO MAINTAIN NET SECTION

DIMENSIONS IN INCHES

1 Hole Out



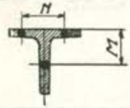
2 Holes Out



⅝" rivets, can be taken at ⅛" less than for ¾".
1" rivets, can be taken at ⅛" more than for ⅞".

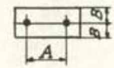
a	¾ Rivet b	⅞ Rivet b	a	¾ Rivet b	⅞ Rivet b
1	1⅝	1¾	5	3 1/16	3 5/16
1½	1⅞	2	5½	3¼	3½
2	2 1/16	2¼	6	3⅜	3⅝
2½	2¼	2 7/16	6½	3½	3¾
3	2 7/16	2⅝	7	3⅝	3⅞
3½	2 9/16	2 13/16	7½	3¾	4
4	2 11/16	3	8	3⅞	4⅛
4½	2 13/16	3 3/16	8½	4	4¼

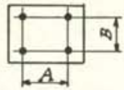
STANDARD GAUGES FOR TEES



Width of Flange	Distance N	Max. Rivet or Bolt Flg.	Depth of Bar	Distance M	Max. Rvt. or Bolt Stem.
1	5/8	1/4	1	9/16	3/8
1 1/8	5/8	1/4	1 1/16	9/16	3/8
1 3/16	5/8	1/4	1 1/8	9/16	1/2
1 1/4	5/8	1/4	1 3/16	5/8	1/2
1 1/2	3/4	1/4	1 1/2	7/8	1/2
1 3/4	7/8	3/8	1 3/4	1	5/8
2 1/4	1 1/8	1/2	1 3/4	1	5/8
2 1/2	1 1/4	1/2	2	1 1/8	5/8
2 3/4	1 3/8	1/2	2 1/4	1 1/4	3/4
3	1 1/2	1/2	2 1/2	1 3/8	3/4
3 1/2	1 3/4	5/8	3	1 3/4	7/8
4	2	5/8	3 1/2	2	1
4 1/2	2 1/4	3/4	4	2 1/4	1
5	2 3/8	3/4	...	...	...

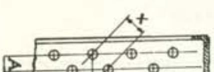
STANDARD TIE PLATES





Size of Beam or Girder	Distance A	Distance B	Size of Plate
3″- I	4	1 1/4	2 1/2 x 5/16 x 0′-7″
4 - I	4	1 1/4	″
5 - I	4	1 1/4	″
6 - I	4	1 1/4	″
7 - I	4	1 1/4	″
8 - I	4	1 1/4	″
9 - I	4	1 1/4	″
10 - I	4	1 1/4	″
12 - I	4	4	7 x 5/16-0′-7″
15 - I	4	4	″
18 - I	4	4	″
20 - I	4	4	″
24 - I	4	4	″
12-Girder	6	4	7 x 5/16-0′-9″
15- ″	7 1/2	4	7 x 5/16-0′-10 1/2″
18- ″	9	4	7 x 5/16-1′-0″
20- ″	10	4	7 x 3/8-1′-1″
24- ″	12	4	7 x 3/8-1′-3″

DISTANCE C/L TO C/L OF STAGGERED RIVETS.



Values below or to the right of upper heavy line are large enough for 5/8″ Rivets.

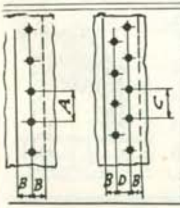
Values below or to the right of second heavy line are large enough for 3/4″ Rivets.

Values below or to the right of lower heavy line are large enough for 7/8″ Rivets.

VALUES OF X FOR VARYING VALUES OF "A" AND "B"

Values of "B"	VALUES OF "A" 7/8	1	1 1/8	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
1 1/8	1 7/16	1 1/2	1 9/16	1 11/16	1 3/4	1 7/8	2	2 1/16	2 3/16	2 5/16	2 3/8	2 1/2	2 5/8	2 3/4
1 1/4	1 9/16	1 5/8	1 11/16	1 3/4	1 7/8	1 15/16	2 1/16	2 1/8	2 1/4	2 3/8	2 7/16	2 9/16	2 11/16	2 13/16
1 3/8	1 5/8	1 11/16	1 3/4	1 7/8	1 15/16	2	2 1/8	2 3/16	2 5/16	2 7/16	2 1/2	2 5/8	2 3/4	2 7/8
1 1/2	1 3/4	1 13/16	1 7/8	1 15/16	2	2 1/8	2 3/16	2 5/16	2 3/8	2 1/2	2 5/8	2 11/16	2 13/16	2 15/16
1 5/8	1 7/8	1 7/8	2	2 1/16	2 1/8	2 3/16	2 5/16	2 3/8	2 1/2	2 9/16	2 11/16	2 3/4	2 7/8	3
1 3/4	1 15/16	2	2 1/16	2 1/8	2 3/16	2 5/16	2 3/8	2 7/16	2 9/16	2 5/8	2 3/4	2 7/8	2 15/16	3 1/16
1 7/8	2 1/16	2 1/8	2 3/16	2 1/4	2 5/16	2 3/8	2 1/2	2 9/16	2 5/8	2 3/4	2 13/16	2 15/16	3	3 1/8
2	2 3/16	2 1/4	2 5/16	2 3/8	2 7/16	2 1/2	2 9/16	2 5/8	2 3/4	2 13/16	2 15/16	3	3 1/8	3 3/16
2 1/8	2 5/16	2 5/16	2 3/8	2 7/16	2 1/2	2 5/8	2 11/16	2 3/4	2 13/16	2 15/16	3	3 1/16	3 3/16	3 1/4
2 1/4	2 7/16	2 7/16	2 1/2	2 9/16	2 5/8	2 11/16	2 3/4	2 7/8	2 15/16	3	3 1/16	3 3/16	3 1/4	3 3/8
2 3/8	2 1/2	2 9/16	2 5/8	2 11/16	2 3/4	2 13/16	2 7/8	2 15/16	3	3 1/8	3 3/16	3 1/4	3 3/8	3 7/16
2 1/2	2 5/8	2 11/16	2 3/4	2 13/16	2 7/8	2 15/16	3	3 1/16	3 1/8	3 3/16	3 1/4	3 3/8	3 7/16	3 9/16

STANDARD RIVET SPACING FOR CAULKING.

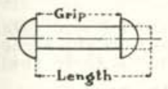


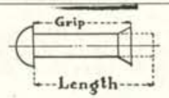
Thickness of Plate	1/2″-Rivets A	B	C	D	5/8″-Rivets A	B	C	D	3/4″-Rivets A	B	C	D	7/8″-Rivets A	B	C	D
3/16	1 5/8	3/4	2 1/4	1 3/8												
1/4	1 3/4	7/8	2 1/2	1 1/2	1 7/8	1	2 5/8	1 5/8	2	1 1/8	2 3/4	1 3/4				
5/16	1 3/4	7/8	2 1/2	1 1/2	2	1	2 3/4	1 3/4	2 1/8	1 1/8	2 7/8	1 7/8				
3/8	1 7/8	1	2 5/8	1 1/2	2	1	2 3/4	1 3/4	2 1/4	1 1/8	3	2	2 3/8	1 1/4	3 1/8	2 1/8
7/16	...	...	...	...	2 1/8	1	2 7/8	1 3/4	2 1/4	1 1/8	3	2	2 3/8	1 3/8	3 1/4	2 1/4
1/2	...	...	...	...	2 1/4	1 1/8	3	1 7/8	2 3/8	1 1/4	3 1/8	2 1/8	2 1/2	1 1/2	3 1/4	2 1/4
5/8	...	...	...	...	...	...	...	...	2 1/2	1 1/4	3 1/4	2 1/8	2 5/8	1 1/2	3 3/8	2 1/4
3/4																

STRUCTURAL RIVETS

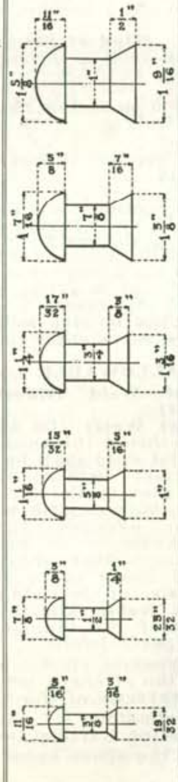
LENGTHS OF FIELD RIVETS FOR VARIOUS GRIPS

Dimensions in Inches





Grip in Inches	Diameter in Inches (Length in Inches) ½	⅝	¾	⅞	1	Diameter in Inches (Length in Inches) ½	⅝	¾	⅞	1	Grip in Inches
½	1½	1¾	1⅞	2	2⅛	1⅛	1¼	1¼	1⅜	1⅜	½
⅝	1⅝	1⅞	2	2⅛	2¼	1¼	1⅜	1⅜	1½	1½	⅝
¾	1¾	2	2⅛	2¼	2⅜	1⅜	1½	1½	1⅝	1⅝	¾
⅞	1⅞	2⅛	2¼	2⅜	2½	1½	1⅝	1⅝	1¾	1¾	⅞
1	2	2¼	2⅜	2½	2⅝	1⅝	1¾	1¾	1⅞	1⅞	1
1⅛	2⅛	2⅜	2½	2⅝	2¾	1¾	1⅞	1⅞	2	2	1⅛
1¼	2¼	2½	2⅝	2¾	2⅞	1⅞	2	2	2⅛	2⅛	1¼
1⅜	2⅜	2⅝	2¾	2⅞	3	2	2⅛	2⅛	2¼	2¼	1⅜
1½	2⅝	2⅞	3	3⅛	3¼	2⅛	2¼	2⅜	2⅜	2½	1½
1⅝	2¾	3	3⅛	3¼	3⅜	2¼	2⅜	2½	2½	2⅝	1⅝
1¾	3	3¼	3⅜	3½	3⅝	2½	2⅝	2¾	2¾	2⅞	1¾
1⅞	3⅛	3⅜	3½	3⅝	3¾	2⅝	2¾	2⅞	2⅞	3	1⅞
2	3¼	3½	3⅝	3¾	3⅞	2¾	2⅞	3	3	3⅛	2
2⅛	3⅜	3⅝	3¾	3⅞	4	2⅞	3	3⅛	3⅛	3¼	2⅛
2¼	3½	3¾	3⅞	4	4⅛	3	3⅛	3¼	3¼	3⅜	2¼
2⅜	3⅝	3⅞	4	4⅛	4¼	3⅛	3¼	3⅜	3⅜	3½	2⅜
2½	3¾	4	4⅛	4¼	4⅜	3¼	3⅜	3½	3½	3⅝	2½
2⅝	3⅞	4⅛	4¼	4⅜	4½	3⅜	3½	3⅝	3⅝	3¾	2⅝
2¾	4	4¼	4⅜	4½	4⅝	3½	3⅝	3¾	3¾	3⅞	2¾
2⅞	4⅛	4⅜	4½	4⅝	4¾	3⅝	3¾	3⅞	3⅞	4	2⅞
3	4⅜	4⅝	4¾	4⅞	5	3⅞	4	4	4⅛	4¼	3
3⅛	4½	4¾	4⅞	5	5⅛	4	4⅛	4⅛	4¼	4⅜	3⅛
3¼	4⅝	4⅞	5	5⅛	5¼	4⅛	4¼	4¼	4⅜	4½	3¼
3⅜	4¾	5	5⅛	5¼	5⅜	4¼	4⅜	4⅜	4½	4⅝	3⅜
3½	4⅞	5⅛	5¼	5⅜	5½	4⅜	4½	4½	4⅝	4¾	3½
3⅝	5	5¼	5⅜	5½	5⅝	4½	4⅝	4⅝	4¾	4⅞	3⅝
3¾	5⅛	5⅜	5½	5⅝	5¾	4⅝	4¾	4¾	4⅞	5	3¾
3⅞	5¼	5½	5⅝	5¾	5⅞	4¾	4⅞	4⅞	5	5⅛	3⅞
4	5⅜	5⅝	5¾	5⅞	6	4⅞	5	5	5⅛	5¼	4
4⅛	5⅝	5⅞	6	6⅛	6¼	5⅛	5¼	5¼	5⅜	5½	4⅛
4¼	5¾	6	6⅛	6¼	6⅜	5¼	5⅜	5⅜	5½	5⅝	4¼
4⅜	6	6¼	6⅜	6½	6⅝	5½	5⅝	5⅝	5⅝	5¾	4⅜
4½	6⅛	6⅜	6½	6⅝	6¾	5⅝	5¾	5¾	5¾	5⅞	4½



IN TANK WORK NOT WATER TIGHT and with FLAT HEADS Use following lengths: For ⅜-inch rivets—cold—add ½-inch stock to grip; for ½-inch rivets—hot—add ¾-inch stock to grip; for ⅝ and ¾-inch rivets—hot—add 1-inch stock to grip.

NOTE: For lengths running in sixteenths use lowest eighth.

Some erectors, because they use a shallower dolly, prefer to use rivets ⅛" shorter than shown in the table.

Rivets over 3½ inches in length are not made in ⅛ inch lengths.

WELDING OF STRUCTURAL STEEL
American Welding Society

203. General

Unit stresses specified herein are for welded joints in which residual stress due to welding and restraint of parts during cooling have been properly controlled and kept as low as possible, by using a planned sequence and procedure of welding.

204. Unit Stresses in Welds

(a) Welded joints constructed with the base material and filler metal prescribed in this Code, shall be proportioned so that the stresses caused therein by the loads specified in the Building Code shall not exceed the following values:

Kind of Stress	Permissible Unit Stress Pounds per Square Inch
Tension on section through throat of butt weld	Same as corresponding allowable stress for base metal
Compression on section through throat of butt weld	Same as corresponding allowable stress for base metal
Shear on section through throat of butt weld	Same as corresponding allowable stress for base metal
Shear on section through throat of fillet weld, or on faying surface area of plug or slot weld	13,600

(b) Fiber stresses due to bending shall not exceed the values prescribed above for tension and compression, respectively.

(c) Stress in a fillet weld shall be considered as shear on the throat, for any direction of the applied stress.

(d) Plug or slot welds shall not be ascribed any value in resistance to stress other than shear.

SAFE ALLOWABLE LOADS FOR FILLET WELDS IN SHEAR

Throat of Weld (Effective Throat)

(a) Fillet Weld: The effective throat thickness of a fillet weld shall be the shortest distance from the root to the face of the diagrammatic weld. (The effective throat thickness of an equal-leg 45° fillet weld is 0.707 times the normal leg size of the weld.)

(b) Butt Weld: The thickness of the thinner of the parts joined.

Size of Fillet Weld	*Pounds Per Lineal Inch
1/8	1200
3/16	1800
1/4	2400
5/16	3000
3/8	3600
1/2	4800

For dynamic, vibrational or lifting loads, the unit stress of fillet welds, or the strength per lineal inch, should be reduced, depending upon the severity of the load.

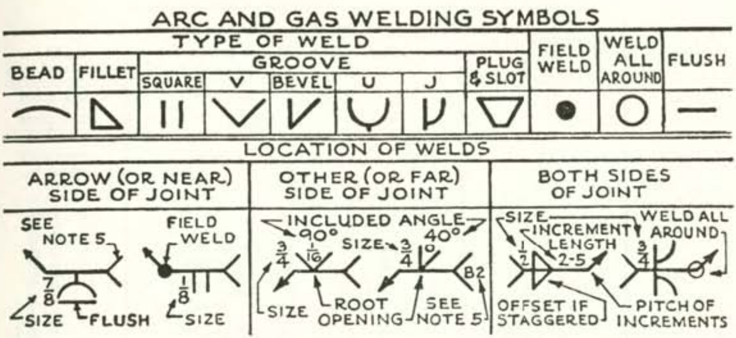
Approximately 1/4" should be added to the designed length of fillet welds for starting and stopping the arc.

All of the above based on the use of covered electrodes only.

*When two members enclose a thin plate or section, do not use double the above allowable stresses without investigating the value of the enclosed section.

WELDING SYMBOLS

The welding symbols shown herein provide the means of placing complete welding information on structural drawings. They are the standard welding symbols of the American Welding Society. For complete instructions concerning the application of these symbols, refer to the bulletin "Welding Symbols and Instructions for Their Use", published by the American Welding Society.



1. The side of the joint to which the arrow points is the arrow (or near) side and the opposite side of the joint is the other (or far) side.
2. Arrow side and other side welds are same size unless otherwise shown.
3. Symbols apply between abrupt changes in direction of joint or as dimensioned. (Except where all around symbol is used.)
4. All welds are continuous and of user's standard proportions, unless otherwise shown.
5. Tail of arrow used for specification reference (tail may be omitted when reference not used).
   E. G. "C. A."—Automatic shielded carbon arc.
   "S. A."—Automatic submerged arc.
6. In joints in which one member only is to be grooved. Arrow points to that member.
7. Dimensions of weld sizes, increment lengths, and spacings, in inches.

Fig. B-1—Legend for Use on Drawings Specifying Arc and Gas Welding.

Arc Welding Electrodes, as follows:

The weight of shop and field welds will be based on the gross weight of electrode required to lay the weld, calculated as follows:

1. For standard equal-leg fillet welds, the weights of electrodes shall be calculated in accordancce with the following table.

WEIGHTS FOR STANDARD FILLET WELDS

Specified Weld Size Inches	Gross Electrode Required Lbs. per Foot of Weld†	
	Continuous	Intermittent*
1/8	.08	.09
3/16	.15	.17
1/4	.25	.28
5/16	.36	.40
3/8	.50	.55
1/2	.83	.91
5/8	1.25	1.40
3/4	1.75	1.95
7/8	2.35	2.60
1	3.00	3.30

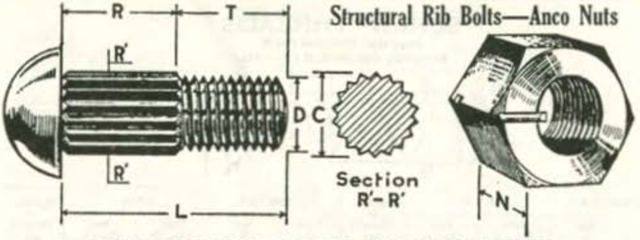
* Weld length less than 32 times the specified size.

† Net length as called for on the drawings, exclusive of starting and stopping ends.

2. For unequal-leg fillet welds, the weight corresponding to the smaller leg, in the above table, shall be multiplied by the ratio of the longer leg to the smaller leg.

3. For all groove welds, the weight of electrode shall be calculated by adding 100% to the weight based upon the net theoretical weld cross section and length. The net theoretical volume of a square groove weld with zero root opening will be calculated as if 1/32" open.

Structural Rib Bolts—Anco Nuts



STANDARD DIMENSIONS AND WEIGHTS OF STRUCTURAL RIB BOLT AND ANCO NUT

Head—A. B. A. Standard. Nut—U. S. S.—C. P. Hex. Anco. Wt.—Lb. weight per 100 bolts and nuts.

Bolt Diam. D		3/8		1/2		5/8		3/4		7/8		1	
Hole Size		7/16		9/16		11/16		13/16		15/16		1 1/16	
Thickness of work	Lgth of Rib R	L	WT.	L	WT.	L	WT.	L	WT.	L	WT.	L	WT.
5/16 & 3/8	11/32	11/16	10.0	1 1/16	20.0	1 3/16	35.0	....	....	....	....	....	....
7/16 & 1/2	15/32	1 1/16	10.5	1 3/16	20.2	1 5/16	36.0	1 1/2	57.5	1 5/8	87.5	....	....
9/16 & 5/8	19/32	1 3/16	10.8	1 5/16	21.0	1 7/16	37.2	1 5/8	59.5	1 3/4	90.0	....	....
11/16 & 3/4	23/32	1 5/16	11.0	1 7/16	22.0	1 9/16	38.0	1 3/4	61.0	1 7/8	92.0	....	....
13/16 & 7/8	27/32	1 7/16	11.3	1 9/16	22.2	1 11/16	39.2	1 7/8	62.2	2	93.5	2 1/8	130
15/16 & 1	31/32	1 9/16	11.7	1 11/16	23.0	1 13/16	40.0	2	63.0	2 1/8	95.0	2 1/4	132
1 1/16 & 1 1/8	1 3/32	1 11/16	12.0	1 13/16	24.0	1 15/16	41.5	2 1/8	66.0	2 1/4	98.0	2 3/8	136
1 3/16 & 1 1/4	1 7/32	1 13/16	12.2	1 15/16	24.3	2 1/16	42.0	2 1/4	67.0	2 3/8	100.0	2 1/2	138
1 5/16 & 1 3/8	1 11/32	1 15/16	12.5	2 1/16	26.0	2 3/16	44.0	2 3/8	69.0	2 1/2	102.0	2 5/8	141
1 7/16 & 1 1/2	1 15/32	2 1/16	12.8	2 3/16	26.5	2 5/16	44.5	2 1/2	70.0	2 5/8	104.0	2 3/4	144
1 9/16 & 1 5/8	1 19/32	2 3/16	12.9	2 5/16	27.0	2 7/16	45.0	2 5/8	71.3	2 3/4	105.0	2 7/8	146
1 11/16 & 1 3/4	1 23/32	....	....	....	....	2 9/16	46.5	2 3/4	73.5	2 7/8	107.0	3	148
1 13/16 & 1 7/8	1 27/32	....	....	....	....	2 11/16	48.0	2 7/8	75.0	3	109.0	3 1/8	152
1 15/16 & 2	1 31/32	....	....	....	....	2 13/16	49.0	3	76.0	3 1/8	111.0	3 1/4	154
2 1/16 & 2 1/8	2 3/32	....	....	....	....	2 15/16	50.0	3 1/8	77.5	3 1/4	113.0	3 3/8	156
2 3/16 & 2 1/4	2 7/32	....	....	....	....	3 1/16	51.0	3 1/4	78.5	3 3/8	115.0	3 1/2	158
2 5/16 & 2 3/8	2 11/32	....	....	....	....	3 3/16	52.1	3 3/8	80.3	3 1/2	117.0	3 5/8	161
2 7/16 & 2 1/2	2 15/32	....	....	....	....	3 5/16	....	3 1/2	82.5	3 5/8	120.0	3 3/4	164
2 9/16 & 2 5/8	2 19/32	....	....	....	....	3 7/16	....	3 5/8	83.5	3 3/4	121.5	3 7/8	166
2 11/16 & 2 3/4	2 23/32	....	....	....	....	3 9/16	....	3 3/4	85.0	3 7/8	123.0	4	168
2 13/16 & 2 7/8	2 27/32	....	....	....	....	3 11/16	....	3 7/8	86.5	4	125.0	4 1/8	171
2 15/16 & 3	2 31/32	....	....	....	....	3 13/16	....	4	88.5	4 1/8	128.0	4 1/4	174
3 1/16 & 3 1/8	3 3/32	....	....	....	....	3 15/16	....	4 1/8	89.4	4 1/4	130.0	4 3/8	176
3 3/16 & 3 1/4	3 7/32	....	....	....	....	4 1/16	....	4 1/4	91.0	4 3/8	133.0	4 1/2	179
3 5/16 & 3 3/8	3 11/32	....	....	....	....	4 3/16	....	4 3/8	93.0	4 1/2	136.0	4 5/8	182
3 7/16 & 3 1/2	3 15/32	....	....	....	....	4 5/16	....	4 1/2	95.0	4 5/8	139.0	4 3/4	185
Lgth. Of Thd. "T"		13/32		21/32		27/32		31/32		1 5/32		1 9/32	
Thk. Of Nut "N"		3/8		1/2		5/8		3/4		7/8		1	
Nut Across Flats		11/16		7/8		1 1/16		1 1/4		1 7/16		1 5/8	
Wt. Per 100 Nuts		3.3		6.9		12.6		21		31.7		47.5	
Diam. C		13/32		17/32		21/32		25/32		29/32		1 1/32	

These bolts, easy to install and remove, fit a punched hole, and are used as a substitute for field rivets or machine bolts.

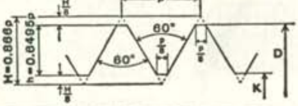
They are made of carbon manganese steel, 70000 p.s.i. tensile strength. The nuts lock or unlock with an ordinary wrench. They are approved by many States and Cities.

We furnish these bolts at an extra price.

We can also furnish a similar Dardelet Rivet Bolt with self locking thread and special nut.

SCREW THREADS

American National Form
American Standard, B 1.1—1935.



DIAMETER Total D In.	DIAMETER Net K In.	AREA Total Dia., D Sq. In.	AREA Net Dia., K Sq. In.	Number of Threads per Inch	DIAMETER Total D In.	DIAMETER Net K In.	AREA Total Dia., D Sq. In.	AREA Net Dia., K Sq. In.	Number of Threads per Inch
¼	.185	.049	.027	20	3	2.675	7.069	5.621	4
⅜	.294	.110	.068	16	3¼	2.925	8.296	6.720	4
½	.400	.196	.126	13	3½	3.175	9.621	7.918	4
⅝	.507	.307	.202	11	3¾	3.425	11.045	9.214	4
¾	.620	.442	.302	10	4	3.675	12.566	10.608	4
⅞	.731	.601	.419	9					
1	.838	.785	.551	8	4¼	3.798	14.186	11.330	2⅞
1⅛	.939	.994	.693	7	4½	4.028	15.904	12.741	2¾
1¼	1.064	1.227	.890	7	4¾	4.255	17.721	14.221	2⅝
1⅜	1.158	1.485	1.054	6					
1½	1.283	1.767	1.294	6	5	4.480	19.635	15.766	2½
1¾	1.490	2.405	1.744	5	5¼	4.730	21.648	17.574	2½
					5½	4.953	23.758	19.268	2⅜
2	1.711	3.142	2.300	4½	5¾	5.203	25.967	21.262	2⅜
2¼	1.961	3.976	3.021	4½					
2½	2.175	4.909	3.716	4	6	5.423	28.274	23.095	2¼
2¾	2.425	5.940	4.619	4					

Sizes over 4" are old U. S. Standard; there is no American Standard.
Dimensions are maximum; specify "Free Fit—Class 2." For Bolts from 2½" to 6" diameter it is always necessary to bill the number of threads per inch.

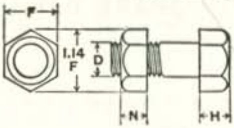
LENGTH OF BOLT THREADS

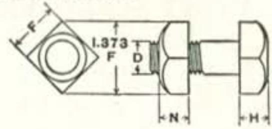
American Standard, B 18.2—1941.

Length of Bolt Inches	Diameter of Bolt, Inches: ¼	⅜	½	⅝	¾	⅞	1	1⅛ 1¼	1⅜ 1½	1⅝ 1¾	1⅞ 2	2¼	2½	2¾	3
	Minimum Thread Length														
1	¾	¾	¾	¾											
1¼	¾	¾	1	1	1										
1½	¾	⅞	1	1⅛	1⅛	1⅛									
1¾	¾	⅞	1	1 3/16	1⅜	1⅜	1⅜								
2	¾	1	1¼	1¼	1⅜	1 9/16	1⅝	1⅝							
2½	¾	1	1¼	1½	1½	1 9/16	1¾	2	2						
3	⅞	1	1¼	1½	1¾	1¾	1¾	2⅛	2½	2½					
4	⅞	1	1¼	1½	1¾	2	2¼	2¼	2½	2⅞	3¼	3¼	3¼		
5	⅞	1 3/16	1¼	1½	1¾	2	2¼	2¾	2¾	2⅞	3¼	3⅝	4	4⅛	4¼
6	⅞	1 3/16	1½	1½	1¾	2	2¼	2¾	3¼	3¼	3¼	3⅝	4	4⅛	4¾
8	⅞	1 3/16	1½	1 13/16	2	2	2¼	2¾	3¼	3¾	4	4	4	4⅛	4¾
10	⅞	1 3/16	1½	1 13/16	2⅛	2 7/16	2½	2¾	3¼	3¾	4¼	4¾	4¾	4¾	4¾
12	⅞	1 3/16	1½	1 13/16	2⅛	2 7/16	2¾	2¾	3¼	3¾	4¼	4¾	5¼	5¾	6¼
16	1	1 3/16	1½	1 13/16	2⅛	2 7/16	2¾	3¼	3¼	3¾	4¼	4¾	5¼	5¾	6¼
20	1	1⅜	1½	1 13/16	2⅛	2 7/16	2¾	3⅜	4	4⅝	4¾	4¾	5¼	5¾	6¼
30			1¾	1 13/16	2⅛	2 7/16	2¾	3⅜	4	4⅝	5¼	5⅞	6½	6½	6½

For intermediate bolt lengths, same minimum thread length as for next shorter tabulated length.

BOLT HEADS AND NUTS





HEADS AND NUTS		American Standard Regular	American Standard Heavy
HEAD	Height, H	2/3 D	3/4 D + 1/16"
	Short Dia., F	1 1/2 D	1 1/2 D + 1/8"
NUT	Height, N	7/8 D	D
	Short Dia., F	1 1/2 D + 1/16" (D = 5/8" or less) 1 1/2 D (D greater than 5/8")	1 1/2 D + 1/8"

American Standard Bolt and Nut dimensions rounded to the nearest 1/16 inch, are those adopted by American Institute of Bolt, Nut and Rivet Manufacturers, American Standard B 18.2—1941. "American Standard Regular" formerly called Manufacturers Standard, American Standard, etc. "American Standard Heavy" formerly called United States Standard. Some fabricators have standard heads and nuts differing only slightly from the table. For bolts with countersunk heads the included angle is 78 degrees, the same as for rivets.

STANDARD DIMENSIONS

HEAD

Dia. of Bolt In.	Series	Hexagon Diameter, In. Long	Hexagon Diameter, In. Short	Height In.	Square Diameter, In. Long	Square Diameter, In. Short
1/4	American Standard Regular	7/16	3/8	3/16	1/2	3/8
3/8		5/8	9/16	1/4	3/4	9/16
1/2		7/8	3/4	5/16	1	3/4
5/8		1 1/16	15/16	7/16	1 5/16	15/16
3/4		1 5/16	1 1/8	1/2	1 9/16	1 1/8
7/8		1 1/2	1 5/16	9/16	1 13/16	1 5/16
1		1 11/16	1 1/2	5/8	2 1/16	1 1/2
1 1/8		1 15/16	1 11/16	3/4	2 5/16	1 11/16
1 1/4		2 1/8	1 7/8	13/16	2 9/16	1 7/8
1 3/8		2 3/8	2 1/16	15/16	2 13/16	2 1/16
1 1/2		2 9/16	2 1/4	1	3 1/16	2 1/4
1 5/8		2 3/4	2 7/16	1 1/16	3 3/8	2 7/16
1 3/4		3	2 5/8	1 3/16	3 5/8	2 5/8
1 7/8		3 3/16	2 13/16	1 1/4	3 7/8	2 13/16
2		3 7/16	3	1 5/16	4 1/8	3
2 1/4		3 7/8	3 3/8	1 1/2	4 5/8	3 3/8
2 1/2		4 1/4	3 3/4	1 11/16	5 1/8	3 3/4
2 3/4		4 11/16	4 1/8	1 13/16	5 11/16	4 1/8
3		5 1/8	4 1/2	2	6 3/16	4 1/2

NUT

Dia. of Bolt In.	Series	Hexagon Diameter, In. Long	Hexagon Diameter, In. Short	Height In.	Square Diameter, In. Long	Square Diameter, In. Short
1/4	American Standard Regular	1/2	7/16	1/4	5/8	7/16
3/8		11/16	5/8	5/16	7/8	5/8
1/2		15/16	13/16	7/16	1 1/8	13/16
5/8		1 1/8	1	9/16	1 3/8	1
3/4		1 5/16	1 1/8	11/16	1 9/16	1 1/8
7/8		1 1/2	1 5/16	3/4	1 13/16	1 5/16
1		1 11/16	1 1/2	7/8	2 1/16	1 1/2
1 1/8		1 15/16	1 11/16	1	2 5/16	1 11/16
1 1/4		2 1/8	1 7/8	1 1/8	2 9/16	1 7/8
1 3/8		2 3/8	2 1/16	1 1/4	2 13/16	2 1/16
1 1/2		2 9/16	2 1/4	1 5/16	3 1/8	2 1/4
1 3/8	American Standard Heavy	2 1/2	2 3/16	1 3/8	3	2 3/16
1 1/2		2 11/16	2 3/8	1 1/2	3 1/4	2 3/8
1 5/8		2 15/16	2 9/16	1 5/8	3 1/2	2 9/16
1 3/4		3 1/8	2 3/4	1 3/4	3 3/4	2 3/4
1 7/8		3 3/8	2 15/16	1 7/8	4 1/16	2 15/16
2		3 9/16	3 1/8	2	4 5/16	3 1/8
2 1/4		4	3 1/2	2 1/4	4 13/16	3 1/2
2 1/2		4 7/16	3 7/8	2 1/2	5 5/16	3 7/8
2 3/4		4 7/8	4 1/4	2 3/4	5 13/16	4 1/4
3		5 1/4	4 5/8	3	6 3/8	4 5/8

WROUGHT WASHERS

Size of Bolt in Inches.	Diameter in Inches	Size of Hole in Inches	Gauge	Number in 1.00 lb.	Size of Bolt in Inches	Diameter in Inches	Size of Hole in Inches	Gauge	Number in 1.00 lb.
1/4	3/4	5/16	16	149	1 1/8	2 3/4	1 1/4	8	4.5
5/16	7/8	3/8	16	111	1 1/4	3	1 3/8	8	3.8
3/8	1	7/16	14	67	1 3/8	3 1/4	1 1/2	7	3.0
1/2	1 3/8	9/16	12	26	1 1/2	3 1/2	1 5/8	7	2.6
5/8	1 3/4	11/16	10	13	1 5/8	3 3/4	1 3/4	7	2.3
3/4	2	13/16	9	9.1	1 3/4	4	1 7/8	7	2.0
7/8	2 1/4	15/16	8	6.5	1 7/8	4 1/4	2	7	1.8
1	2 1/2	1 1/16	8	5.3	2	4 1/2	2 1/8	7	1.6

UPSET SCREW ENDS FOR SQUARE BARS

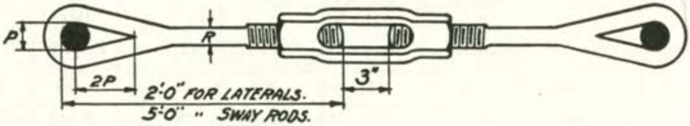
Diameter or Side of Square Bar	Area of Body of Bar	Diameter of Screw	Length of Upset	Area at Root of Thread	Number of Threads per Inch	Weight per foot of Bar	Add for Upset
Inches	Sq. Inches	Inches	Inches	Sq. Inches		Pounds	Inches
½	.25	¾	4¼	.302	10	.850	4
⅝	.391	1	4½	.550	8	1.328	5¾
¾	.563	1⅛	4¾	.694	7	1.913	4½
⅞	.766	1⅜	5	1.057	6	2.603	5¾
1	1.000	1½	5	1.295	6	3.400	4¾
1⅛	1.266	1⅝	5¼	1.515	5½	4.303	4¼
1¼	1.563	1⅞	5½	2.048	5	5.312	5¼
1⅜	1.891	2	5½	2.302	4½	6.428	4½
1½	2.250	2⅛	5¾	2.650	4½	7.650	4¼
1⅝	2.641	2⅜	6	3.419	4½	8.978	5
1¾	3.063	2½	6	3.715	4	10.410	4½
1⅞	3.516	2⅝	6¼	4.155	4	11.950	4¼
2	4.000	2⅞	6½	5.108	4	13.60	5
2⅛	4.516	3	6½	5.428	3½	15.35	4½
2¼	5.063	3⅛	6¾	5.957	3½	17.22	4¼
2⅜	5.641	3⅜	7	7.087	3½	19.18	5¼
2½	6.250	3½	7	7.548	3¼	21.25	4¾
2⅝	6.891	3⅝	7¼	8.171	3¼	23.43	4½
2¾	7.563	3⅞	7½	9.305	3	25.71	5¼
2⅞	8.266	4	7½	9.993	3	28.10	4¾
3	9.000	4⅛	7¾	10.706	3	30.60	4½
3⅛	9.766	4⅜	8	12.087	2⅞	33.20	5¼
3¼	10.563	4½	8	12.743	2¾	35.92	5
3⅜	11.391	4⅝	8¼	13.544	2¾	38.73	5
3½	12.250	4⅞	8½	15.068	2⅝	41.65	5½

UPSET SCREW ENDS FOR ROUND BARS

Diameter of Bar	Area of Body of Bar	Diameter of Screw	Length of Upset	Area at Root of Thread	Number of Threads	Weight per Foot of Bar	Add for Upset
Inches	Sq. In.	Inches	Inches	Sq. In.	per Inch	Pounds	Inches
½	.196	¾	4¼	.302	10	.668	6½
⅝	.307	⅞	4½	.420	9	1.043	5½
¾	.442	1	4½	.550	8	1.502	4½
⅞	.601	1¼	4¾	.893	7	2.044	6¼
1	.785	1⅜	5	1.057	6	2.670	5¼
1⅛	.994	1½	5	1.295	6	3.379	4¾
1¼	1.227	1⅝	5¼	1.515	5½	4.173	4½
1⅜	1.485	1¾	5¼	1.744	5	5.049	4
1½	1.767	2	5½	2.302	4½	6.008	5¼
1⅝	2.074	2⅛	5¾	2.650	4½	7.051	5
1¾	2.405	2¼	5¾	3.023	4½	8.178	4¾
1⅞	2.761	2⅜	6	3.419	4½	9.388	4½
2	3.142	2½	6	3.715	4	10.68	4¼
2⅛	3.547	2⅝	6¼	4.155	4	12.06	4
2¼	3.976	2⅞	6½	5.108	4	13.52	5¼
2⅜	4.430	3	6½	5.428	3½	15.07	4¾
2½	4.909	3⅛	6¾	5.957	3½	16.69	4¾
2⅝	5.412	3¼	6¾	6.510	3½	18.40	4½
2¾	5.940	3⅜	7	7.087	3½	20.20	4½
2⅞	6.492	3⅝	7¼	8.171	3¼	22.07	5¼
3	7.069	3¾	7¼	8.641	3	24.03	5
3⅛	7.670	3⅞	7½	9.305	3	26.08	5¼
3¼	8.296	4	7½	9.993	3	28.20	4¾
3⅜	8.946	4⅛	7¾	10.706	3	30.42	4¾
3½	9.621	4¼	8	11.329	2⅞	32.71	4½

LATERAL AND SWAY BARS

Dimensions for Loops and Forks

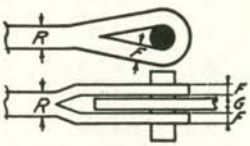


FORMULA: LENGTH IN INCHES BEYOND PIN CENTER TO FORM ONE EYE EQUALS $3.7(P+R)+5$

Diam. of Pins	Diameter of Round or Side of Square Bars.													Diam. of Pins
	¾"	⅞"	1"	1⅛"	1¼"	1⅜"	1½"	1⅝"	1¾"	1⅞"	2"	2⅛"	2¼"	
1	11½	12	12½											1
1¼	12½	12⅞	13⅜	13⅞	14¼									1¼
1½	13⅜	13⅞	14¼	14¾	15¼	15⅝	16⅛							1½
1¾	14¼	14¾	15¼	15⅝	16⅛	16⅝	17	17½	18					1¾
2	15¼	15⅝	16⅛	16⅝	17	17½	18	18⅜	18⅞	19⅝	19¾			2
2¼	16⅛	16⅝	17	17½	18	18⅜	18⅞	19⅜	19¾	20¼	20¾	21⅛	21⅝	2¼
2½	17	17½	18	18⅜	18⅞	19⅜	19¾	20¼	20¾	21⅛	21⅝	22⅛	22⅝	2½
2¾	18	18⅜	18⅞	19⅜	19¾	20¼	20¾	21⅛	21⅝	22⅛	22⅝	23	23½	2¾
3	18⅞	19⅜	19¾	20¼	20¾	21⅛	21⅝	22⅛	22⅝	23	23½	24	24⅜	3
3¼	19¾	20¼	20¾	21⅛	21⅝	22⅛	22⅝	23	23½	24	24⅜	24⅞	25⅜	3¼
3½	20¾	21⅛	21⅝	22⅛	22⅝	23	23½	24	24⅜	24⅞	25⅜	25⅞	26¼	3½
3¾	21⅝	22⅛	22⅝	23	23½	24	24⅜	24⅞	25⅝	25⅞	26¼	26¾	27¼	3¾
4	22⅝	23	23½	24	24⅜	24⅞	25⅜	25⅞	26¼	26¾	27¼	27⅝	28⅛	4
4¼	23½	24	24⅜	24⅞	25⅜	25⅞	26¼	26¾	27¼	27⅝	28⅛	28⅝	29	4¼
4½	24⅜	24⅞	25⅜	25⅞	26¼	26¾	27¼	27⅝	28⅛	28⅝	29	29½	30	4½
4¾	25⅜	25⅞	26¼	26¾	27¼	27⅝	28⅛	28⅝	29	29½	30	30½	31	4¾
5	26¼	26¾	27¼	27⅝	28⅛	28⅝	29	29½	30	30½	31	31⅜	31⅞	5
5¼	27¼	27⅝	28⅛	28⅝	29	29½	30	30½	31	31⅜	31⅞	32¼	32¾	5¼
5½	28⅛	28⅝	29	29½	30	30½	31	31⅜	31⅞	32¼	32¾	33¼	33⅝	5½
5¾	29	29½	30	30½	31	31⅜	31⅞	32¼	32¾	33¼	33⅝	34⅛	34⅝	5¾
6	30	30½	31	31⅜	31⅞	32¼	32¾	33¼	33⅝	34⅛	34⅝	35	35½	6

SIZE OF FORKED EYE FOR ● OR ■ BARS.

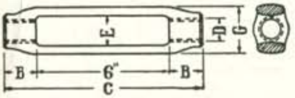
Diameter of ● or Side of ■ Bars	R	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½	1⅝	1¾
Side of ■ for Eye	F	⅜	7/16	½	9/16	11/16	¾	13/16	⅞	1	1 1/16	1⅛



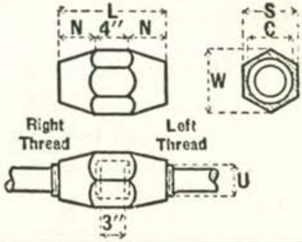
G = Thickness of Plt. + 1/16'

Maximum Shipping Length Should Not Exceed 35 Ft.

TURNBUCKLES & SLEEVE NUTS
ALL DIMENSIONS IN INCHES



Drop Forged Steel—Weldless



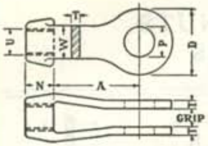
DIMENSIONS					Weight in Pounds
D	C	B	E	G	
3/8	7 1/8	9/16	9/16	31/32	.41
1/2	7 1/2	3/4	11/16	1 7/32	.70
5/8	7 13/16	29/32	13/16	1 1/2	.89
3/4	8 1/8	1 1/16	15/16	1 23/32	1.20
7/8	8 7/16	1 7/32	1 3/32	1 7/8	1.46
1	8 3/4	1 3/8	1 9/32	2 1/32	2.27
1 1/8	9 1/8	1 9/16	1 13/32	2 9/32	2.72
1 1/4	9 1/2	1 3/4	1 9/16	2 17/32	3.58
1 3/8	9 7/8	1 15/16	1 11/16	2 3/4	4.13
1 1/2	10 1/4	2 1/8	1 27/32	3 1/32	5.25
1 5/8	10 1/2	2 1/4	1 31/32	3 9/32	5.88
1 3/4	11	2 1/2	2 1/8	3 9/16	7.05
2	11 1/2	2 3/4	2 3/8	4	9.95
2 1/4	12 3/4	3 3/8	2 11/16	4 5/8	18.00
2 1/2	13 1/2	3 3/4	3	5	23.25
2 3/4	14 1/4	4 1/8	3 1/4	5 5/8	31.50
3	15	4 1/2	3 5/8	6 1/8	39.50

SLEEVE NUTS

Inches						
Diam. of Screw	Clear	Nut	Length	Min. Width	Max. Width	Wght. Lbs.
U	C	N	L	S	W	
4	4 1/8	4 1/2	13	6 1/8	7 1/16	55
4 1/4	4 3/8	4 3/4	13 1/2	6 1/2	7 1/2	65
4 1/2	4 3/4	5	14	6 7/8	7 15/16	75
4 3/4	5	5 1/4	14 1/2	7 1/4	8 3/8	98
5	5 1/4	5 1/2	15	7 5/8	8 7/8	110
5 1/4	5 1/2	5 3/4	15 1/2	8	9 1/4	122
5 1/2	5 3/4	6	16	8 3/8	9 3/4	142
5 3/4	6	6 1/4	16 1/2	8 3/4	10 1/8	157
6	6 1/4	6 1/2	17	9 1/8	10 5/8	176

CLEVELAND CITY FORGE CO.

Weights given are for Turnbuckles only.
1 7/8, 2 1/8 and 2 3/8 properties same as 2, 2 1/4 and 2 1/2, respectively.



STANDARD CLEVISES

DROP FORGED—WELDLESS

CLEVELAND CITY FORGE CO.

Diameter D for Various Sizes of Pins (In Inches)

	DIAMETER OF PIN—INCHES														
Tap Dia.	7/8	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4¼
5/8	2½	2½	2½	...	...	...	...	...	...	...	...	...	...	...	...
3/4	2½	2½	2½	...	...	...	...	...	...	...	...	...	...	...	...
7/8	2½	2½	2½	3	3	...	...	...	...	...	...	...	...	...	...
1	...	3	3	3	3½	...	...	...	...	...	...	...	...	...	...
1⅛	...	3	3	3	3½	...	...	...	...	...	...	...	...	...	...
1¼	...	3	3	3	3½	4	...	...	...	...	...	...	...	...	...
1⅜	...	...	3½	3½	3½	4	...	...	...	...	...	...	...	...	...
1½	...	...	3½	3½	4	4	5	...	...	...	...	...	...	...	...
1⅝	...	...	...	4	4	5	5	5	...	...	...	...	...	...	...
1¾	...	...	...	4	5	5	5	5	...	...	...	...	...	...	...
1⅞	...	...	...	5	5	5	5	5	...	...	...	...	...	...	...
2	...	...	...	5	5	5	5	6	6	...	...	...	...	...	...
2⅛	...	...	...	5	5	5	6	6	6	6	...	...	...	...	...
2¼	...	...	...	...	...	6	6	6	6	6	7	7	...	...	...
2⅜	...	...	...	...	...	6	6	6	6	7	7	7	8	..	...
2½	...	...	...	...	...	6	6	6	7	7	7	7	8	..	...
2⅝	...	...	...	...	...	...	...	7	7	7	7	7	8	..	...
2¾	...	...	...	...	...	...	...	7	7	7	7	8	8	..	...
2⅞	...	...	...	...	...	...	...	7	7	7	8	8	8	8	8
3	...	...	...	...	...	...	...	7	7	8	8	8	8	8	8
3⅛	...	...	...	...	...	...	...	...	8	8	8	8	8	8	8
3¼	...	...	...	...	...	...	...	...	8	8	8	8	8	8	8
3⅜	...	...	...	...	...	...	...	...	8	8	8	8	8	8	8
3½	...	...	...	...	...	...	...	...	8	8	8	8	8	8	8
3⅝	...	...	...	...	...	...	...	...	8	8	8	8	8	8	8
3¾	...	...	...	...	...	...	...	...	8	8	8	8	8	8	8
3⅞	...	...	...	...	...	...	...	...	...	8	8	8	8	8	8
4	...	...	...	...	...	...	...	...	...	8	8	8	8	8	8

To find the proper size of eye for any combination of tap and pin size, find the point where a horizontal line from the tap diameter meets a vertical line dropped from the pin diameter.

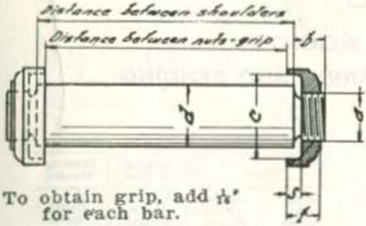
The above chart conforms with the recommendations of the American Institute of Steel Construction; that is the net area thru the pin hole is at least 135% of the net area of the rod.

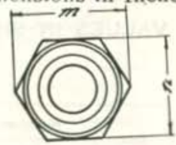
Clevis No.	D	N	Max. U	W	T	A	Max. P	Grip
2½	2½	1	7/8	1¼	3/8	5	1¼	
3	3	1¼	1¼	1½	1/2	5	1½	
3½	3½	1½	1½	1¾	1/2	6	1¾	
4	4	1¾	1¾	2	1/2	6	2	
5	5	2¼	2⅛	2½	5/8	7	2½	
6	6	2¾	2⅝	3	3/4	8	3	
7	7	3	3	3½	7/8	9	3½	
8	8	4	4	4	1¼	10	4¼	

NOTE: In ordering be sure to state size of tap, whether R. H. or L. H., size of pin or pin hole, and size of grip opening.

PINS AND RECESSED PIN NUTS

All Dimensions in Inches





To obtain grip, add $\frac{1}{16}$" for each bar.

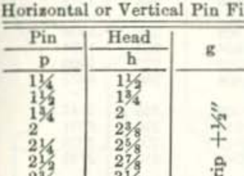
Nuts threaded 6 threads per inch.

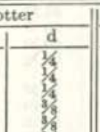
To obtain distance between shoulders, add amount given in table to grip.

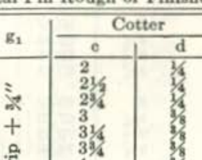
Diameter of Pin, d	Pin: Thread a	Pin: Thread b	Pin: Add to Grip	Nut: Thickness t	Nut: Diameter n	Nut: Diameter m	Nut: Diameter c	Nut: Depth s	Nut: Diameter rough hole	Nut: Weight, Pounds	Nut: Pattern No.
2, 2¼	1½	1	¼	⅞	2 11/16	3⅜	2⅝	¼	1⅝	1.1	PN 21
2½, 2¾	2	1⅛	¼	1	3 9/16	4⅛	3⅛	¼	1 11/16	1.7	PN 22
3, 3¼, 3½	2½	1¼	¼	1⅛	4 5/16	5	3 11/16	⅜	2 3/16	2.5	PN 23
3¾, 4	3	1⅜	½	1¼	4⅞	5⅝	4⅜	⅜	2 11/16	3.7	PN 24
4¼, 4½, 4¾	3½	1½	½	1⅜	5¾	6⅝	5¼	½	3 3/16	4.6	PN 25
5, 5¼	4	1⅝	½	1½	6¼	7 3/16	5¾	½	3 11/16	6.2	PN 26
5½, 5¾, 6	4½	1¾	½	1⅝	7	8⅛	6½	⅝	4 3/16	7.8	PN 27
6¼, 6½	5	1⅞	¾	1¾	7⅝	8⅞	7	⅝	4 11/16	9.9	PN 28
6¾, 7	5½	2	¾	1⅞	8⅛	9⅜	7½	¾	5 3/16	11.8	PN 29
7¼, 7½	5½	2	¾	1⅞	8⅝	10	8	¾	5 3/16	14.3	PN 30
7¾, 8, 8¼	6	2¼	¾	2⅛	9⅜	10⅞	8¾	¾	5 11/16	18.6	PN 31
8½, 9	6	2¼	¾	2⅛	10¼	11⅞	9⅝	¾	5 11/16	23.8	PN 32
9½, 10	6	2⅜	¾	2¼	11¼	13	10⅝	¾	5 11/16	31.1	PN 33

COTTER PINS

All Dimensions in Inches







Horizontal or Vertical Pin Finished

Horizontal Pin Rough or Finished

Pin p	Head h	g	Cotter c	Cotter d	Pin p_1	g_1	Cotter c	Cotter d
1¼	1½	Net Grip + ½"	2	¼	1¼	Net Grip + ¾"	2	¼
1½	1¾		2½	¼	1½		2½	¼
1¾	2		2¾	¼	1¾		2¾	¼
2	2⅜		3	⅜	2		3	⅜
2¼	2⅝		3¼	⅜	2¼		3¼	⅜
2½	2⅞		3¾	⅜	2½		3¾	⅜
2¾	3⅛		4	⅜	2¾		4	⅜
3	3½		5	½	3		5	½
3¼	3¾		5	½	3¼		5	½
3½	4		6	½	3½		6	½
3¾	4¼		6	½	3¾		6	½

PINS

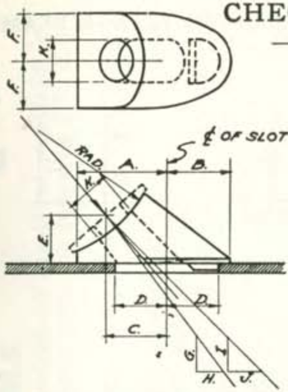
AREAS AND WEIGHTS

VALUES IN SHEAR, BEARING AND BENDING

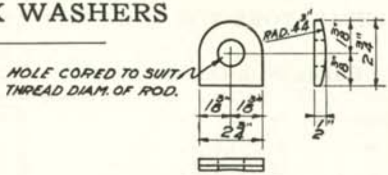
Diameter of Pin	Area of Section	Weight per Foot		Section Modulus S	Shear		Bearing on Steel	Resisting Moment
		Rough Turned	Finished		Single 15,000 Pounds per Sq. In.	Double 15,000 Pounds per Sq. In.	1 Inch Thick 32,000 Pounds per Sq. In.	30,000 Pounds per Sq. In.
In.	In.²	Lb.	Lb.	In.³	Kips	Kips	Kips	Kip Inches
1	.79	....	2.67	.10	11.8	23.6	32	3.0
1¼	1.23	....	4.17	.19	18.4	36.8	40	5.7
1½	1.77	....	6.01	.33	26.5	53.0	48	9.9
1¾	2.41	....	8.18	.53	36.1	72.2	56	15.9
2	3.14	....	10.68	.79	47.1	94.3	64	23.7
2¼	3.98	....	13.52	1.12	59.6	119.3	72	33.6
2½	4.91	....	16.69	1.53	73.6	147.3	80	45.9
2¾	5.94	....	20.20	2.04	89.1	178.2	88	61.2
3	7.07	....	24.03	2.65	106.0	212.1	96	79.5
3¼	8.30	....	28.21	3.37	124.4	248.9	104	101.1
3½	9.62	....	32.71	4.21	144.3	288.6	112	126.3
3¾	11.05	....	37.55	5.18	165.7	331.4	120	155.4
4	12.57	....	42.73	6.28	188.5	377.0	128	188.4
4¼	14.19	....	48.23	7.54	212.8	425.6	136	226.2
4½	15.90	....	54.07	8.95	238.6	477.1	144	268.5
4¾	17.72	....	60.25	10.52	265.8	531.6	152	315.6
5	19.64	....	66.76	12.27	294.5	589.1	160	368.1
5¼	21.65	....	73.60	14.21	324.7	649.4	168	426.3
5½	23.76	....	80.78	16.33	356.4	712.7	176	489.9
5¾	25.97	....	88.29	18.66	389.5	779.0	184	559.8
6	28.27	100.2	96.13	21.21	424.1	848.2	192	636.3
6¼	30.68	108.5	104.3	23.97	460.2	920.4	200	719.1
6½	33.18	117.2	112.8	26.96	497.7	995.5	208	808.8
6¾	35.79	126.2	121.7	30.19	536.8	1074	216	905.7
7	38.49	135.6	130.9	33.68	577.3	1155	224	1010
7¼	41.28	145.2	140.4	37.41	619.2	1239	232	1122
7½	44.18	155.3	150.2	41.42	662.7	1325	240	1243
7¾	47.17	165.6	160.4	45.70	707.6	1415	248	1371
8	50.27	176.3	170.9	50.27	754.0	1508	256	1508
8¼	53.46	187.3	181.8	55.13	801.8	1604	264	1654
8½	56.75	198.7	192.9	60.29	851.2	1702	272	1809
8¾	60.13	210.3	204.5	65.79	902.0	1804	280	1973
9	63.62	222.4	216.3	71.57	954.3	1909	288	2147
9¼	67.20	234.7	228.5	77.70	1008	2016	296	2331
9½	70.88	247.4	241.0	84.18	1063	2127	304	2525
9¾	74.66	260.4	253.9	91.00	1120	2240	312	2730
10	78.54	273.8	267.0	98.18	1178	2356	320	2945

Pins up to 6 inch diameter are usually purchased as cold-rolled shafting and require no finish. Larger pins are forgings, purchased rough-turned leaving 1/16" finish all over.

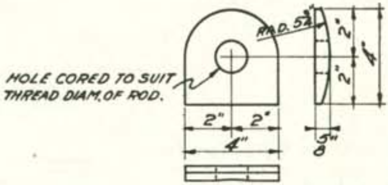
STANDARD CAST IRON BEVEL WASHERS AND CHECK WASHERS



Std. Bevel Washer.



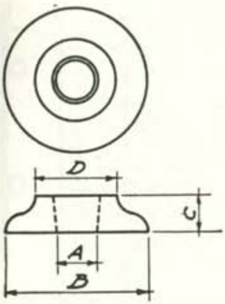
Std. Check Washer No. 1



Std. Check Washer No. 2

Wshr No.	Dimensions in Inches of Std. Cast Iron Bevel Washers												Size of Slot Req'd.	Chk. Wshr	Rod Thrd
	A	B	C	D	E	F	G	H	I	J	K	Rad.			
1	2⅜	1 13/16	1⅜	1⅜	1½	1⅜	12	6	12	9	1⅛	4¾	1¼ x 2¾	1	⅝"
2	2⅜	2	1¾	1½	1½	1⅜	12	9	12	12	1⅛	4¾	1¼ x 3	1	rd.
3	2⅞	2¼	2¼	1⅜	1½	1⅜	12	12	9	12	1⅛	4¾	1¼ x 3½	1	to
4	3⅝	2¾	3⅛	2¼	1½	1⅜	9	12	6	12	1⅛	4¾	1¼ x 4½	1	1"
5	2⅛	1¾	15/16	1¼	1½	1⅜	12	3	12	6	1⅛	4¾	1¼ x 2½	1	rd.
6	3⅜	2 7/16	1 13/16	1 13/16	2	2	12	6	12	9	1¾	5¾	1⅞ x 3⅞	2	1⅛"
7	3¾	2 11/16	2 9/16	2 3/16	2	2	12	9	12	12	1¾	5¾	1⅞ x 4⅜	2	rd.
8	4⅛	3	3	2½	2	2	12	12	9	12	1¾	5¾	1⅞ x 5	2	to
9	5⅛	3 9/16	4¼	3⅛	2	2	9	12	6	12	1¾	5¾	1⅞ x 6¼	2	1⅝"
10	3	2 5/16	1¼	1 11/16	2	2	12	3	12	6	1¾	5¾	1⅞ x 3⅝	2	rd.

STANDARD ROUND CAST IRON WASHERS

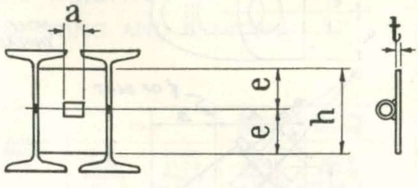


Size of Bolt Inches	Dimensions in Inches				Approx. Weight Per 100 in lbs.
	A	B	C	D	
½	⅝	2	½	1¼	25-45
⅝	¾	2½	⅝	1½	45-70
¾	⅞	3	¾	1⅞	110
⅞	1	3½	⅞	2⅛	150
1	1⅛	4	1	2⅜	200
1⅛	1¼	4½	1⅛	2⅝	265
1¼	1⅜	5	1¼	2⅞	400
1⅜	1½	5½	1⅜	3⅛	462
1½	1⅝	6	1½	3⅜	612
1⅝	1¾	6½	1⅝	3⅝	772
1¾	2	7	1¾	3⅞	936
1⅞	2⅛	7½	1⅞	4¼	1186
2	2¼	7½	2	4½	1288
2¼	2½	7¾	2¼	5	1609

SEPARATORS FOR STRAIGHT AND SLOPING FLANGE BEAMS

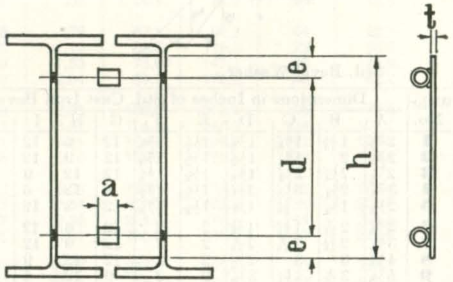
Separators With One Bolt

Beams	d	h	e	t	a
6″	...	4½	2¼	5/16	1½
7″	...	5	2½	5/16	1½
8″	...	5½	2¾	5/16	1½
9″	...	6½	3¼	5/16	1½
10″	...	7½	3¾	5/16	1½



Separators With Two Bolts

Beams	d	h	e	t	a
12″	6	9	1½	⅜	1½
14″	6	11	2½	⅜	1½
15″	6	11	2½	⅜	1½
16″	9	12	1½	⅜	1½
18″	9	14	2½	⅜	1½
20″	12	15½	1¾	⅜	1½
21″	12	16½	2¼	⅜	1½
24″	12	20	4	⅜	1½



Separators With Three Bolts

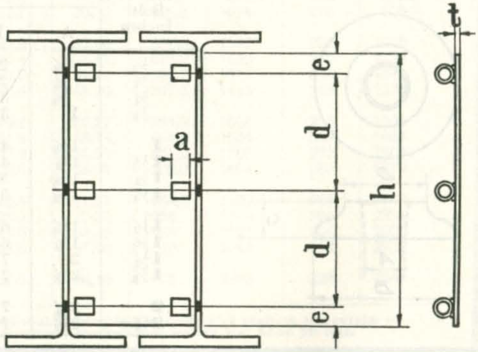
Beams	d	h	e	t	a
26″	9	21	1½	⅜	1½
27″	9	23	2½	⅜	1½
28″	9	23	2½	⅜	1½
30″	9	25	3½	⅜	1½
33″	9	27½	4¾	⅜	1½
36″	12	30	3	⅜	1½

Separators are made of steel plate with pieces of ¾″ gas pipe welded to plate.

Bolts—usual ¾″ small beams ⅝″.

Dimensions shown are for nominal size beams. For heavy beams use same construction and give dimensions as required.

Where permissible and for light loads use gas pipe separators.



HIGH-TENSILE STEELS

Where designers require a material which is light in weight and capable of withstanding high unit stresses, economical of space, and of comparable cost, the following STEELS are recommended.

They can be welded without subsequest heat treatment, and are more corrosion resistant than ordinary carbon steel.

Silicon and manganese steels are to ASTM standard specifications.

Designers should consult manufacturers as to their adaptability.

TABLE SHOWING CHEMICAL AND PHYSICAL PROPERTIES OF HIGH TENSILE STEELS AS COMPARED WITH REGULAR OPEN HEARTH STEEL

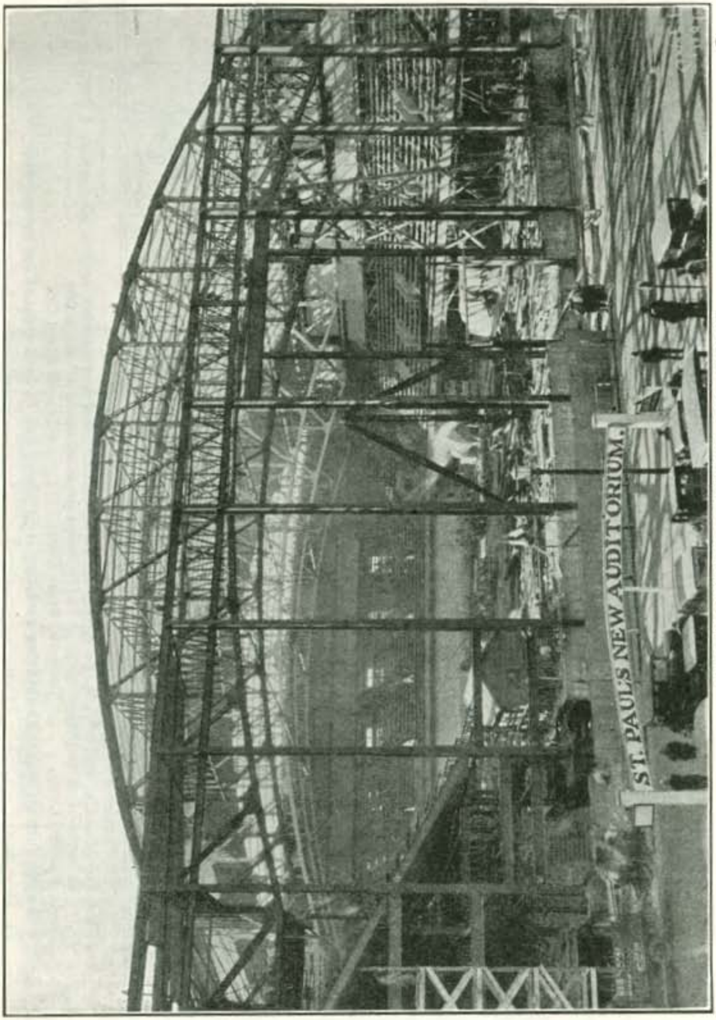
	Properties	a-b-c Open Hearth Structural Steel	a Man-Ten ½″ to 1″	a-b Manganese—Nickel—Copper	a Cor-Ten ½″ to 1″	
Chemical Properties	Carbon, Per Cent	0.05 to 0.20	0.25—Max.	0.25—Max.	0.12—Max.	
	Manganese, Per Cent	0.30 to 0.50	1.10 to 1.60	1.50—Max.	0.20 to 0.50	
	Phosphorus, Per Cent	0.04—Max.	0.045—Max.	0.08—Max.	0.07 to 0.15	
	Sulphur, Per Cent—Max.	0.05	0.05—Max.	0.05—Max.	0.05—Max.	b-Mayari R
	Silicon, Per Cent	0.10—Max.	0.30—Max.	0.25—Max.	0.25 to 0.75	c-Hi Steel
	Copper, Per Cent	X 0.20	0.20—Min.	0.25 to 0.50	0.25 to 0.55	similar to
	Chromium, Per Cent	....	....	....	0.50 to 1.25	Cor-Ten
	Nickel, Per Cent	....	....	0.50 to 1.00	0.65—Max.	
Physical Properties	Yield Point, Lb. Per Sq. In.	33,000—Min.	47,000—Min.	47,000—Min.	47,000—Min.	
	Tensile Strength, Lb. Per Sq. In.	60,000—Min.	72,000—Min.	67,000—Min.	67,000—Min.	
	Elongation, Per Cent 8 inches $\frac{3}{16}$″ and over	Y $\frac{1,500,000}{\text{T. S.}}$	Y $\frac{1,500,000}{\text{T. S.}}$	Y $\frac{1,500,000}{\text{T. S.}}$	Y $\frac{1,500,000}{\text{T. S.}}$	
	Elongation, Per Cent 2 inches	22	....	....	....	
	Cold Bend	180° d = t	180° D = 2t	180° D = 2t	180° D = 2t	

X = Minimum—if Copper is specified, known as Copper Bearing.

Y = For Material under $\frac{5}{16}$ in. to $\frac{3}{16}$ in., inclusive, in thickness or diameter, reduce elongation 1.25% for each decrease of $\frac{1}{32}$ in. below $\frac{5}{16}$ in. Table based on steel up to 1″ thickness.

a-U. S. Steel Corp. b-Beth. Steel Corp. c-Inland Steel Co.

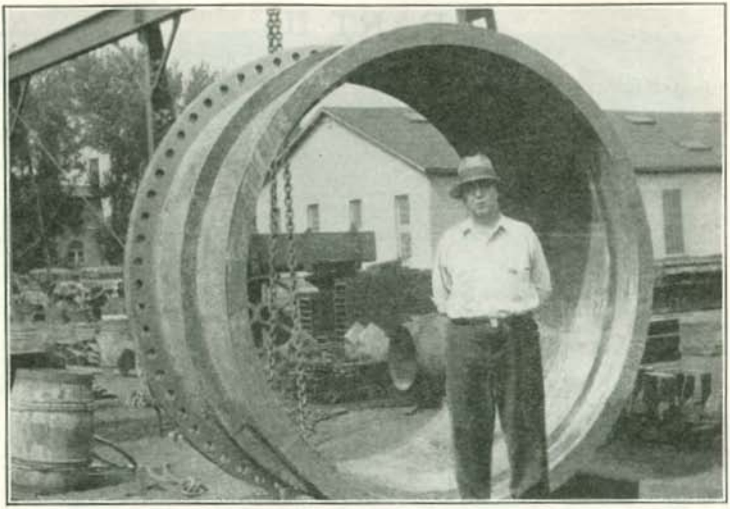
We can furnish a **special abrasion resisting** steel which can be heat treated for severe wear



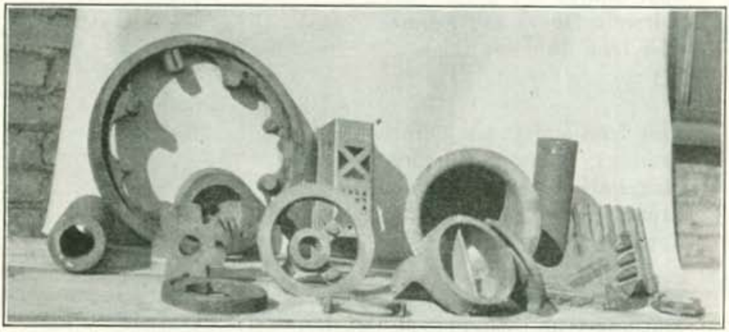
AUDITORIUM ANNEX, ST. PAUL
230' x 300' - Steel 2,000 Tons

PART II

GREY IRON AND ALLOY IRON CASTINGS AND MISCELLANEOUS PRODUCTS



Bell and Flange Water Pipe Special
Weight 10,000 Lbs.—Inside Diameter 84"



Miscellaneous Small Cast Iron and Alloy Iron Castings
We make castings from a few ounces to twenty tons
We make brass and bronze machine castings

We make—

GREY IRON—various grades
WHITE IRON—extreme hardness
SEMI-STEEL IRON—strong
NICKEL IRON—high pressure, wear resistant
CHROME IRON—heat resistant
CHROME NICKEL IRON—high strength
NICKEL MOLYBDENUM IRON—
high strength, wear resistant
BRASS FACED IRON—specialty

CASTINGS

Castings on following pages can be made of the new

Rust-resisting and Stronger Alloy Irons

Special Designs and Specifications

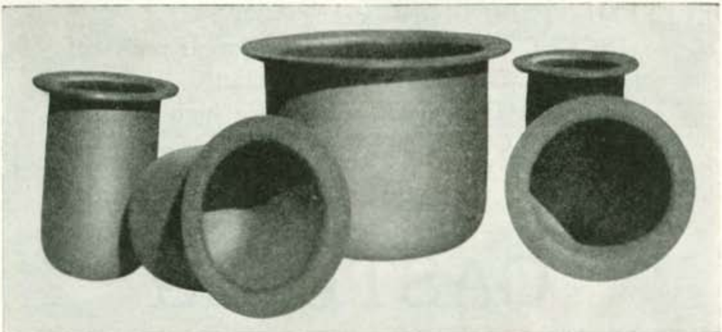
We guarantee a high quality casting of 40,000 pounds per square inch standard test

---

In our research work we have produced nickel molybdenum iron—

58,610 Pounds per sq. inch in tension
5,750 Pounds transverse load
.18 Inches deflection
217 Brinell hardness

(All on a Standard A. S.T. M. test bar)



CYANIDE POTS

Used for the Cyanide Case Hardening Method
Stock Patterns on hand

Diameter	**6- 8- 8- 8-10-10-10-12-12-12-14-14-16-16-16-18-20-20**
Depths	**12-10-12-14-12-14-16-12-16-18-14-16-10-14-16-12-12-14**

Thickness of metal 3/8″

NICKEL-COPPER-CHROME-MOLY-ALLOY

IRON CASTINGS

Resist Erosion or Wear

High Tensile Strength

EXPLANATION OF TABLES ON SAFE LOADS FOR CAST IRON COLUMNS

The loads in these tables are based on the following formulæ:

$$p = \frac{80000}{1+\frac{(12L)^2}{800d^2}} \text{ for round columns.}$$

$$p = \frac{80000}{1+\frac{3(12L)^2}{3200d^2}} \text{ for rectangular columns.}$$

In which—

p = pressure in pounds per square inch.

L = length in feet.

d = outside diameter or least side of rectangle in inches.

Factor of safety, 8.

It is assumed that the columns are set with the care usual in building work, that the bases have a square bearing, and that the ends of the shafts are accurately turned to a true plane.

For diameters or lengths intermediate of those given in the table, the loads may be found by interpolation.

For practical purposes it may be assumed that the loads diminish in the same proportion as the thickness of the metal, the outer diameter remaining the same; but where the thickness is increased special calculations will be necessary unless the new thickness is less than ⅛ of the outside diameter.

SAFE LOAD IN POUNDS FOR ROUND HOLLOW CAST IRON COLUMNS WITH SQUARE ENDS

Outside Diameter	Thickness of Metal	Length of Column in Feet.							
		6	7	8	9	10	11	12	13
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
4	½	39,000	35,400	31,900	28,800	25,900	.....	.....	.....
	¾	54,400	49,400	44,500	40,000	36,000	.....	.....	.....
	1	67,000	60,800	54,800	49,300	44,400	.....	.....	.....
5	½	56,100	52,300	48,400	44,600	41,100	37,600	34,600	31,400
	¾	79,500	74,000	68,400	63,100	58,100	53,300	49,000	44,400
	1	99,800	92,800	85,900	79,300	73,000	66,900	61,500	55,800
6	¾	104,900	99,300	93,800	88,000	82,400	77,000	71,900	67,300
	1	133,100	126,100	119,000	111,800	104,600	97,800	91,400	85,400
	1¼	158,000	149,600	141,300	132,600	124,300	116,100	108,400	101,400
7	¾	130,000	124,900	119,600	113,400	107,800	101,500	96,100	90,800
	1	166,400	159,800	153,100	145,100	137,900	129,900	123,000	116,100
	1¼	199,300	191,400	183,500	173,900	165,100	155,500	147,400	139,100
8	¾	155,400	150,100	144,800	139,000	133,400	127,500	121,500	115,800
	1	200,300	193,400	186,500	179,000	171,800	164,100	156,500	149,000
	1½	278,800	269,100	259,600	249,300	239,100	228,600	217,900	207,500
9	¾	180,000	174,000	168,900	164,600	159,100	153,100	147,300	141,100
	1	232,500	226,500	220,000	213,000	205,800	197,900	190,400	182,500
	1¼	281,500	274,300	266,300	257,900	249,100	239,600	230,500	221,000
	1¾	368,700	359,300	348,800	337,900	326,400	313,900	302,000	289,500
10	¾	204,600	200,300	195,400	190,300	184,800	178,800	173,000	167,000
	1	265,500	259,900	253,500	246,700	239,600	231,900	224,500	216,800
	1¼	322,600	315,800	308,000	299,900	291,300	281,900	272,800	263,400
	1¾	425,900	416,800	406,500	395,800	384,400	372,000	360,000	347,600
11	1	298,100	292,600	286,800	280,400	273,400	266,300	258,400	250,600
	1¼	364,500	356,600	349,400	340,300	333,100	324,500	314,900	305,400
	1½	424,800	416,900	408,500	397,900	389,500	379,400	368,300	357,000
	2	536,500	526,600	516,000	502,600	492,000	479,300	465,100	451,000
12	1	329,500	324,800	318,800	313,600	306,300	299,400	292,000	284,300
	1¼	402,700	396,900	389,600	383,300	374,400	365,900	357,000	347,500
	1½	472,300	465,500	458,300	449,500	438,900	429,100	418,600	407,500
	2	600,000	591,400	581,800	570,900	557,600	545,000	531,800	517,600
13	1	362,600	357,900	353,100	347,000	340,900	333,900	326,800	319,300
	1¼	443,800	438,000	432,300	424,800	417,300	408,600	400,000	390,800
	1½	521,300	514,500	507,800	499,000	490,100	480,000	469,900	459,000
	2	665,000	656,400	647,800	636,500	625,300	612,300	599,400	585,500
14	1	395,800	391,100	386,500	381,400	374,300	368,100	361,000	354,300
	1¼	484,800	479,100	473,500	467,100	458,400	450,900	442,100	434,100
	1½	569,600	563,000	556,300	549,000	538,600	529,900	519,500	510,000
	2	729,100	720,600	712,100	702,800	690,500	678,300	665,000	652,800
15	1	427,400	423,000	418,500	413,100	406,300	401,500	394,400	387,300
	1¼	523,300	519,100	513,600	506,900	499,500	492,800	484,000	475,300
	1½	618,600	612,400	606,000	598,000	589,300	581,300	570,900	560,500
	2	793,300	785,000	776,900	766,600	755,500	745,300	732,500	718,800
16	1	459,300	453,400	450,400	445,600	439,800	433,900	428,600	421,000
	1¼	564,400	557,300	553,600	547,900	540,600	533,400	526,900	517,500
	1½	665,900	657,400	653,100	646,300	637,800	629,300	621,500	610,400
	2	858,000	847,000	841,500	832,800	821,800	810,800	800,800	786,500

SAFE LOAD IN POUNDS FOR ROUND HOLLOW CAST IRON COLUMNS WITH SQUARE ENDS

Length of Column in Feet.						Weight of Col. Shaft Lbs. per Lineal foot	Thickness of Metal.	Outside Diameter.
14	16	18	20	22	24			
Pounds	Pounds	Pounds	Pounds	Pounds	Pounds			
....	....	....	....	....	....	17.20	½	
....	....	....	....	....	....	24.00	¾	4
....	....	....	....	....	....	29.50	1	
29,300	....	....	....	....	....	22.10	½	
41,400	....	....	....	....	....	31.30	¾	5
52,000	....	....	....	....	....	39.30	1	
62,600	54,300	....	....	....	....	39.00	¾	
79,500	68,900	....	....	....	....	49.10	1	6
94,400	81,900	....	....	....	....	58.30	1¼	
85,600	76,000	67,300	59,500	52,600	47,500	46.00	¾	
109,600	97,400	86,000	76,100	67,400	60,800	59.00	1	7
131,300	116,000	103,600	91,100	80,800	72,900	70.60	1¼	
110,100	99,300	89,300	80,500	72,400	65,100	53.40	¾	
141,900	127,900	115,000	103,600	93,300	83,900	69.10	1	8
197,600	178,000	160,000	144,400	129,800	116,800	95.80	1½	
135,400	123,900	113,000	102,800	93,500	85,300	60.70	¾	
175,000	160,300	146,100	132,900	121,000	110,300	78.60	1	
211,900	194,000	176,900	160,900	146,500	133,500	95.10	1¼	9
277,500	254,100	231,600	210,800	191,900	174,900	124.36	1¾	
161,000	149,000	137,600	126,800	116,100	107,600	68.00	¾	
209,000	193,400	178,500	164,400	150,600	139,600	88.40	1	
253,900	235,000	217,000	199,800	183,000	169,800	107.40	1¼	10
335,100	310,100	286,600	263,600	241,500	224,000	142.00	1¾	
243,100	227,400	211,800	196,400	182,600	168,900	98.20	1	
296,300	277,100	258,300	244,500	223,500	205,800	120.10	1¼	
346,400	321,800	301,700	285,800	260,300	240,600	140.00	1½	11
437,500	409,300	381,000	361,000	328,800	304,000	176.80	2	
276,500	261,000	245,100	229,600	214,500	200,100	108.00	1	
338,000	319,000	299,600	280,600	262,300	244,900	131.40	1¼	
396,400	374,100	351,300	329,000	307,500	287,100	154.70	1½	12
503,500	475,300	446,300	418,000	390,500	364,600	195.80	2	
311,800	295,800	279,800	264,100	248,500	233,100	117.53	1	
381,500	362,000	343,000	323,500	304,400	285,300	144.20	1¼	
448,100	425,100	402,000	379,800	357,500	335,100	169.40	1½	13
571,800	542,400	513,000	484,500	456,000	427,500	216.00	2	
346,600	330,800	313,900	298,600	283,300	266,900	128.10	1	
424,600	405,500	386,000	365,800	347,000	326,900	156.50	1¼	
498,900	478,400	454,300	429,800	407,600	384,100	184.10	1½	14
638,600	560,500	581,000	551,500	521,900	493,000	235.70	2	
381,300	364,100	349,300	333,300	317,000	300,900	137.50	1	
467,800	448,300	428,600	409,100	390,100	369,300	169.40	1¼	
550,000	527,100	505,600	482,500	458,800	435,500	198.90	1½	15
707,500	678,000	648,300	618,600	588,100	558,400	255.30	2	
413,900	399,100	383,300	367,600	351,500	335,000	147.30	1	
508,800	490,800	471,100	452,000	432,100	411,900	181.00	1¼	
600,100	578,900	555,800	534,400	509,800	485,800	213.50	1½	16
773,300	745,800	716,100	687,000	656,800	625,900	274.90	2	

SAFE LOAD IN POUNDS FOR SQUARE HOLLOW CAST IRON COLUMNS WITH SQUARE ENDS

Side of Square.	Thickness of Metal.	Length of Column in Feet.							
		6	7	8	9	10	11	12	13
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
4	½	53,800	49,500	45,400	41,500		......	......	......
	¾	75,000	69,000	63,300	57,900		......	......	......
5	⅝	91,500	86,400	81,300	76,100	71,000	66,000	61,500	57,100
	¾	106,400	100,600	94,600	88,600	82,800	77,000	71,800	66,600
	⅞	120,800	114,100	107,300	100,400	93,600	87,100	81,300	75,500
6	¾	138,800	132,800	127,300	121,000	115,000	108,300	102,100	96,500
	1	176,300	168,500	161,300	153,800	146,000	137,500	129,800	122,500
	1¼	209,300	200,100	191,500	182,600	173,400	163,300	154,100	145,500
7	¾	170,600	165,000	159,400	153,300	147,000	140,600	134,100	128,000
	1	218,400	211,500	204,000	196,100	188,100	180,000	171,600	163,800
	1¼	261,600	253,400	244,400	236,300	225,400	215,600	205,600	196,300
8	¾	202,000	197,100	191,600	185,600	179,400	173,100	166,600	160,900
	1	260,000	253,800	246,800	239,000	231,000	223,000	214,500	207,300
	1¼	313,500	305,900	297,400	288,100	278,500	268,800	258,600	249,800
9	¾	233,200	228,600	223,600	218,100	211,900	205,800	199,500	193,400
	1	302,100	295,600	289,300	282,000	274,000	266,000	258,000	250,000
	1½	424,200	415,600	406,800	396,600	385,400	374,100	362,900	351,600
10	¾	264,400	260,100	255,300	249,800	244,500	237,600	232,000	225,800
	1	342,900	337,500	331,300	324,000	317,300	308,300	301,000	293,000
	1½	485,800	477,500	469,300	459,000	449,500	436,800	426,500	415,000
	2	609,600	600,000	588,800	576,000	564,000	548,000	535,100	506,800
11	¾	295,600	291,700	286,800	281,800	276,800	271,000	263,300	258,300
	1	384,500	379,500	373,000	366,500	360,000	352,500	343,000	336,000
	1½	547,900	540,800	531,500	522,300	513,000	502,400	488,800	478,800
	2	692,100	683,100	671,400	659,600	648,000	634,500	617,400	604,900
12	¾	326,100	322,400	318,100	313,500	308,400	302,900	297,400	294,900
	1	425,100	420,300	414,800	408,600	402,000	394,900	387,800	379,500
	1½	608,800	601,600	593,800	585,100	575,600	565,400	555,300	543,400
	2	773,000	764,000	754,000	734,000	731,000	718,000	705,000	690,000
13	1	466,300	461,400	456,100	452,400	445,300	437,400	430,300	423,000
	1¼	570,600	564,800	558,900	553,800	544,900	535,400	526,500	517,800
	1½	670,100	663,300	658,900	650,400	640,000	628,800	618,400	608,100
	2	854,800	845,900	837,100	829,400	816,300	801,900	788,800	775,500
14	1	507,000	503,800	497,900	492,000	486,300	479,800	472,500	465,400
	1½	731,300	726,600	718,100	709,800	701,300	691,900	681,600	671,300
	2	936,000	930,000	919,300	908,400	897,600	885,500	872,500	859,300
15	1	548,100	543,900	538,300	533,400	527,800	521,500	514,500	508,300
	1½	792,800	786,600	778,600	771,400	763,400	754,300	744,100	735,000
	2	1,017,900	1,010,000	999,800	990,600	980,300	968,500	955,500	943,800
16	1	588,000	584,300	581,300	575,300	569,300	564,000	557,300	550,500
	2	1,097,600	1,090,600	1,085,000	1,073,800	1,062,600	1,052,800	1,040,300	1,027,600
17	1	628,800	625,600	621,500	616,000	611,300	605,600	599,300	593,600
	2	1,179,000	1,173,000	1,165,500	1,155,000	1,146,000	1,135,500	1,123,500	1,113,000
18	1	669,800	666,400	662,100	657,000	652,800	646,900	640,900	635,000
	2	1,260,900	1,254,500	1,246,400	1,236,800	1,228,700	1,217,600	1,206,400	1,195,300
19	1	710,100	706,500	702,900	698,400	693,900	688,500	682,300	676,800
	2	1,341,000	1,334,500	1,327,800	1,319,300	1,310,800	1,300,500	1,287,400	1,278,400
20	1	750,500	746,800	743,900	739,100	734,400	729,600	723,900	718,300
	2	1,420,000	1,414,800	1,409,400	1,400,400	1,391,400	1,382,400	1,371,600	1,360,800

SAFE LOAD IN POUNDS FOR SQUARE HOLLOW CAST IRON COLUMNS WITH SQUARE ENDS

Length of Column in Feet.						Weight lbs. of Column per foot of Length.	Thickness of Metal.	Side of Square.
14	**16**	**18**	**20**	**22**	**24**			
Pounds	Pounds	Pounds	Pounds	Pounds	Pounds			
....	....	....	....	....	....	21.8	½	**4**
....	....	....	....	....	....	30.4	¾	
53,100	....	....	....	....	....	34.2	⅝	**5**
62,000	....	....	....	....	....	39.8	¾	
70,000	....	....	....	....	....	45.1	⅞	
90,800	80,400	71,100	....	....	....	49.2	¾	**6**
115,300	102,000	90,200	....	....	....	62.5	1	
136,900	121,100	107,100	....	....	....	74.2	1¼	
121,600	110,100	98,800	89,200	79,700	72,400	58.6	¾	**7**
155,800	140,000	126,600	114,200	102,600	92,700	75.0	1	
186,500	168,900	151,900	136,900	122,800	111,000	89.8	1¼	
153,900	141,100	129,100	117,300	107,300	98,100	68.0	¾	**8**
198,100	181,600	166,200	151,500	138,200	126,300	87.5	1	
238,800	219,000	200,400	182,600	166,600	152,200	105.5	1¼	
187,100	173,200	160,600	148,500	136,700	126,200	77.3	¾	**9**
242,000	224,000	207,600	192,000	176,700	163,200	100.0	1	
340,400	315,000	292,000	270,000	248,600	229,500	140.6	1½	
219,600	206,000	193,200	180,000	167,500	155,400	86.7	¾	**10**
284,900	267,200	250,600	233,500	217,400	201,600	112.5	1	
403,500	378,600	355,100	330,800	308,000	285,600	159.4	1½	
506,400	475,200	445,600	415,200	386,300	358,400	200.0	2	
252,100	239,500	225,600	212,500	199,500	186,000	96.1	¾	**11**
328,000	311,500	293,500	276,500	259,500	242,500	125.0	1	
467,400	443,700	418,100	393,700	368,700	345,000	178.1	1½	
590,400	560,700	528,200	497,500	467,100	436,500	225.0	2	
284,400	272,100	259,500	246,400	232,200	219,400	105.5	¾	**12**
370,800	354,700	338,200	321,200	303,000	285,500	137.5	1	
530,800	508,000	484,400	459,800	433,900	408,700	196.6	1½	
673,800	645,000	615,000	584,000	551,000	519,000	250.0	2	
415,800	398,400	381,000	363,000	345,600	328,500	150.0	1	**13**
508,900	487,600	466,400	444,200	423,000	402,500	183.6	1¼	
597,800	572,700	547,700	521,900	496,700	472,600	215.6	1½	
762,300	730,400	698,500	665,500	633,700	602,700	275.0	2	
458,300	444,600	425,100	406,900	390,000	372,500	162.5	1	**14**
661,300	641,200	613,100	586,900	562,500	537,100	234.4	1½	
846,000	820,700	784,700	751,200	720,000	687,600	300.0	2	
500,500	485,100	468,200	451,500	433,200	415,700	175.0	1	**15**
723,900	701,600	677,400	653,000	626,700	601,400	253.2	1½	
929,500	900,900	869,700	838,500	804,700	772,200	325.0	2	
543,800	528,700	512,200	495,000	477,700	459,700	187.5	1	**16**
1,015,000	987,000	956,200	924,000	891,600	858,200	350.0	2	
585,600	572,000	555,200	539,200	521,600	504,000	193.8	1	**17**
1,098,000	1,072,300	1,041,000	1,011,000	978,000	945,000	374.4	2	
628,100	614,500	599,200	582,200	565,200	548,200	212.5	1	**18**
1,182,400	1,156,700	1,128,000	1,096,000	1,064,000	1,032,000	400.0	2	
670,500	656,100	641,600	626,400	609,200	593,100	225.0	1	**19**
1,266,500	1,239,200	1,212,100	1,183,200	1,150,900	1,120,200	425.0	2	
712,500	699,200	685,000	669,700	652,600	636,500	237.5	1	**20**
1,350,000	1,324,700	1,297,700	1,269,000	1,236,600	1,206,000	450.0	2	

SAFE LOADS IN POUNDS FOR RECTANGULAR CAST IRON COLUMNS

Size in Inches.	Thickness of Metal.	Length of Column in Feet.							
		6	7	8	9	10	11	12	13
		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
4	¾	98,000	90,300	82,800	75,800	69,100	63,100	57,500	52,600
x	1	123,000	113,300	103,800	95,000	86,800	79,300	72,300	66,000
6	1¼	143,800	132,500	121,300	111,400	101,400	92,800	84,600	77,400
4	¾	121,100	111,400	102,100	93,500	85,400	78,000	71,100	65,000
x	1	153,800	141,500	129,800	118,800	108,500	99,000	90,300	82,500
8	1¼	182,600	168,000	154,100	141,000	128,900	117,500	107,100	98,000
4	¾	143,800	132,500	121,300	111,400	101,400	92,800	84,600	77,400
x	1	184,500	169,800	155,800	142,500	130,100	118,800	108,400	99,000
10	1¼	221,000	203,400	186,500	170,800	156,000	142,300	129,800	118,600
5	¾	131,500	124,400	117,000	109,500	102,100	95,000	88,600	82,300
x	1	167,000	158,000	148,500	139,000	129,800	120,800	112,500	104,500
7	1¼	198,300	187,600	176,300	165,000	154,100	143,400	133,600	124,000
5	¾	194,100	183,600	172,600	161,600	150,900	140,400	130,800	121,500
x	1	250,500	237,000	222,800	208,500	194,600	181,100	168,800	156,800
12	1¼	302,600	286,300	269,100	251,900	235,100	218,800	203,900	189,400
6	¾	165,300	158,000	151,100	144,100	136,900	128,900	121,600	114,900
x	1	211,500	202,100	193,500	184,500	175,000	165,000	155,600	147,000
8	1¼	253,300	242,300	231,800	221,000	209,900	197,600	186,500	176,100
6	¾	218,100	208,500	199,500	190,300	180,600	170,100	160,600	151,600
x	1	282,000	269,600	258,000	246,000	233,600	220,000	207,600	196,000
12	1¼	341,500	326,500	312,500	297,900	282,900	266,400	251,400	237,400
7	¾	213,900	204,900	200,000	190,100	182,300	174,400	166,300	158,600
x	1	276,000	264,400	258,000	245,300	235,100	225,000	214,500	204,800
10	1¼	333,500	319,500	311,800	296,400	284,100	271,900	259,100	247,400
7	¾	241,500	231,400	225,800	214,600	205,800	196,900	187,600	180,300
x	1	312,800	299,600	292,400	278,000	266,500	255,000	243,100	232,000
12	1¼	379,500	363,500	354,800	337,300	323,300	309,400	294,900	281,500
8	¾	257,800	251,500	244,500	236,900	228,900	221,000	212,600	205,400
x	1	334,400	326,300	317,300	307,400	297,000	286,600	275,900	266,900
12	1¼	406,500	396,500	385,500	373,500	360,900	348,400	335,300	323,600
8	¾	313,500	305,900	297,400	288,100	278,400	268,800	258,600	249,800
x	1	408,600	398,800	387,800	375,600	363,000	350,300	337,100	325,600
16	1¼	499,300	487,100	473,600	458,900	443,400	425,500	411,900	397,600
9	¾	275,600	270,300	264,500	257,800	250,500	243,100	235,900	228,600
x	1	358,100	351,000	343,400	334,900	325,400	315,900	306,400	296,900
12	1¼	435,900	427,300	418,000	407,600	396,000	384,500	372,900	361,400
9	¾	332,300	325,600	318,600	310,600	301,900	293,000	284,300	275,400
x	1	433,500	425,000	415,900	405,600	393,800	382,400	370,900	359,400
16	1¼	530,100	519,600	508,400	495,800	481,600	467,600	453,500	439,500
10	¾	350,000	344,500	338,100	331,100	323,400	315,600	307,300	299,000
x	1	457,300	450,000	441,300	432,600	422,400	412,300	401,400	390,600
16	1¼	559,600	550,800	540,500	529,400	517,000	504,500	491,300	478,100
10	¾	407,300	400,800	393,300	385,300	376,300	367,100	357,500	347,900
x	1	533,400	525,000	515,300	504,800	492,800	480,900	468,300	455,800
20	1¼	654,900	644,500	632,500	619,700	605,000	590,400	574,900	559,500
12	1	502,500	496,600	490,000	483,000	475,100	466,600	458,300	448,500
16	1¾	828,500	818,700	808,300	796,400	783,500	769,600	755,800	739,600
12	1	657,000	649,400	640,900	631,500	621,300	610,300	599,300	586,500
24	1¾	1,099,100	1,086,300	1,072,100	1,056,500	1,039,400	1,020,900	1,002,400	981,100

SAFE LOADS IN POUNDS FOR RECTANGULAR CAST IRON COLUMNS.

Length of Column in Feet.						Weight of Column Shaft per Lineal Foot.	Thickness of Metal.	Size in Inches.
14	**16**	**18**	**20**	**22**	**24**			
Pounds	Pounds	Pounds	Pounds	Pounds	Pounds			
48,000	....	....	....	....	....	39.8	¾	**4**
60,300	....	....	....	....	....	50.0	1	x
70.600	59.300	....	....	....	....	58.6	1¼	**6**
59,300	49,800	42,100	35,900	....	....	49.2	¾	**4**
75,300	63,300	53,500	45,500	....	....	62.5	1	x
89,400	75,100	63,500	53,800	....	....	74.2	1¼	**8**
70,600	59,300	50,000	42,600	....	....	58.6	¾	**4**
90,300	75,900	64,300	54,600	....	....	75.0	1	x
108,100	90,900	76,900	65,400	....	....	89.8	1¼	**10**
76,400	66,000	57,100	49,800	43,800	38,300	49.2	¾	**5**
97,000	83,800	72,500	63,300	55,500	48,500	62.5	1	x
115,100	99,500	86,100	75,300	65,900	57,600	74.2	1¼	**7**
112,800	97,400	84,300	73,500	64,500	56,400	72.7	¾	**5**
145,500	125,600	108,800	94,900	83,300	72,800	93.8	1	x
175,800	151,800	131,400	114,600	100,500	87,900	113.3	1¼	**12**
108,000	95,500	84,500	75,000	66,800	59,300	58.6	¾	**6**
138,300	122,400	108,300	96,000	85,500	75,900	75.0	1	x
165,600	146,600	129,600	115,000	102,400	90,900	89.8	1¼	**8**
142,600	126,300	111,600	99,000	88,100	78,300	77.3	¾	**6**
184,400	163,300	144,400	128,000	114,000	101,300	100.0	1	x
223,300	197,600	174,900	155,000	138,000	122,500	121.1	1¼	**12**
151,500	136,600	122,600	110,600	99,400	89,800	72.7	¾	**7**
194,500	176,300	158,300	142,900	128,300	115,900	93.8	1	x
235,100	213,000	191,300	172,600	155,000	140,000	113.3	1¼	**10**
170,300	154,300	138,500	125,000	112,300	101,400	82.0	¾	**7**
220,600	199,800	179,400	161,900	145,400	131,400	106.3	1	x
267,600	242,400	217,600	196,500	176,400	159,400	128.9	1¼	**12**
196,400	180,000	164,800	150,300	137,000	125,300	86.7	¾	**8**
254,800	233,500	213,800	294,900	177,800	162,500	112.5	1	x
309,500	283,900	259,800	236,800	216,000	197,400	136.7	1¼	**12**
238,800	218,900	200,400	182,600	166,600	152,300	105.5	¾	**8**
311,300	285,500	261,300	238,100	217,300	198,500	137.5	1	x
379,300	348,800	319,100	290,900	265,400	242,500	168.0	1¼	**16**
221,300	204,800	189,800	175,500	161,600	149,100	91.4	¾	**9**
287,400	266,000	246,500	228,000	210,000	193,800	118.8	1	x
349,800	323,800	300,000	277,500	255,500	235,900	144.5	1¼	**12**
266,600	246,800	228,600	211,500	194,800	179,600	110.2	¾	**9**
347,800	322,000	298,400	276,000	254,100	234,600	143.8	1	x
425,400	393,800	364,900	337,500	310,800	286,900	175.8	1¼	**16**
290,400	272,900	255,300	238,400	222,400	207,100	114.8	¾	**10**
379,300	356,400	333,600	311,100	290,400	270,600	150.0	1	x
464,100	436,300	408,300	381,100	355,400	331,300	183.6	1¼	**16**
337,900	317,400	297,100	277,300	258,600	241,000	133.6	¾	**10**
442,400	415,800	389,300	363,300	338,800	315,800	175.0	1	x
543,100	510,800	477,800	446,000	415,900	387,600	214.9	1¼	**20**
438,100	419.300	399,800	379.600	358,100	337.400	162.5	1	**12**
722,500	691,500	659,400	626,000	590,600	556,400	268.0	1¾	**16**
572,900	548.300	523,000	496.400	468.400	441,100	212.5	1	**12**
958,400	917,100	874,500	830,400	783,800	738,000	355.5	1¾	**24**

BASES FOR CAST IRON COLUMNS

Size of Column	Thickness of Metal	Size of Plate (Ordinary Masonry)	Weight	Size of Plate (Cut Stone)	Weight
5	¾	14 x 14 x 1¾	90 lbs.	10 x 10 x 1½	40 lbs.
5	1	16 x 16 x 2¼*	110 "	12 x 12 x 2	75 "
6	¾	16 x 16 x 2*	105 "	12 x 12 x 1¾	65 "
6	1	18 x 18 x 2½*	165 "	14 x 14 x 2¼	115 "
7	¾	18 x 18 x 2¼*	140 "	14 x 14 x 2	105 "
7	1	20 x 20 x 2½*	205 "	16 x 16 x 2½*	135 "
8	¾	20 x 20 x 2¾*	230 "	16 x 16 x 2¼*	125 "
8	1¼	24 x 24 x 6	330 "	18 x 18 x 2¾*	185 "
9	1	24 x 24 x 6	270 "	18 x 18 x 2½*	175 "
9	1½	30 x 30 x 8	555 "	20 x 20 x 2¾*	235 "
10	1	28 x 28 x 7	360 "	20 x 20 x 2¾*	235 "
10	1½	32 x 32 x 10	715 "	24 x 24 x 6	370 "
11	1	30 x 30 x 8	420 "	24 x 24 x 6	270 "
11	1½	36 x 36 x 10	840 "	28 x 28 x 7	490 "
12	1	32 x 32 x 10	515 "	28 x 28 x 7	360 "
12	1½	38 x 38 x 12	1020 "	30 x 30 x 8	570 "

Bases marked thus * are beveled to ½ thickness shown.

Bases of greater thickness than 2¾" will be ribbed.

Above sizes are based on a pressure of 250 pounds per square inch for masonry and 500 pounds per square inch for cut stone.

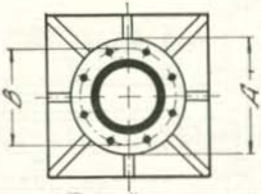
Sizes given can be varied for allowable load on concrete from 250 to 450 pounds per square inch.

Bases for columns less than 8 feet in length and loaded to full safe load and bases for columns of thicker metal than sizes shown by more than ¼ inch will require special calculation.

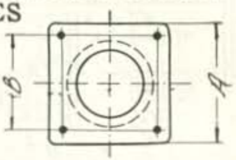
Thickness of metal in ribbed bases same as thickness of metal in columns.

Weights of ribbed bases are approximate only.

STANDARD CAST IRON COLUMN BASES AND FLANGES

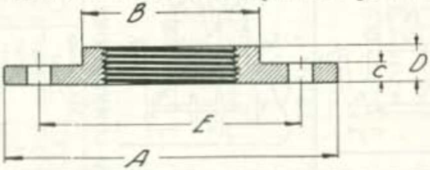


Size of Column	A	B
7	13	10 1/4
8	14	11 1/4
9	15	12 1/4
10	16	13 1/4
11	17	14 1/4
12	18	15 1/4
13	19	16 1/4
14	20	17 1/4
15	21	18 1/4
16	22	19 1/4



Size of Column	A	B
4	7 1/2	4 1/2
5	8	5 1/8
6	9	6
7	9 3/4	6 3/4
8	10 1/2	7 1/2
9	11 1/4	8 1/4
10	12	9
11	13	9 1/2
12	14	10 1/2
13	14 1/2	11 1/2
14	16	12
15	17	13
16	18	14

Dimensions of Crane Co. Standard Companion Pipe Flanges



Size of Pipe—Inches	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10
A | Dia. of Flange	3 1/2	4 1/4	4 5/8	5	6	7	7 1/2	8 1/2	9	10	11	13 1/2	16
C | Thickness of Flange	7/16	7/16	1/2	9/16	5/8	11/16	3/4	13/16	13/16	15/16	1	1 1/8	1 3/16
D | Height of Flange	5/8	11/16	3/4	7/8	1	1 1/16	1 1/8	1 3/16	1 3/16	1 5/16	1 7/16	1 5/8	1 7/8
E | Dia. of Bolt Circle		3 1/8	3 1/2	3 7/8	4 3/4	5 1/2	6	7	7 1/2	8 1/2	9 1/2	11 3/4	14 1/4
Size of Bolts		1/2	1/2	1/2	5/8	5/8	5/8	5/8	5/8	3/4	3/4	3/4	7/8
No. of Bolts		4	4	4	4	4	4	8	8	8	8	8	12

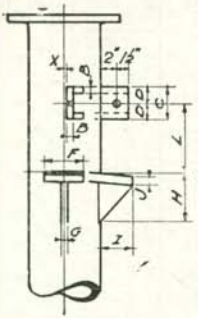
Used with Pipe for Bolted Connections to Valves, etc.

Dimensions of St. Paul Foundry & Mfg. Co. Standard Pipe Flanges

Size of Pipe—Inches	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	6	7	8	9	10
A | Dia. of Flange	3 3/4	4	4 1/2	5 1/4	5 3/4	6 1/2	7 7/8	8 3/8	9 1/2	10	10 3/4	11 1/4	13	14	15 1/4	16 3/8
B | Dia. of Hub	1 1/2	1 7/8	2 1/4	2 1/2	3	3 11/16	4 5/8	4 7/8	5 1/2	6	6 5/8	7 3/4	8 13/16	9 7/8	11	12 5/16
C | Thickness of Flange	5/16	5/16	3/8	3/8	3/8	1/2	9/16	9/16	5/8	5/8	5/8	11/16	3/4	13/16	7/8	15/16
D | Height of Flange	3/4	13/16	7/8	15/16	1	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 13/16	1 7/8	1 15/16	2 1/16	2 1/4
E | Dia. of Bolt Circle	2 5/8	3	3 3/8	3 7/8	4 3/8	5 1/8	6 1/8	6 5/8	7 1/2	8	8 5/8	9 3/4	10 7/8	12	13 1/8	14 1/4
Size of Bolts	3/8	3/8	3/8	1/2	1/2	1/2	5/8	5/8	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4
No. of Bolts	4	4	4	4	4	4	4	4	4	8	8	8	8	8	12	12

STANDARD CONNECTIONS FOR SINGLE I-BEAMS TO CAST IRON COLUMNS.

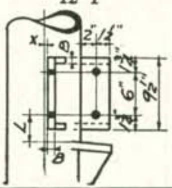
5"-6"-7"-8"-9" & 10"Is



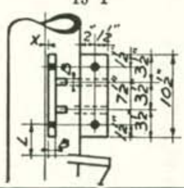
$X = \frac{\text{Web Thickness}}{2} + \frac{1}{16}''$

Slope of All Beam Seats $\frac{3}{16}''$ In 12"

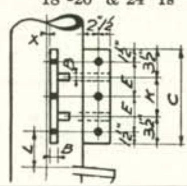
12" I



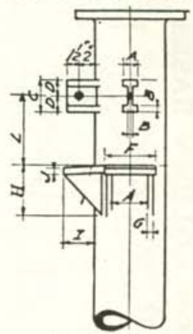
15" I



18"-20" & 24" Is

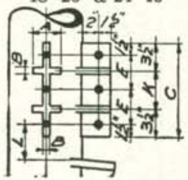


5"-6"-7"-8"-9" & 10"Is

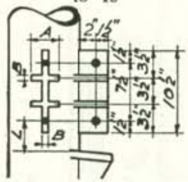


A = Ctr. to Ctr. of Beams Less (Web Thickness + $\frac{1}{16}''$)

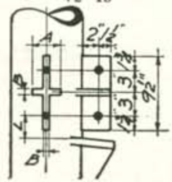
18"-20" & 24" Is



15" Is



12" Is



STANDARD CONNECTIONS FOR DOUBLE I-BEAMS TO CAST IRON COLUMNS.

Beam		Distances for Single I-Beams											Maximum	Distances for Double I-Beams												Maximum
Size	Wgt.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	Load	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	Load
5	10.0	5/8	3	1½	...	4	¾	5	3½	7/8	...	2½	13200	3¼	5/8	3	1½	...	6¾	¾	5	3½	7/8	...	2½	24000
6	12.5	5/8	3	1½	...	4	¾	5	3½	7/8	...	3	13200	3 11/16	5/8	3	1½	...	7½	7/8	5	3½	7/8	...	3	27500
7	15.3	5/8	3	1½	...	5	¾	6	3½	1	...	3½	17500	3 13/16	5/8	3	1½	...	8	7/8	5	3½	1	...	3½	30000
8	18.4	¾	4	2	...	5	7/8	6	4	1	...	4	18700	4 3/16	¾	4	2	...	8¾	1	6	4	1	...	4	37500
9	21.8	¾	4	2	...	5	7/8	6	4	1	...	4½	18700	4 5/8	¾	4	2	...	9½	1	8	4	1	...	4½	47000
10	25.4	¾	4	2	...	6	1	7	4	1	...	5	24000	5 1/8	¾	4	2	...	10½	1	8	4	1	...	5	49000
12	31.8	¾	...	...	...	6	1	8	4	1	...	3	26000	5 5/16	¾	9½	...	...	11	1	10	4	1	...	3	58000
12	40.8	¾	...	...	...	7	1 1/8	8	4	1	...	3	29700	5 7/16	¾	9½	...	...	11½	1 1/8	10	4	1	...	3	63500
15	42.9	7/8	...	...	...	7	1 1/8	10	4	1 1/8	...	3¾	35700	5¾	7/8	10½	...	...	12	1 1/8	11	4	1 1/8	3½	3¾	71400
15	60.8	1	...	...	...	7	1¼	10	4	1 1/8	...	3¾	37900	6 1/16	1	10½	...	...	13	1¼	11	4	1 1/8	3½	3¾	78600
18	54.7	1	12	...	4½	7	1¼	11	4	1¼	5	4½	41800	6¼	1	12	...	4½	13	1¼	12½	4	1¼	5	4½	88600
20	65.4	1	13	...	5	8	1 3/8	12	4	1¼	6	5	54900	6 7/16	1	13	...	5	13½	1 3/8	14	4	1¼	6	5	103800
24	79.9	1	15	...	6	8	1½	14	4	1 3/8	8	6	59800	7 3/16	1	15	...	6	15	1½	15	4	1½	8	6	126000

Loads figured at 2000 lbs. per square inch shear on shelf and bracket. All holes cored for ¾ bolts.
Distances A and F are for standard separator spacing for beams of weight shown.

Tables apply to Standard American Sections only. We have patterns which meet requirements of WF Beams.

WEIGHTS OF CAST IRON RECTANGULAR PLATES 1 INCH THICK

WEIGHT OF 1 CUBIC INCH OF CAST IRON, 0.26 LBS.

Length in inches	WIDTH IN INCHES												
	4	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**24**	**28**	**30**	**36**
4	4.16	6.25	8.3	10.4	12.5	14.6	16.6	18.7	20.8	25	29	31	37
5	5.21	7.81	10.4	13.2	15.6	18.2	20.8	23.4	26.0	31	36	39	47
6	6.25	9.37	12.5	15.6	18.7	21.8	25.0	28.1	31.2	38	44	47	56
7	6.29	10.94	14.6	18.2	21.9	25.5	29.2	32.8	36.5	44	51	55	66
8	8.33	12.50	16.6	20.8	25.0	29.2	33.3	37.5	41.6	50	58	62	75
9	9.37	14.06	18.7	23.4	28.1	32.8	37.5	42.2	46.9	56	66	70	84
10	10.42	15.62	20.8	26.0	31.2	36.5	41.7	46.9	52.1	63	73	78	94
11	11.46	17.19	22.9	28.6	34.4	40.1	45.8	51.6	57.3	69	80	86	103
12	12.50	18.75	25.0	31.2	37.5	43.7	50.0	56.2	62.5	75	88	94	112
14	14.58	21.87	29.2	36.5	43.7	51.0	58.3	65.6	72.9	88	102	109	131
16	16.67	25.00	33.3	41.7	50.0	58.3	66.7	75.0	83.3	100	117	125	150
18	18.75	28.12	37.5	46.9	56.2	65.6	75.0	84.4	93.7	112	131	141	169
20	20.83	31.25	41.6	52.1	62.5	72.9	83.3	93.7	104.2	125	146	156	188
22	22.92	34.37	45.8	57.3	68.7	80.2	91.7	103.1	114.6	138	160	172	206
24	25.00	37.50	50.0	62.5	75.0	87.5	100.0	112.5	125.0	150	175	187	225
26	27.08	40.62	54.2	67.7	81.2	94.8	108.3	121.9	135.4	162	190	203	224
28	29.17	43.75	58.3	72.9	87.5	102.1	116.7	131.2	145.8	175	204	219	263
30	31.25	46.87	62.5	78.1	93.7	109.4	125.0	140.6	156.2	187	219	234	281
32	33.33	50.00	66.7	83.3	100.0	116.7	133.3	150.0	166.7	200	233	250	300
34	35.42	53.12	70.8	88.5	106.2	124.0	141.7	159.4	177.1	212	248	266	319
36	37.50	56.25	75.0	93.7	112.5	131.2	150.0	168.7	187.5	225	263	281	337
38	39.58	59.37	79.2	99.0	118.7	138.5	158.3	178.1	197.9	237	277	297	356
40	41.67	62.50	83.3	104.2	125.0	145.8	166.7	187.5	208.3	250	292	312	375
42	43.75	65.62	87.5	109.4	131.2	153.1	175.0	196.9	218.7	262	306	328	394
44	45.83	68.75	91.7	114.6	137.5	160.4	183.3	206.2	229.2	275	321	344	412
46	47.92	71.87	95.8	119.8	143.7	167.7	191.7	215.6	239.6	287	335	359	431
48	50.00	75.00	100.0	125.0	150.0	175.0	200.0	245.0	250.0	300	350	375	450
50	52.08	78.12	104.2	130.2	156.2	182.3	208.3	234.4	260.4	312	365	391	469
52	54.16	81.25	108.3	135.4	162.5	189.6	216.7	243.7	270.8	325	379	406	487
54	56.25	84.37	112.5	140.6	168.7	196.9	225.0	253.1	281.2	337	394	422	506

COAL HOLE AND CATCH BASIN RINGS AND COVERS

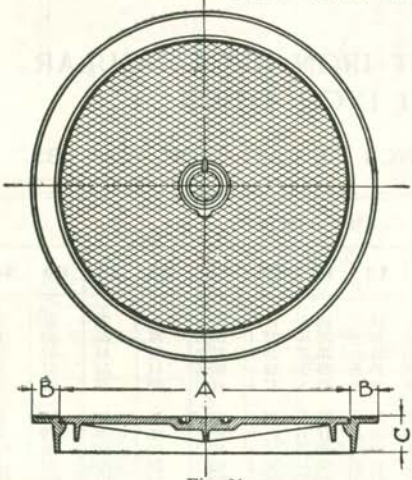


Fig. 21

COAL HOLE RINGS AND COVERS

A	B	C	Type
*36	3¾	4½	Heavy
*30	3¾	5	Heavy
30	2¾	6	Light
*24	3½	4	Heavy
*24	2″	2½	Light
*20½	2	2¼	Light
18	1¾	2	Light
16	1¾	2	Light
14	2¼	2¼	Light
12	2	2	Light
10	2	2	Light

*Also water tight.

CATCH BASIN RINGS AND COVERS

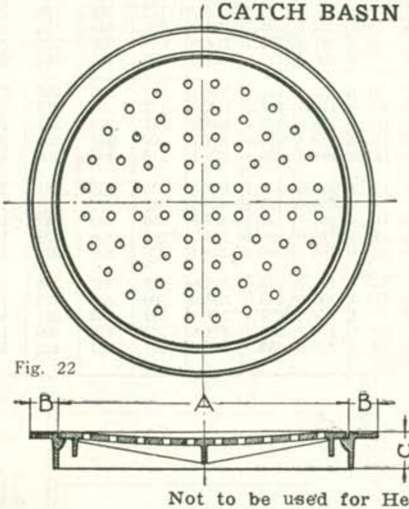


Fig. 22

A	B	C
24	**2¼**	3
20½	**2**	**2¼**
18	**1¾**	**2**
16	**1¾**	**2**
14	2¼	2½
12	**2**	**2**
10	2	**2**
8	1¾	1¾
7	1½	1½
6	1½	1½

Stock sizes are in heavy type

Not to be used for Heavy Traffic.

HEAVY STREET RINGS AND COVERS

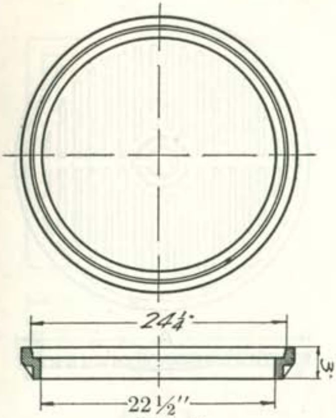


Fig. 24

HEAVY STREET RING

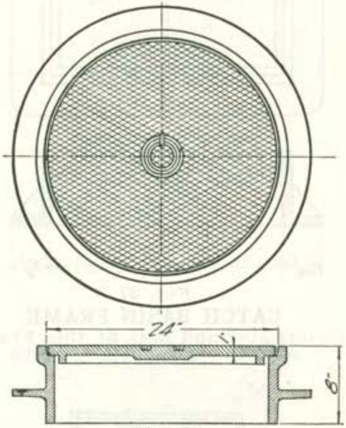


Fig. 23

HEAVY RING AND COVER

23-6L—6" high with lugs
23-8L—8" high with lugs
23-6F—6" high with ring
23-8F—8" high with ring

Cover 23-C

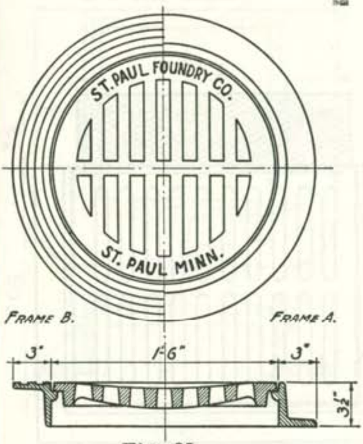


Fig. 25

18" HEAVY RINGS AND COVER

Also diamond checkered cover.

Fig. 23 Cover will fit Frames 35-A, 38-A and 24.

Figs. 23 and 24 Rings will take Covers 39B, 40C, 41D and 42.

Used for Heavy Traffic and Garages.

CATCH BASIN FRAMES AND COVERS

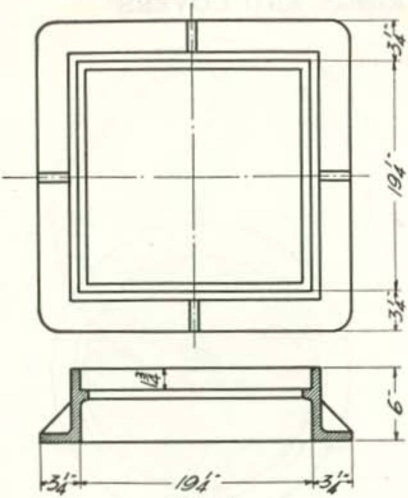


Fig. 27

CATCH BASIN FRAME

Covers 31-F and 32-G, fit this Frame.
Also made for 1⅛" covers.

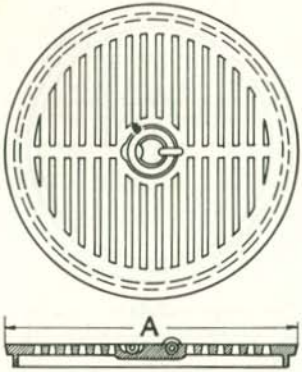


Fig. 28

A-18"-20½"-24"

Fits Frames Fig. 21, Omaha Ry. Std.

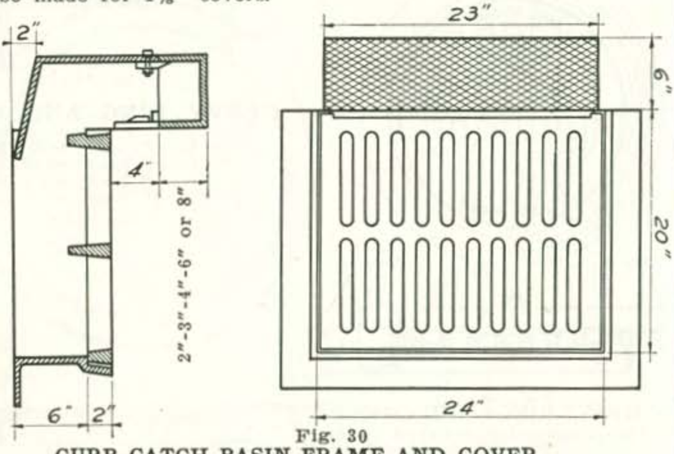


Fig. 30

CURB CATCH BASIN FRAME AND COVER

See also Figs. 194 and 195

CATCH BASIN FRAME AND COVERS

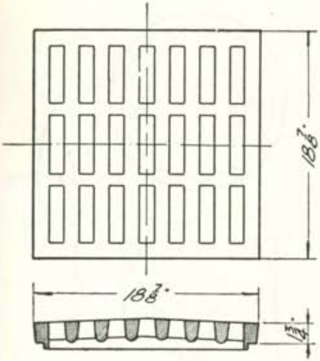


Fig. 31-F

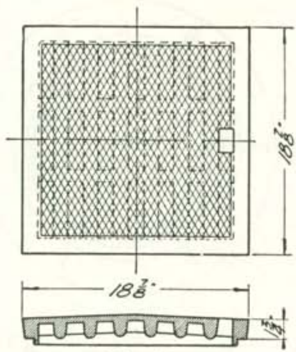


Fig. 32-G

These Covers fit Frames 27, 33-E and 54.
Covers also 1⅛" thick for Frame 33-H.

VENTILATED STREET COVER

SOLID STREET COVER

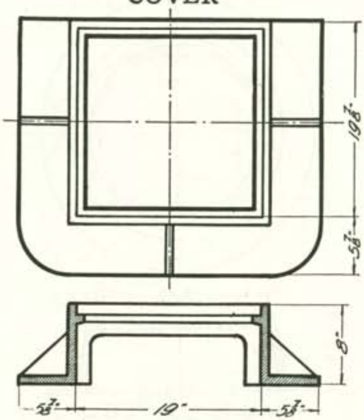


Fig. 33-H

CATCH BASIN FRAME

Also pattern 33-E, same as above except end is closed and cover is 1¾".

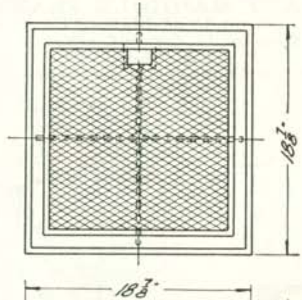


Fig. 34-I

This Cover fits Frame 33-H and 54.

SOLID CURB COVER

The letters indicate that these patterns are City of St. Paul Standards.

MANHOLE FRAMES, TRAP AND DRIP PAN

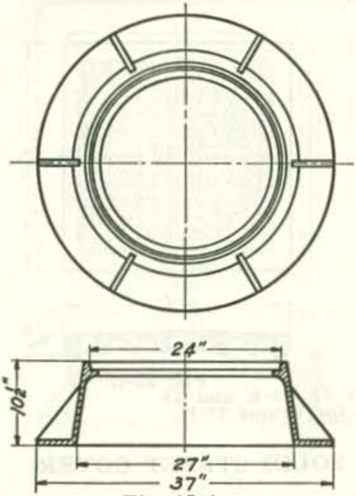


Fig. 35-A

HEAVY MANHOLE FRAME

24" also made 6" high—Fig. 35-6. Also made for 30" cover—Fig. 35-C. Made with watertight covers on order

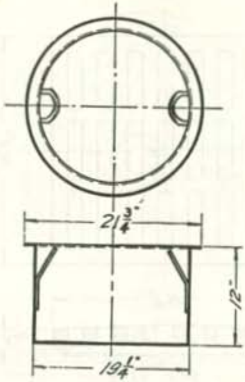


Fig. 36

DRIP PAN FOR LIGHT MANHOLE

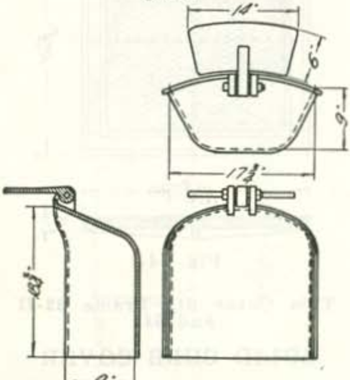


Fig. 37-KL

TRAP FOR CATCH BASIN

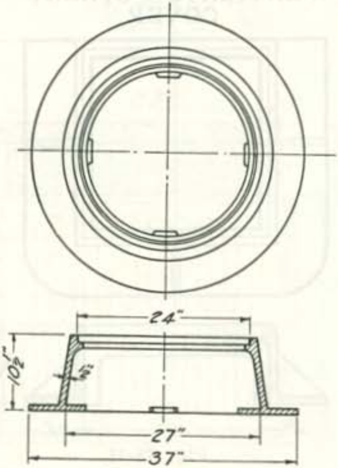


Fig. 38-AL
Fig. 38-AH

LIGHT MANHOLE FRAME

Also have heavier Manhole Frame with ribs and no lugs for drip pan.

MANHOLE COVERS

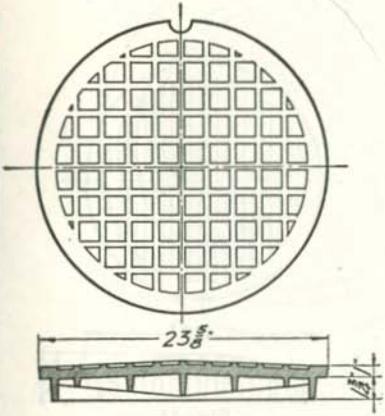


Fig. 39-B
Fig. 39R-B has Radial Ribs
SOLID COVER

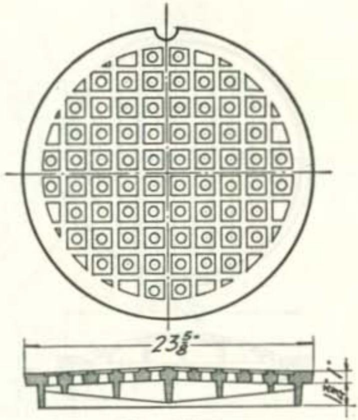


Fig. 40-C
Fig. 40R-C has Radial Ribs.
PERFORATED COVER

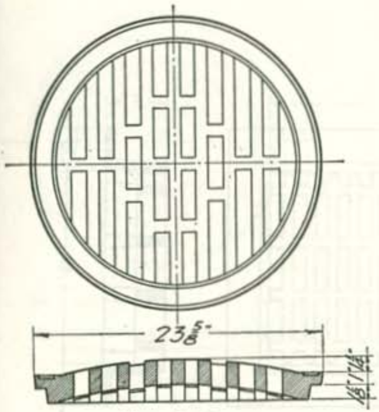


Fig. 41-D
CONVEX COVER

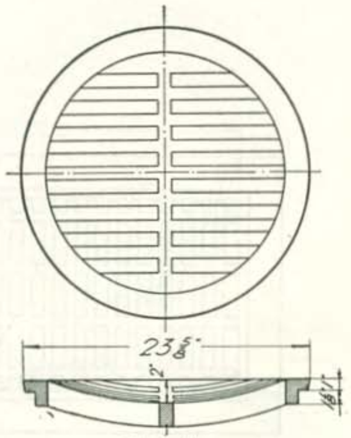


Fig. 42
CONCAVE COVER

All of the above Covers will fit Frames.
Figs. 23-24, 35-A and 38-A.

SEWER CASTINGS

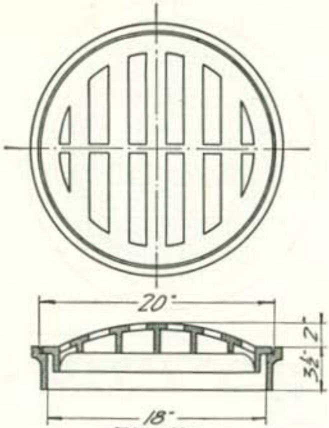


Fig. 43

RING AND COVER

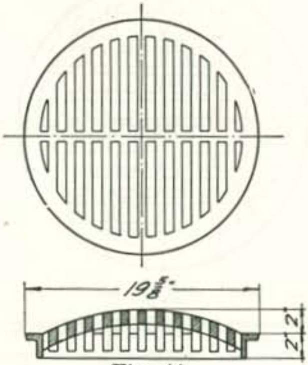


Fig. 44

Use ring Fig. 43.

COVER

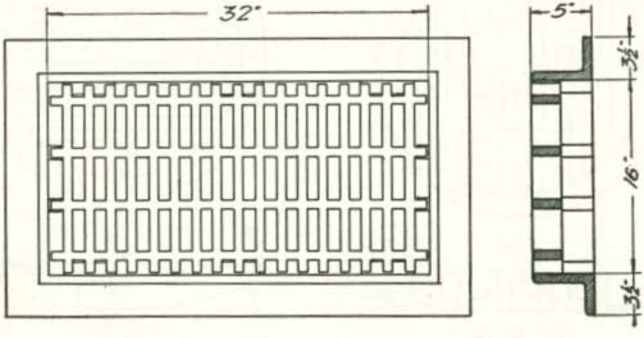


Fig. 45

FRAME AND GRATING

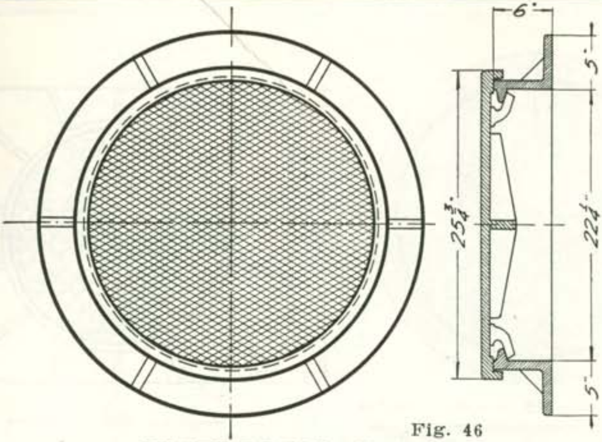


Fig. 46

CISTERN RING AND COVER

Cover Has Locking Device

If desired, this frame and cover can be machined for watertight fit.

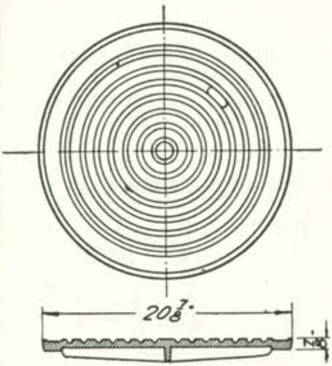


Fig. 47-J
Also 22⅞" MHD Cast
No. 718

COVER FOR CORNER STONE CATCH BASIN

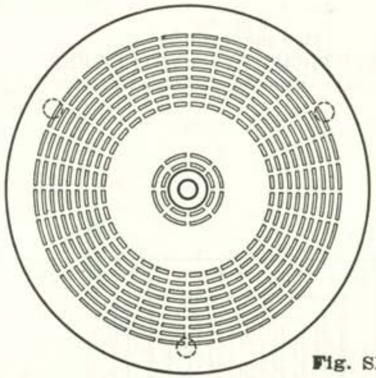
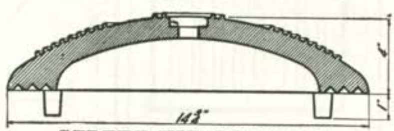


Fig. SB1



STREET INTERSECTION BUTTONS

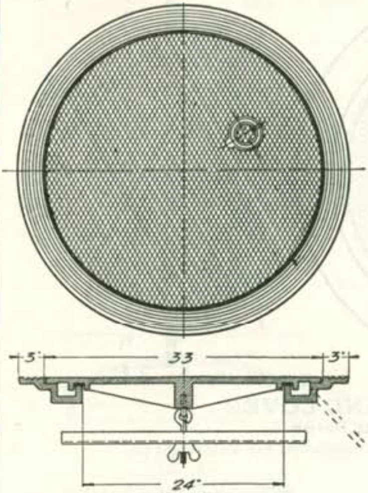


Fig. 50
Also made in 30".

WATERTIGHT RING AND COVER

Locking device under slab with drain pipe.

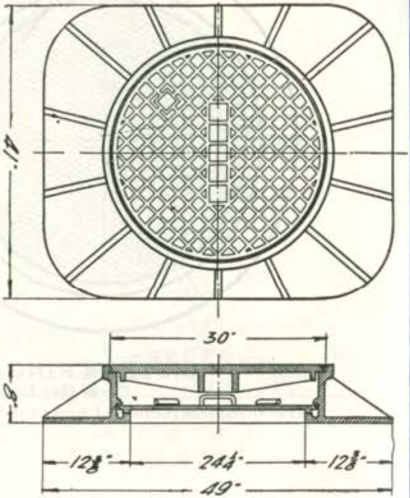
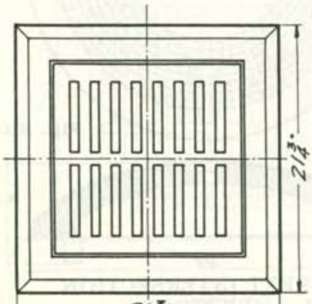


Fig. 49

MANHOLE FRAME AND COVER

Used for Electric Power and Telephone Street Openings



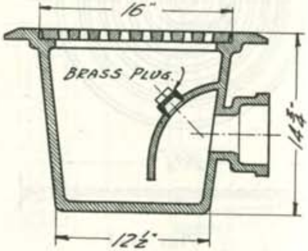
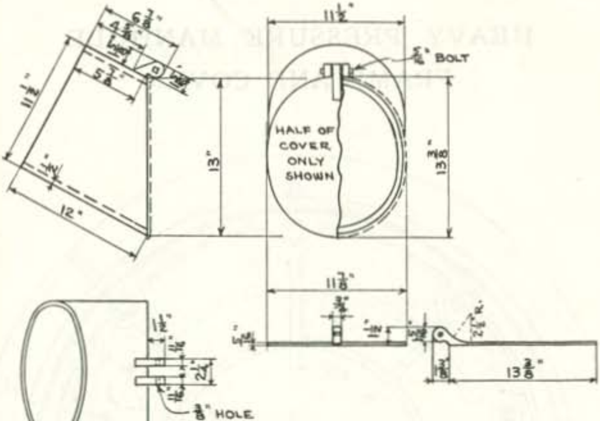


Fig. T1

SEWER TRAP

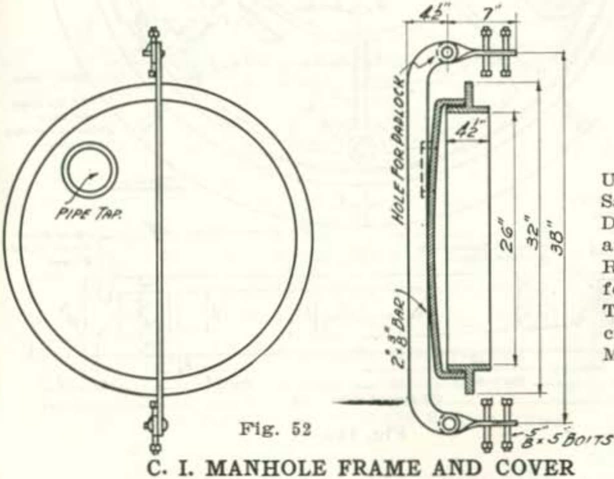
Standard for Railroad in Roundhouses
Outlet for 4" & 6" pipe



Casting "N" Fig. 48 Casting "O"

FLAP VALVE

Frame N
Cover O
St. Paul City Standard



Used by State Sanitary Department and by Railroads for Signal Tower Concrete Control Manholes.

Fig. 52

C. I. MANHOLE FRAME AND COVER

With Locking Bar.

HEAVY PRESSURE MANHOLE FRAME AND COVER

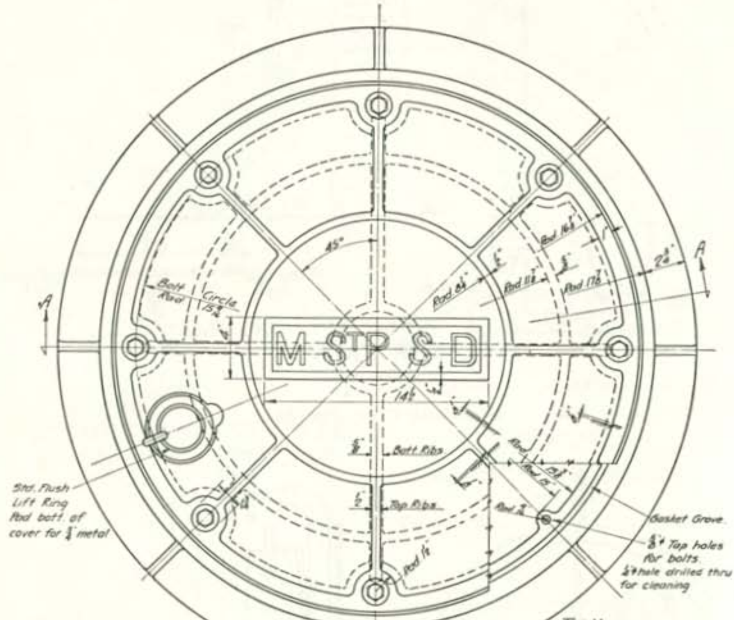


Fig. 186

Standard for Minneapolis-St. Paul Sanitary District

MANHOLE FRAME

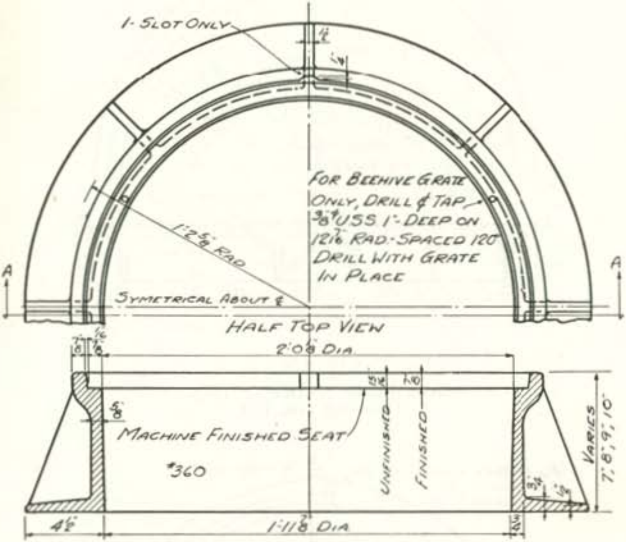


Fig. 187

Minnesota State Highway Department

7" high Casting MHD No. 707

8" high Casting MHD No. 708

9" high Casting MHD No. 709

10" high Casting MHD No. 710

Covers—Figs. 188 to 193 fit this frame

COVERS

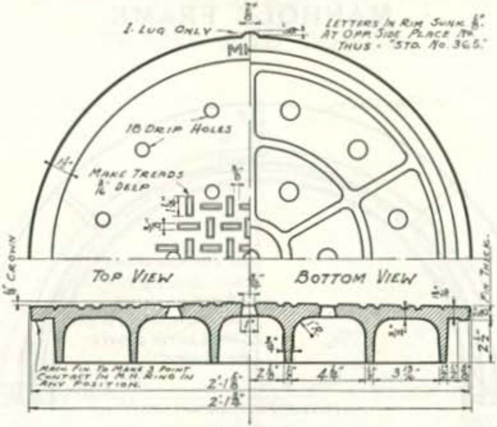


Fig. 188

Minn. State Highway Dept.
Casting No. 711

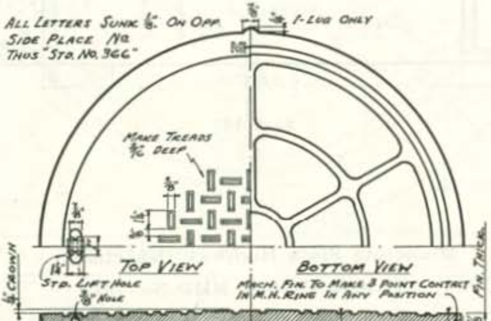


Fig. 189

Minn. State Highway Dept.
Casting No. 712

COVERS

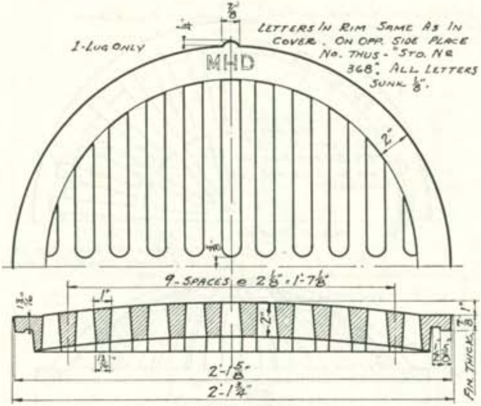


Fig. 190

Minn. State Highway Dept.
Casting No. 720

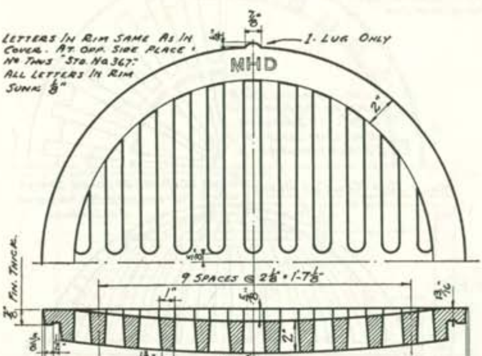


Fig. 191

Minn. State Highway Dept.
Casting No. 721

BEEHIVE COVERS

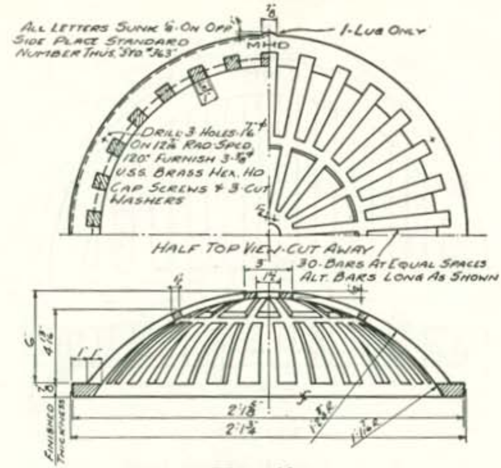


Fig. 192
Minn. State Highway Dept. No. 722

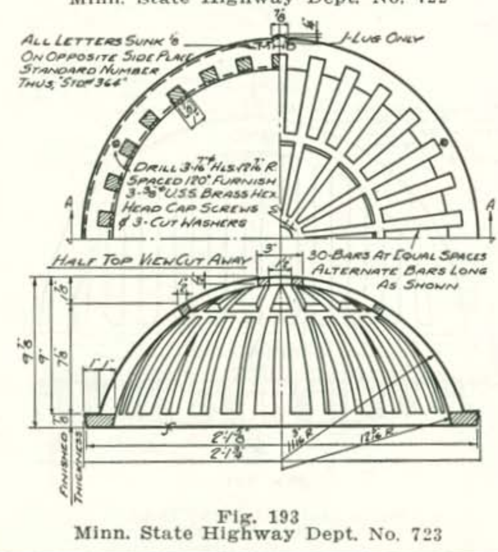


Fig. 193
Minn. State Highway Dept. No. 723

CURB CATCH BASIN FRAMES AND COVERS

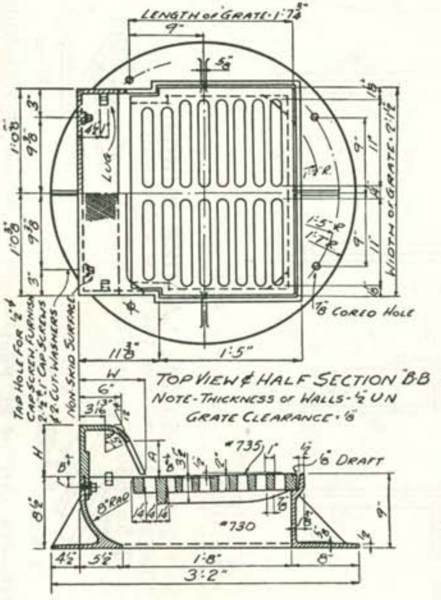


Fig. 194

Minn. Highway Dept. Casting No. 730

SCHEDULE FOR CURB CASTINGS

H	W	A	Casting No.
6¼″	7¾″	4½″	736
8¼″	8 7/16″	5¼″	738
9¼″	8¾″	5⅝″	739
10¼″	9⅛″	6″	740
*4¼″	7¾″	2″	745

*Top not checkered

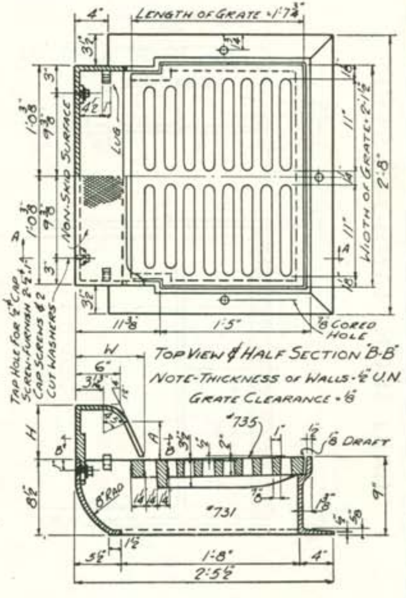


Fig. 195

Minn. Highway Dept. Casting No. 731

CAST IRON MANHOLE STEPS

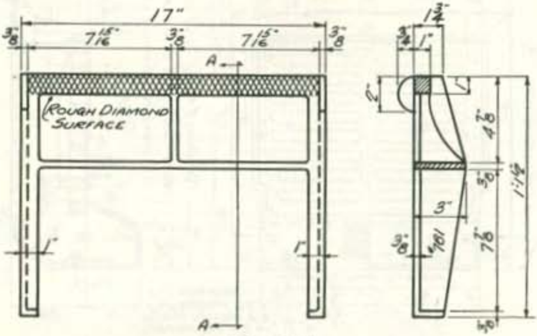
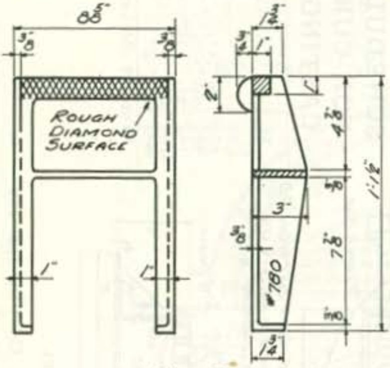


Fig. 197
Minn. State Highway Dept. No. 881



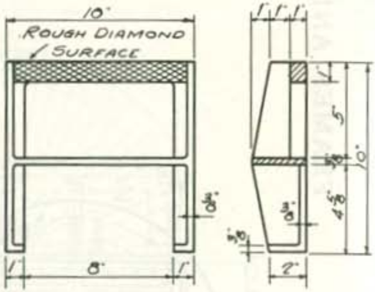


Fig. 196
Minn. State Highway Dept. No. 880.
City of St. Paul Sewer Dept.

Fig. 198

STEEL LADDER RUNGS

Can be plated or galvanized.

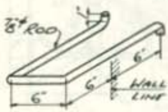


Fig. 199—Std. City of St. Paul

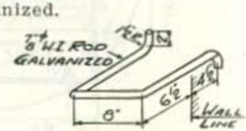


Fig. 199S—Std. Mpls.-St. Paul Sanitary District

VALVE, METER, CLEANOUT AND SEWER GRATES

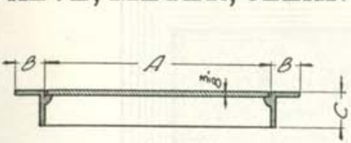


Fig. 53
Cast Iron Frame.
5/16" checkered steel plate covers.

CLEANOUT VALVE AND METER BOXES

Stock Patterns

A	B	C
In.	In.	In.
*6 ×6	⅞	1½
*7½×7½	2	2
*8 ×8	1½	2
*9½×10	2	2½
* 10×12	2	3
10×10	2	3
10×12	2	2
10×16	2½	3
10×20	2	2½
12×12	2½	3
12×16	2½	3
12×20	2	2
12×30	2½	3
14×34	....	....
16×16	2½	3
18×18	2½	2½
18×24	2½	2½
18×36	....	....
18×42	2½	3
20×20	2½	2½
20×24	2½	3
20×30	3	3
20×36	2½	2½
22×22	3	3½
24×24	3	3½
24×26	3	3½
24×30	2½	2½
24×36	2½	2½
24×48	2¾	2¾
26×30	2½	3
28×28	....	....
28×30	....	....
30×30	2½	3
30×36	2¾	2¾
30×42	2¾	2¾
30×48	2¾	2¾
36×36	2½	2½
36×42	2¾	2¾
36×48	2¾	2¾

*Cast Iron Covers.

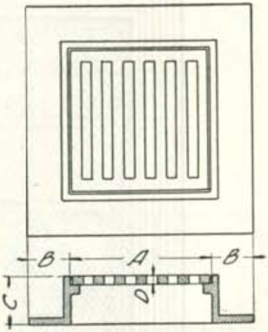


Fig. 54
SEWER GRATE AND FRAME

A	B	C	D
12	3½	4	⅝
19	3½	6	1⅛

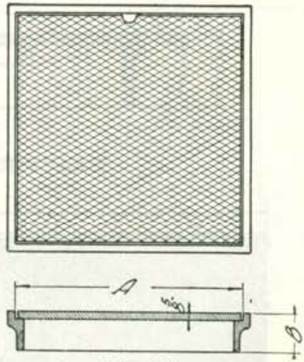


Fig. 55
HEAVY CLEANOUT VALVE AND METER BOXES
For Heavy Traffic and Trucking

A	B
13½×13½	3
16½×26½	4

Made on order. (Not carried in stock.) Prices quoted upon request.

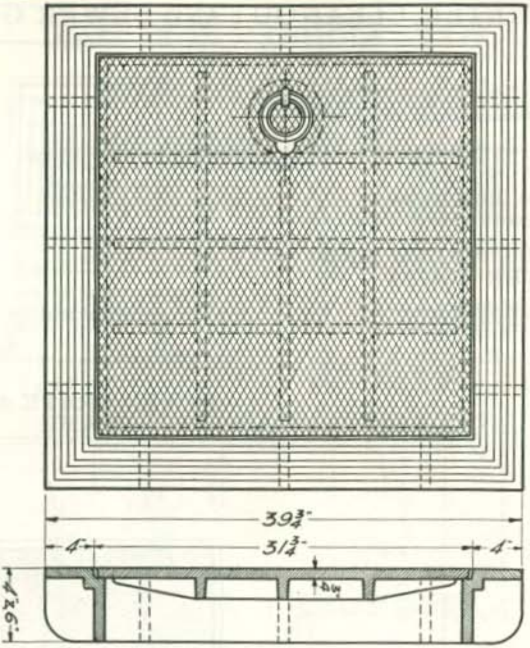


Fig. 56
HEAVY FRAME AND COVER

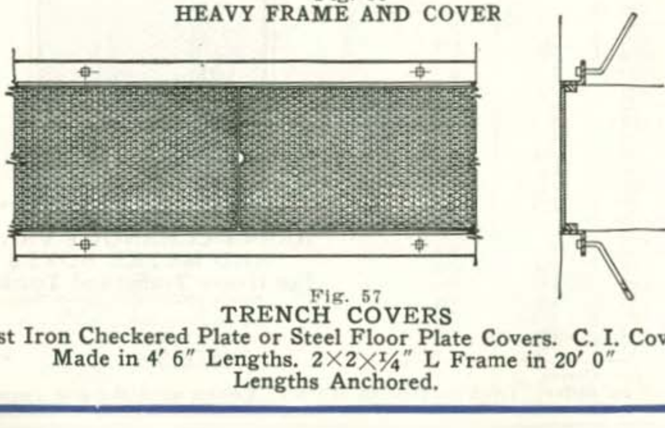
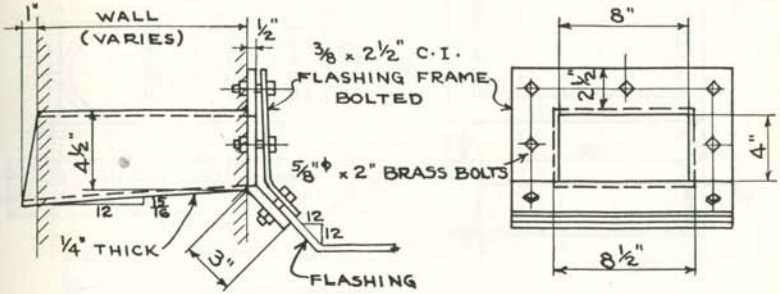


Fig. 57
TRENCH COVERS

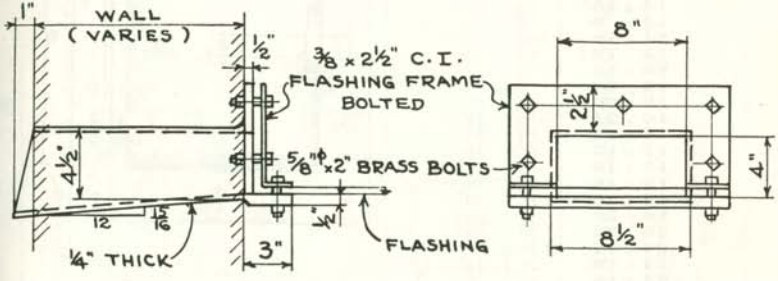
Cast Iron Checkered Plate or Steel Floor Plate Covers. C. I. Covers Made in 4′ 6″ Lengths. $2\times2\times\frac{1}{4}$″ L Frame in 20′ 0″ Lengths Anchored.

CAST IRON SCUPPERS

For Level and Sloping Roofs



STYLE A FOR INSIDE DOWNSPOUTS



STYLE B FOR OUTSIDE DOWNSPOUTS

CLEAN-OUT DOORS.

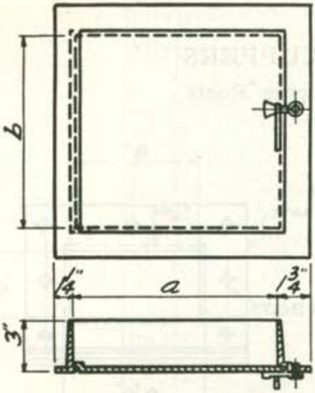


Fig. 58

Nominal Size	A	B
8 x 8	8	8
8 x 12	8	12
10 x 8	10	8
10 x 10	10	10
12 x 10	12	10

No hinges on the smaller sizes because they would rust and break out with the door—thus ruin frame.

STOCK PATTERNS

Nominal Sizes	a	b
12 x 12	12	12
12 x 14	12	14
12 x 15	12	15
12 x 16	12	16
12 x 18	12	18
12 x 20	12	20
13 x 15	13	15
14 x 9	14	9
14 x 18	14	18
15 x 19	15	19
16 x 16	16	16
16 x 18	16	18
16 x 20	16	20
16 x 24	16	24
16 x 25	16	25
17 x 17	17	17
18 x 10	18	10
18 x 18	18	18
18 x 20	18	20
18 x 30	18	30
20 x 24	20	24
24 x 12	24	12
24 x 16	24	16
24 x 18	24	18
24 x 24	24	24
24 x 28	24	28
24 x 30	24	30
24 x 36	24	36
26 x 16	26	16
28 x 28	28	28
30 x 30	30	30
30 x 36	30	36

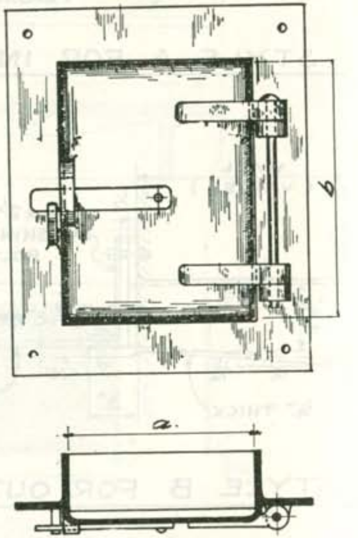


Fig. 59

Sizes given can be reversed.
Made on order. (Not carried in stock.) Prices quoted upon request.

CAST IRON SMOKE STACKS

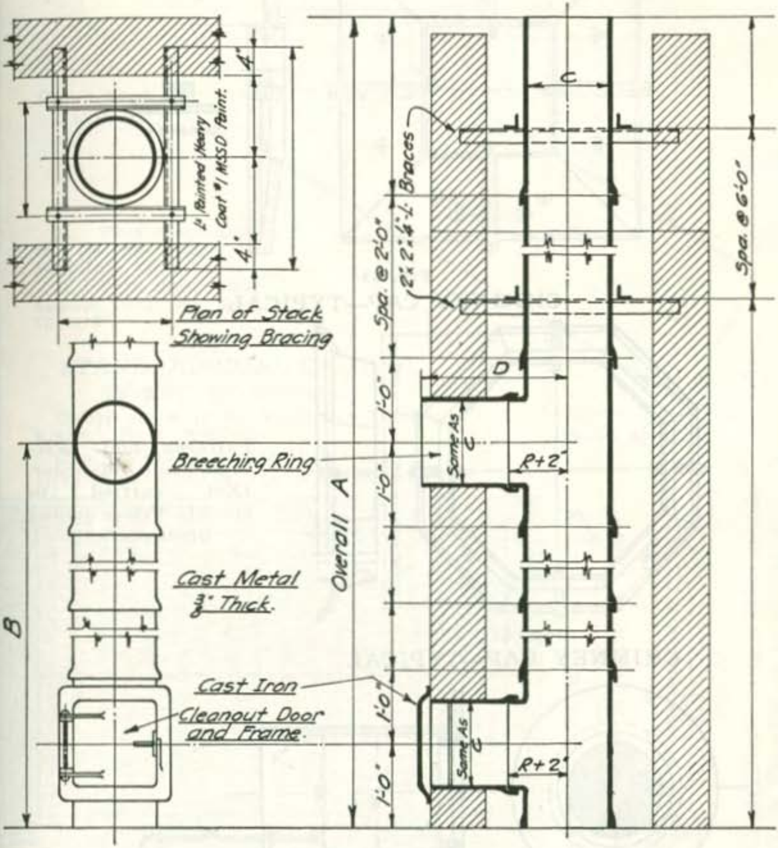


Fig. 60

Made in all sizes.
Stock pattern sizes: 10" 12" and 15" inside diameter.
Standard for Minnesota State Schools.
When ordering give dimensions A-B-C-D.

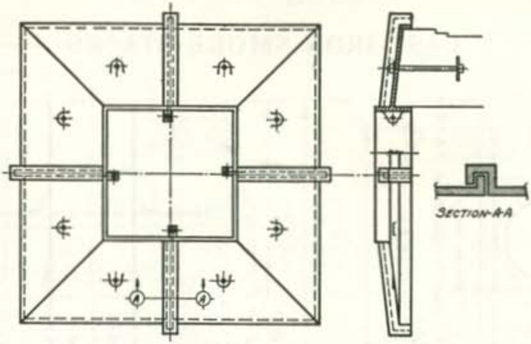
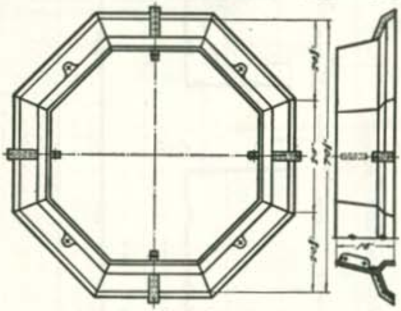


Fig. 64

CHIMNEY CAP—TYPICAL



Patterns and castings made on order. (Not carried in stock). Prices quoted upon request.

Fig. 65

CHIMNEY CAP—TYPICAL

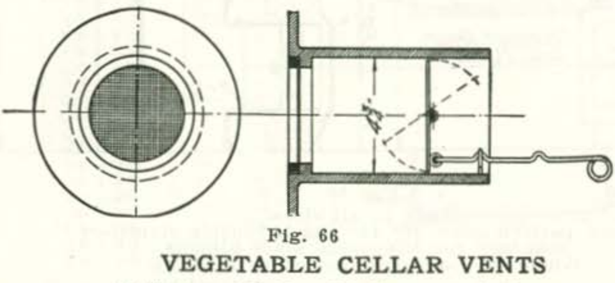
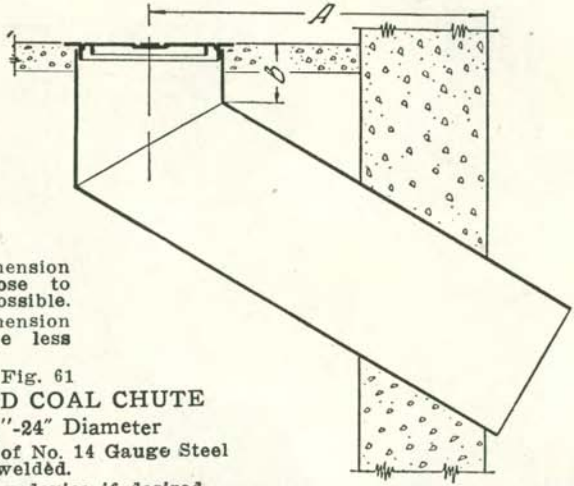


Fig. 66

VEGETABLE CELLAR VENTS

Built Into Walls, with Screen and Damper.

COAL CHUTES AND SIDEWALK DOORS



Cover used is Fig. 21

A. This dimension to be as close to building as possible.
B. This dimension should not be less than 9".

Fig. 61

STANDARD COAL CHUTE

18"-20½"-24" Diameter

Chute made of No. 14 Gauge Steel plate. Butt welded.

Chain locking device if desired.

Give dimensions A and B when ordering.

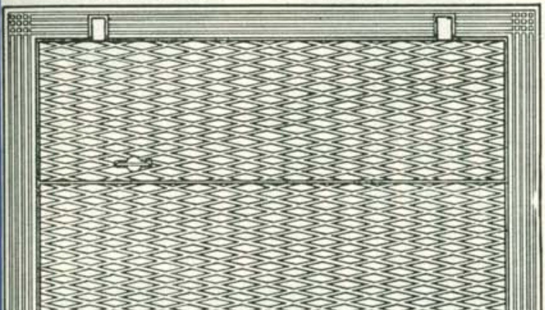
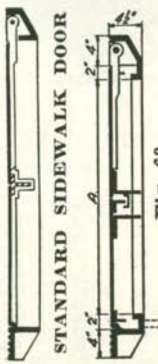


Fig. 62

STANDARD SIDEWALK DOOR

Made either with single or double doors in suitable sizes. Frame cast iron with $\frac{5}{16}$" steel floor plate doors. See page 97. Doors have locking device on underside.



STANDARD SIDEWALK DOOR

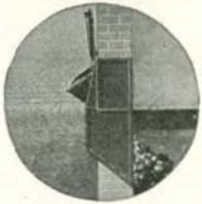
Fig. 63

WATERTIGHT SIDEWALK DOOR
Stock Patterns up to 6'-0"x8'-0".

Special coal chutes and sidewalk doors of any kind or size made to order.

MAJESTIC FOUNDATION COAL-CHUTE

M10A-M20A

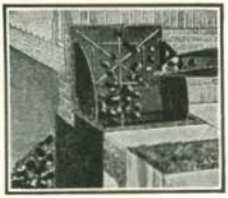


M12 and M15

Majestic Store Chute

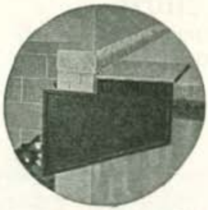
No.	Wght.	Door Opening	Wall Opening Above Grade	Wall Opening Below Grade
M12B	110	21"x15"	23"x16¾"	23"x25"
M15B	155	29"x19¼"	31"x21½"	31"x24½"
M12D	98	21"x15"	23"x16¾"	23"x25"
M15D	135	29"x19¼"	31"x21½"	31"x24½"

(Style B is with Hopper—Style D is without Hopper.)



M14-M16-M18

M10A-M20A



Majestic Grade-Line Chute

No.	Wght.	Door Opening	Wall Opening
*M14	85	20½"x14½"	23"x23"
M16	135	23¼"x18¼"	25"x25"
M18	214	29" x24"	31"x31"

*For Residences only.

M101B-M203B

No.	Style	Weight	Description	Size of Wall Opening		
M 10	A	62	Complete with Glass Door	23 in. wide	18 in. high	12 in. deep
M 10	C	51	Without Hopper	Do	Do	Do
M101	B	54	Complete with Steel Door	Do	Do	Do
M101	D	43	Without Hopper	Do	Do	Do
* 551		32	With Steel Door	Do	17 in. high	Do
M 20	A	117	Complete with Glass Door	32 in. Wide	23 in. high	17 in. deep
M 20	C	99	Without Hopper	Do	Do	Do
M203	B	105	Complete with Steel Door	Do	Do	Do
M203	D	87	Without Hopper	Do	Do	Do
M600		45	With Glass Door	23 in. wide	17 in. high	8 in. deep
M500		37	With Steel Door	Do	Do	Do
* 550		28	With Steel Door	Do	Do	Do
M620		82	With Glass Door	32 in. wide	22 in. high	12 in deep
M520		72	With Steel Door	Do	Do	Do

Nos. M600, M620, M500, M520, 550 and 551 are without Hopper and Chain, and bottom of body is straight. Nos. M12D and M15D are without Hopper

All chutes equipped with automatic gravity latches. *For Residences Only.

For Additional Information Send for Catalog—Address—See Index.

GREAT NORTHERN RAILWAY STATION STOVE

Dimensions of 20″ Fire Pot Stove

Total height 6′-3″.

Base 2′-1″ square.

Height to drum 3′-11″.

Diameter of drum 1′-8½″.

Height of drum 2′-4″.

Fire Pot 1′-6½″x12″ deep.

CABOOSE STOVE

Type A—Without Oven
Type B—With Oven

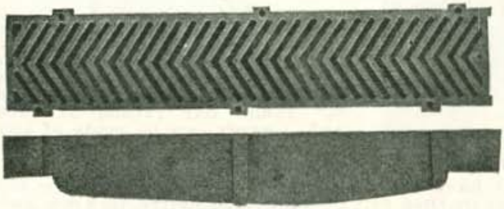
General Dimensions

Height 2′-8″.
Base 1′-7½″x1′-11½″.
Fire Pot 1′-3″ by 8″ deep.

STATION STOVE

Furnished also without drum.

Made in four sizes with 14″, 18″, 20″ and 22″ diameter of fire pot.



TUPPER GRATE BARS

We Have a Great Variety of Patterns for Grates of Different Size and Type

We have patterns for Tupper Grates, sizes 16″ to 5′-6″.

STEEL AND CAST IRON JAMB GUARDS

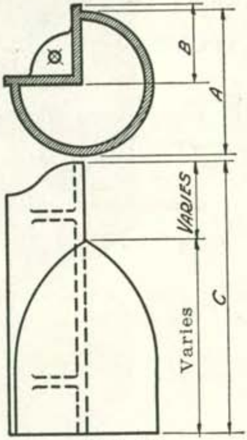


Fig. 68
When ordering give dimensions A, B and C

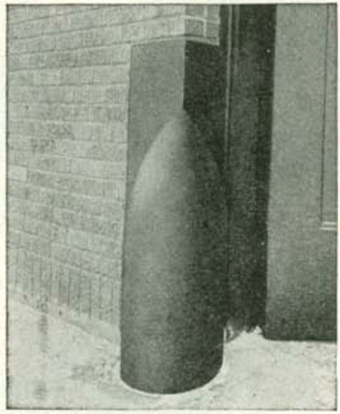


Fig. 69
Diam. 8"-9"-10"-12"-14"-16"-18"
24" dia. Fixed Height 18"

Fig. 70, 8" diam.

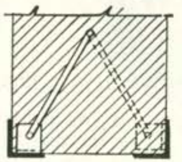


Fig. 71

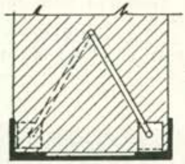


Fig. 72

Anchored in place by means of clips riveted to main members (rivet heads flush outside) and ½" round bar turned at each end. Guards can be made of any section or height to suit conditions.

Cast Iron Guards have lugs on back to which hook bars are fastened for anchorage or they can be expansion bolted to brick and concrete walls.

Special designs upon request.

THRESHOLDS, DOOR AND ELEVATOR SILLS

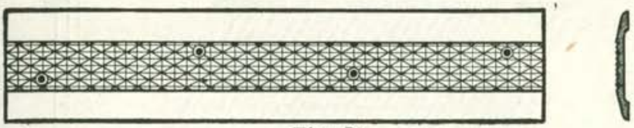


Fig. 73
CHECKERED CAST IRON THRESHOLD

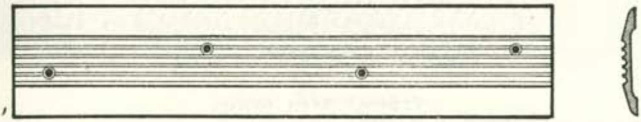


Fig. 74
RIBBED BRASS OR CAST IRON THRESHOLD

Note: In ordering, state width of opening and thickness of door. Steel thresholds with plain tops can be furnished; also thresholds of checkered steel plate.

Unless otherwise specified, plain top cast iron thresholds will be furnished.

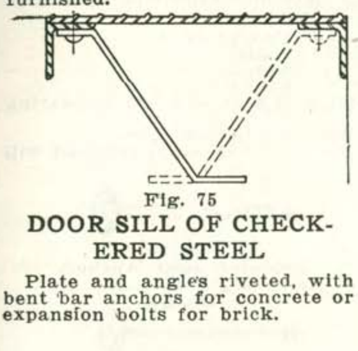


Fig. 75
DOOR SILL OF CHECKERED STEEL

Plate and angles riveted, with bent bar anchors for concrete or expansion bolts for brick.

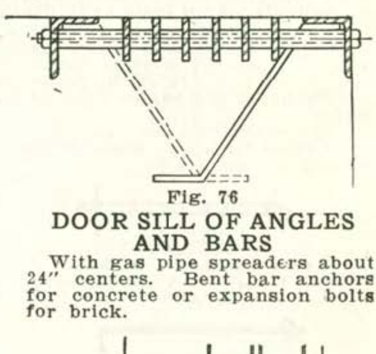


Fig. 76
DOOR SILL OF ANGLES AND BARS

With gas pipe spreaders about 24" centers. Bent bar anchors for concrete or expansion bolts for brick.

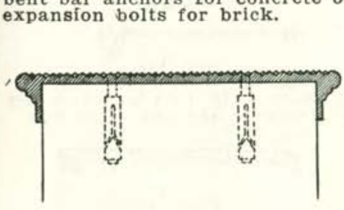


Fig. 77
CAST IRON DOOR SILL

Anchored with expansion bolts

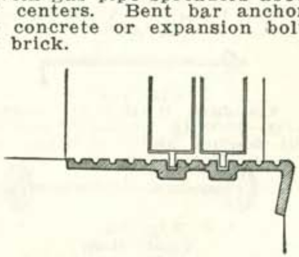
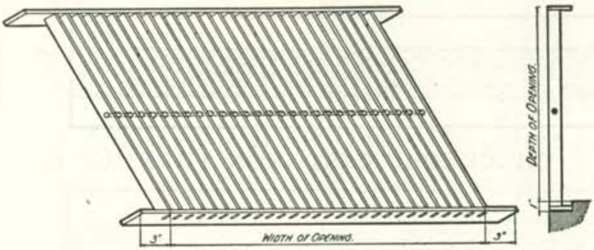


Fig. 78
CAST IRON ELEVATOR DOOR SILL

AREA GRATES AND ANCHORS.



Typical Area Grate.

Cross bars 1x$\frac{3}{16}$, bars $\frac{15}{16}$″ on centers. Where grates exceed 2′-0″ in width, cross bars to be stiffened sideways with a $\frac{3}{8}$″ rod and cast thimbles as shown in sketch. The distance between stiffening rods not to exceed 1′-6″.

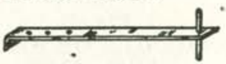
Frames to be of 2x$\frac{3}{8}$″ bar for grates 3′-0″ long or less. Of 2$\frac{1}{2}$″x $\frac{3}{8}$″ bar for grates 3′-0″ to 4′-0″ long. Grates of longer length to be supported by angle iron brackets placed at intervals if possible, otherwise frame to be made of 2x$\frac{3}{8}$″ bars and supported by angles or channels placed loose underneath as follows:

Span	4′-0″ to 6′-0″	use	3$\frac{1}{2}$x2$\frac{1}{2}$x$\frac{1}{4}$″	angle.
"	6′-0″ to 8′-0″	"	3″	channel.
"	8′-0″ to 10′-0″	"	4″	channel.
"	10′-0″ to 12′-0″	"	5″	channel.

Channels and angles have 6″ bearing at each end and no bearing plates.

These instructions apply to grates for sidewalks only.

Grates for alleys where heavy loads are likely to be imposed will require special design.



No. 144
Standard Joist Anchor.
Bar 1″x$\frac{1}{4}$″—2′-6″ and pin $\frac{1}{2}$″x4″.

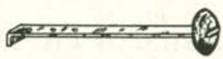


Fig. 147
Special Joist Anchor.
Bar 1″x$\frac{1}{4}$″—2′-6″ and cast Washer.

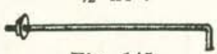


Fig. 145
Standard Wall Plate Bolt.
$\frac{5}{8}$″Ø—2′-6″ lg. turned 3″ one end. Cut washer and nut other end.

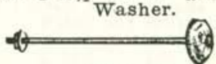


Fig. 148
Special Wall Plate Bolt.
$\frac{5}{8}$″Ø—2′-6″ lg. cast washer 1 end Cut washer and nut other end.

Fig. 146
Vault Rod.
Round rod (dia. variable) and cast washers.

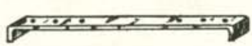


Fig. 149
Strap Anchor.
Bar 1″x$\frac{1}{4}$″—2′-6″

Note:—We make special anchors of any size and kind.

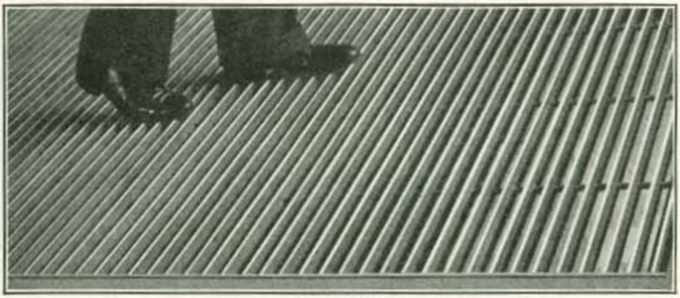


Fig. 143

Special Floor Grating

Minneapolis-St. Paul Sanitary District

In this grating the bars are mortised and riveted into the bearing bars. The rods are driven through holes in the bars punched same size as the rods. All grating is hot dipped galvanized which freezes the rods in place and maintains the spacing of the bars. Rods may or may not be welded.

All bars 1¼″ deep up to 5′-0″ span.

STIRRUPS

Fig. 95
SINGLE STIRRUP

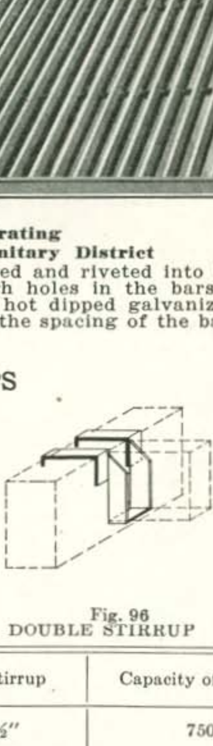


Fig. 96
DOUBLE STIRRUP

Size of Joist or Timber to be Supported	Section of Stirrup	Capacity of Stirrup
2″ x 8″— 3″ x 10″ 2″ x 10″— 2″ x 12″	¼″ x 2½″	7500
4″ x 10″— 6″ x 10″ 3″ x 12″— 2″ x 14″	⅜″ x 2½″	11250
8″ x 10″— 4″ x 12″ 6″ x 12″— 3″ x 14″	⅜″ x 3″	13500
9″ x 10″—10″ x 10″ 8″ x 12″— 6″ x 14″	½″ x 3½″	21000
9″ x 12″—10″ x 12″ 6″ x 16″	½″ x 4″	24000
8″ x 14″—10″ x 14″ 8″ x 16″— 9″ x 16″	⅝″ x 4″	30000

Unless otherwise ordered stirrups will be made ¼″ smaller than nominal size of timber joist. The sizes of stirrups are proportioned to capacities of timbers.

FLAG POLES

FLAG POLES are fabricated from lengths of various sizes of wrought iron pipe as shown in tables below; near top of pole a revolving swivel with pulley is provided as shown in cuts. The top of pole is surmounted with a spun copper or zinc gilded ball of proper size.

A ¼" "Samson Spot" sash cord or $\frac{3}{16}$" wire cable twice the height of pole will be furnished if specified.

Poles under 50′ 0″ in length have shrunk joints, poles over 50′ 0″ in length are made with sections of pipe let into each other at least 3′ 0″ and riveted.

Poles are painted 2 shop coats of red lead and oil and another coat of color to suit in field. All joints are made water-tight.

Footings for flag poles to be made of 1-3-5 mix concrete; depth of poles in ground 1/10 height of pole. ½" rd. × 12" anchor pins about 12" centers are built into footings.

Poles on top of buildings to be securely anchored to roof and walls.

Tops for wood poles are made with a ¾" rd. or 1" rd. rod let into end of pole at least 1′ 0″.

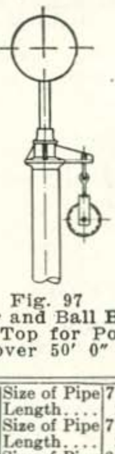


Fig. 97
Roller and Ball Bearing Top for Poles over 50′ 0″

Fig. 98
Swivel and Pulley Top for Wood Poles

90	Size of Pipe	7" EH	6" EH	5"	4½"	4"	3½"
	Length....	21	18	18	18	13	11
80	Size of Pipe	7" EH	6" EH	5"	4½"	4"	3½"
	Length....	21	18	18	12	10	9
70	Size of Pipe	6" EH	5"	4½"	4"	3½"	......
	Length....	21	18	18	11	9	......
60	Size of Pipe	6"	5"	4½"	4"	3½"	3"
	Length....	15	13	11	10	9	8
50	Size of Pipe	5"	4½"	4"	3½"	3"	......
	Length....	15	12	10	10	8	......
40	Size of Pipe	4½"	4"	3½"	3"	......	......
	Length....	16	11	10	8	......	......
30	Size of Pipe	3½"	3"	2½"	......	......	......
	Length....	13	12	9	......	......	......
20	Size of Pipe	3"	2½"	......	......	......	......
	Length....	14	9	......	......	......	......

Lengths are in feet. EH=Extra Heavy Pipe.

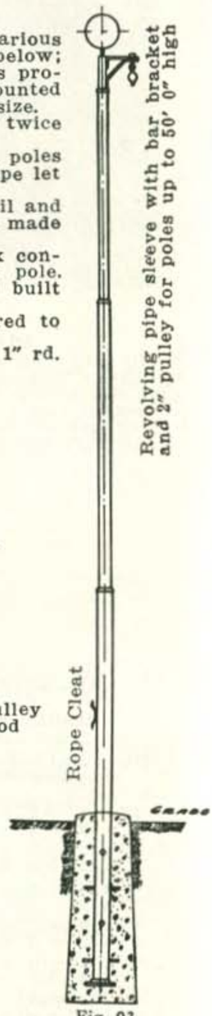


Fig. 93

CAST IRON FLAG POLE BASES

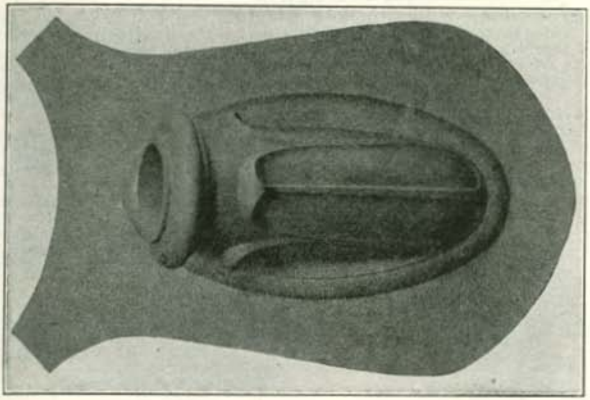


Fig. 101
FLAG POLE SOCKET
Vocational School, St. Paul
(Pole inclined)

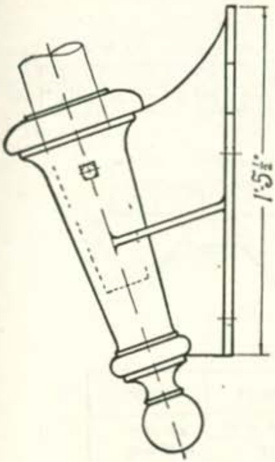


Fig. 100

CAST IRON FLAG POLE SOCKET
Anchored to Face of Wall
For 3" & 3½" Wood Pole

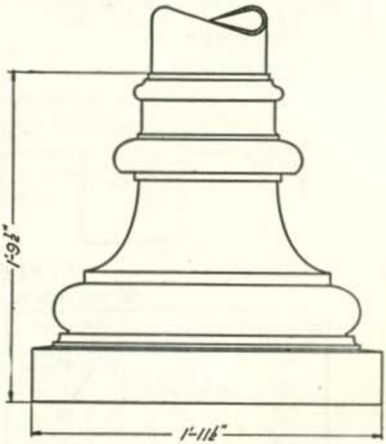


Fig. 102

CAST IRON FLAG POLE BASE
For 7" Pipe Pole

We have patterns for other sizes and designs.

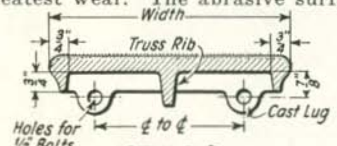
AMERICAN ABRASIVE METALS CO.

General Description

Feralun, Bronzalun, Alumalun and Nicalun are the trade names given by the American Abrasive Metals Co. to its anti-slip abrasive castings, each trade name indicating respectively the metal used as a matrix. Grains of the hardest known electric furnace abrasive product are uniformly and **deeply** impregnated in the face of the castings, so that they become an integral part of the castings and not simply a surface covering.

Durable—Stairs, entrances, platforms or other walkway surfaces equipped with Feralun, Bronzalun, Alumalun or Nicalun will outlast the normal life of the building with no expense for repairs or maintenance.

Safe—The abrasive surface is carried over the nosing edge affording anti-slip protection and wear resistant qualities at the point of greatest wear. The abrasive surface is equally effective wet or dry.



STYLE R

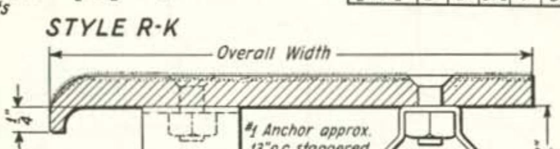
STYLE R-K

Recommended practice
STYLES R, R-K

Thickness
Not over 42" long... 7/16"
" " 57" " ... 1/2"
For extra heavy loads submit inquiry.

Hole Spacing R & R-K

Width	5"	6"	7"	8"	9"	10"
¢ to ¢	2"	3"	3½"	4"	5"	6"



STYLE A

Recommended practice

Thickness	Feralun	Bronzalun Nicalun	Alumalun	Length
1/4"	—	Up to 6" wide	Up to 8" wide	Not over 6'-0" long
5/16"	Up to 6" wide	" " 9" "	" " 12" "	
3/8"	" " 12" "	" " 15" "	" " 18" "	Not over 9'-0" long
7/16"	" " 18" "	" " 21" "	" " 24" "	
1/2"	" " 24" "	" " 30" "	" " 36" "	Not over 6'-0" long
Over 9'-0" made in sections				

Send your inquiries to St. Paul Foundry & Mfg. Co.
For Additional Information Send for Catalog—Address—See Index.

MASON SAFETY TREAD.

Fig. 110
Cross Section

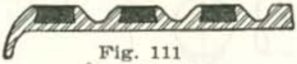


Fig. 111
Cross Section

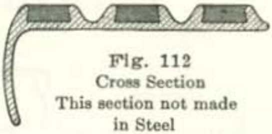


Fig. 112
Cross Section
This section not made in Steel

Steel Treads with Nosing
Widths 3″ and 3½″
Steel Treads without Nosing
Widths 2½″, 4,″ 4¾″ and 6″

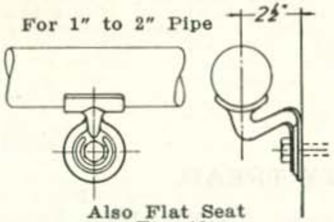
Brass Treads with Nosing
Widths, 2⅛″ and 3½″
Brass Treads without Nosing
Widths, 2¼,″ 3″, 4″ and 6″

These treads are composed of rolled unperforated steel or hard brass (Delta Metal) in one uniform thickness (¼ inch), with alternate U-shaped and dovetailed grooves, filled with the non-slippery, soft metal lead or with carborundum grains. They are clean, neat in appearance and noiseless in use.

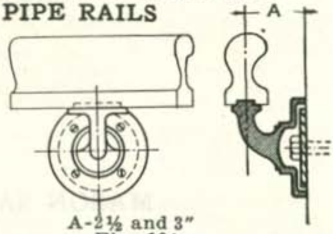
These treads can be furnished in lengths up to 14′-0″.

CAST IRON HAND RAIL AND COAT BRACKETS
FOR WOOD OR PIPE RAILS

For 1" to 2" Pipe



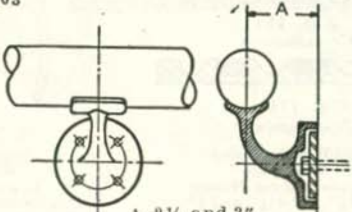
Also Flat Seat
Fig. 103



A-2½ and 3"
Fig. 104

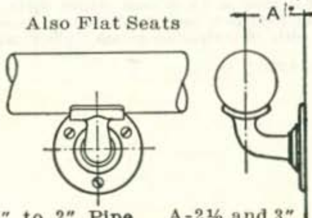
1¼" to 2" Pipe
Also 2½" for 1¼" and 1½" Pipe

Also Flat Seats
1¼ to 2" pipes



A-2½ and 3"
Fig. 105

Also Flat Seats



1" to 2" Pipe A-2½ and 3"
Fig. 106

A-2½ and 3"

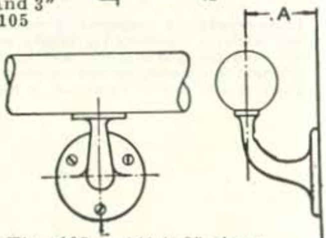


Fig. 107 1¼ to2" pipes

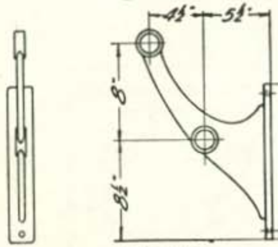
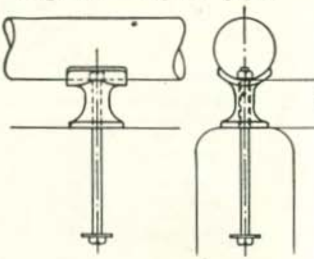


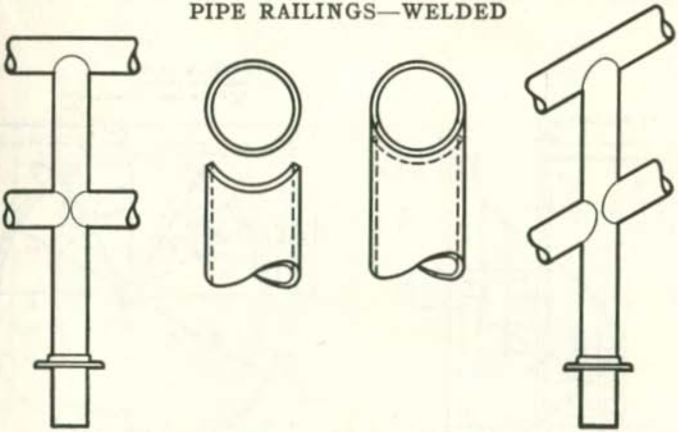
Fig. 108
Coat Rail Brackets
For supporting 2—1½" rd. Wood Rails for Coat Hooks



B-1¾ and 2"

1¼"-1½" and 2" Pipe
Fig. 109
Brackets for Stair Curb
⅜"x8" Bolts Built into Curb

PIPE RAILINGS—WELDED

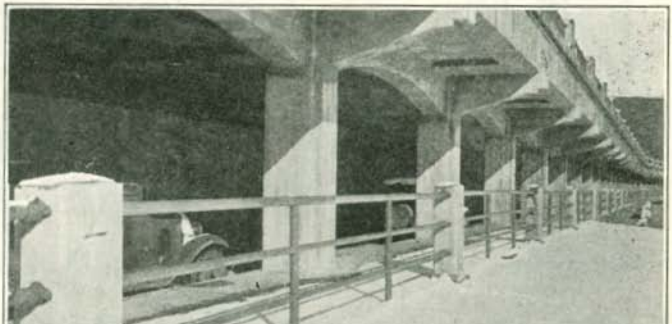


We highly recommend welded pipe railing for its smoothness, good appearance, and strength.

The above details show how our special machines properly cut the pipe to secure the best welded straight, circular, or inclined railing.

We also make plain or ball fitted railing.

Posts for railing should be built into concrete wherever possible by setting inserts (or cans) into the concrete about 6" deep.



RAILING—WELDED

All railing is welded unless fittings are specified.

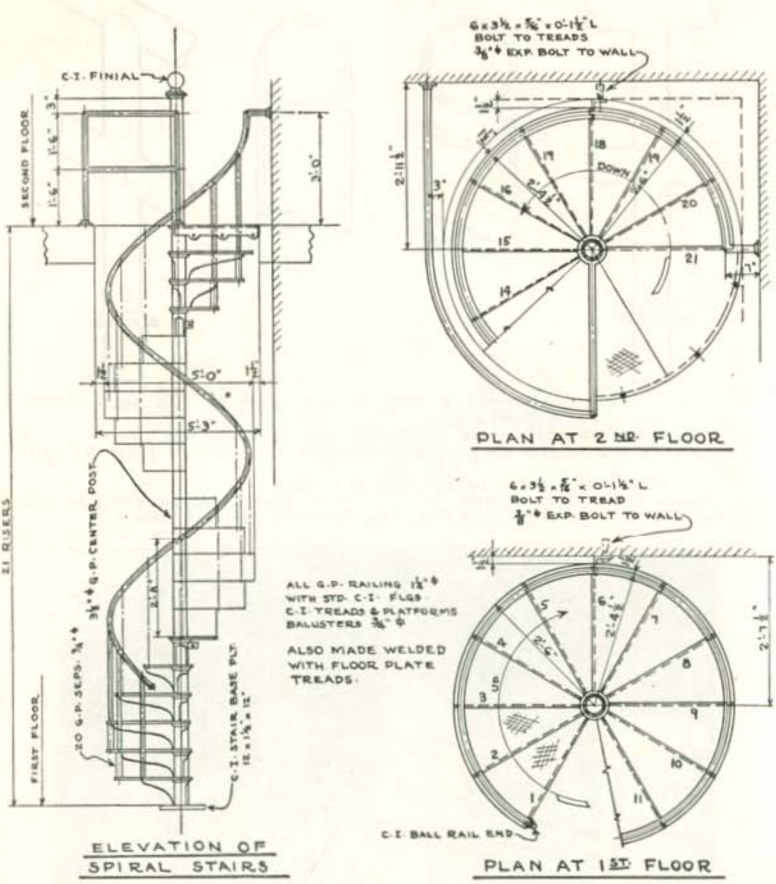


Fig. 136

TYPICAL DETAIL OF CIRCULAR STAIR

Well adapted to pumping stations, power plants, vaults and schools

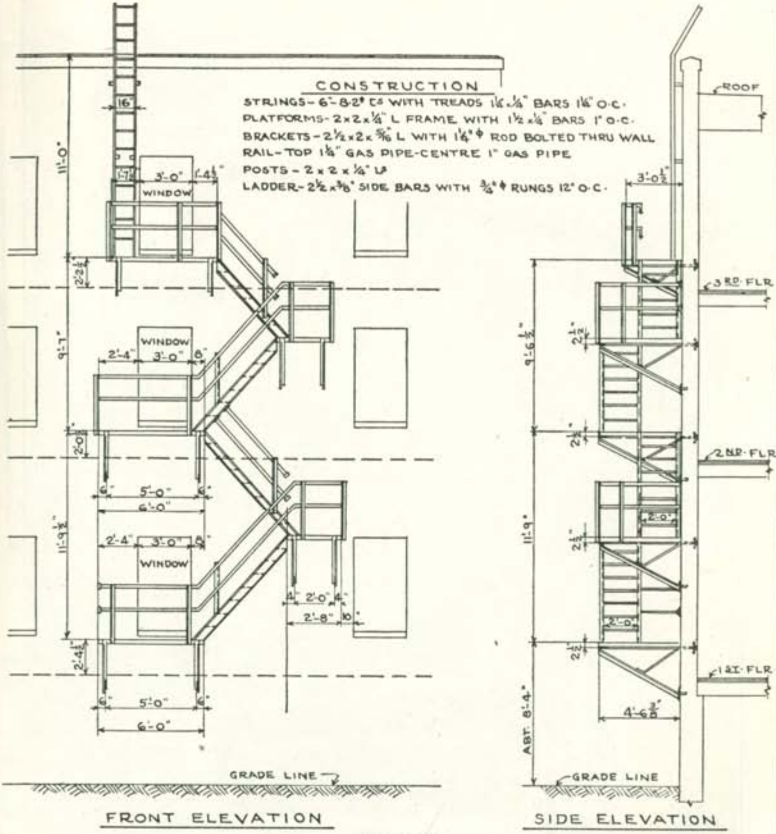
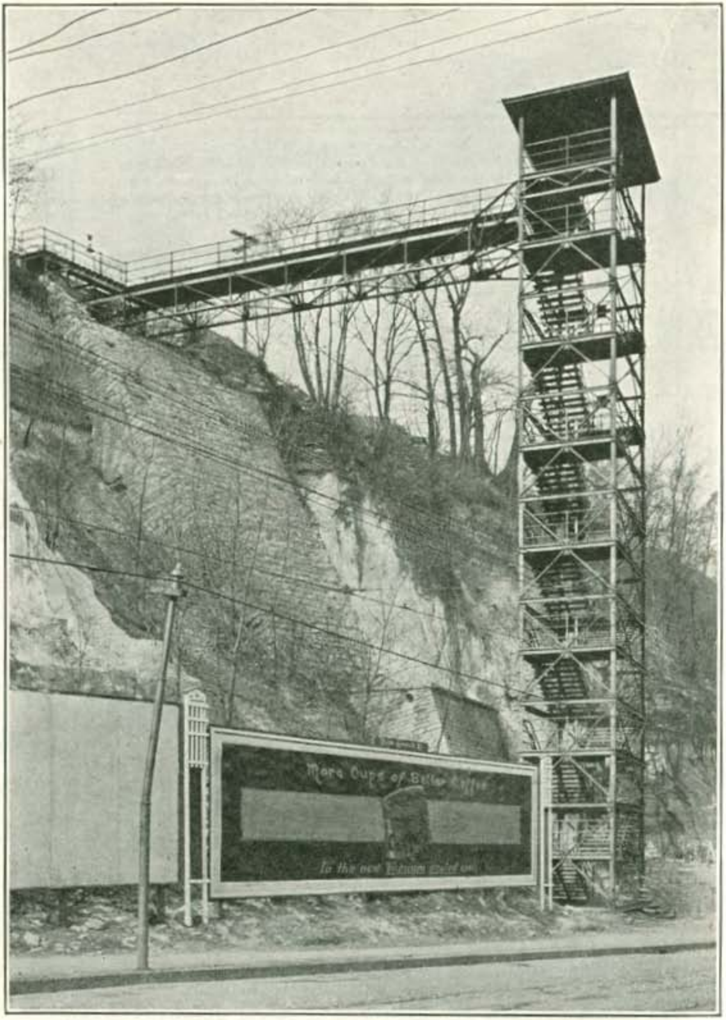


Fig. 137

TYPICAL DETAIL OF FIRE ESCAPE

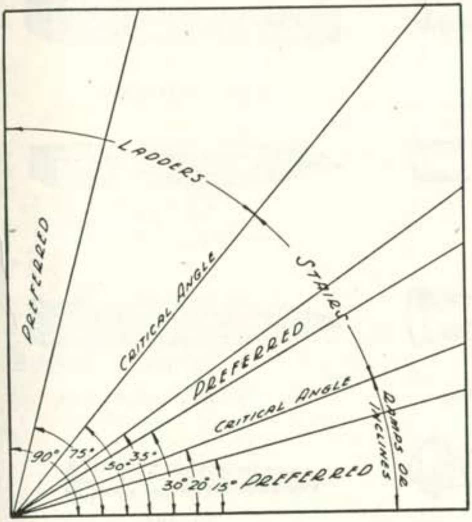
Our Fire Escapes conform to the specifications and laws of the State in which the building is located.

The construction is standard and of latest approved detail.



STAIR TOWER AND BRIDGE, CITY OF ST. PAUL
Fabricated and Erected by The St. Paul Foundry & Mfg. Company

STAIRS, LADDERS, RAMPS AND INCLINES



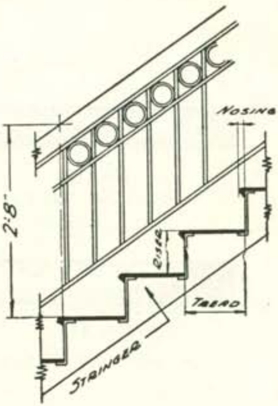


TABLE OF RISERS AND TREADS FOR STAIRS

Tread + Riser = 17½"

Angle With Horizontal	Riser in Inches	Tread in Inches	
22°-00′	5″	12½″	
23°-14′	5¼″	12¼″	
24°-38′	5½″	12″	
26°-00′	5¾″	11¾″	
27°-33′	6″	11½″	
29°-03′	6¼″	11¼″	
30°-35′	6½″	11″	Preferred.
32°-08′	6¾″	10¾″	Preferred.
33°-41′	7″	10½″	Preferred.
35°-16′	7¼″	10¼″	Preferred.

Angle With Horizontal	Riser in Inches	Tread in Inches
36°-52′	7½″	10″
38°-29′	7¾″	9¾″
40°-08′	8″	9½″
41°-44′	8¼″	9¼″
43°-22′	8½″	9″
45°-00′	8¾″	8¾″
46°-38′	9″	8½″
48°-16′	9¼″	8¼″
49°-54′	9½″	8″

TYPES OF BOLTS

No. 150
Plain Round Drift Bolt

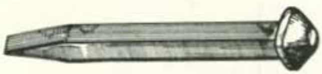
No. 151
Plain Square Drift Bolt

No. 152
Round Drift Bclt, Pointed

No. 153
Square Drift Bolt, Pointed

No. 154
Round Drift Bolt, Head and Point

No. 155
Square Drift Bolt, Head and Point



No. 156
Boat Spike

No. 157
Lag Screw

No. 158
Round Head Machine Bolt

No. 159
Countersunk Head Machine Bolt

No. 160
Expansion Bolt

No. 161
Wedge Expansion Bolt

We carry a large stock of Machine Bolts, and can deliver on short notice.
We manufacture bolts as illustrated above in a variety of sizes.
Special bolts of any description made to order.

See pages 140 and 269 for information on screws, nails and bolts.

MISCELLANEOUS HINGES

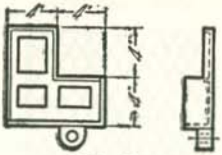


Fig. 92

WINDOW SHUTTER EYES

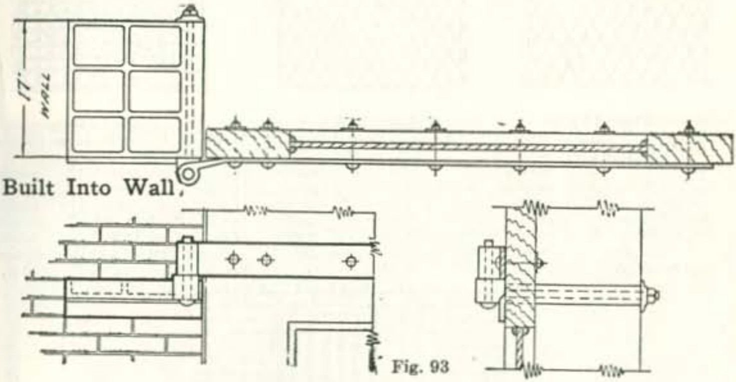


Fig. 93

STRAP HINGE, HINGE CASTING AND LUG FOR HEAVY WOOD DOORS

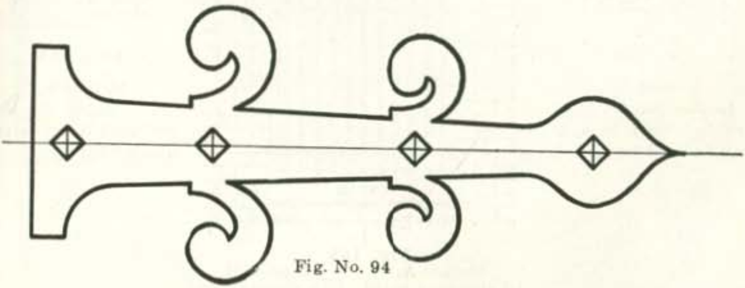


Fig. No. 94

BLIND HINGE

STEEL BAR AND WIRE WINDOW GRILLES

Diamond Mesh, Crimped Wire.

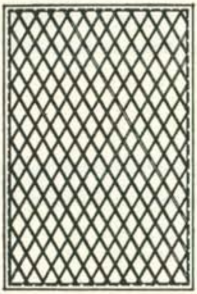


Fig. 162
Made of Channel Iron Frame and
No. 12 Wire—1" mesh.
No. 10 Wire—1½" mesh.
No. 8 Wire—2" mesh.
No. 7 Wire—2" mesh.
No. 6 Wire—2½" mesh.
These can be made square mesh.

Diamond Mesh, Crimped Wire.

Fig. 163
Made of Round Iron Frame and
No. 12 Wire—1" mesh.
No. 10 Wire—1½" mesh.
No. 8 Wire—2" mesh.
No. 7 Wire—2" mesh.
No. 6 Wire—2½" mesh.
These can be made square mesh.

Basket Weave, Flat Wire.

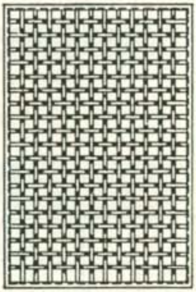


Fig. 164
Made of Channel Iron Frame and
¼x3/32" Flat Iron—1" mesh.
¼x3/32" Flat Iron—1¼" mesh.
¼x3/32" Flat Iron—1½' mesh.
½x⅛" Flat Iron—2" mesh.
⅝x⅛" Flat Iron—2½" mesh.
These can be made diamond mesh.

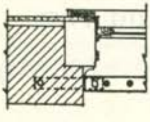


Fig. 166

Method A.
In this case anchors are first built in and guard placed later.

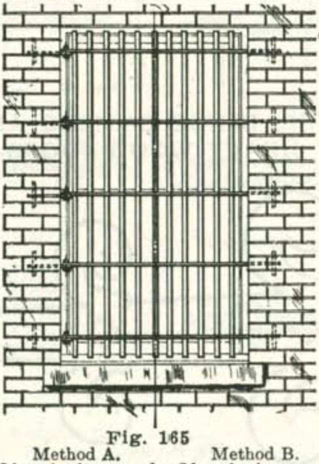


Fig. 165
Method A. Of anchoring guard into wall.
Method B. Of anchoring guard into wall.

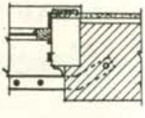
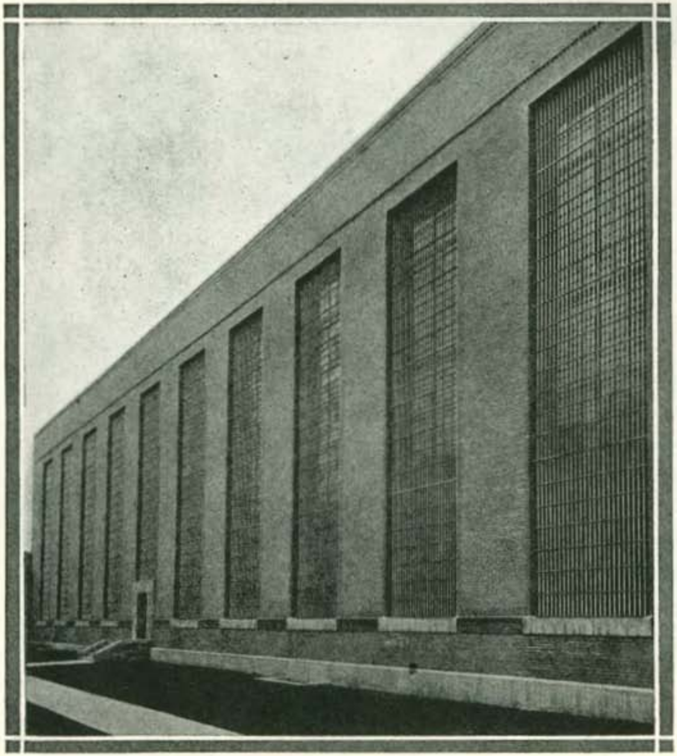


Fig. 167

Method B.
The guard in this case must be set before wall is built up.

Special Designs Upon Application.



WINDOW GUARDS

Minnesota State Prison
Stillwater, Minn.

These guards, Cell House D, are 8′ 7″ wide by 36′ 9″ high, made in sections riveted in the field. The horizontal bars are 2¼″ by ⅜″ with vertical bars ⅞″ round all carefully mortised and welded. We fabricated 128 similar guards for Cell Houses A and B of this prison.

At the Indiana State Reformatory, Pendleton, we furnished 51 tool-proof steel guards with ⅞″ rounds while at the Minnesota Reformatory, St. Cloud, the tool-proof guards have 1¼″ rounds.

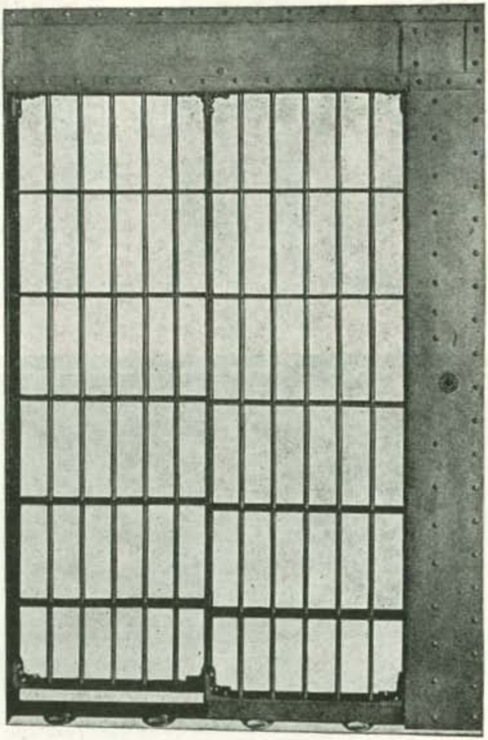
We have furnished hundreds of steel guards for State, County, and City prisons and jails.

PLATE AND BARRED DOORS

These doors can be made in varying sizes carefully fitted, riveted and welded. They are equipped with standard prison locks in steel case, cast steel ball bearing hinges, nickel plated brass door pulls and escutcheons.

Both types of doors may be fitted to angle or channel frames and double doors are fitted with a lock of the Cremorne type.

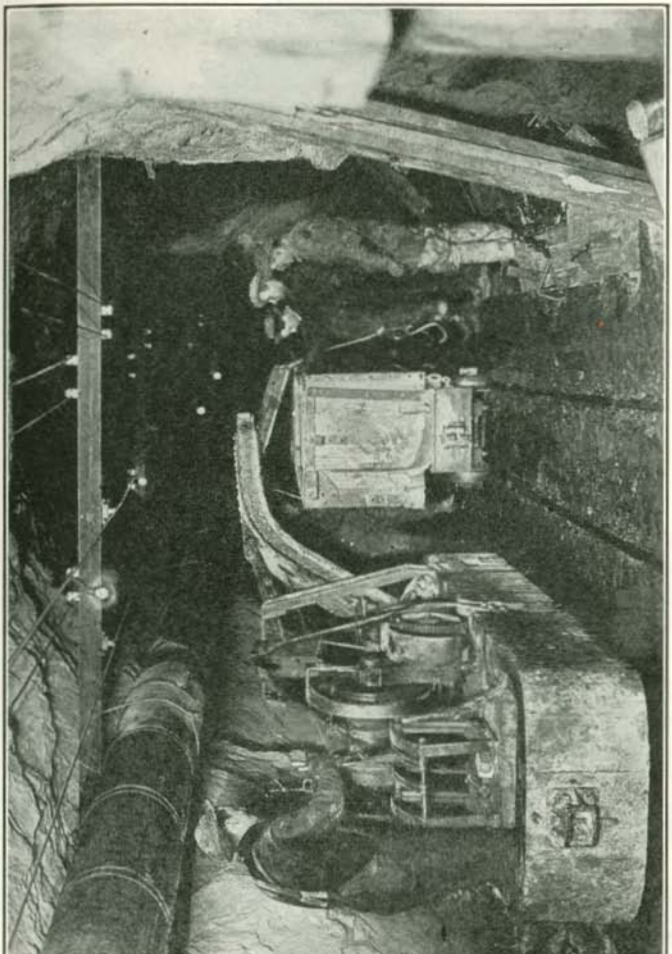
PRISONS, CELLS AND EQUIPMENT



INSTALLATIONS BY ST. PAUL FOUNDRY & MFG. CO.

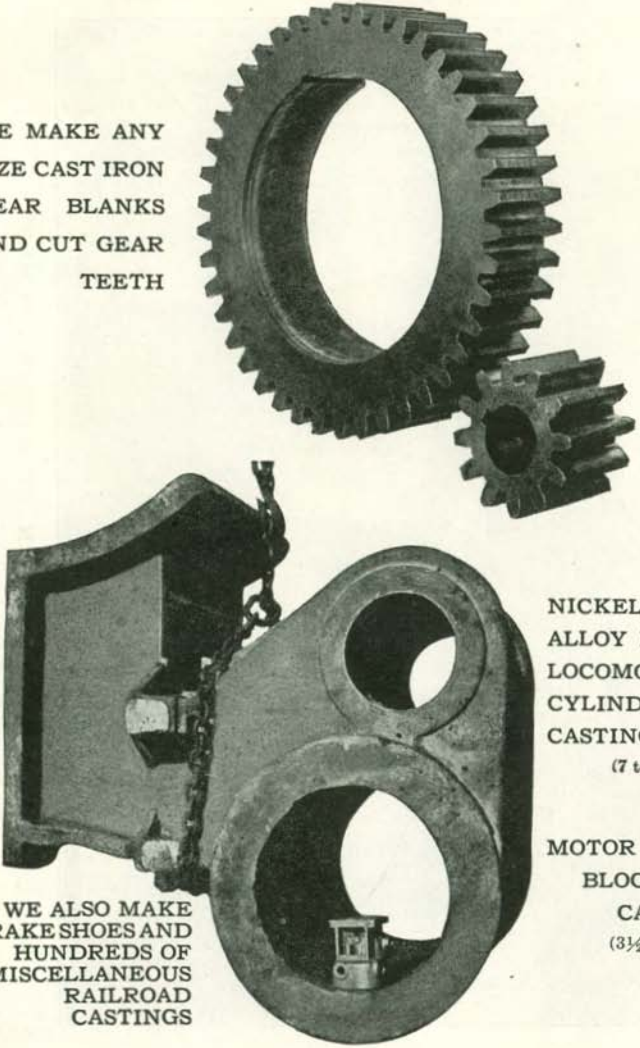
1224 Cells, Minnesota State Prison, Stillwater, Minnesota
320 Cells, Washington State Prison, Monroe, Washington
440 Cells, Wisconsin State Prison, Waupun, Wisconsin
320 Cells, Missouri State Prison, Jefferson City, Missouri
160 Cells, Minnesota State Reformatory, St. Cloud, Minnesota
744 Cells, Illinois State Prison, Lockport, Illinois
200 Cells, S. Dakota State Prison, Sioux Falls, S. Dakota
184 Cells, Chester State Hospital, Menard, Illinois
44 Cells, Public Safety Building, St. Paul, Minn.
Sally Port Gates, U. S. Penitentiary, Leavenworth, Kan.

These installations include, severally, window guards, barred partitions, plate and barred doors, balcony framing with stairs and railing, cell equipment, wagon locks, and railroad gates, for State Prisons, City and County Jails.



"CHERRY PICKER" G. N. RY. CASCADE TUNNEL
Used for Shifting Empty Cars to the Loading Track.
Fabricated for A. Guthrie & Co., St. Paul, Minn.

WE MAKE ANY
SIZE CAST IRON
GEAR BLANKS
AND CUT GEAR
TEETH



NICKEL
ALLOY IRON
LOCOMOTIVE
CYLINDER
CASTING
(7 tons)

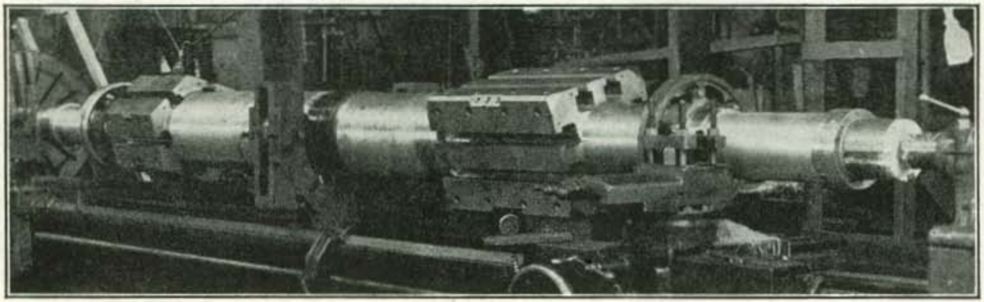
MOTOR
BLOCK
CASTING
(3½ lbs.)

WE ALSO MAKE
BRAKE SHOES AND
HUNDREDS OF
MISCELLANEOUS
RAILROAD
CASTINGS

KNURLED ROLLS

18" x 12'6"

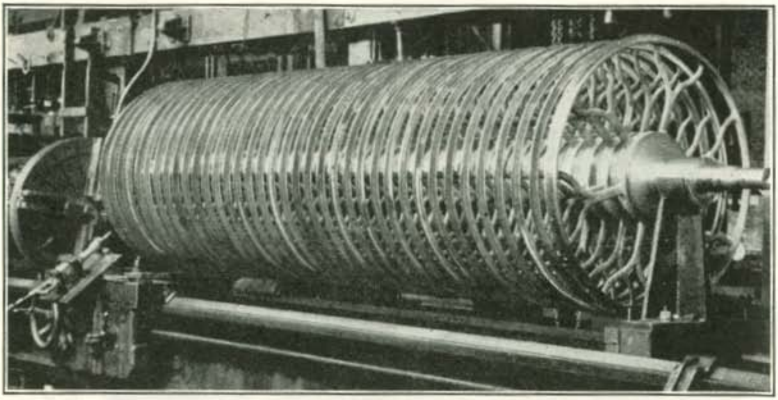
Made of cast iron and machined for installation in paper machines



ELECTRIC MACHINERY CO., MINNEAPOLIS

Synchronous Motor Shaft—New Orleans, La.

We did the machining on this 11,000 pound steel shaft. Hexagon shape 19"x1'-8½". Square shape 18"x2'-5½". Shaft 15"x21'-0".



WALDORF PAPER PRODUCTS CO.
Starter Rolls for Paper Pulp

10 Units—each with 12"x12'-4" cast iron shafts on which 38-42" diam. bronze spiders were mounted.

All castings, machining and assembly by us. We also made the copper lined steel shell pulp tanks.

EQUIPMENT REPAIRS

We invite you to store your
Power Shovels—Trench Machines
Road Machinery—Farm Machinery
with us for GENERAL REPAIRS by our
expert Machinists-Blacksmiths and Steel Men.

(The Winter months are the best)

We are completely equipped for

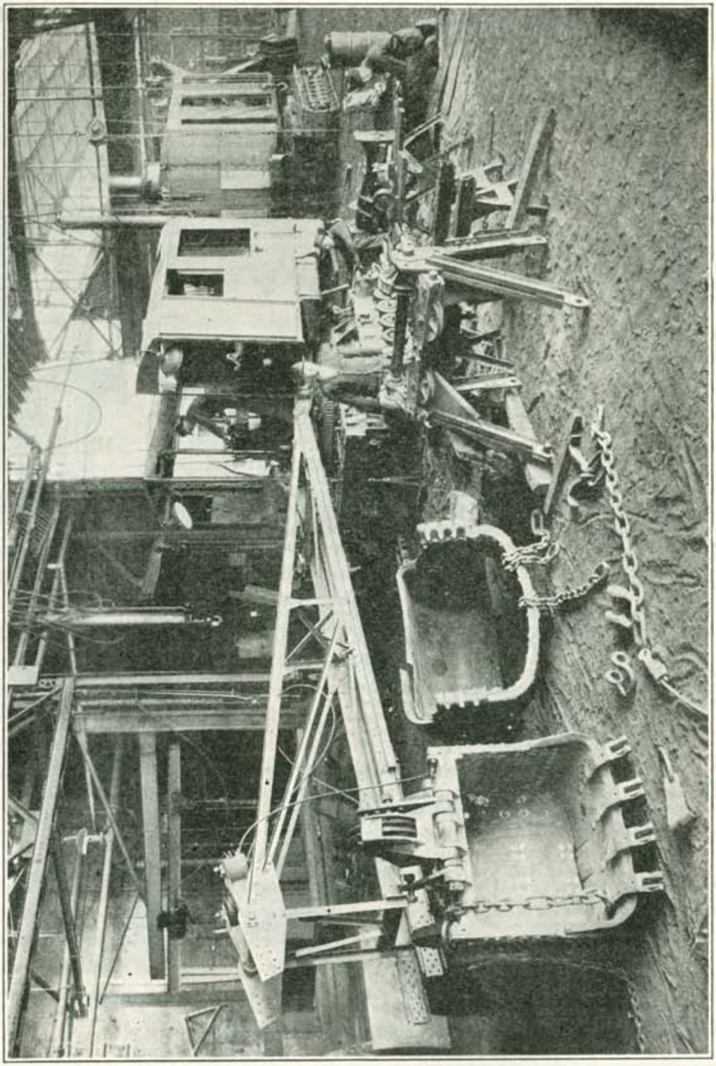
ELECTRIC WELDING

and

ACETYLENE WELDING **and** CUTTING

All departments are piped for oxygen and acetylene

EQUIPMENT REPAIRS



HESTON & ANDERSON, Fairfield, Iowa
A DIVISION OF ST. PAUL FOUNDRY AND MANUFACTURING COMPANY

SWING CUT-OFF SAW

MODEL 5

MODEL 5

You can use the Portable #5 anywhere in your plant—or take it with you on the job. Weight is only 175 lbs. without base; yet all the accuracy and convenience of the larger saw is incorporated. Cuts up to 3 x 12-inch material, and uses a 10-inch blade.

MODEL 25

THE #25 SWING SAW is the intermediate size between the #5 and #55. Cuts material up to 4 x 14 inches, and in all other respects is very similar to the #55. Power is supplied by a sealed-bearing 2 H.P. motor with thermal overload relay a part of the switch.

MODEL 55

FOR EXTRA HEAVY CAPACITY—The #55 cuts material up to 5 x 16 inches. Uses 16-inch blade, and on thinner material will cut wider. Power can be supplied by heavy duty 5 H.P. motor with thermal overload relay a part of the switch. 3 H.P. motor may be used if desired.

MODEL 25

MODEL No. 5 SPECIFICATIONS

CAPACITY—Cuts material up to 3 x 12 inches.
FRAME—Cast-iron frame stands 38 inches high. Covers bench space 16 x 24 inches. Floor stand is not supplied as standard equipment but may be ordered. Height over-all (with base) is 66 inches.
SWING BEAM—Free of side play or vibration. Weight of motor counterbalances the beam thus making springs and weights unnecessary, and accurate operation with a minimum of effort.
MOTOR—We recommend 1 or ¾ H.P. motor. Motor slides on base to tighten belt or compensate blade wear.
BLADE—One 10-inch saw blade supplied with machine. Other shapers, abrasive wheels or special type blades may be ordered.
BEARINGS—Arbor is fitted with life-sealed, dust-proof ball bearings set into a one-piece casting.
GUARDS—Blade, arbor and belt all inclosed for protection of operator.
WEIGHT—175 lbs. complete with 1 H.P. motor for saw only.
FLOOR STAND—Weighs 71 lbs., is 28 inches high and takes floor space 18 x 26 inches.

MODEL No. 25 SPECIFICATIONS

CAPACITY—Cuts material up to 4 x 14 inches.
FRAME—Heavy Channel Steel Construction, welded and braced to stand the roughest usage. Stands 84 inches high. Requires floor space 20 x 20 inches.
SWINGING BEAM—Free of side play or vibration. Weight of motor counterbalances the beam thus making springs and weights unnecessary, and accurate operation with a minimum of effort.
MOTOR—Designed to use 2 or 3 H.P. motor. Motor slides on base to tighten belt or compensate blade wear.
BLADE—One 12-inch saw blade supplied with machine. However 14-inch blade may be used, if desired.
BEARINGS—Arbor is fitted with life-sealed, dust-proof ball bearings set into a one-piece casting.
GUARDS—Blade, arbor and belt all inclosed for protection of operator. Special rear saw guard also acts as sawdust exhaust.
WEIGHT—397 lbs. complete with 2 H.P. motor.

MODEL No. 55 SPECIFICATIONS

CAPACITY—Cuts material up to 5 x 16 inches.
FRAME—Heavy Channel Steel Construction. Welded and braced to stand the roughest use. Stands 98 inches high over-all, and uses floor space 21 x 25 inches.
SWINGING BEAM—Free of side play or vibration. Weight of motor counterbalances the beam thus making springs and weights unnecessary, and accurate operation with a minimum of effort.
MOTOR—Designed to use 3, 4 or 5 H.P. motor. A 3 H.P. motor is the smallest we recommend. Motor slides on base to tighten belt or compensate blade wear.
BLADE—One 16-inch saw blade supplied with each machine. Other abrasive wheels, shapers and special type blades may be ordered.
BEARINGS—Arbor is fitted with life-sealed, dust-proof ball bearings set into a one-piece casting.
GUARDS—Blade, arbor and belt all inclosed for protection of operator. Special rear saw guard acts as sawdust exhaust.
WEIGHT—615 lbs. complete with 5 H.P. motor; 595 lbs. complete with 3 H.P. motor.

For More Detailed Information—Write For Catalog

HESTON & ANDERSON, Fairfield, Iowa
A DIVISION OF ST. PAUL FOUNDRY AND MANUFACTURING COMPANY

14-INCH TILTING TABLE BAND SAW

MODEL 14

- ★ Accurate 45° Tilting Table
- ★ Easy Adjustment—Simple Design
- ★ Full 11½-Inch Depth of Cut
- ★ New, Improved Saw Guides
- ★ Life-Sealed Ball Bearings
- ★ Built-In Light

SPECIFICATIONS

WHEELS—Both 14-inch diameter, with 1-inch face, covered with rubber.

TABLE—20″ x 23″ Reinforced Cast Iron, carefully machined and leveled. Fitted with easily renewable aluminum throat disc. Tilts 45° to right and 5° to left.

BEARINGS—Life-Sealed bearings in each wheel.

BLADES—One ¼″ band saw blade 8′5″ long furnished.

GUARDS—Aluminum guards cover all moving parts.

HEIGHT—With base, 69 inches overall.

FLOOR SPACE—18″ x 25″.

WEIGHT—Complete with base (less motor) 240 lbs. net.

MOTOR—½ H.P. motor recommended for ordinary use.

MOTOR BASE—10″ x 12″.

6-INCH JOINTER-PLANER WITH TILTING FENCE

MODEL 6F

- ★ Quick Job Set-Ups
- ★ Life-Sealed Ball Bearings
- ★ Tilting Fence Allows Angular Cuts
- ★ 6-Inch Width Capacity

SPECIFICATIONS

Depth of cut, 5/16″
Width of cut, 6″
Table width, 8″
Length of table, 42″
Width over-all, 18″
Height over-all, 37″
Motor plate, 10″ x 12″

Motor, ¾ H.P. recommended

Frame, stand, fence and table of Heavy Cast Iron

Aluminum Safety Guard

Solid Machined-Steel Head

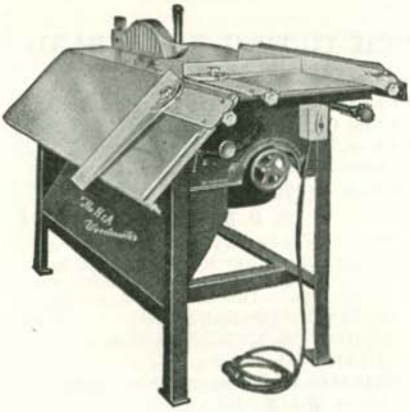
Net weight (less motor) 200 lbs.

For More Detailed Information—Write For Catalog

HESTON & ANDERSON, Fairfield, Iowa

A DIVISION OF ST. PAUL FOUNDRY AND MANUFACTURING COMPANY

THE WOODMASTER *Combination Bench Saw*



MOTOR

¾ or 1 H.P., 110/220, Single Phase, 60 Cycle, Capacity start.
Other motors can also be supplied if requested.

SPECIFICATIONS

SAW

Diameter Saw Supplied	10 inch
Diameter Saw Shaft	⅝ inch
Travel of Cutting Head	23 inches
Crosscut Capacity	18 inches
Height of Rip Fence	2¼ inches
Length of Rip Fence	30 inches
Maximum Vertical Adjustment of Saw	3¾ inches
Range Miter Adjustable	Full 45 Degrees
Miter Gauge Length	17 inches
Range Bevel Adjustable	Full 45 Degrees
Height of Machine (over all)	43 inches
Height of Table	35 inches
Width of Table	39 inches
Depth of Table	51½ inches
Width of Base	21 inches
Depth of Base	47 inches
Maximum Depth of Cut: 8″ Blade	1¾ inches
10″ Blade	2¾ inches
12″ Blade	3¾ inches
Net Weight	405 lbs. (with 1 H.P. motor)

For More Detailed Information—Write For Catalog

MEMO

PART III

MISCELLANEOUS INFORMATION

ST. PAUL BUILDING CODE

* Pertaining to Structural Steel

Sec. 9-23. (a) Structural steel shall conform to the Standard Specifications of the American Society for Testing Materials for Steel for Buildings, Serial Designation A7-46, as amended to date.

(b) Rivet steel shall conform to the Standard Specifications of the American Society for Testing Materials for Structural Rivet Steel, Serial Designation A141-39, as amended to date.

(c) Alloy steels and other metals mentioned in this code shall conform to the applicable Specifications of the American Society for Testing Materials, as amended to date.

Unit Stresses

Sec. 10-7. (a) All parts of the structure shall be so proportioned that the unit stress in pounds per square inch shall not exceed the following values:

(1) Structural and Rivet steel

Tension

Structural steel, net section 20,000
Rivets, on area based on nominal diameter 15,000

Compression

Columns, gross section

For columns with values of $\frac{l}{r}$ not greater than 120,

$17{,}000 - 0.485\frac{l^2}{r^2}$ in which l is the unbraced length of the column, and r is the corresponding radius of gyration of the section, both in inches.

For columns with values of $\frac{l}{r}$ greater than 120..........18,000

$$1 \text{ plus } \frac{l^2}{18{,}000\, r^2}$$

in which l is the unbraced length of the column, and r is the corresponding radius of gyration of the section, both in inches.

Plate girder stiffeners, gross section 20,000
Webs of rolled sections at toe of fillet 24,000

*Stresses same as A.I.S.C. specifications, 1947.

Bending

Tension on extreme fibers of rolled sections, plate girders and built up members 20,000

Compression of extreme fibers of rolled sections, plate girders and built up members, for values of $\frac{l}{b}$ not greater than 40 22,500

$$\frac{22{,}500}{1 \text{ plus} \frac{l^2}{1{,}800\ b^2}}$$

with a maximum of 20,000, in which l is the unsupported length of the member and b is the width of the compression flange, both in inches.

Stress on extreme fibers of pins 30,000

Shearing

Rivets, pins and turned bolts in reamed or drilled holes	15,000
Unfinished bolts	10,000
Webs of beams and plate girders, gross section	13,000

Bearing	Double Shear	Single Shear
Rivets and turned bolts in reamed or drilled holes	40,000	32,000
Unfinished bolts	25,000	20,000
Pins		32,000
Contact area, milled stiffeners and other milled surfaces		30,000
Contact area, fitted stiffeners		27,000

Expansion rollers and rockers (pounds per linear inch) 600d in which d is diameter of roller or rocker in inches.

(2) Cast Steel

Compression and bearing same as for structural steel. Other unit stresses 75 per cent of those for structural steel.

(3) Wrought Iron

Tension on net section	12,000
Maximum compression on gross section	10,000
Bending on extreme fiber, tension	12,000

(4) Cast Iron

Maximum compression on gross section	10,000
Bending on extreme fiber, tension	3,000
Bending on extreme fibre, compression	10,000
Shear on brackets	2,000

Compression stress per square inch on cast iron columns

$$10{,}000\text{-}60\ \frac{l}{r}$$

Reversal of Stress

(1) Members subject to live loads producing alternate tensile and compressive stresses shall be proportioned as follows:

To the net total compressive and tensile stresses add 50 per cent of the smaller of the two and proportion the member to resist either of the increased stresses resulting therefrom.

Connections shall be proportioned to resist the larger of the two increased stresses.

Combined Stresses

Axial and Bending

Members subject to both axial and bending stresses shall be so proportioned that the quantity

$$\frac{f_a}{F_a} + \frac{f_b}{F_b}$$ shall not exceed unity, in which

F_a = axial unit stress that would be permitted by this Specification if axial stress only existed

F_b = bending unit stress that would be permitted by this Specification if bending stress only existed

f_a = axial unit stress (actual)=axial stress divided by area of member

f_b = bending unit stress (actual)=bending moment divided by section modulus of member.

Rivets

Rivets subject to shearing and tensile forces shall be so proportioned that the combined unit stress will not exceed the allowable unit stress for rivets in tension only.

Wind and Other Forces

Members subject to stresses produced by a combination of wind and other loads may be proportioned for unit stresses 33⅓ per cent greater than those specified in Section 10-7 (a) provided the section thus required is not less than that required for the combination of the dead load, live load, and impact (if any).

Members Carrying Wind Only

(1) Members subject only to stresses produced by wind forces may be proportioned for unit stresses 33⅓ per cent greater than those specified in Section 10-7 (a).

Composite Beams

(1) The term "composite beam" shall apply to any rolled or fabricated steel floor beam entirely encased in a poured concrete haunch at least four inches wider, at its narrowest point, than the flange of the beam, supporting a concrete slab on each side without openings adjacent to the beam; provided that the top of the beam is at least 1½ inches below the top of the slab and at least 2 inches above the bottom of the slab; provided that a good grade of stone or gravel concrete with Portland cement, is used; and provided that the concrete haunch has adequate mesh, or other reinforcing steel, throughout its whole depth and across its soffit.

(2) Composite beams may be figured on the assumptions that:

1. The steel beam carries unassisted all dead loads, prior to the hardening of the concrete, with due regard for any temporary support provided.
2. The steel and concrete carry by joint action all loads, dead and live, applied after the hardening of the concrete.

(3) The total tensile unit stress in the extreme fiber of the steel beam thus computed shall not exceed 20,000 pounds per square inch.

(4) The maximum stresses in the concrete, and the ratio of Young's moduli for steel and concrete, shall be prescribed by the specifications governing the design of reinforced concrete for the structure.

(5) The web and the end connections of the steel beam shall be adequate to carry the total dead and live load without exceeding the unit stresses prescribed in this Specification, except as this may be reduced by the provision of other proper support.

Effective Span Length

(1) Simple Spans

Beams, girders and trusses shall ordinarily be designed on the basis of simple spans whose effective length is equal to the distance between centers of gravity of the members to which they deliver their end reactions.

(2) End Restraint

If, on the assumption of end restraint, full or partial, based on continuous or cantilever action, beams, girders and trusses are designed for a shorter effective span length than that specified in the preceding paragraph, their sections, as well as the sections of the members to which they connect, shall be designed to carry the shears and moments so introduced, in addition to all other forces, without exceeding at any point the unit stresses prescribed in Section 10-7 (a).

The allowable compressive stresses per square inch shall be determined by the following formula:

(1) For steel columns filled with and encased in concrete extending at least three inches beyond the outer edge of the steel, where the steel is calculated to carry the entire live and dead load, the allowable stress per square inch shall be determined by the following formula:

$$18{,}000 - 70\frac{l}{r}$$

but shall not exceed 16,000 per square inch.

(2) For steel columns filled with, but not encased in concrete, the steel shall be calculated to carry the entire live and dead load. In this case the above formula may be used but the allowable stress shall not exceed 15,000 pounds.

(3) Stresses due to eccentric loading shall be provided for in all compressive members.

(4) The length of rolled steel compressive members shall not exceed one hundred twenty (120) times the least radius of gyration, but the limiting length of struts for wind bracing only may be one hundred fifty (150) times the least radius of gyration. The limiting length for cast iron columns shall be seventy (70) times the least radius of gyration.

Design

Unsupported Compression Flanges

(a) The ratio of unbraced length to width of flange (l/b) for compression flanges of rolled sections, plate girders, and built-up members subject to bending shall not exceed 40.

Minimum Thickness of Material

(b) Main material. The minimum thickness of steel except for linings, fillers and the webs of rolled beams and channels, shall be: for exterior construction—5/16 inch; for interior construction—1/4 inch. (These provisions do not apply to light structures such as skylights, marquees, fire-escapes, light one-story buildings, steel houses, or light miscellaneous steelwork.

Gusset Plates

(c) Gusset plates for trusses with end reactions greater than 35,000 pounds shall be not less than ⅜ inch thick.

Compression Members

(d) In compression members consisting of segments connected by webs, the thickness of the webs of the segments shall be not less than $1/32$ of the unsupported distance between the nearest rivet lines, or the roots of the flanges in case of rolled sections. The thickness of the cover plates or webs connecting the segments shall be not less than $1/40$ of the unsupported distance between the nearest lines of their connecting rivets or the roots of their flanges in case of rolled sections.

Web Crippling of Beams

(e) Rolled beams shall be so proportioned that the compression stress at the web toe of the fillets, resulting from concentrated loads, shall not exceed the value of 24,000 pounds per square inch allowed in Sections 10-7 (a). The governing formulas shall be:

For interior loads $\dfrac{R}{t(A+2N)} = \text{not over } 24{,}000$

For end reactions $\dfrac{R}{t(A+N)} = \text{not over } 24{,}000$

R = concentrated interior load or end reactions, in pounds
t = thickness of web, in inches
A = length of bearing, in inches
N = distance from outer face of flange to web toe of fillet, in inches

Riveting—Tension

(a) In proportioning tension members the diameter of the rivet holes shall be taken one-eighth (⅛) of an inch larger than the nominal diameter of the rivet.

(b) In proportioning rivets the nominal diameter of the rivet shall be used.

Plate Girders—Flanges—Compression

(a) Plate girders shall be proportioned either by the moment of inertia of their net section, or by assuming that the flanges are concentrated at their centers of gravity and a unit stress used such that the extreme fibre stress does not exceed 20,000 pounds per square inch, in which case one-eighth (⅛) of the gross section of the web, if properly spliced, may be used as flange section.

(b) The flanges of plate girders shall be connected to the web with a sufficient number of rivets to transfer the total shear at any point in a distance equal to the effective depth of the girder at that point combined with any load that is applied directly on the flanges.

(c) Webs of plate girders shall be provided with stiffeners over all bearing points, under all points of concentrated loading and elsewhere when required by good engineering practice.

Wind Bracing

(a) All structures shall be designed to have surfaces exposed to a wind pressure of thirty (30) pounds for every square foot of surface exposed, unless otherwise specifically provided.

(b) In structures exposed to wind, if the resisting moments of the ordinary materials of construction, such as masonry, partitions, floors and connections are not sufficient to resist the moment of distortion due to wind pressure taken in any direction or any part of the building or structure, additional bracing shall be introduced, sufficient to make up the difference in the moments.

Rivets and Bolts

Use of Unfinished Bolts

(a) All field connections may be made with unfinished bolts, except as provided in Paragraph (b) hereof.

Use of Rivets

(b) Rivets, turned bolts, or special bolts shall be used for the following connections:

Connections for supports of running machinery, or of other live loads which produce impact or reversal.

Column splices in all tier structures 60 feet or more in height

Connections of all beams and girders to columns, and of any other beams and girders on which the bracing of columns is dependent, in structures over 60 feet in height.

Walls, Piers and Columns—Dead and Live Loads

(a) The full live load on roofs of all buildings shall be taken on walls, piers, and columns.

(b) The walls, piers and columns of all buildings shall be designed to carry the full dead loads and not less than the proportion of the live load given in the following table:

Floor	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
17	85 per cent																
16	80	85															
15	75	80	85														
14	70	75	80	85													
13	65	70	75	80	85												
12	60	65	70	75	80	85											
11	55	60	65	70	75	80	85										
10	50	55	60	65	70	75	80	85									
9	50	50	55	60	65	70	75	80	85								
8	50	50	50	55	60	65	70	75	80	85							
7	50	50	50	50	55	60	65	70	75	80	85						
6	50	50	50	50	50	55	60	65	70	75	80	85					
5	50	50	50	50	50	50	55	60	65	70	75	80	85				
4	50	50	50	50	50	50	50	55	60	65	70	75	80	85			
3	50	50	50	50	50	50	50	50	55	60	65	70	75	80	85		
2	50	50	50	50	50	50	50	50	50	55	60	65	70	75	80	85	
1	50	50	50	50	50	50	50	50	50	50	55	60	65	70	75	80	85

(c) The proportion of the live load on walls, piers and columns on buildings more than seventeen stories in height shall be taken in same ratio as the above table.

(d) The entire dead load and the percentage of live load on basement columns, piers and walls shall be taken in determining the stress in foundations.

(e) In addition to the entire dead load, not less than the following proportion of the percentage of live load on the basement columns, piers and walls shall be taken in determining the number of piles for pile foundations and the area of concrete caissons.

75 per cent for Dept. Stores—Garages*—Stables*—Workshops*—Storage—Fire Stations—Light Manufactories.

50 per cent for Hotels—Club Houses, Lodging and Rooming Houses — Family Hotels — Offices — Hospitals — Dwellings — Flats — Apartments—Private Garages*—Stables*—Workshops*.

25 per cent for Theatres—Lodges—Skating Rinks—Exhibition Halls—Churches—Assembly and Dance Halls—Schools.

(f) In all foundations eccentric loading must be provided for.

(*Over 500 □′ Area)

(*Under 500 □′ Area)

EXCERPTS FROM

SPECIFICATIONS FOR STEEL FOR BUILDINGS

A. S. T. M. DESIGNATION: A 7-46.

1. **Structural Rivet Steel.** (Same—unless specified.)

Rolled Base Plates

2. Rolled base plates over 2 in. in thickness for bearing purposes shall be open-hearth or electric-furnace steel containing 0.20 to 0.35 per cent carbon. The chemical composition shall also conform to the requirements specified in Section 4. A sufficient discard shall be made from each ingot to secure sound plates. Physical tests shall not be required for this material.

MANUFACTURE.

Process

3. (a) The steel, except as specified in Paragraph (b), shall be made by one or more of the following processes: open-hearth, electric-furnace.

(b) Steel for plates and shapes over 7/16 in. in thickness which are to be punched shall be made by either or both of the following processes: open-hearth or electric-furnace.

Chemical Composition

4. The steel shall conform to the following requirements as to chemical composition:

		Structural Steel	Rivet Steel
Phosphorus	Bessemer	not over 0.10 per cent	....
	Open-hearth	not over 0.06 per cent	not over 0.06 per cent
Sulfur		0.05 per cent	not over 0.05 per cent
Copper, when copper-steel is specified		not under 0.20 per cent	not under 0.20 per cent

Ladle Analyses

5. (a) A carbon determination, and a copper determination when copper steel is specified shall be made of each melt of bessemer steel, and determinations for manganese, phosphorus and sulfur representing the average of the melts applied for each 8-hour period.

(b) An analysis of each melt of open-hearth or electric-furnace steel shall be made to determine carbon, manganese, phosphorus and sulfur; also copper when copper steel is specified.

(c) The analyses prescribed in Paragraphs (a) and (b) shall be made by the manufacturer from test ingots taken during the pouring of each melt. The chemical composition thus determined shall be reported to the purchaser or his representative and the percentage of phosphorus and sulphur, and also copper when copper steel is specified, shall conform to the requirements specified in Section 4.

Check Analyses

6. Analyses may be made by the purchaser from finished material representing each melt. The phosphorus and sulphur content thus determined shall not exceed that specified in Section 4 by more than 25 per cent.

Tension Tests

7. (a) The material shall conform to the following requirements as to tensile properties:

Properties Considered	Structural Steel	Rivet Steel
Tensile strength, lb. per sq. in...	60,000—72,000	52,000—62,000
Yield point, min., per sq. in......	0.5 tens. str.	0.5 tens. str.
but in no case less than.......	33,000	28,000
Elongation in 8 in., min., per cent.	1,500,000 / Tens. str.	1,500,000 / Tens. str.
Elongation in 2 in., min., per cent.	22	....

See section 8.

(b) Flat rolled steel $\frac{5}{16}$ in. and under in thickness, shapes less than 1 sq. in. in cross section and bars, other than flats, less than ½ in. in thickness or diameter need not be subjected to tension tests.

(c) The yield point shall be determined by the drop of the beam or halt in the gage of the testing machine.

Modifications in Elongation

8. (a) For material over ¾ in. in thickness or diameter, a deduction from the percentage of elongation in 8 in. specified in Section 7 (a) of 0.25 per cent shall be made for each increase $\frac{1}{32}$ in. of the specified thickness or diameter above ¾ in., to a minimum of 18 per cent. For plates, shapes and bars.

(b) For material under $\frac{5}{16}$ in. in thickness or diameter, a deduction from the percentage of elongation in 8 in. specified in Section 7 (a) of 2.00 per cent shall be made for each decrease of $\frac{1}{32}$ in. of the specified thickness or diameter below $\frac{5}{16}$ in.

Bend Tests

9. Bend test specimens shall stand being bent cold through 180 deg. without cracking on the outside of the bent portion, around a pin, the diameter of which shall have the following relation to the thickness of the specimen.

Thickness of Material	Ratio: Pin Diameter / Thickness of Specimen
Up to ¾ in., inclusive	½
Over ¾ to 1 in., inclusive	1
Over 1 to 1½ in., inclusive	1½
Over 1½ to 2 in., inclusive	2½
Over 2 in.	3

Test Specimens

10. (a) Test specimens shall be prepared for testing from the material in its rolled or forged condition except as specified in Paragraph (b).

(b) Test specimens for annealed material shall be prepared from the material as annealed for use, or from a short length of a full section from the same melt similarly treated.

(c) Test specimens shall be taken longitudinally and, except as specified in Paragraphs (e), (f) and (g), shall be the full thickness or section of material as rolled.

(d) Test specimens for plates, shapes and flats may be machined to the form and dimensions shown in Fig. 1, or with both edges parallel.

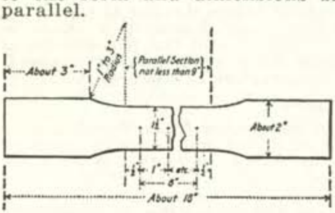


Fig. 1

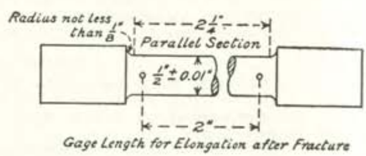


Fig. 2

(e) Tension test specimens for material over 1½ in. in thickness or diameter, except pins and rollers, may be machined to a thickness or diameter of at least ¾ in. for a length of at least 9 in., or they may conform to the dimensions shown in Fig. 2.

(f) Bend test specimens for material over 1½ in. in thickness or diameter, except pins and rollers, may be machined to a thickness or diameter of at least ¾ in. or to 1 by ½ in. in section.

(g) Tension test specimens for pins and rollers shall conform to the dimensions shown in Fig. 2, and bend test specimens shall be 1 by ½ in. in section.

(h) Test specimens for pins and rollers shall be taken so that the axis is 1 in. from the surface.

(i) The machined sides of rectangular bend test specimens may have the corners rounded to a radius not over 1/16 in.

Number of Tests

11. (a) Two tension and two bend tests shall be made from each melt, unless the finished material from a melt is less than 30 tons when one tension and one bend test will be sufficient. If, however, material from one melt differs 3/8 in. or more in thickness, one tension and one bend test shall be made from both the thickest and thinnest material rolled regardless of the weight represented.

(b) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(c) If the percentage of elongation of any tension test specimen is less than that specified in Section 7 (a) and any part of the fracture is more than 3/4 in. from the center of the gage length of a 2-in. specimen or is outside the middle third of the gage length of an 8 in. specimen, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

PERMISSIBLE VARIATIONS IN WEIGHT AND THICKNESS

Permissible Variations

12. (a) One cubic inch of rolled steel is assumed to weigh 0.2833 lb. The cross-sectional area or weight of each structural-size shape shall not vary more than 2.5 per cent from the theoretical or specified amounts.

Finish

13. The finished material shall be free from injurious defects and shall have a workmanlike finish. See No. ASTM specifications for Modifications.

Marking

14. The name or brand of the manufacturer and the melt number shall be legibly stamped or rolled on all finished material, except that lattice bars and other small sections shall, when loaded for shipment, be properly separated and marked for identification. The identification marks shall be legibly stamped on the end of each pin and roller. The melt number shall be legibly marked, by stamping if practicable, on each test specimen.

Inspection

15. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection

16. (a) Unless otherwise specified, any rejection based on tests made in accordance with Section 6 shall be reported within five working days from the receipt of samples.

(b) Material which shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

Rehearing

17. Samples tested in accordance with Section 6, which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION

CODE OF STANDARD PRACTICE FOR STEEL BUILDINGS AND BRIDGES

AS ADOPTED 1924
REVISED DECEMBER 1, 1946

THIS DOCUMENT INCLUDES THE A. I. S. C. STANDARD PROPOSAL CONTRACT FORM AND STANDARD RELEASE AND INDEMNITY AGREEMENT.

SECTION 1. GENERAL.

(a) Scope.

The rules and practices hereinafter defined are adopted by the American Institute of Steel Construction as standard for the industry and shall govern all conditions relating to the use of Class "A" Structural Steel, unless the contract between the Buyer and Seller specifies otherwise.

(b) Design, Fabrication and Erection.

Unless otherwise specified or required, the following Standard Specifications, as amended to date, shall apply: The Standard Specification for the Design, Fabrication and Erection of Structural Steel for Buildings of the American Institute of Steel Construction, the Standard Specifications for Highway Bridges of the American Association of State Highway Officials, the Specifications for Steel Railway Bridges of the American Railway Engineering Association, or the Specifications for Welded Highway and Railway Bridges of the American Welding Society.

(c) Plans and Specifications for Bidding.

The plans shall show a complete design with sizes, sections and the relative location of various members with floor levels, column centers and offsets figured, and shall show the character of the work to be performed with sufficient dimensions to permit the making of an accurate estimate of cost. Plans shall be made to scale not less than ⅛ inch to the foot, and large enough to convey the information adequately.

Wind bracing and special details when required shall be shown in sufficient detail regarding rivets, welds and construction to permit an accurate estimate of cost.

(d) Responsibility for Design and Erection.

If the design, plans and specifications are prepared by the Buyer, the Seller shall not be responsible for the suitability, strength and rigidity of design, nor for the practicability or safety of erection when the erection is not done by the Seller.

(e) Patented Devices.

The Seller shall not be responsible for claims arising from the use of patented designs, devices or parts shown on the Buyer's plans or called for by the specifications furnished by the Buyer, but the Seller shall protect the Buyer against claims arising from the use of patented designs, devices or parts proposed by the Seller.

SECTION 2. CLASSIFICATION.

Class "A" Structural Steel.

Contracts taken to furnish the structural steel for buildings or bridges are based on furnishing the following items only:

Anchors for structural steel
Bases of steel or iron
Beams, purlins, and girts
Bearing plates for structural steel
Bearing shoes for bridges
Brackets made of structural steel
Bridge pins
Bridge railings of rolled structural steel
Checkered floor plates connected to the steel frame
Columns of steel, iron or pipe, or cement filled pipe, and struts of structural steel or pipe
Counterweight boxes for bridges
Crane rails and stops
Door frames constituting part of exterior wall steel framing
Expansion joints
Girders
Grillage beams
Hangers of structural steel, if attached to the structural steel framing and shown on the framing plans
Lintels shown on the framing plans or otherwise enumerated
Marquees (structural frame only)
Monorail beams of standard structural shapes

Rivets and bolts sold on a delivered basis for field connections, as follows:

1. The Seller shall furnish sufficient rivets of suitable size, plus at least 10 per cent to cover waste, for all field connections of steel to steel which are designated as riveted field connections.
2. The Seller shall furnish sufficient bolts of suitable size, plus 5 per cent to cover waste, for all field connections of steel to steel which are designated to be bolted.
3. In cases where materials in excess of minimum requirements are furnished to provide for waste or loss, all unused material remaining after completion of the work shall be the property of the Seller and be returned to him.

Separators, angles, tees, clips, bracing and detail fittings in connection with structural steel frame
Suspended ceiling supports of structural shapes 3 inches or greater in depth
Tie and sag rods
Trusses

Unless specifically agreed to as part of the contract steel or iron items which are essentially required for the assembly or erection of materials supplied by other trades will not be furnished, even though shown on the plans as being fastened to the structural steel.

SECTION 3. INVOICING.

When conditions make it possible to award contracts on a lump sum basis the confusion of determining weights will be avoided. Scale weights involve a variation which frequently leads to a compromise based on calculated weights.

The rules hereinafter established, while not giving exact weights, are the basis upon which the Seller will make a lump sum or a pound price bid and they eliminate the necessity of increased cost of shop drawings and other refinements of manufacture which would very materially increase costs if exact weights were required.

Weights.

The weight of steel shall be assumed as 0.2833 pound per cubic inch and that of cast iron as 0.2604 pound per cubic inch.

Structural steel and iron sold at a unit price per pound, hundred weight (100 pounds) or ton (2000 pounds) shall be invoiced on the calculated weights of shapes, plates, bars, castings, rivets, bolts, and weld metal based on the detailed shop drawings and shop bills of material which show actual dimensions of materials used* as follows:

Dimensions:

The weight will be figured on the basis of rectangular dimensions for all plates, and ordered overall lengths for all structural shapes from which the required material is cut, with no deductions for copes, clips, sheared edges, punchings, borings, milling or planing. When parts can be economically cut in multiples from material of larger dimension, the calculated weight shall be taken as that of the material from which the parts are cut. All the material shall be ordered as economically as possible in conformity with the suppliers' standards of cutting dimensions.

Over-run, as follows:

1. To the nominal, theoretical weight of all plates or slabs will be added one-half the allowance for over-weight, in accordance with the applicable table in Specification A-7 of the American Society for Testing Materials.
2. To the nominal theoretical weight of checkered plates will be added the allowance for over-weight in accordance with the published weights of the manufacturers.
3. The calculated weights of castings shall be the weights determined from the detail drawings of the pieces including standard fillets for such pieces. To this an average over-run of 10 per cent shall be added.

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*This is based on the usual practice of ordering material from the rolling mills to the nearest available dimensions. When material, obtained from local sources, involves unusual waste, special terms of contract shall be agreed upon.

MEMO

ALLOWABLE UNIT STRESSES
IN ACCORDANCE WITH THE BUILDING CODES OF SEVERAL CITIES

	COMPRESSION			St. Paul	Minn'pls	Wisc.
				Revised to 1947		
				Pounds per square inch		
Steel and Iron	Rolled Steel			17000	20000	20000
	Cast Steel			17000	16000	....
	Wrought Iron			10000	12000	10000
	Cast Iron (in Short Blocks)			10000	10000	10000
	Steel Pins and Rivets (Bearing)			32000	32000	32000
Timber	Oak	With	Grain	1000	800	1000
	Oak	Across	"	500	500	500
	Yellow Pine, Wash. Fir	With	"	1100	....	1100
	Yellow Pine, Wash. Fir	Across	"	250	....	350
	Spruce	With	"	800	....	250
	Spruce	Across	"	250	....	....
	Hemlock	With	"	500	560	700
	Hemlock	Across	"	150	300	300
Concrete	Concrete P. C. (1) sand (2) stone (4)			500	....	....
	Concrete P. C. (1) sand (2½) stone (5)			350	....	....
Masonry	Rubble Stonework in P. C. Mortar			100	125	140
	Rubble Stonework in L. & C. Mortar			....	100	100
	Rubble Stonework in Lime Mortar			60	70	....
	Brickwork in P. C. Mortar 1:3			175	175	175
	Brickwork in L. & C. Mortar 1:1:3			125	150	140
	Brickwork in Lime Mortar 1:3			100	90	90
	Granite Masonry			600	400 L	C 800
	Limestone Masonry			500	250 L	C 500
	Sandstone Masonry			500	160 L	C 400
	TENSION					
Steel and Iron	Cast Iron			3000	3000	3000
	Rolled Steel			20000	20000	20000
	Cast Steel			15000	16000	....
	Rivets			15000	15000	15000
Timber	Oak			1000	....	Av.1500
	Yellow Pine (Short Leaf)			1000	....	Av.1450
	Yellow Pine (Long Leaf) & Wash. Fir			1200	....	Av.1525
	Spruce			1000	....	Av.1150

Special alloy steel tensile stresses shall not exceed 30% of the minimum ultimate strength, other stresses to be in proportion.

	SHEAR			St. Paul	Minn'pls	Wisc.
Steel and Iron	Cast Iron			2000	....	....
	Steel Plates & Girders with stiffeners			13000	13000	13000
	Steel Shop Rivets and Pins			15000	15000	15000
	Steel Field Bolts			10000	10000	10000
Timber	Yellow Pine (Short Leaf)	With	Grain	120	....	100
	Yellow Pine (Long Leaf)	With	"	130	....	100
	Yellow Pine	Across	"	....	....	....
	Spruce	With	"	120	....	Av. 85
	Spruce	Across	"	....	....	....
	Oak	With	"	200	....	Av. 110
	Oak	Across	"	....	....	....
	Hemlock	With	"	60	....	Av. 60
	Hemlock	Across	"	....	....	....

P = Portland. C = Cement. L = Lime.

NOTATION: L = Length in inches, R = Radius of Gyration in inches, D = Diameter or least dimension in inches, C = Allowable compressive unit stress (with grain) for that wood. Formulae below give allowable unit stress in pounds per square inch

D	E	F	M	T	C
$9000-40\frac{L}{R}$	$10000-60\frac{L}{R}$	$10000-40\frac{L}{D}$	$C\left(1-\frac{L}{80D}\right)$	$C\left(1-\frac{L}{60D}\right)$	$\frac{18000}{1+\left(\frac{l^2}{18000r^2}\right)}$

$C17000-.485\frac{L^2}{R^2}$ for less than 120

$P=C\left(1-\frac{L}{48D}\right)$

ALLOWABLE UNIT STRESSES
IN ACCORDANCE WITH THE BUILDING CODES OF SEVERAL CITIES

SAFE EXTREME FIBER STRESS BENDING	Revised to 1947 St.Paul	Minn'pls	Wisc.
	Pounds per square inch.		
Rolled Steel Beams	20000	20000	20000
Rolled Steel Pins, Rivets and Bolts	30000	30000	30000
Riveted Steel Beams (net flange section)	20000	20000	20000
Cast Iron Compressive Side	10000	10000	10000
Cast Iron Tension Side	3000	3000	3000
Short Leaf Yellow Pine, Wash. or Oregon Fir	1000	1200	Av1350
Long Leaf Yellow Pine	1200	1400	Av1525
Spruce	1000	....	Av1100
Oak	1000	1120	Av1500
Hemlock	600	1040	Av 950
Granite	180	....	....
Limestone	150	....	....
Slate	400	....	....
Marble	120	....	....
Sandstone	100	....	....
Concrete Portland Cement 1:2:4	30	....	....
Concrete Portland Cement 1;2½:5	20	....	....

Depending upon encasement and quality of concrete, some cities permit extreme fibre stresses in beams to be increased from 12% to 30%.

COLUMN FORMULAE.

CITY	STEEL Formula	STEEL Max. Lgth.	CAST IRON Formula	CAST IRON Max. Lgth.	WOOD Long Leaf Yellow Pine	WOOD Spruce	WOOD Oak	WOOD Hem-lock
St. Paul	C-C[1]	.....	E	.....	M	M	M	M
Mpls.	C-C[1]	120R	D	90R	P	P	P	P
Wisc.	C-C[1]	120R	F		T	T	T	T

SAFE BEARING CAPACITY OF SOILS—TONS PER SQ. FT.

Character of soil	St. Paul	Minne-apolis	Wisc.
Soft clay	1	1	1
Clay and sand, wet and springy	2	2	2
Loam clay or fine sand, firm and dry	3	3	3
Very firm coarse sand, gravel or hard clay	4	4	4-5

DATA ON WOODEN PILES

According to the building laws of various cities the most common dimension for wooden piles less than twenty feet long is 5 inches on the small end and 10 inches on the butt end. For piles longer than 20 feet the butt end is increased to 12 inches. The safe load for piles is figured by the following formulae; (A) being for drop hammer and (B) for steam hammer. The maximum load per pile is limited to 20 to 25 tons.

(A) Safe load in tons $= \frac{2\,W\,H}{P+1}$ (B) Safe load in tons $= \frac{2\,W\,H}{P+\frac{1}{10}}$

"H" = Drop of hammer in feet "W" = weight of hammer in ton. "P" = Penetration of last blow in inches (or average of last several blows).

WEIGHTS OF BUILDING MATERIAL, ETC.

WEIGHT OF MATERIALS IN LBS. PER SQUARE FOOT

Kind of Material	THICKNESS IN INCHES														
	2	3	4	5	6	7	8	9	10	12	13	17	21	25	30
Hollow tile (Wall)	13	16	17	19	25	....	....	....	....	....	....	....	....	....	....
Reinf. Con. slab	24	36	48	60	72	84	96	108	120	144	....	....	....	....	....
Concrete fill	22	32	43	54	65	....	....	....	....	....	....	....	....	....	....
Cinder Con. fill	16	24	32	40	48	....	....	....	....	....	....	....	....	....	....
Stone wall Sandstone Rubble Masonry	....	....	....	....	....	....	86	....	108	130	....	....	217	282	325
Brick wall Common Brick	....	....	40	....	....	....	....	80	....	....	120	155	....	250	....
Concrete Block (Wall)	....	....	....	....	37	....	45	....	....	47	....	....	....	....	....

2"x4" spruce sleepers 16" ctrs. and 2" dry cinder concrete fill	8.50
Copper sheets	1.50
Corrugated sheets	1.00
7/8" single flooring, wood	3.00
Metal lath and plaster 5/8"	9.00
Plastering 1" thick	10.00
1/4" Wood Lath and Plaster 1/2"	6.00
5 ply felt and gravel	6.00
4 ply felt and gravel	5.50
3 ply ready roofing	1.00
Skylight with galv. iron frame	5.00
2 inch book tile	12.00
3 inch book tile	20.00
Ludowici tile	8.00

Weights of Various Building Materials in Lbs. per Cubic Foot.

Ashes and cinders	40–45
Asphalt, paving comp	81–100
Brass and Bronze	504-524
Brick, pressed, fire and paving	120-150
Brickwork, common	110-120
Cement, bulk	92–115
Coal, anthracite (Loose and Solid)	47–93
Coal, bituminous (Loose and Solid)	40–84
Coke (Loose)	23–32
Copper	542-555
Cork	15
Glass	156-186
Gravel	90-120
Gypsum and plaster of paris	53-65
Ice	58
Iron, cast	450
Lead	709
Limestone, marble	165
Masonry, ashlar	140-165
Mortar, set	103
Sand, (Clay and earth dry to wet)	72–120
Snow, (Dry and loose to wet)	10–50
Steel	490
Terra cotta masonry	100
Timber, pine (Southern Yellow and white)	25–48
Timber, white oak	46–59

Weights of Contents of Storage Warehouses in Lbs. per Cubic Foot of Space

Canned goods, in cases	58
Cement, Portland	90
Coffee, green in bags	39
Flour, in barrels	40
Molasses, in barrels	48
Rice, in bags	58
Salt, in bags	70
Sugar, in barrels	43
Tea, in chests	25
Wine and Liquors, in barrels	38
Burlap, in bales	43
Cotton in bales, compressed	35
Cotton bleached goods, in cases	28
Hemp, Manila, compressed	30
Linen goods, in cases	30
Sisal, compressed	21
Wool in bales, compressed	48
Sheet tin, in boxes	278
Wire cables, on reels	425
Linseed Oil, in barrels	36
White lead paste, in cans	174
White lead, dry	86
Hides and leather, in bales	20
Paper, Newspaper, strawboard	35
Paper, writing and calendered	60
Rope, in coils	32

When cases, barrels, etc., are stacked, multiply weights given by number of units in each stack.

NOTES ON QUANTITY OF PAINT FOR STRUCTURAL STEEL.

THE QUANTITY of paint required to coat a given number of tons of structural steel in a bridge, building, or similar structure is determined by the spreading capacity of the paint and the character of the surface to be covered, also the temperature.

The spreading capacity of a paint varies with different paints, i. e., oil alone, red lead, graphite, iron oxide, with the specific gravity, the fineness of the pigment, the consistency of the mixture, the manner of mixing, and with the "brushing out" given the paint in its application.

The kind and condition of the surface has even a greater influence on the amount required. On a smooth rolled plate a paint may be spread over fully 50% more area than on a rough, porous, rusty surface. More paint is required on a cold surface than on a warm one, approximating 20%. Again the area of the surface to be covered varies with the character of the construction irrespective of the tonnage.

The surface area of structural steel varies from 100 square feet to 1,000 square feet per ton of metal. The data given below is therefore only approximate, but will give a reasonably close estimate of the areas and quantities required in ordinary structural work.

(a) Area per ton of metal, light structural steel, 250 to 325 square feet. Includes plate ¼" to ½" thick per ton of metal, 3" to 5" I's and channels.

(b) Area per ton of metal, medium structural steel, 100 to 250 square feet. Includes plate ½" to 1" thick per ton of metal, 6" to 24" I's and channels.

(c) Area per ton of metal, heavy girders and columns, 50 to 100 square feet.

(d) Paint required first coat, (a) 3/5 to 5/7 gal., (b) 2/5 gal., (c) 1/5 to 1/7 gal.

(e) Paint required two coat, (a) ¾ to 1 gal., (b) ⅝ gal., (c) ¼ gal.

(f) Paint required one coat applied on erected work at intervals, (b) 2/5 to ½ gal.

In the interest of economy and for the longer life of steel structures exposed to the elements, it is absolutely necessary that they be well painted with a good quality of paint and that the structures be watched for the time when they will require repainting.

When structural steel is used in creameries and laundries, where there is a great deal of moisture, it has been found advisable to paint with blue lead. Any succeeding coats of paint will last longer without change of color or deterioration.

When material is to be sprayed, figure double the amounts given above.

GENERAL SYMBOLS

Kip = 1000 pounds,
A = area of section in square inches,
l = length of span in inches,
W = load uniformly distributed in pounds, total load,
M = bending moment in inch pounds,
d = height of cross section, out to out, in inches,
c = distance of center of gravity of section, from top or from bottom, in inches,
f = stress per square inch in extreme fibers,
Δ = maximum deflection in inches,
I = moment of inertia of section neutral axis through center of gravity,
I'' = moment of inertia of section neutral axis parallel to above, but not through center of gravity,
h = distance between these neutral axes or ks,
S = section modulus,
r = radius of gyration in inches,
E = modulus of elasticity for steel 29,000,000,
F = force or concentrated load,
L = length in feet,
R = reaction,
t = thickness,
V = total shear,
x = distance parallel to X axis,
y = distance parallel to Y axis

GENERAL FORMULAE ON THE FLEXURE OF BEAMS OF ANY CROSS-SECTION

Then $S = \dfrac{I}{c}$ $\qquad r = \sqrt{\dfrac{I}{A}}$ $\qquad M = \dfrac{f\,I}{c} = fS.$

$$f = \frac{M\,c}{I} = \frac{M}{S}. \qquad W = \frac{8\,f\,I}{l\,c} = \frac{8\,f}{l}S.$$

$$f = \frac{W\,l\,c}{8\,I} = \frac{W\,l}{8\,S}. \qquad I'' = I + Ah^2.$$

$\Delta = \dfrac{5\,W\,l^3}{384\,E\,I}$ for beam supported at both ends uniformly loaded,

$\Delta = \dfrac{P\,l^3}{48\,E\,I}$ for beam supported at both ends and loaded with a single load P at middle.

$\Delta = \dfrac{W\,l^3}{8\,E\,I}$ for beam fixed at one end and unsupported at the other and uniformly loaded.

$\Delta = \dfrac{P\,l^3}{3\,E\,I}$ for beam fixed at one end and unsupported at other and loaded with a single load P at the latter end.

Weight of beam not considered in the above.

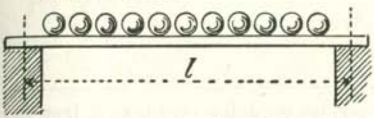
The section modulus required is numerically equal to 1.33 the bending moment in foot tons, using 18000 lbs. per sq. in., and 1.5 when using 16000 lbs. per sq. in.

BENDING MOMENTS AND DEFLECTIONS OF BEAMS UNDER VARIOUS SYSTEMS OF LOADING

W = Total load.

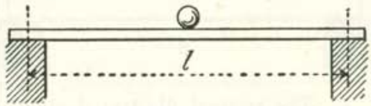
l = Length of beam in inches.

(1) Beam supported at both ends and uniformly loaded.



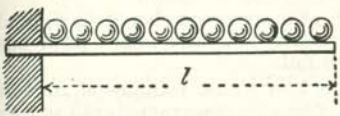
Safe load = that given in tables. Maximum bending moment at center of beam = $\frac{Wl}{8}$

(2) Beam supported at both ends, single load in middle.



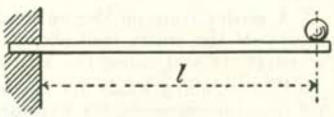
Safe load = ½ that given in tables. Maximum bending moment at center of beam = $\frac{Wl}{4}$

3) Beam fixed at one end and uniformly loaded.



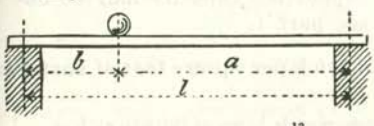
Safe load = ¼ that given in tables. Maximum bending moment at point of support = $\frac{Wl}{2}$

(4) Beam fixed at one end and loaded at the other.



Safe load = ⅛ that given in tables. Maximum bending moment at point of support = Wl.

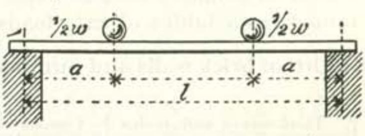
(5) Beam supported at both ends, single unsymmetrical load.



Safe load = that given in tables × $\frac{l^2}{8ab}$

Maximum bending moment under load = $\frac{Wab}{l}$

(6) Beams supported at both ends, two symmetrical loads.



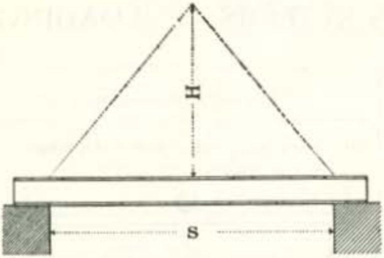
Safe loads = that given in tables × $\frac{l}{4a}$

Maximum bending moment between loads = ½ Wa

Case 1 — Deflection under safe load = that given in tables.
" 2 — " " " " = 8/10 " " " "
" 3 — " " " " = 2.4 " " " "
" 4 — " " " " = 3.2 " " " "

Case 1—Deflection = $\frac{5\ Wl^3}{384\ EI}$
where E = modulus of elasticity = 29 000 000
I = moment of inertia

BEAMS SUPPORTING BRICK WALLS



$H = S$ then

load $= \frac{1}{2}(S)^2 \times$ weight per foot of wall.

The method illustrated above may be used for openings 6 feet in width or less, provided there are no openings above, which, by a failure in the masonry, might cause the concentration of a heavy load on the girder.

For larger openings different conditions prevail. If the masonry is not thoroughly bonded, if there is danger of failure along a series of openings one above another, or if great inflexibility is desired it is good practice to consider the weight of entire wall as carried by the girder.

A girder running the entire length of a structure should be figured to support the entire wall above, as excessive deflection might push out the supports and cause the structure to fail.

Where heavy loads are carried, it is best to use columns of steel or cast iron for supports, for masonry, as ordinarily constructed, will fail by crushing out under heavy concentrated loads. When the wall carries any portion of the floor load, same should be added to weight of wall to ascertain the entire load carried by the girder.

Figures 179 to 184, page 281, show various types of steel lintels in common use, and their supporting capacity may be obtained from tables of safe loads, see part 1.

Weights of brick walls and number of brick per square foot of surface:

Thickness of wall, inches	Common Brick, pounds	No. of Brick in sq. foot
9	80	15
13	120	22½
17	155	30
21	190	37½
25	230	45
29	266	52½
33	300	60
37	336	67½

NOTES ON WOOD FLOORS.

The common type of wood floors used for store buildings, small office buildings, etc., where the loads are not heavy consists of joists placed transversely, supported by girders of steel or wood.

Methods of supporting wood joists on steel girders are shown on page 281. The method shown in Fig. 178 may be used where girders are not concealed. Where a flush ceiling is desired, a plate as shown in Fig. 177 or stirrups may be used without notching the joists.

Mill or slow-burning construction is used for storehouses, mill buildings, etc., where heavy loads must be carried. These floors are constructed of beams placed from 4 to 8 feet on centers and covered with plank from 2 to 3½ inches thick, on top of which is laid the finished floor.

Safe loads for wood beams and posts are given on pages 277 and 276 and for gas pipe columns on page 117.

Several types of joist hangers are in use for framing around stair and wall openings. On page 197 we have illustrated the single and double stirrups.

We have shown in Figs. 144 to 149, page 196, our stock joist and strap anchors; special anchors made to order.

WEIGHTS OF WOOD FLOORS IN POUNDS PER SQUARE FOOT. INCLUDING PLASTER CEILING.

Spacing of Joists	DIMENSIONS OF JOISTS					
	2 x 10	2 x 12	2 x 14	3 x 12	3 x 14	3 x 16
12	22	22	23	24	26	27
14	21	22	22	24	25	26
16	21	21	22	23	24	25
18	20	21	21	22	23	24

Based on softwood joist at 2½ lbs. per board foot, 1 thickness of ⅞ inch softwood flooring at 2½ lbs. per square foot and 1 thickness of ⅞ inch hardwood flooring at 4 lbs. per square foot.

When no ceiling is used deduct 10 lbs. per sq. ft.

Weight per sq. foot for various woods. ⅞" thick.

White Oak	White Pine	Southern Long Leaf or Georgia Yellow Pine	Hemlock	Cedar	Spruce California	Maple
4.16	1.98	3.17	2.08	1.93	2.08	3.5

SAFE LOADS IN POUNDS PER SQUARE FT. FOR PLANK FLOORS FOR FIBER STRESS OF 1200 LBS. PER SQ. IN.

SIZES—In.		Wt. Per Sq. Ft. Based on 34 Lbs. Per Cu. Ft.	SPAN IN FEET										
Nomin'l	Dressed		5	6	7	8	9	10	12	14	16	18	20
2"	1⅝	4.6	169	117	86	66	52	42	....	....	....	....	....
3"	2⅝	7.44	440	306	225	172	136	110	76	56	....	....	....
4"	3⅝	10.27	....	583	428	328	259	210	145	107	82	64	52

FIREPROOF FLOORS.

Fireproof floors are constructed with a framework of steel beams and girders, the spaces between the beams being filled with fire-proofing, which consists of arches of brick or hollow tile, or concrete steel in the form of arches or slabs.

Several types of tile arches are in common use, the tiles being hollow blocks of dense or porous structure made to form a flat or segmental arch. The webs of these blocks are either parallel with the floor beams or perpendicular thereto, the systems being termed side or end construction, respectively. Floors of this type will weigh from 70 to 90 pounds per square foot, including filling and steel beams.

Tie rods to take the thrust of the arches are required for both brick and tile construction These are ¾ or ⅞ inches in diameter, placed at or below the center of the beam, and from 4 to 6 feet apart.

Floors of concrete, reinforced with steel wire, or rods are used extensively. Examples of different methods of concrete floor construction are shown on pages 245 and 246 together with tables of safe loads and necessary rods for reinforced concrete floor slabs. On page 245 table gives the quantities of material required, for different proportions, in one yard of concrete.

One of the latest innovations in floor construction is the use of ribbed steel decking on spans of 10 to 15 feet. Steel decking is welded to the beam or joist support and is covered with any type of floor desired.

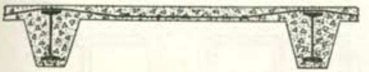
ALLOWABLE FLOOR LOADS IN POUNDS PER SQUARE FOOT.

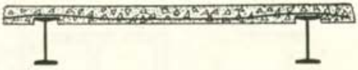
From St. Paul Building Code.

Dwellings, flats, apartments	40 lbs.
Hotels, club houses, lodging or rooming houses, family hotels, offices, hospitals	50 lbs.
Schools	60 lbs.
Private garages	85 lbs.
Light manufactories, and storage, work shops, stores	100 lbs.
Garages, fire stations, churches, assembly and dance halls, lodges, skating rinks, exhibition halls, theatres	100 lbs.
Large department stores	100 lbs.
Heavy storage and manufactories	200-250 lbs.
Sidewalks and sidewalk doors	250 lbs.

NOTE.—To the above loads the dead weight of floor must be added to obtain the total load.

CONCRETE FLOORS





Strength of Floor Slabs

Calculated for $M = \frac{1}{10} WL^2$; For $M = \frac{1}{12} WL^2$ multiply given span lengths by 1.08.

M = Bending Moment in Foot Lbs.

W = Load per square foot.

L = Length of Span in feet taken C. to C. of supports.

Ratio of Modulus of Elasticity of Steel to that of concrete = 15.

700 lbs. = Unit stress on concrete per sq. in. Coefficient of Resistance = 113.1.

18000 lbs. = Unit stress on steel per sq. in. Percentage of Steel in Concrete = .716%.

Tota thickness of slab. Inches	Thickn's concrete below under side of steel, In.	Weight of Slab Per Sq. Foot	Span in Feet For Given Live Loads in Pounds Per Square Foot of Floor														Area Steel Req. Per. Lin. Foot	Reinforcing Rods	
			30	40	50	60	75	80	90	100	125	150	175	200	250	300		Size	Spac.
2 "	¾"	24	6.5	6.0	5.6	5.3	4.9	4.7	4.5	4.3	4.0	3.7	3.4	3.2	2.8	2.7	.108	*	*
2½"	¾"	30	8.7	8.1	7.6	7.1	6.6	6.5	6.2	5.9	5.4	5.0	4.7	4.5	4.0	3.7	.151	*	*
3 "	¾"	36	10.8	10.0	9.4	8.9	8.3	8.1	7.8	7.5	6.9	6.4	6.0	5.7	5.1	4.8	.194	¼φ	3 "
3½"	¾"	42	11.4	10.7	10.1	9.6	8.9	8.8	8.4	8.1	7.5	7.0	6.6	6.2	5.7	5.2	.215	⅜φ	6 "
4 "	¾"	48	13.2	12.4	11.7	11.2	10.5	10.3	9.9	9.5	8.8	8.3	7.8	7.4	6.7	6.2	.258	⅜φ	5 "
4½"	¾"	54	14.8	14.0	13.3	12.7	12.0	11.7	11.3	10.9	10.2	9.5	9.0	8.5	7.8	7.3	.301	⅜φ	4¾"
5 "	¾"	60	16.6	15.5	14.8	14.1	13.4	13.1	12.6	12.2	11.8	10.7	10.1	9.6	8.8	8.2	.344	½φ	7 "
5½"	¾"	66	17.8	16.9	16.2	15.5	14.7	14.4	14.0	13.5	12.6	11.9	11.2	10.7	9.8	9.1	.387	½φ	6 "
6 "	¾"	72	19.2	18.3	17.5	16.8	16.0	15.7	15.2	14.8	13.8	12.6	12.3	11.8	10.8	10.0	.430	⅝φ	8½"
6½"	¾"	78	20.4	19.6	18.8	18.2	17.2	16.9	16.4	16.0	15.0	14.1	13.4	12.8	11.8	11.0	.473	⅝φ	8 "
7 "	¾"	84	21.8	20.8	20.0	19.4	18.4	18.1	17.6	17.1	16.1	15.2	14.5	13.8	12.7	11.9	.516	⅝φ	7¾"
7½"	¾"	90	23.0	22.0	21.2	20.6	19.6	19.3	18.8	18.3	17.2	16.2	15.4	14.8	13.7	12.8	.559	⅝φ	6½"
8 "	¾"	96	24.1	23.2	22.4	21.7	20.7	20.4	19.9	19.4	18.2	17.3	16.5	15.7	14.6	13.6	.602	⅝φ	6 "
9 "	¾"	108	26.4	25.4	24.6	23.8	22.9	22.6	22.0	21.4	20.3	19.3	18.4	17.6	16.4	15.3	.688	⅝φ	5¾"
10 "	¾"	120	28.4	27.5	26.8	26.0	25.0	24.6	24.0	23.5	22.2	21.2	20.3	19.5	18.1	17.0	.774	⅝φ	4¾"
11 "	¾"	132	30.4	29.5	28.7	28.0	27.0	26.6	26.0	25.4	24.2	23.1	22.1	21.2	19.8	18.6	.860	⅝φ	4¼"
12 "	¾"	144	32.3	31.4	30.6	29.8	28.8	28.4	27.8	27.2	26.0	24.8	23.8	23.0	21.5	20.2	.946	⅝φ	4 "

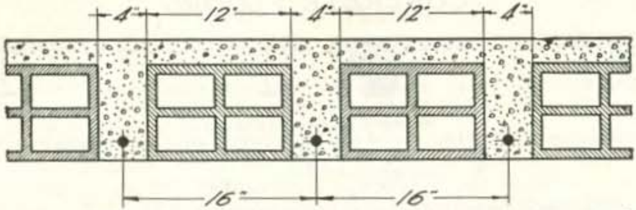
MATERIALS REQUIRED FOR ONE CUBIC YARD OF CONCRETE

Proportion by Parts			Material Required on the Basis of 1 Barrel = 3.8 Cubic Feet			Material Required on the Basis of 1 Barrel = 4.0 Cubic Feet		
Portland Cement	Sand	Stone	Cement in Barrels	Sand In Cubic Yards	Stone In Cubic Yards	Cement in Barrels	Sand In Cubic Yards	Stone In Cubic Yards
1	1.5	3	1.94	0.41	0.82	1.86	0.41	0.82
1	2	4	1.52	0.43	0.86	1.46	0.43	0.86
1	2.5	5	1.26	0.44	0.88	1.20	0.44	0.88
1	3	5	1.17	0.49	0.82	1.10	0.49	0.82
1	3	6	1.07	0.45	0.90	1.02	0.45	0.90

Approximately the same quantities will be required if gravel is used. Quantities may be found to vary 10 per cent from those given due to variation in fineness of sand and stone.

*Patented or Wire Reinforcement.

NATCO "ONE-WAY" LONG SPAN FLOORS



The upper figures in tables denote the depth of tile; the lower figures indicate the area of reinforcing steel required in each concrete joist. Thickness of floor=depth of tile+2" of concrete top.

The tables below are so arranged that they can be used for floor slabs freely supported at both ends, semi-continuous, or continuous.

For slabs freely supported at both ends (simple span) use load given opposite WL/8. For slabs freely supported at one end and continuous over other support use loads given opposite WL/9, or if building code permits WL/10. For slabs continuous over both supports use loads given opposite WL/10, or if building code permits WL/12.

For semi-continuous and continuous spans proper reinforcement must be provided in top of slab over support to take care of negative bending moment. Where heavy loads and short spans are encountered, the vertical and longitudinal shear must be investigated.

The load tables are for general information only as each particular operation should be designed in accordance with actual conditions.

2" CONCRETE TOP

fc. 700 pounds per square inch.
fs. 18000 pounds per square inch.

$$\frac{Ec}{Es} = \frac{1}{15}$$

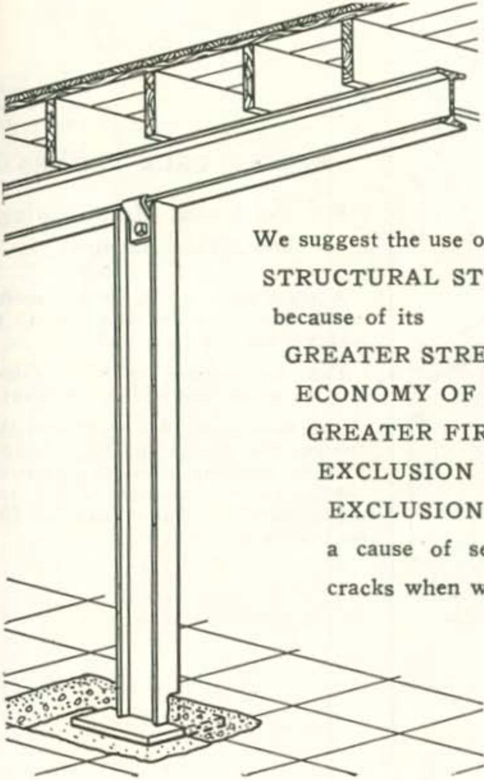
¾" of concrete below reinforcement
4" concrete joists 16" on centers.

Bending Moment	TOTAL SAFE LOADS (Dead & Live)											
WL/12	150	165	180	195	210	225	240	260	300	335	375	450
WL/10	125	135	150	160	175	185	200	220	250	280	310	375
WL/9	110	120	135	145	155	170	180	195	225	250	280	335
WL/8	100	110	120	130	140	150	160	175	200	225	250	300
Span 6'-0"						3/.17	3/.18	3/.20	3/.23	3/.26	3/.29	3/.34
" 8'-0"	3/.20	3/.22	3/.24	3/.26	3/.28	3/.30	3/.32	3/.35	3/.41	3/.46	4/.40	4/.49
" 10'-0"	3/.32	3/.35	3/.38	3/.41	3/.44	4/.38	4/.40	4/ 44	4/.51	4/.57	5/.53	5/.63
" 12'-0"	3/.46	4/.40	4/.44	4/.47	4/.51	4/.55	5/.48	5/.53	5/.60	5/.68	6/.64	7/.69
" 14'-0"	4/.50	4/.55	5/.50	5/.54	5/.58	5/.62	5/.66	6/.61	6/.70	7/.71	7/.78	8/.83
" 16'-0"	5/.54	5/.59	5/.65	6/.60	6/.64	6/.69	6/.73	7/.72	8/.72	8/.81	9/.82	10/.89
" 18'-0"	5/.68	6/.64	6/.69	6/.75	7/.73	7/.78	8/.73	8/.80	9/.83	10/.84	10/.93	12/.93
" 20'-0"	6/.71	7/.70	7/.77	8/.73	8/.79	8/.84	9/.82	10/.81	10/.92	12/.86	12/.97	15/.92
" 22'-0"	7/.77	8/.75	8/.82	9/.81	9/.87	10/.85	10/.89	12/.81	12/.93	15/.83	15/.92	
" 24'-0"	8/.81	9/.81	9/.89	10/.86	10/.93	12/.83	12/.88	12/.97	15/.88	15/.99		

Weights of Natco Combination Floors and Concrete Required

Thickness of Tile	3"	4"	5"	6"	7"	8"	9"	10"	12"	15"
ONE-WAY—2" Concrete Top—4" Joists, 16" on centers										
Weight per sq. ft. of floor area	45 lbs.	50 lbs.	55 lbs.	60 lbs.	65 lbs.	70 lbs.	75 lbs.	80 lbs.	90 lbs.	105 lbs.
Cu. ft. concrete per sq. ft. floor	0.229	0.250	0.271	0.292	0.313	0.333	0.354	0.375	0.417	0.479

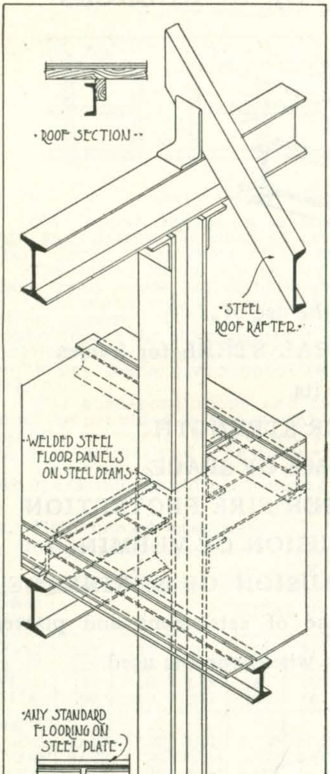
STRUCTURAL STEEL FOR RESIDENCES



We suggest the use of
STRUCTURAL STEEL for homes
because of its
GREATER STRENGTH
ECONOMY OF SPACE
GREATER FIRE PROTECTION
EXCLUSION OF VERMIN
EXCLUSION OF SHRINKAGE,
a cause of settlement and plaster cracks when wood is used.

Steel H columns 4″ and 5″ square can be set into partitions conveniently without unsightly projection.

Erection of columns and beams in residences is simple and rapid.



BATTLE DECK FLOORS

For Residences, Manufacturing and Office Buildings

A steel floor which is fire resistant, shrink-proof and light in weight, and shallow.

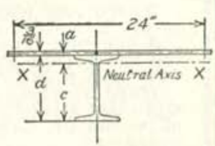
Can be covered with linoleum, tile, or wood, and is non-resonant.

The floor plates are welded to the beams, the beams to the columns, thereby assuring strength and stiffness. All holes required by the other building trades can readily be provided.

3 4 5 6

BATTLEDECK FLOOR CONSTRUCTION

I is Moment of Inertia
S is Section Modulus
w_1 is Weight of Beam in pounds per linear foot
w_2 is Weight of Plate in pounds per linear foot
w_3 is Weight of Steel Floor Const. in pounds per sq. ft.
C is Coefficient of Strength for Simple span
M is Maximum Moment in inch pounds
V is Maximum Web Shear in pounds



Type of Beam	Standard Beams					
Depth of Beam . . d	3"	3"	4"	4"	5"	6"
Weight of Beam w_1	5.7	5.7	7.7	7.7	10.0	12.5
Size of Plate	24 x 3/16	24 x 1/4	24 x 3/16	24 x 1/4	24 x 1/4	24 x 1/4
Weight of Plate w_2	15.3	20.4	15.3	20.4	20.4	20.4
Weight of Floor w_3	10.5	13.05	11.5	14.05	15.2	16.45
a	.425	.35	.690	.572	.849	1.174
c	2.668	2.775	3.404	3.553	4.276	4.951
Axis X-X I	5.56	5.93	12.508	13.32	25.51	43.84
Axis X-X S	2.085	2.14	3.674	3.75	5.966	8.85
Coef. Strength . . C	25000	25700	44100	45000	71600	106300
Max. Mom."# . . M	37500	38500	66100	67500	107400	159400
Max. Web Shear . V	6100	6100	9100	9100	12600	16600

Span in feet	3" Total Load in Kips	3" Load per square foot of floor	3" Deflection	3" Total Load in Kips	3" Load per square foot of floor	3" Deflection	4" Total Load in Kips	4" Load per square foot of floor	4" Deflection	4" Total Load in Kips	4" Load per square foot of floor	4" Deflection	5" Total Load in Kips	5" Load per square foot of floor	5" Deflection	6" Total Load in Kips	6" Load per square foot of floor	6" Deflection
7	5.4	385	.051	5.5	395	.049	9.4	675	.040	9.6	690	.039	15.3	1095	.032	22.8	1625	.028
8	4.7	295	.067	4.8	300	.064	8.3	515	.052	8.4	525	.050	13.4	840	.042	19.9	1245	.036
9	4.2	230	.085	4.3	240	.082	7.3	410	.067	7.5	415	.064	11.9	665	.053	17.7	985	.046
10	3.8	190	.104	3.9	195	.101	6.6	330	.082	6.8	335	.079	10.7	535	.065	15.9	795	.056
11	3.4	155	.126	3.5	160	.122	6.0	275	.099	6.1	280	.095	9.8	445	.079	14.5	660	.068
12	3.1	130	.150	3.2	135	.145	5.5	230	.118	5.6	235	.113	8.9	375	.094	13.3	555	.081
13	2.9	110	.177	3.0	115	.170	5.1	195	.139	5.2	200	.133	8.3	320	.111	12.3	470	.095
14	2.7	95	.205	2.8	100	.197	4.7	170	.161	4.8	170	.154	7.7	275	.128	11.4	405	.111
15	2.5	85	.235	2.6	85	.226	4.4	145	.185	4.5	150	.177	7.2	240	.147	10.6	355	.127
16	2.3	75	.268	2.4	75	.258	4.1	130	.210	4.2	130	.201	6.7	210	.167	10.0	310	.145
17	2.2	65	.302	2.3	65	.291	3.9	115	.238	4.0	115	.228	6.3	185	.189	9.4	275	.163
18	2.1	60	.338	2.1	60	.326	3.7	100	.266	3.7	105	.255	6.0	165	.212	8.9	245	.183
19	2.0	50	.377	2.0	55	.363	3.5	90	.296	3.6	95	.284	5.7	150	.236	8.4	220	.204
20	1.9	45	.418	1.9	50	.403	3.3	85	.328	3.4	85	.315	5.4	135	.261	8.0	200	.226
21							3.1	75	.362	3.2	75	.347	5.1	120	.288	7.6	180	.249
22							3.0	70	.397	3.1	70	.380	4.9	110	.316	7.2	165	.273
23							2.9	60	.435	2.9	65	.416	4.7	100	.346	6.9	150	.299
24							2.8	55	.473	2.8	60	.453	4.5	95	.376	6.6	140	.325
25							2.6	55	.513	2.7	55	.491	4.3	85	.408	6.4	130	.353

The Total Load tabulated for various span lengths is the Total Allowable Uniformly Distributed Load in Kips for continuous beam, as fixed by shear or flexure whichever is least. The Total Allowable Concentrated Center Load for continuous beam and the Total Allowable Uniformly Distributed Load for simple span beam may be obtained by dividing the Coefficient of Strength 'C' by the length of the span in feet.

The Deflection tabulated above is the Total Deflection in inches for the Maximum Uniformly Distributed Load for continuous beams.
The Total Deflection in inches for Maximum Concentrated Center Load for continuous beams is one and one-third times those tabulated above.
The Total Deflection in inches for Maximum Uniformly Distributed Load for simple span beams is three and one-third times those tabulated above.
Live Load Deflection must not exceed 1/360 of the Span.

$$\text{Live Load Deflection} = \frac{\text{Total Deflection x Live Load}}{\text{Total Allowable Load}}$$

Table based on 18000 Tension

NOTES ON ROOFS

Where roof loads are to be supported over wide spans, steel trusses are generally used.

A common type of combination truss is illustrated on page 254, the top and bottom chords and compression members being made of wood, with iron rods to take tension.

Wood members at connections are notched in and bolted, or castings and steel straps may be used. In all cases the connections should be of sufficient strength to develop the entire strength of members connected.

Where top chord is notched into bottom chord, care should be taken to leave sufficient section in bottom chord at that point to resist shear and bending. Where bottom chord forms an arched ceiling provisions must be made either in the truss or in the supporting walls to take the thrust.

Over large spans, steel trusses may be built stronger, lighter and at less cost than wood trusses. The cost of assembling is saved as in most cases they can be shipped in one or two pieces. Their lightness and stiffness make erection of steel trusses relatively easy.

On page 252 we illustrate a few types of steel trusses of simple form and good for short and long spans. We will furnish designs and estimates for any type and size of truss upon application.

The size of steel trusses varies with the span, and with the roof and other loads to be imposed. For preliminary estimates of the weight where only an approximation is necessary, the following formula is applicable:

$$W = \frac{1}{8}\left(\sqrt{L} + \frac{1}{8}L\right)$$

Where L is the length of span in feet
W is the approximate weight per horizontal square foot, when 40 pounds is the weight of the imposed load per square foot.

For loads greater or less than 40 lbs. per square foot, interpolate.

Note the table of roof loads including both dead and live loads for various kinds of roofing and figured per horizontal square foot; these to be used generally on spans of 80 feet or less. We also give a table of weights for various kinds of roofing materials.

Approximate Weight of Roofing Materials

Material	Weight per sq. ft.
Copper No. 22 B. W. G.	1½
Corr. Galvanized iron No. 22B.W.G.	1¾
Corr. Galvanized iron No. 26B.W.G.	1¼
Felt, two layers	½
Felt and asphalt or coal tar	2
Glass, ⅛-inch thick	1¾
Lath and plaster ceiling	6–8
Lead, ⅛-inch thick	7½
Sheathing, white pine or spruce, 1 inch thick	2¼-2½
Sheathing, yellow pine, 1-inch thick	3½
Shingles, 6x18, 6 in. to weather	2
Skylight glass $\frac{3}{16}$x½ in. thick, including frame	4–10
Slag cof 4 ply with cement and sand	4
Slate $\frac{1}{16}$-in. thick, 3 in. double lap	6¾
Tiles, plain, 5¼ in. to weather	18
Tiles, Spanish, 7¼ in. to weather	8½
Tin roofing and one thickness of felt	1
Five ply felt and gravel	6
Concrete slab, 3 in. thick	37½
Concrete cinder slab 4 in. thick	33⅓
For Ceiling tiles see page 288	
Federal Tile, see page 310	
Pyrobar Blocks, 3 in. thk.	13

TOTAL LOADS

KIND OF ROOFING		Weight per sq. ft. Lbs.
Gravel or Composition Roofing	on boards, slope 1:6 or less	50
	on boards, slope over 1:6	45
	on 3-in. flat tile or cinder concrete	60
Corr. sheathing on boards or purlins		40
Slate	on boards or purlins	50
	on 3-in flat tile or cinder concrete	65
Tile on steel purlins		55
Steel roof decking (Depending on span.)		2 to 3
Steel floor decking (Depending on span.)		5 to 10
Glass		45

To the loads given, classed as dead loads, must be added the loads due to snow or wind, or both, i. e., the live loads. Any live load due to machinery, hangers for balconies, trolleys, etc., should not be omitted.

Generally 30 pounds total live load, for snow and wind combined, will suffice. That loading may be changed, due to climatic conditions and type of truss selected In temperate climes a minimum snow load of 25 pounds should be used on each horizontal square foot for all pitches of the roof surface up to 20 degrees; this loading is to be reduced one pound for each degree of increase of the slope up to 45 degrees; beyond this no snow load need be considered. Special calculations are necessary in severe climes or where snow or ice is apt to concentrate. Where advisable, wind loads for various pitches of roofs may be figured according to the following:

Wind Pressure Normal to Slope of Roof.

FROM HUTTON'S TRIGONOMETRIC FORMULA

$P = P' \text{sine}\, x^{1.84 \cos x - 1}$

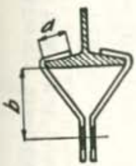
P = Pressure in pounds per sq. ft. normal to slope of roof

P' = Wind pressure in pounds per sq. ft. of vertical surface (30 lbs. per sq. ft.)

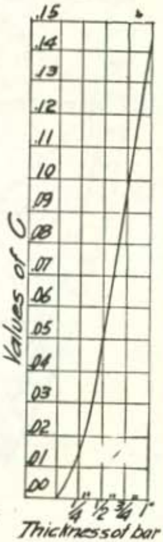
X = Internal angle roof slope makes with horizontal

RISE	Angle of slope with Horizontal	Pitch Proportion of Rise to span	Wind Pressure Normal to slope Pounds per sq. ft
4 inches per foot horizontal	18°–25′	1/6	12.6
6 inches per foot horizontal	26°–33′	1/4	17.8
8 inches per foot horizontal	33°–42′	1/3	21.7
12 inches per foot horizontal	45°–0′	1/2	27.0
16 inches per foot horizontal	53°–7′	2/3	29.0
18 inches per foot horizontal	56°–20′	3/4	29.4
24 inches per foot horizontal	63°–27′	1	30.0

Method of Obtaining Correct Standard Sizes of Beam Hangers:



Size of Beam	a	b
For 3″-4″ and 5″ Is	7/8″	3½″
For 6″-7″ Is	1¼″	4″
For 8″-9″ and 10″ Is	1½″	4½″
For 12″-15″-18″ and 20″ Is	2″	5″
For 20″ heavy—24″ Is	2½″	6″



Method of Calculation.

Given:

P = load carried by hanger in lbs.
S = Allowable fibre stress in lbs. per sq. in.
B = width of bar used in inches

$$\text{Then } C = \frac{P}{2BS} \quad \text{or } S = \frac{P}{2BC}$$

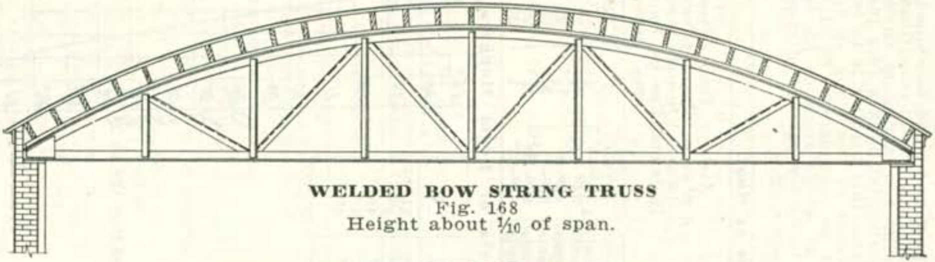
When C is obtained then thickness of bar may be found from the accompanying curve,

Example: load to be carried = 3000 lbs.
Fibre stress = 16000 lbs./□″
Width of hanger used = 3″

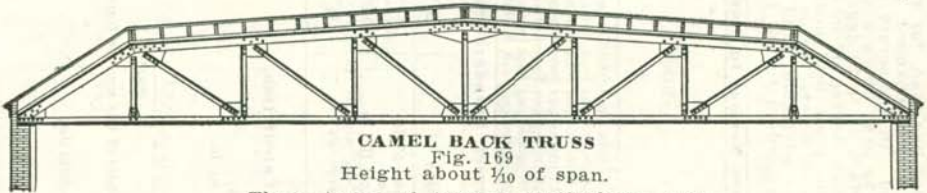
$$\text{Then } C = \frac{3000}{2 \times 3 \times 16000} = 0.03$$

This corresponds to a bar 3/8″ thick. Therefore a hanger of 2-3/8″x3″ bars should be used.

TYPICAL STEEL TRUSSES

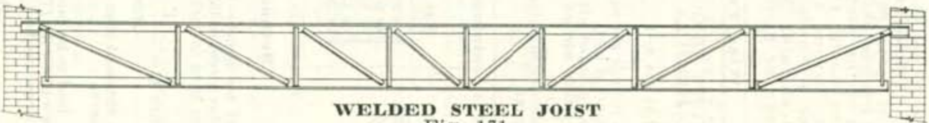


WELDED BOW STRING TRUSS
Fig. 168
Height about 1/10 of span.



CAMEL BACK TRUSS
Fig. 169
Height about 1/10 of span.

These types of trusses particularly well adapted to garages of various spans.



WELDED STEEL JOIST
Fig. 171
Height about 1/15 of span.

For floors and roofs of various types of buildings with T sections for top and bottom cord and angle web members.

We design and fabricate all styles of trusses for various spans and types of buildings.

ROOF TRUSSES

TABLES FOR FINDING STRESSES IN MEMBERS FOR ROOF TRUSSES OF THE DIFFERENT TYPES AND PITCHES AS GIVEN BELOW AND OF ANY SPAN.

RULE: To find the stress in any member, multiply the coefficient given for that member by total load carried by truss (=span in feet × distance between trusses in feet × weight per square foot). If the truss is acted upon by wind forces or other unsymmetrical loading, the stresses in the members must be calculated accordingly and combined with the load stresses as found below.

Member of Truss	Pitch (Depth to Span)			
	⅓	30°	¼	⅕
Fig. IV				
A-a	.675	.750	.838	1.010
B-b	.537	.625	.726	.917
C-a	.563	.650	.750	.938
C-c	.375	.433	.500	.625
a-b	.208	.217	.224	.232
b-c	.188	.217	.250	.313
Fig. V				
A-a	.750	.833	.930	1.120
B-b	.589	.666	.757	.928
C-c	.568	.666	.783	.995
D-a	.625	.721	.833	1.042
D-d	.375	.433	.500	.625
a-b	.155	.167	.180	.202
b-c	.155	.167	.180	.202
c-d	.250	.288	.333	.417
Fig. VI				
A-a	.788	.874	.978	1.178
B-b	.718	.812	.922	1.131
C-c	.649	.750	.866	1.085
D-d	.580	.687	.810	1.038
E-a	.655	.758	.875	1.094
E-f	.562	.650	.750	.938
E-e	.375	.433	.500	.625
a-b	.104	.108	.112	.116
b-f	.093	.108	.125	.156
f-g	.208	.216	.224	.232
g-c	.093	.108	.125	.156
c-d	.104	.108	.112	.116
g-e	.187	.217	.250	.313
d-e	.280	.325	.375	.469

NOTE—Heavy lines denote compression and light lines tension members. Loads are considered as concentrated at the joints.

Fig. IV

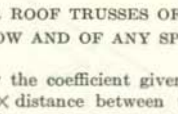


Fig. V

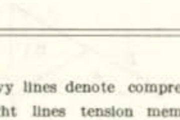
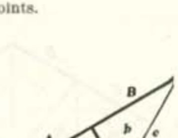
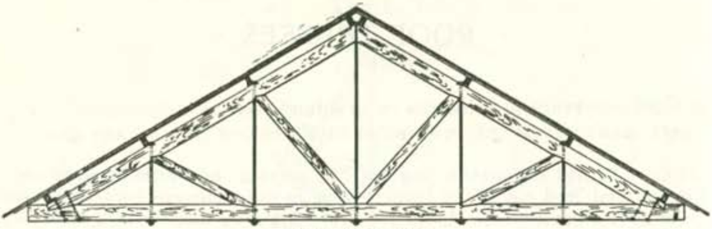


Fig. VI





Wooden Roof Truss.
Fig. 172

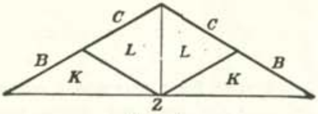


Fig 1

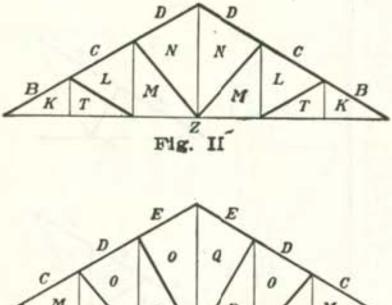


Fig. II

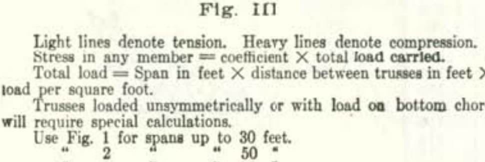


Fig. III

Light lines denote tension. Heavy lines denote compression.
Stress in any member = coefficient × total load carried.

Total load = Span in feet × distance between trusses in feet × load per square foot.

Trusses loaded unsymmetrically or with load on bottom chord will require special calculations.

Use Fig. 1 for spans up to 30 feet.
" 2 " " 50 "
" 3 " " 70 "

COEFFICIENTS

Member of Truss	Pitch (depth to span)		
	1:3	30°	1:4
Fig. I			
BK	.676	.750	.837
CL	.450	.500	.558
KL	.225	.250	.279
KZ	.562	.647	.750
LL	.250	.250	.250
Fig. II			
BK	.750	.835	.930
CL	.600	.665	.749
DN	.450	.497	.555
KT	.0	.0	.0
LM	.083	.083	.083
NN	.334	.334	.334
TL	.150	.170	.185
MN	.207	.220	.235
KZ	.625	.720	.830
TZ	.625	.720	.830
MZ	.500	.575	.667
Fig. III			
BK	.785	.870	.986
CM	.673	.750	.845
DO	.560	.620	.700
EQ	.450	.500	.560
QQ	.375	.375	.375
PQ	.210	.215	.225
OP	.125	.125	.125
NO	.156	.165	.176
MN	.062	.062	.062
LM	.112	.124	.141
KL	.0	.0	.0
KZ	.655	.755	.875
LZ	.655	.755	.875
NZ	.560	.645	.750
PZ	.470	.540	.625

SUSPENDED CEILINGS

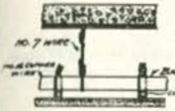


Fig No. 173

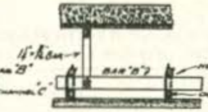


Fig No. 174

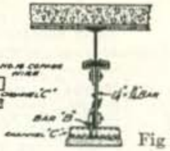


Fig No. 175

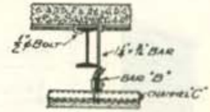


Fig No. 176

Suspended ceilings are constructed wherever it is necessary to cover overhead floor framing so as to secure a lower flat ceiling. These ceilings will cover overhead ducts and passages and will prevent undue condensation on the under side of roof or similar cold surfaces.

The above sketches show several types of suspension. Fig. 173 shows the method used for ceilings carrying the dead load of framing and plaster only; Figs. 174, 175, 176, show the method used for ceilings carrying live loads in addition to the dead loads.

The various sizes of hangers, bars and channels for the several types of suspended ceilings are given in the table below. The small channels should be wired to the longitudinal bars with No. 16 copper wire, and the expanded metal should be fastened to the small channels in the same way at every crossing. Where a ribbed expanded metal is used the small channels are omitted.

For special conditions of loading and spacing, different sizes from those given should be designed.

Total Load Lbs. Per Sq. Ft.		SPAN IN FEET, BARS SPACED 4′-0″ CTRS. USUAL SPACING						Size of Channels C
		3	4	5	6	7	8	
10	Bar "B"	1¼x¼	1½x¼	2 x5/16	2½x¼	3 x5/16	5 x5/16 4 [	¾ @ { .40 lbs. .56 lbs.
	Hanger	No.7 wire ¼—rod	No.7 wire ¼—rod	¼—rod ¼—rod	¼—rod 1¼x3/16	¼—rod 1¼x3/16	1¼x3/16 1¼x3/16	
16	Bar "B"	1½x¼	2 x¼	2¼x5/16	2½x5/16	3½x¼	5½x5/16 4 [	¾ @ { .40 lbs. .56 lbs.
	Hanger	No.7 wire ¼—rod	No.7 wire ¼—rod	¼—rod 1¼x3/16	¼—rod 1¼x3/16	¼ rod 1¼x3/16	1¼x3/16 1¼x3/16	
20	Bar "B"	1½x5/16	2 x5/16	2½x5/16	3 x¼	3½x5/16 3 [	6 x5/16 4 [	⅞ @ { .68 lbs. .92 lbs.
	Hanger	No.7 wire ¼—rod	¼—rod 1¼x3/16	1¼x3/16 1¼x3/16	1¼x3/16 1¼x3/16	1¼x3/16 1¼x3/16	1¼x3/16 1¼x3/16	
25	Bar "B"	1¾x¼	2¼x5/16	2½x⅜	3 x5/16	4 x¼ 3 [	6½x5/16 4 [	1 @ { .68 lbs. .82 lbs.
	Hanger	1¼x3/16	1¼x3/16	1¼x3/16	1¼x3/16	1¼x3/16	1¼x3/16	
30	Bar "B"	1¾x5/16	2½x5/16	3 x¼	3½x¼	4½x¼ 3 [	6½x5/16 4 [	1¼ @ { 1.29 lbs. .92 lbs.
	Hanger	1¼x3/16	1¼x3/16	1¼x3/16	1¼x3/16	1¼x3/16	1¼x3/16	
35	Bar "B"	2 x⅜	3 x¼	3 x5/16	3½x5/16 3 [	5 x3/16 4 [	7 x¼ 4 [	1¼ @ { 1.54 lbs. .85 lbs.
	Hanger	1¼x3/16	1¼x3/16	1¼x3/16	1¼x3/16	1¼x3/16	1¼x3/16	
40	Bar "B"	2½x⅜	3 x5/16	3½x¼	4 x5/16 3 [	5½x3/16 4 [	7 x5/16 4 [	1½ @ { 1.12 lbs. 1.67 lbs.
	Hanger	1¼x3/16	1¼x3/16	1¼x3/16	1¼x3/16	1¼x¼	1¼x¼	

A ½″ Bolt is sufficient for all connections. Rods round.

TRUSCON ¾″ HY-RIB FOR FLOORS AND ROOF SLABS

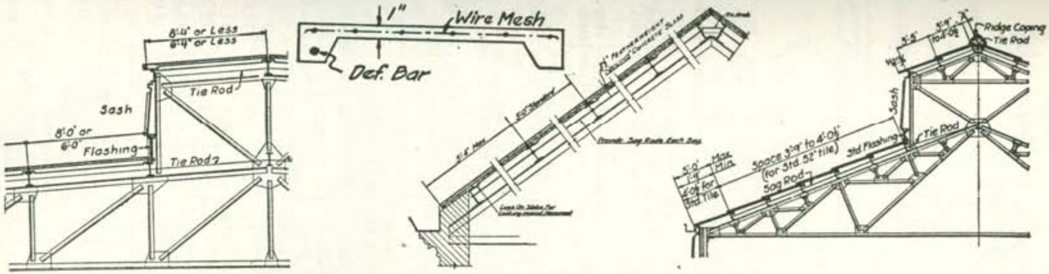
SAFE LOADS FOR ¾″ HY-RIB SLABS

Safe Loads include Weight of Slab. For Safe Live Load Deduct Weight of Slab.

Thickness of Slabs above Base of Hy-Rib	Weight Per Sq. Ft. ¾″ Hy-Rib	Moment of Resistance Per Ft. of Width	SPAN IN FEET								
			3	4	5	6	7	8	9	10	11
2″ thick slab	.58	3440	318	179	115	80	....	....	....	....	....
Wgt. = 24 lbs.	.68	3940	365	205	131	91	....	....	....	....	....
per sq. ft.	.78	4160	385	216	138	96	....	....	....	....	....
2½″ thick slab	.58	4530	420	236	151	105	77	59	....	....	....
Wgt. = 30 lbs.	.68	5380	498	280	179	125	91	70	....	....	....
per sq. ft.	.78	6230	577	325	208	144	106	81	....	....	....
3″ thick slab	.58	5630	522	293	188	131	96	73	....	....	....
Wgt. = 30 lbs.	.68	6710	622	349	224	155	114	87	69	....	....
per sq. ft.	.78	7780	720	405	259	180	132	101	80	....	....
3½″ thick slab	.58	6750	625	352	225	156	115	88	....	....	....
Wgt. = 42 lbs.	.68	8020	743	418	268	186	136	104	83	....	....
per sq. ft.	.78	9300	862	484	310	215	158	121	96	78	....
4″ thick slab	.58	7850	727	409	262	182	134	102	81	....	....
Wgt. = 48 lbs.	.68	9350	866	487	312	216	159	122	96	78	...
per sq. ft.	.78	10870	1060	566	362	252	185	142	112	91	75

B. M. = $1/10WL^2$ For B. M. = $1/12WL^2$, add 20% to above loads.
For B. M. = $1/8WL^2$, deduct 20% from above loads.

HY-RIB, of plain or copper-alloyed steels in various gages, is also used in place of wood lath for plastered walls and ceilings and for plastered partitions in which case the rib is ⅜″ or ¾″, depending upon the span over which the Hy-rib lath is supported.



FEATHERWEIGHT CONCRETE INSULATING ROOF SLABS

These fireproof, precast reinforced concrete roof slabs are composed of an approved brand of portland cement and the highest grade Haydite aggregate in a mixture of one part of cement to four parts of aggregate, accurately graded and thoroughly mixed and vibrated so as to obtain the greatest possible density. Ultimate load 250 lbs. per sq. ft. Data on three types follows:

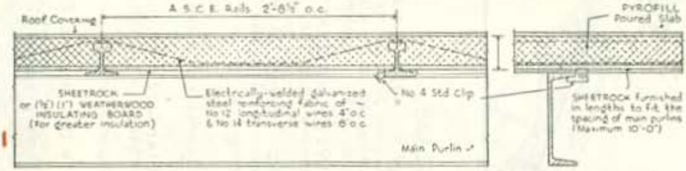
Type	(1) CHANNEL SLABS Space purlins 6′ for 2¾″ slabs, max. 6′4″. Space 8′ for 3½″ slabs, max. 8′4″.	(2) NAILING SLABS Space purlins 5′ apart—for longer lengths space purlins 5′ to 5′4″ max.	(3) INTERLOCKING SLABS Space purlins 3′9″ to 4′0½″ back to back for 52″ slabs. Max. 5′ for special lengths.
Roof	Flat or sloping.	Sloping.	Sloping.
Reinforcing	Deformed bars in legs and galvanized welded wire mesh in web.	Galvanized wire mesh.	Galvanized wire mesh.
Size		2′ wide with layer of 1¼″ nailing concrete cast integrally on top.	Standard 52″ long, 24″ wide, 1⅛″ thick.
Joints	Asphaltic cement on upper side.		Special elastic cement.
Weight	2¾″—12 lbs. per sq. ft. 3½″—14 lbs. per sq. ft.	18 lbs. per sq. ft.	14 lbs. per sq. ft.

Type (1) covered with weatherproof covering by others. Type (2) takes ornamental roof nailed direct to the slabs. Type (3) has permanent red color; no composition covering required. Glass Insert Slabs for daylighting, furnished to interchange with standard slabs.

For Additional Information Send for Catalog—Address—See Index.

USG

SHEETROCK-PYROFILL AND WEATHERWOOD-PYROFILL ROOF CONSTRUCTIONS



TYPICAL SHEETROCK OR WEATHERWOOD PYROFILL CONSTRUCTION

Whenever steel framing is used (whether the roof be flat, 45° pitched, monitor, sawtooth, Pond, Aiken, etc.) the inherent value of either Sheetrock-Pyrofill or Weatherwood-Pyrofill construction may be employed advantageously; the latter increases heat insulation and acoustical correction.

The Sheetrock-Pyrofill Roof Deck is a poured-in-place reinforced gypsum roof construction over permanent Sheetrock or Weatherwood forms. There are no joints for heat loss, and the monolithic construction helps stiffen the building structure.

Regardless of how great the spacing is between purlins, the gypsum spans only 32½ inches—the spacing between sub-purlins. The sub-purlins are designed to carry the total live and dead load.

After the reinforcing has been placed over the Sheetrock or Weatherwood permanent forms, Pyrofill is poured and screeded to the proper thickness, making the total depth of the slab 2½ or 3 inches, including the thickness of the form. Pyrofill consists of gypsum stucco, water, and 12½ lbs. of fiber to 87½ lbs. of calcined gypsum. Pyrofill weighs only 52 lbs. per cubic foot.

Curbs, end walls, etc., are usually constructed of Precast Gypsum Tile. Curbs may also be made of Sheetrock-Pyrofill or Weatherwood-Pyrofill construction.

SUB-PURLIN SIZES AND WEIGHTS OF SLABS
Sub-Purlins Spaced 32⅝" Total Load—45 Lbs. Per Sq. Ft. M=1/10 WL

Size & Section Modulus of Sub-Purlins	Allowable Span		Weight of Sub-Purlins in Lbs. Per Sq. Ft. of Roof	Weight of Slab Including Sub-Purlins					
	18M Lbs. Per Sq. In. Sub-Purlin Stress	20M Lbs. Per Sq. In. Sub-Purlin Stress		Sheetrock Pyrofill		Weatherwood Pyrofill		Asbestos Board Pyrofill	
				Min. Slab	Wt. #/□'	Min. Slab	Wt. #/□'	Min. Slab	Wt. #/□'
#178 bulb T S=.348 in.³	6'- 6"	6'-10"	1.00	2½"	11.5	3"	10.5	2½"	11.5
#218 bulb T S=.450 in.³	7'- 5"	7'-10"	1.03	2½"	11.5	3"	10.5	2½"	11.5
12#/yd. Rail S= .63 in.³	8'-11"	9'- 3"	1.50	2½"	12.0	3"	11.0	2½"	12.0
16#/yd. Rail S=1.01 in.³	11'- 2"	11'- 6"	2.0	2½"	12.5	3"	11.5	2½"	12.5
20#/yd. Rail S=1.43 in.³	13'- 3"	13'- 8"	2.5	3 "	15.0	3"	12.0	3 "	15.0

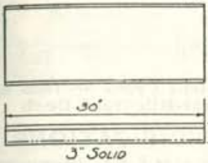
THERMAL CONDUCTIVITY—Btu Per Sq. Ft., Per Hour, Per Degree F. Difference in Temperature

2½" Sheetrock Pyrofill	3" Weatherwood Pyrofill	2½" Asbestos Board Pyrofill
With No Roof Insulation .38 Btu	With No Roof Insulation .19 Btu	With No Roof Insulation 40 Btu
With ½" Weatherwood Roof Insulation....... .24 Btu	With ½" Weatherwood Roof Insulation...... .15 Btu	With ½" Weatherwood Roof Insulation...... .25 Btu
With 1" Weatherwood Roof Insulation....... .18 Btu	With 1" Weatherwood Roof Insulation...... .12 Btu	With 1" Weatherwood Roof Insulation...... .18 Btu

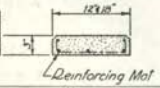
DETAILS OF SHORT SPAN ROOF TILE

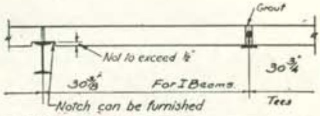
Note: All Tile Reinforced With Electrically Welded Galvanized Steel Mat

3″ Short Span Gypsum Roof Tile



Depth	3″ Solid
Length	30″
Wt./□′	17 lbs.





3″-Short Span Gypsum ROOF TILE

Dimensions			Weight Per Sq. Ft.	Design Load Per Sq. Ft.
Thick	Width	Length		
3″	12″	30″	17 Lbs.	55 Lbs.

THERMAL CONDUCTIVITY

Btu per square foot per hour per Degree F difference in Temperature

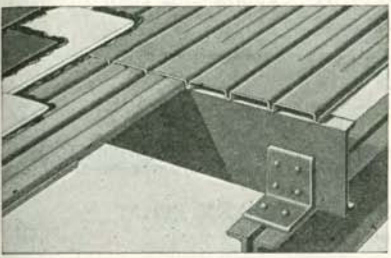
No Insulation	½″ Weatherwood	1″ Weatherwood
0.48	0.28	0.19

STEEL SUB-PURLINS

Spaced 2′6¾″ O. C.

Based on Total Roof Load of 55 lbs. per sq. ft. and M = 1/10 WL

Size & Section Modulus of Sub-Purlins		Weight Per Lin. Foot Sub-Purlin	Weight Per Sq. Foot Roof	Allowable Span 18,000 #/□″ Stress	Allowable Span 20,000 #/□″ Stress
#178 Bulb Tee	S = .348 in.³	2.66 Lbs.	1.03 Lbs.	6′1″	6′5″
#218 Bulb Tee	S = .450 in.³	2.80 "	1.08 "	6′11″	7′3″
2½″x2½″x5/16″ Std. Tee	S = .500 in.³	5.50 "	2.15 "	7′3″	7′8″
2½″x3″ x 5/16″ Std. Tee	S = .720 in.³	6.10 "	2.40 "	8′9″	9′3″
3″x3″x5/16″ Std. Tee	S = .740 in.³	6.70 "	2.61 "	8′10″	9′4″



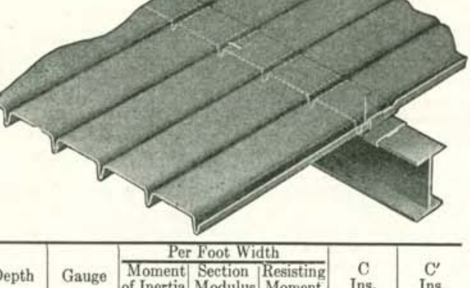
THE U. S. GYPSUM CO.'S STEEL ROOF DECK of special copper bearing steel is used in steel framed structures where a low priced, incombustible roof deck is required. The deck plates are 18″ wide. Reinforcing ribs, 1½″ deep with ½″ base, are rolled into the plate 6″ ctrs. Plate laps, not less than 2″ in length, are directly over purlins. Intermediate stiffening beads midway between reinforcing ribs are an exclusive USG feature.

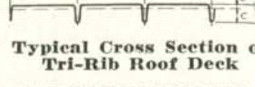
Gauge & Weight	Bending Moment	ALLOWABLE LIVE LOADS IN POUNDS PER SQ. FT. For Purlin Spacings Shown 5′0″	5′6″	6′0″	6′6″	7′0″	7′6″	8′0″	INSULATION VALUE—Btu No Insulation	½″ Weatherwood	1″ Weatherwood	1½″ Weatherwood
20 GA.	1/8 WL	81	67	56	48	41	......	......	0.94	0.39	0.24	0.18
2.4 psf.	1/10 WL	102	85	71	61	52	44	38				
18 GA.	1/8 WL	......	......	71	60	52	45	39	0.94	0.39	0.24	0.18
3.2 psf.	1/10 WL	......	......	90	76	66	57	50				

Notes: The allowable live loads shown are based on test. An allowance of 5 lbs. per sq. ft. has been made for a dead load. No. 20 gauge has a factor of safety of 4 and No. 18 gauge a factor of safety of 3.5. The Btu values shown are for the complete roof with a roof covering. Values are Btu per sq. ft., per hr., per Fahrenheit Degree difference in Temperature. Stock gauge—standard lengths are 5′8″ to 15′2″.

For Additional Information Send for Catalog—Address—See Index.

TRI-RIB STEEL ROOF DECK





Typical Cross Section of Tri-Rib Roof Deck

Depth	Gauge	Per Foot Width: Moment of Inertia (in) 4	Per Foot Width: Section Modulus (in) 3	Per Foot Width: Resisting Moment (in lbs.)	C Ins.	C' Ins.
1½"	18	.1784	.149	2680	1.195	.305
	20	.1333	.111	1998	1.198	.302
	22	.1129	.094	1692	1.198	.302
1¾"	18	.2704	.198	3564	1.37	.38
	20	.2004	.146	2630	1.37	.38
	22	.1695	.124	2230	1.37	.38
2"	18	.3864	.2516	4520	1.537	.463
	20	.2860	.1862	3350	1.536	.464
2½"	18	.7001	.375	6750	1.86	.64
	20	.5164	.277	5000	1.86	.64

SPECIFICATIONS

MATERIAL. Wherever possible the deck sheets shall be furnished in sufficiently long lengths to span continuously over three or more purlins. All end laps shall be of the overlapping type and shall occur only at purlin points.

PAINTING

Roof Deck and Accessories shall receive one standard factory baked-on coat of protective gray paint after fabrication.

ERECTION

For Clipped Jobs—One purlin clip shall be used at each purlin at the side of each deck sheet. Provide one intermediate clip at all side laps for spans up to 5 ft.-0 in., and two intermediate clips for all spans exceeding 5 ft.-0 in.

For Welded Jobs—One ⅛-in. fillet weld, ¾ in. long, shall be provided at each purlin at the side of each deck sheet. Wherever end laps occur, the upper deck sheet shall be welded to the lower deck sheet at the side of each deck sheet.

Side laps shall be fastened together by electric arc welding, one weld to be used on spans up to 5 ft.-0 in., and two welds to be used on spans exceeding 5 ft.-0 in.

SAFE UNIFORM LOAD PER SQUARE FOOT

fs = 18,000 Lbs. per Square Inch

Depth	Gauge	Weight per Sq. Ft.	SPAN 4'-0"		4'-6"		5'-0"		5'-6"		6'-0"		6'-6"		7'-0"		7'-6"		8'-0"		8'-6"		9'-0"		9'-6"		10'-0"	
			M = WL/10	M = WL/8	M = WL/10	M = WL/8	M = WL/10	M = WL/8	M = WL/10	M = WL/8	M = WL/10	M = WL/8	M = WL/10	M = WL/8	M = WL/10	M = WL/8	M = WL/10	M = WL/8	M = WL/10	M = WL/8	M = WL/10	M = WL/8	M = WL/10	M = WL/8	M = WL/10	M = WL/8	M = WL/10	M = WL/8
1½"	18	2.89	139	111	110	88	89	71	73	59	62	49	52	42	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	20	2.18	104	83	82	65	66	53	55	44	46	37	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	22	1.81	88	70	69	55	56	45	46	37	39	31	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1¾"	18	3.07	185	148	146	117	119	95	98	79	82	66	70	56	60	48	52	42	46	37	...	...	...	...	...	...	...	...
	20	2.30	137	109	108	86	87	70	72	58	61	48	50	41	44	35	...	...	...	...	...	...	...	...	...	...	...	...
	22	1.92	116	93	91	73	74	59	61	49	51	41	44	35	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2"	18	3.26	...	...	...	...	...	...	...	...	104	83	87	70	77	61	66	53	59	47	52	41	46	37	...	...	...	...
	20	2.45	...	...	...	...	...	...	...	...	77	62	65	52	57	45	49	39	43	35	...	...	...	...	...	...	...	...
2½"	18	3.57	...	...	...	...	...	...	...	...	...	...	...	...	114	92	100	80	87	70	77	62	69	55	62	49	56	45
	20	2.68	...	...	...	...	...	...	...	...	...	...	...	...	85	68	74	59	65	52	57	46	51	41	46	36	41	...

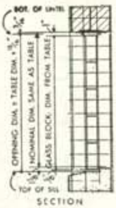
Safe Uniform Load Includes the Weight of the Deck. Safe Uniform Loads given will not produce deflections exceeding 1/250 of the span length.

For Additional Information Send for Catalog—Address—See Index.

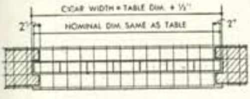
OWENS-ILLINOIS INSULUX GLASS BLOCK

Dimension Table

To determine clear opening size for glass block panels use dimensions given below and add ½″ for the width and 15/16″ for the height. For modular layout a ¼″ mortar joint is required.



SECTION



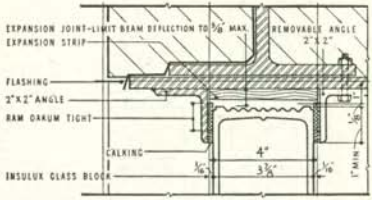
PLAN

No. of Units	5¾″ x 5¾″ Hght or Width ¼″ Joints	5¾″ x 5¾″ Hght or Width 3/16″ Joints	7¾″ x 7¾″ Hght or Width ¼″ Joints	7¾″ x 7¾″ Hght or Width 3/16″ Joints	11¾″ x 11¾″ Hght or Width ¼″ Joints	11¾″ x 11¾″ Hght or Width 3/16″ Joints
1	6″	5 15/16″	8″	7 15/16″	1′0″	11 15/16″
2	1′0″	11 7/8″	1′4″	1′ 3 7/8″	2′0″	1′11 7/8″
3	1′6″	1′ 5 13/16″	2′0″	1′11 13/16″	3′0″	2′11 13/16″
4	2′0″	1′11 3/4″	2′8″	2′ 7 3/4″	4′0″	3′11 3/4″
5	2′6″	2′ 5 11/16″	3′4″	3′ 3 11/16″	5′0″	4′11 11/16″
6	3′0″	2′11 5/8″	4′0″	3′11 5/8″	6′0″	5′11 5/8″
7	3′6″	3′ 5 9/16″	4′8″	4′ 7 9/16″	7′0″	6′11 9/16″
8	4′0″	3′11 1/2″	5′4″	5′ 3 1/2″	8′0″	7′11 1/2″
9	4′6″	4′ 5 7/16″	6′0″	5′11 7/16″	9′0″	8′11 7/16″
10	5′0″	4′11 3/8″	6′8″	6′ 7 3/8″	10′0″	9′11 3/8″
11	5′6″	5′ 5 5/16″	7′4″	7′ 3 5/16″	11′0″	10′11 5/16″
12	6′0″	5′11 1/4″	8′0″	7′11 1/4″	12′0″	11′11 1/4″
13	6′6″	6′ 5 3/16″	8′8″	8′ 7 3/16″	13′0″	12′11 3/16″
14	7′0″	6′11 1/8″	9′4″	9′ 3 1/8″	14′0″	13′11 1/8″
15	7′6″	7′ 5 1/16″	10′0″	9′11 1/16″	15′0″	14′11 1/16″
16	8′0″	7′11″	10′8″	10′ 7″	16′0″	15′11″
17	8′6″	8′ 4 15/16″	11′4″	11′ 2 15/16″	17′0″	16′10 15/16″
18	9′0″	8′10 7/8″	12′0″	11′10 7/8″	18′0″	17′10 7/8″
19	9′6″	9′ 4 13/16″	12′8″	12′ 6 13/16″	19′0″	18′10 13/16″
20	10′0″	9′10 3/4″	13′4″	13′ 2 3/4″	20′0″	19′10 3/4″
21	10′6″	10′ 4 11/16″	14′0″	13′10 11/16″	21′0″	20′10 11/16″
22	11′0″	10′10 5/8″	14′8″	14′ 6 5/8″	22′0″	21′10 5/8″
23	11′6″	11′ 4 9/16″	15′4″	15′ 2 9/16″	23′0″	22′10 9/16″
24	12′0″	11′10 1/2″	16′0″	15′10 1/2″	24′0″	23′10 1/2″
25	12′6″	12′ 4 7/16″	16′8″	16′ 6 7/16″	25′0″	24′10 7/16″
26	13′0″	12′10 3/8″	17′4″	17′ 2 3/8″	26′0″	25′10 3/8″
27	13′6″	13′ 4 5/16″	18′0″	17′10 5/16″	27′0″	26′10 5/16″
28	14′0″	13′10 1/4″	18′8″	18′ 6 1/4″	28′0″	27′10 1/4″
29	14′6″	14′ 4 3/16″	19′4″	19′ 2 3/16″	29′0″	28′10 3/16″
30	15′0″	14′10 1/8″	20′0″	19′10 1/8″	30′0″	29′10 1/8″
31	15′6″	15′ 4 1/16″	20′8″	20′ 6 1/16″	31′0″	30′10 1/16″
32	16′0″	15′10″	21′4″	21′ 2″	32′0″	31′10″
33	16′6″	16′ 3 15/16″	22′0″	21′ 9 15/16″	33′0″	32′ 9 15/16″
34	17′0″	16′ 9 7/8″	22′8″	22′ 5 7/8″	34′0″	33′ 9 7/8″

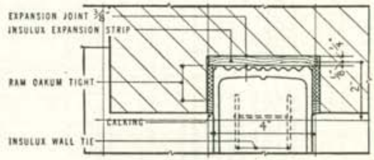
For Additional Information
Send For Catalog—
Address—See Index

Panels in 12″ Masonry Walls

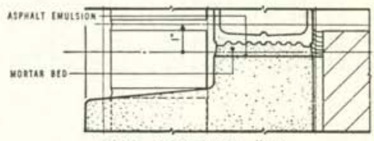
ELEVATION



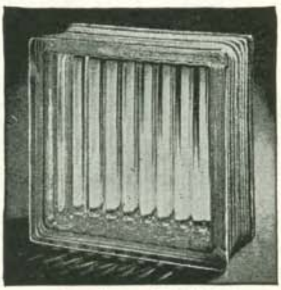
HEAD SECTION "A"



JAMB SECTION "B"



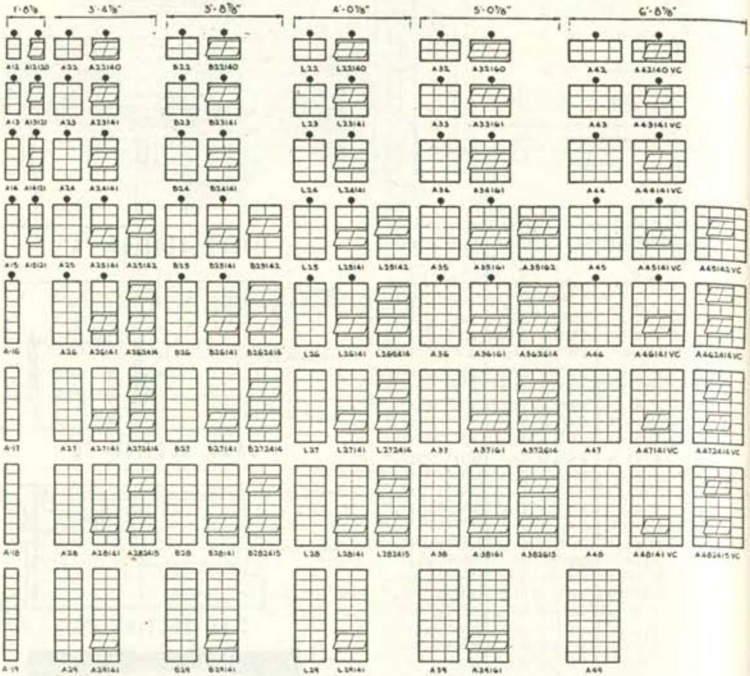
SILL SECTION "C"



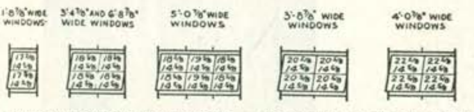
Design No. 7

STEEL SASH

In modern fire-proof, or semi fire-proof construction and where building laws or fire regulations require it, steel sash is used in place of wood sash. Steel sash improves the general appearance of a building and provides maximum illumination of the interior.



GLASS SIZE SCHEDULE



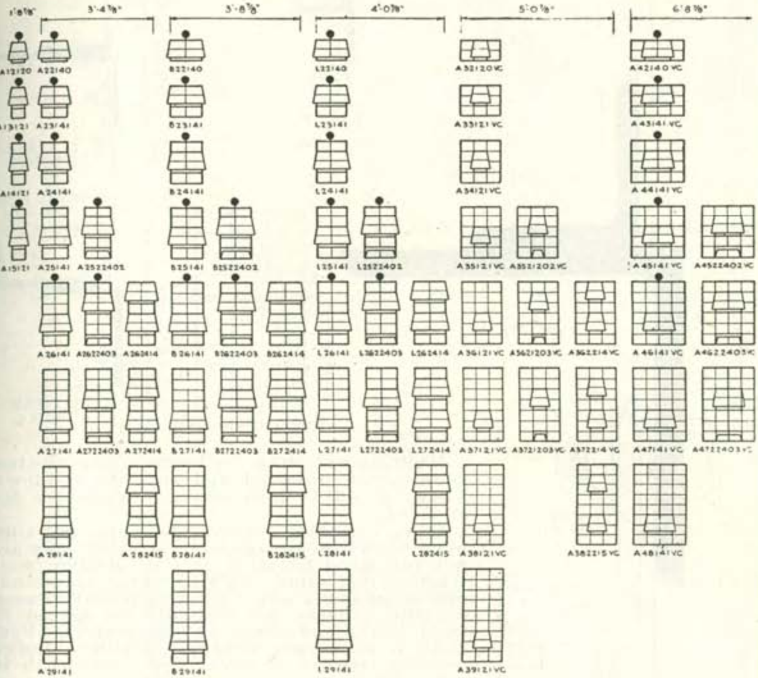
◀ GLASS IN ALL FIXED LIGHTS (IN BOTH FIXED AND VENTED UNITS) IN THIS GROUP IS 19⅝"×15⅝" ▶ GLASS IN ALL FIXED LIGHTS IS 21⅝"×15⅝" GLASS IN ALL FIXED LIGHTS IS 23⅝"×15⅝"

NOTE

● TYPES MARKED THUS ARE CARRIED IN STOCK, ALL OTHER TYPES ARE STANDARD. SIZES SHOWN ARE WINDOW AND OPENING DIMENSIONS; FRAME MEMBERS PROJECT BEYOND THESE POINTS FOR WALL BEARING. IN NOMENCLATURES, PREFIX "A" INDICATES TYPES WITH 20"×16" BAR CENTERS, PREFIX "B" INDICATES TYPES WITH 22"×16" BAR CENTERS AND PREFIX "L" INDICATES TYPES WITH 24"×16" BAR CENTERS.

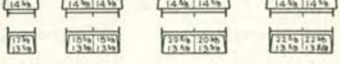
The above sketches give the sizes and ventilator locations of Fenestra Steel Sash. Other steel sash is quite similar in size and construction.

STEEL SASH



GLASS SIZE SCHEDULE

1'-8 7/8" & 5'-0 7/8" WIDE WINDOWS · 3'-4 7/8" & 6'-8 7/8" WIDE WINDOWS · 3'-8 7/8" WIDE WINDOWS · 4'-0 7/8" WIDE WINDOWS



GLASS IN ALL FIXED LIGHTS IN THIS GROUP IS 19 5/8" × 15 5/8"

GLASS IN ALL FIXED LIGHTS IS 21 5/8" × 15 5/8"

GLASS IN ALL FIXED LIGHTS IS 23 5/8" × 15 5/8"

● TYPES MARKED THUS ARE CARRIED IN STOCK, ALL OTHER TYPES ARE STANDARD. . . . SIZES SHOWN ARE WINDOW AND OPENING DIMENSIONS; FRAME MEMBERS PROJECT BEYOND THESE POINTS FOR WALL BEARING.

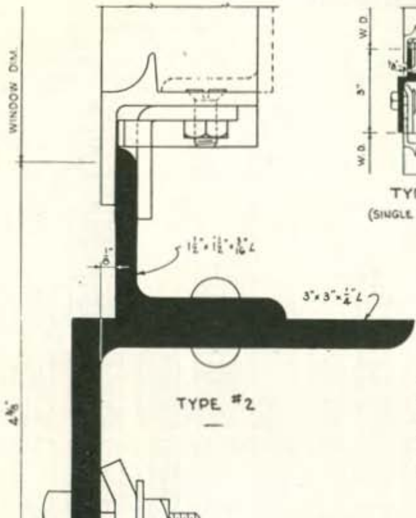
FIXED (NON-OPENING) TYPES USED WITH COMMERCIAL PROJECTED WINDOWS ARE THE SAME FIXED UNITS SHOWN ON PLATE OF PIVOTED WINDOW TYPES AND SIZES.

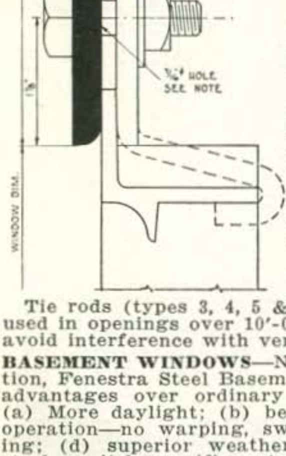
} INDICATES PROJECTED-OUT VENT. } INDICATES PROJECTED-IN VENT.

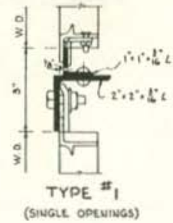
VENTS SHOWN AS PROJECTED-OUT MAY BE CHANGED TO PROJECTED-IN PROVIDING ALL VENTS IN THE SAME UNIT PROJECT-IN.

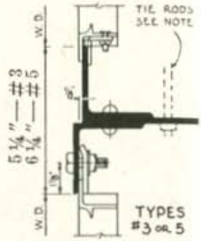
IN NOMENCLATURES, PREFIX "A" INDICATES TYPES WITH 20"×16" BAR CENTERS, PREFIX "B" INDICATES TYPES WITH 22×16 BAR CENTERS, PREFIX "L" INDICATES TYPES WITH 24"×16" BAR CENTERS.

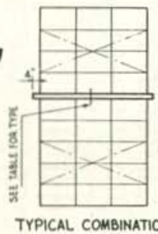
STEEL SASH

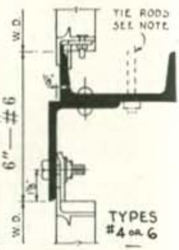










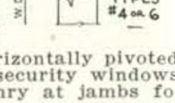


Mullions are alike for horizontally pivoted, commercial projected and security windows. They extend 4" into masonry at jambs for anchorage.

Clips, attaching screws and bolts are supplied by window manufacturer. Mullions are not furnished by D. S. P. Co. Mullion contractor must supply $\frac{5}{16}''$ø holes in downstanding leg of lower angle for attachment of sash or clips. These holes should be spaced 6" from jambs and about 18" on centers. Vertical location per details. Mullion design permits erection of upper and lower sash in same plane.

Overall opening height of combined units equals total of window dimensions plus height dimension of horizontal mullion.

Tie rods (types 3, 4, 5 & 6) attached to structural steel, etc., may be used in openings over 10'-0" wide to brace horizontal mullion. Space to avoid interference with vents. Not furnished or attached by D. S. P. Co.

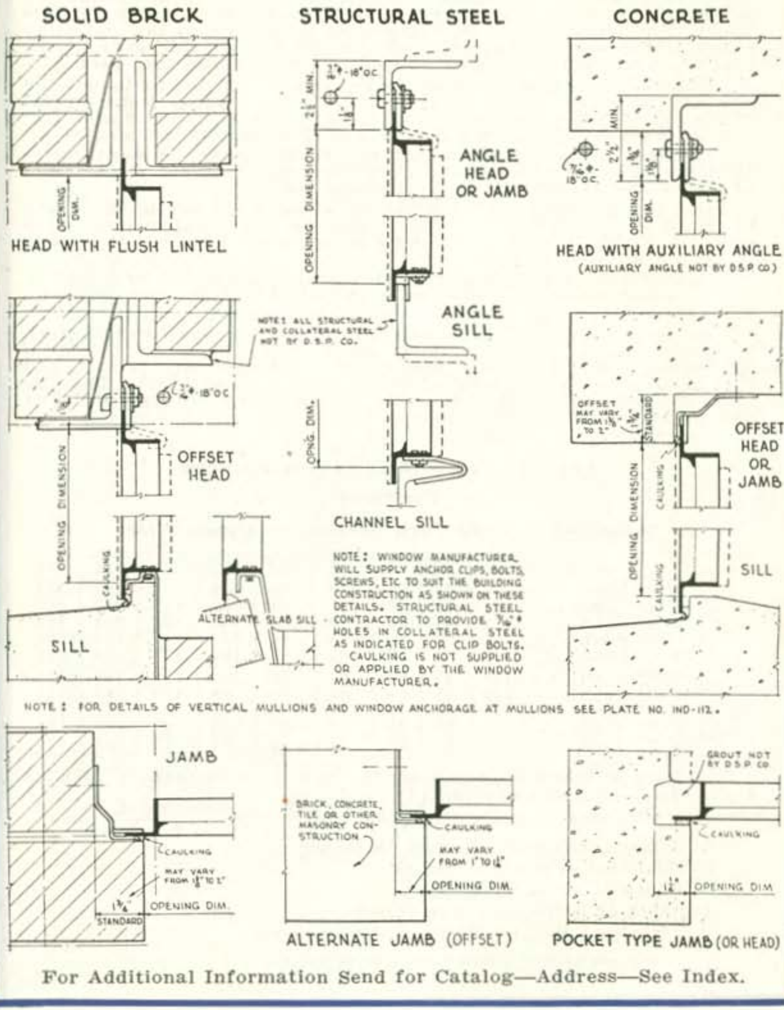


Basement Window

BASEMENT WINDOWS—New in design and construction, Fenestra Steel Basement Windows provide many advantages over ordinary windows. These include: (a) More daylight; (b) better ventilation; (c) easier operation—no warping, swelling, shrinking or sticking; (d) superior weathertightness; (e) firesafety—steel won't burn; (f) protection against vermin—steel is impervious to rats and termite; (g) better screening—Fenestra All-Metal Screens are quickly attached.

For Additional Information Send for Catalog—Address—See Index.

STEEL SASH


SOLID BRICK
STRUCTURAL STEEL
CONCRETE
ANGLE HEAD OR JAMB
HEAD WITH FLUSH LINTEL
HEAD WITH AUXILIARY ANGLE
(AUXILIARY ANGLE NOT BY D.S.P. CO.)
NOTE: ALL STRUCTURAL AND COLLATERAL STEEL NOT BY D.S.P. CO.
ANGLE SILL
OPENING DIMENSION
OPENING DIM.
OFFSET HEAD
OFFSET HEAD OR JAMB
CHANNEL SILL
OFFSET MAY VARY FROM 1⅛" TO 2"
STANDARD
CAULKING
SILL
ALTERNATE SLAB SILL
NOTE: WINDOW MANUFACTURER WILL SUPPLY ANCHOR CLIPS, BOLTS, SCREWS, ETC. TO SUIT THE BUILDING CONSTRUCTION AS SHOWN ON THESE DETAILS. STRUCTURAL STEEL CONTRACTOR TO PROVIDE 7/16" Φ HOLES IN COLLATERAL STEEL AS INDICATED FOR CLIP BOLTS. CAULKING IS NOT SUPPLIED OR APPLIED BY THE WINDOW MANUFACTURER.
NOTE: FOR DETAILS OF VERTICAL MULLIONS AND WINDOW ANCHORAGE AT MULLIONS SEE PLATE NO. IND-112.
JAMB
MAY VARY FROM 1⅛" TO 2"
1¾"
STANDARD
OPENING DIM.
BRICK, CONCRETE, TILE OR OTHER MASONRY CONSTRUCTION
MAY VARY FROM 1" TO 1¼"
GROUT NOT BY D.S.P. CO.
ALTERNATE JAMB (OFFSET)
POCKET TYPE JAMB (OR HEAD)

CORRUGATED SHEETS.

Corrugated sheets are used for roofs and sides of buildings. They are usually laid directly upon the roof purlins and held in place by means of clips of steel hoops which encircle the purlin and are placed about 12 inches apart. Special care must be taken that the projecting edges of the corrugated sheets at the eaves and gable ends of the roof are well secured, otherwise the wind will loosen the sheets.

Corrugated sheets are made in the sizes given in the tables, the size most generally used has nominally 2½ inch corrugations (actual width 2⅔ inches), about ½ of an inch in depth. The gauges frequently used for roofing are Nos. 20 and 22, U. S. standard gauge.

By one corrugation is meant the double curve between corresponding points, and by depth of corrugation the greatest deviation of the curved surfaces from the straight line.

One and one-half corrugations are allowed for lap in the width of the sheet and 6 inches in the length for the usual quarter pitch roof; one corrugation in width and 4 inches in the length of the sheets is usually allowed for sidings.

Corrugated sheets are furnished in standard lengths of 5, 6, 7, 8, 9 and 10 feet, and with a covering width of 24 inches, when laid with a lap of either one or one and one-half corrugations.

By experiment it has been determined that corrugated sheet steel, ⅝ inch deep and 0.035 inch thick, spanning 6 feet, began to give a permanent deflection with a load of 30 pounds per square foot, and that it collapsed with a load of 60 pounds per square foot. The distance betwen centers of purlins should, therefore, not exceed 6 feet and should preferably be less than this.

SAFE LOADS CORRUGATED SHEETS

Per Sheet

Supported at Ends Only. Sheets, 26 Inches Wide.

	Gauge	28	27	26	24	22	20	18	16
2½" Corrugations	6' 0" Span	88	97	106	141	176	211	282	352
	7' 0" Span	75	83	91	121	151	181	242	302
	8' 0" Span	66	73	79	106	132	158	211	264
	9' 0" Span	59	65	70	94	117	141	188	235
	10' 0" Span	53	58	63	85	106	127	169	211
1¼" Corrugations	6' 0" Span	53	58	64	85	106	127	169	211
	7' 0" Span	45	50	55	73	91	109	145	181
	8' 0" Span	40	44	47	64	79	95	127	158
	9' 0" Span	35	39	42	56	70	85	113	141
	10' 0" Span	32	34	38	51	64	76	101	127

⅝ inch is taken as depth of 2½ inch corrugations, ⅜ inch as depth of 1¼ inch corrugations.

The following formula has been used: $W = \frac{99900\ t\ b\ d}{L}$

L=Supported length of sheet in inches.

t=Thickness of sheet in inches.

b=Width of sheet in inches.

d=Depth of corrugations in inches.

W=Breaking weight distributed in pounds.

$\frac{W}{4}$=Safe loads per sheet between supports.

CORRUGATED SHEETS.

Description of Corrugated Sheets

Corrugations Width Ins. Nominal	Corrugations Width Ins. Act'l	Depth Approx Ins.	Number per Sheet	Width Ins. Full Sheet	Width Ins. Covers Approx
5	4 2/3	7/8	6	28	24
3	2 8/9	5/8	9	26	24
2½	2 3/5	½	10	26	24
2	2 4/11	½	11	26	24
1¼	1¼	3/8	20	25	24
5/8	25/26	3/16	26	25	24

Standard lengths, 5, 6, 7, 8, 9 and 10 ft. maximum length, 12 ft. for 5″ to 1¼″ Corrugations.

Area of Corrugated Sheets.

Length of Sheet Ins.	Sq. Ft. in 1 Sheet Corrugations 5″	Sq. Ft. in 1 Sheet Corrugations 3″, 2½″, 2″	Sq. Ft. in 1 Sheet Corrugations 1¼″, 5/8″	Sheets in 100 Sq. Ft. Corrugations 5″	Sheets in 100 Sq. Ft. Corrugations 3″, 2½″, 2″	Sheets in 100 Sq. Ft. Corrugations 1¼″, 5/8″
60	11.67	10.83	10.42	8.57	9.23	9.60
72	14.00	13.00	12.50	7.14	7.69	8.00
84	16.33	15.17	14.58	6.12	6.59	6.86
96	18.67	17.33	16.67	5.36	5.77	6.00
108	21.00	19.50	18.75	4.76	5.13	5.33
120	23.33	21.67	20.83	4.29	4.62	4.80
144	28.00	26.00	25.00	3.57	3.85	4.00

CORRUGATED SHEETS—PAINTED.

Weight in Pounds per 100 square Feet

Nominal Corrugations Inches	Thickness, U. S. Standard Gauge and Decimals of an Inch												
	12	**14**	**16**	**18**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
	.109	.078	.063	.050	.038	.034	.031	.028	.025	.022	.019	.017	.016
5	.....	339	271	217	163	150	136	123	110	96	83	76	68
3	.....	.....	271	217	163	150	136	123	110	96	83	76	68
2½	474	339	271	217	163	150	136	123	110	96	83	76	68
2	.....	.....	271	217	163	150	136	123	110	96	83	76	68
1¼	.....	.....	.....	.....	170	156	142	128	114	100	86	79	72
5/8	.....	.....	.....	.....	.....	.....	.....	.....	114	100	86	79	72

CORRUGATED SHEETS—GALVANIZED.

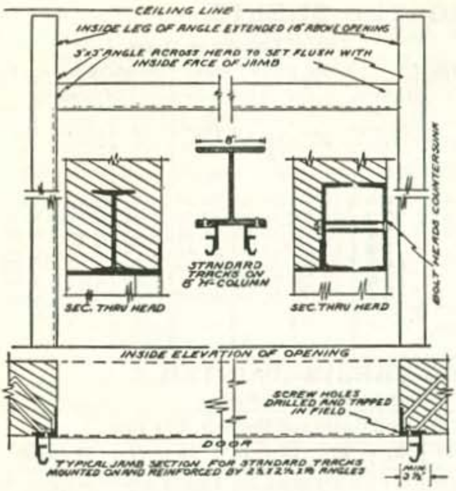
Weight in Pounds per 100 Square Feet

Nom. Corrug. Inches	Thickness, U. S. Standard Gauge and Decimals of an Inch												
	12	**14**	**16**	**18**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
	.109	.078	.063	.050	.038	.034	.031	.028	.025	.022	.019	.017	.016
5	.....	354	286	232	178	165	151	138	124	111	98	91	85
3	.....	.....	286	232	178	165	151	138	124	111	98	91	85
2½	488	354	286	232	178	165	151	138	124	111	98	91	85
2	.....	.....	286	232	178	165	151	138	124	111	98	91	85
1¼	.....	.....	.....	.....	185	.....	157	.....	129	.....	101	94	87
5/8	.....	.....	.....	.....	.....	.....	.....	.....	129	.....	101	94	87

The weights per 100 square feet given in preceding tables do not include allowances for end or side laps. The following table gives the approximate number of square feet of sheeting necessary to cover an area of 100 square feet and is based on sheets of standard width, 96 inches long. If longer or shorter sheets are used, the number of square feet required will vary accordingly.

Square Feet of Corrugated Sheets to Cover 100 square feet

Side Lap	End Lap, Inches					
	1	**2**	**3**	**4**	**5**	**6**
1 Corrugation	110	111	112	113	114	115
1½ "	116	117	118	119	120	121
2 "	123	124	125	126	127	128



The "OVERHEAD DOOR"

REG. U. S. PAT. OFF.

for

GARAGE - FACTORY WAREHOUSE

WOOD-METAL CLAD-OR ALL METAL CONSTRUCTION

MANUAL-OR ELECTRIC OPERATION

CONDENSED SPECIFICATIONS

The "OVERHEAD DOOR" opens UP—completely out of the way. Operation is smooth, quick, silent. Available in any size or design.

Finest grade materials obtainable are used. In stock construction Sitka Spruce stiles and rails and three-ply fir panels are used. Stock sizes are 8'x8'; 8'x7' 6"; 8'x7'. Construction in other woods on specification.

All tracks and hardware are made of steel. Varying gauge and size hardware is used with varying size and weight doors. All moving parts are ball bearing.

Any or all sections may be arranged for glass, only when specified.

Patented locking device which operates from either side, securely locks, bolts and bars the door across its entire width.

Angle mounted track may be applied directly to steel jambs, as shown, but 2"x6" facings secured to wall with bolts and made flush with sides of opening may be used for jamb foundation. Facings should extend 15" above header.

The "OVERHEAD DOOR" may be had in all-aluminum, all-steel, metal clad, or all-steel with rock wool insulation construction. Flat casement sash appearance construction also offered.

WHEN ARCHITECTS SPECIFY THE "OVERHEAD DOOR" CONSULT US AS TO MINIMUM CLEARANCES AT SIDES AND HEAD OF OPENING.

OVERHEAD DOOR COMPANY OF MINNESOTA

For Additional Information Send for Catalog—Address—See Index.

NAILS AND SPIKES.

	Standard Steel Wire Nails							Cut Steel Nails Common			Steel Wire Spikes		
		Common				Barbed Car							
		Diameter											
Size	Lgth. Ins.	Am. Steel & Wire Gauge	Ins.	No. Per Lb.	Finishing	Hvy.	Light	Size	Leng. Ins.	No. Per Lb.	Leng. Ins.	Dia. Ins.	No. Per Lb.
2d	1	15	.072	876	1351	.....	.....	**2d**	1	740	3	.192	41
3d	1¼	14	.080	568	807	.....	.....	**3d**	1¼	460	3¼	.192	38
4d	1½	12½	.099	316	584	165	274	**4d**	1½	280	3½	.207	30
5d	1¾	12½	.099	271	500	118	142	**5d**	1¾	210	4	.225	23
6d	2	11½	.113	181	309	103	124	**6d**	2	160	4½	.244	17
7d	2¼	11½	.113	161	238	76	92	**7d**	2¼	120	5	.263	13
8d	2½	10¼	.131	106	189	69	82	**8d**	2½	88	5½	.283	10
9d	2¾	10¼	.131	96	172	54	62	**9d**	2¾	73	6	.283	8
10d	3	9	.148	69	121	50	57	**10d**	3	60	7	5/16	7
12d	3¼	9	.148	63	113	42	50	**12d**	3¼	46	8	3/8	6
16d	3½	8	.162	49	90	35	43	**16d**	3½	33	9	3/8	5
20d	4	6	.192	31	62	26	31	**20d**	4	23	10	3/8	4
30d	4½	5	.207	24	......	24	28	**30d**	4½	16	12	3/8	3
40d	5	4	.225	18	......	18	21	**40d**	5	12	.....	.....	....
50d	5½	3	.244	14	......	15	17	**50d**	5½	10	.....	.....	....
60d	6	2	.263	11	......	13	15	**60d**	6	8	.....	.....	....

SQUARE BOAT SPIKES.

Approximate Number in a Keg of 200 Pounds

Size Inches	LENGTH OF SPIKE, INCHES											
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**14**	**16**
¼	3000	2375	2050	1825	......	......	......	......	......	.....	.....	.....
5/16	1660	1360	1230	1175	990	880	......	......	......	.....	.....	.....
⅜	1320	1140	940	800	650	600	525	475	......	.....	.....	.....
7/16	......	......	......	600	590	510	400	360	320	280	.....	.....
½	......	......	......	450	375	335	300	275	260	240	.....	.....
⅝	......	......	......	......	......	260	240	220	205	190	175	160

WOOD SCREWS.

Diameter = Number x 0.01325 + 0.056

No.	Dia. Ins.	Dia. Ins.	No.	Dia. Ins.	Dia. Ins.	No.	Dia. Ins.	Dia. Ins.	No.	Dia. Ins.	Dia. Ins.	No.	Dia. Ins.	Dia. Ins.
0	.056	7/128	**6**	.135	17/128	**12**	.215	7/32	**18**	.293	19/64	**24**	.374	⅜
1	.069	9/128	**7**	.149	19/128	**13**	.228	29/128	**19**	.308	39/128	**25**	.387	49/128
2	.082	11/128	**8**	.162	21/128	**14**	.241	31/128	**20**	.321	41/128	**26**	.401	51/128
3	.096	13/128	**9**	.175	11/64	**15**	.255	¼	**21**	.334	43/128	**27**	.414	53/128
4	.109	7/64	**10**	.188	3/16	**16**	.268	17/64	**22**	.347	45/128	**28**	.427	55/128
5	.122	⅛	**11**	.201	13/64	**17**	.281	9/32	**23**	.361	23/64	**29**	.440	57/128
												30	.453	29/64

BREAKING STRENGTH OF ROPE.

Manila, New		
Dia. Inches	Brk. Str. Pounds	No. Feet In Lb.
¼	620	54.5
⅜	1275	27.2
½	2400	13.3
¾	4700	6.0
⅞	6500	4.4
1	7500	3.7
1¼	12500	2.3
1½	17000	1.6
1¾	25000	1.2
2	30000	0.9
2½	43000	0.6

STEEL WIRE ROPE 6 Strands, 19 Wires Per Strand, Hemp Center						
Crucible Steel				Plow Steel		
Break. Weight Pounds	Proper Work Ld Pounds	Weight Pounds 100 Ft.	Dia. Inches	Break. Weight Pounds	Proper Work Ld Pounds	Weight Pounds 100 Ft.
4400	880	10	¼	5300	1060	10
9600	1920	22	⅜	11500	2300	22
16800	3360	39	½	20000	4000	39
25000	5000	62	⅝	31000	6200	62
35000	7000	89	¾	46000	9200	89
46000	9200	120	⅞	58000	11600	120
60000	12000	158	**1**	76000	15200	158
76000	15200	200	**1⅛**	94000	19080	200
94000	18800	245	**1¼**	116000	24000	245

STANDPIPES, TANKS AND PIPE LINES.

1 cubic foot of water weighs 62½ lbs., and contains 7½ gallons.

1 gallon of water (U. S. standard) weighs 8⅓ lbs., and contains 231 cubic inches.

31½ gallons equal one barrel.

CAPACITY OF ROUND TANKS IN U. S. GALLONS.

Per Foot of Depth.

Dia. of Tanks	3 Ft.	5 Ft.	10 Ft.	12 Ft.	14 Ft.	16 Ft.	18 Ft.	20 Ft.	24 Ft.	28 Ft.	30 Ft	32 Ft.
No. U. S. Gallons	52.68	146.88	578.52	846.03	1151.5	1504.1	1903.6	2350.1	3384.1	4606.2	5287.7	6016.2
Cubic Ft. and Area Sq. Ft.	7.069	19.63	78.54	113.1	153.94	201.06	254.47	314.16	452.39	615.75	706.86	804.25

To find the capacity of tanks of other sizes than given in table, look in the table for a tank of one-half of the given size and multiply its capacity by 4, or one of one-third its size and multiply its capacity by 9, etc.

In the design of stand pipes the height should never be more than ten times the diameter and preferably not more than eight times.

The thickness of plates can be determined by the following considerations: Allowing that the double-riveted vertical joints have an ultimate strength of 70 per cent of the gross section, and counting the tensile strength at 60,000 lbs. per square inch, the actual strength of the vertical joint is 42,000 lbs. per square inch of gross section. Taking a factor of safety of four, we may allow a tensile stress of 10,500 lbs. per square inch on the gross section or of 15,000 lbs. per square inch on net section.

The tensile stress in the shell, per vertical inch, is $T=pr$, where p is the fluid pressure per square inch, and r is the radius of the cylinder in inches. But $p=\frac{62.4h}{144}=0.434\ h$, where h is the head in feet. taking $d=\frac{2r}{12}$ as the diameter in feet, we have, for the thickness of the shell required at any depth

$$t=\frac{Pr}{10500}=0.00025\ hd\ \text{(nearly)}$$

Where t is in inches and h and d in feet.

The least thickness should not be less than one-fourth of an inch. It is not wise to try to use plates thicker than one inch. If this does not give the capacity required it would be better to duplicate the plant than to try to use thicker plates.

To find the thickness of steel to be used in hollow cylinders under tension, such as pipe lines, etc.: Multiply the specified working pressure in pounds by the radius of the cylinder in inches, then by the factor of safety, and divide the result obtained by the tensile strength of the steel multiplied by the percentage of efficiency of the riveted joint employed.

EFFICIENCY OF RIVETED JOINTS OF VARIOUS TYPES IN PER CENT.

Type of Joint	Rivet Size and Spacing	1/4" Plt.	Rivet Size and Spacing	5/16" Plt.	Rivet Size and Spacing	3/8" Plt.	Rivet Size and Spacing	7/16" Plt.	Rivet Size and Spacing	1/2" Plt.
Single Riveted Lap Joints	5/8" 1 11/16" o.c.	59.2	11/16" 1 13/16" o.c.	58.6	7/8" 2 1/4" o.c.	58.3	1" 2 7/16" o.c.	56.4	1" 2 15/32" o.c.	54.8
Double Riveted Lap Joints	5/8" 1 15/32" o.c.	71.8	5/8" 1 15/32" o.c.	71.8	3/4" 1 5/8" o.c.	71.7	7/8" 1 7/8" o.c.	70.0	1" 2 1/8" o.c.	70.4
Triple Riveted Lap Joints	1/2" 1 5/8" o.c.	78.5	5/8" 1 7/8" o.c.	77.0	3/4" 2 1/8" o.c.	75.0	7/8" 2 3/8" o.c.	75.0	7/8" 2 3/8" o.c.	75.0
Double Riveted Butt Joints	5/8" 1 21/32" o.c.	80.7	11/16" 1 15/16" o.c.	80.6	3/4" 2 1/8" o.c.	80.8	3/4" 2 1/8" o.c.	80.8	7/8" 2 3/8" o.c.	80.2
Triple Riveted Butt Joints	1/2" 2 1/4" o.c.	87.5	11/16" 3 1/8" o.c.	88.0	3/4" 3 1/4" o.c.	87.5	7/8" 3 3/8" o.c.	86.1	1" 3 3/4" o.c.	85.8

The above figures are for standard tank splices. The rivet spacing given for double and triple riveted joints is the short pitch. The long pitch being double in each case.

STANDARD WOODEN WATER TANKS.

Capacity in Gallons	Weight of Water	Inside Diameter	Inside Depth	Size of Wood Joists
5000	41667 Lbs.	10 Ft.	11 1/3 Ft.	3" x 12"-16" o.c.
7500	62500 "	11 1/2 "	11 1/3 "	3" x 12"-14" o.c.
10000	83333 "	13 1/2 "	11 1/3 "	4" x 12"-15" o.c.
12000	100000 "	13 1/2 "	13 1/3 "	4" x 12"-12" o.c.
15000	125000 "	14 1/2 "	13 1/3 "	3" x 12"-15" o.c.
20000	166667 "	15 1/2 "	15 1/3 "	3" x 12"-13" o.c.
25000	208333 "	17 1/2 "	15 1/3 "	3" x 12"-11" o.c.
30000	250000 "	18 "	17 1/3 "	4" x 12"-12" o.c.
40000	333333 "	19 1/2 "	19 1/3 "	4" x 12"-12" o.c.
50000	416667 "	22 "	19 1/3 "	4" x 14"-12" o.c.
60000	500000 "	24 "	19 1/3 "	4" x 14"-12" o.c.
75000	625000 "	24 1/2 "	23 1/3 "	6" x 14"-15" o.c.
100000	833333 "	28 1/2 "	23 1/3 "	6" x 14"-15" o.c.

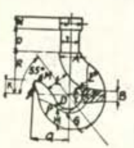
Capacities and weights of tanks taken from Caldwell's catalogue of factory mutual tanks. Staves for tanks of 20000 gals. or less, 2 1/2" thick, over 20,000 gals. 3" thick.

Designs and estimates of steel towers for support of above tanks will be furnished upon application.

WEIGHTS, DIMENSIONS
AND SAFE LOADS OF STEEL CHAINS

	Diameter of Link Bar	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/8	1 1/4
Common or Proof Coil Chain	Length of Link Inches (Outside)	1 3/8	1 1/2	1 3/4	2 1/8	2 1/4	2 1/2	2 7/8	3 3/8	3 7/8	4 3/8	5	5 1/2	6 1/8
	Width of Link Inches (Outside)	7/8	1 1/16	1 1/4	1 1/2	1 11/16	1 7/8	2 1/8	2 1/4	2 11/16	3 1/8	3 5/8	4	4 3/8
	Approximate Weight Lbs. Per Foot	.46	.75	1.10	1.65	2.05	2.65	3.25	4.25	6.10	8.10	10.25	13.50	16.50
	Safe Load in Thousand Lbs.	.50	.82	1.32	1.85	2.55	3.35	4.25	5.25	7.55	10.30	13.45	17.05	21.05
BB Chain	Length of Link Inches (Outside)	1 1/4	1 7/16	1 3/4	1 13/16	2 3/16	2 7/16	2 11/16	3 1/8	3 5/8	4 1/8	4 3/4	5 1/4	5 7/8
	Width of Link Inches (Outside)	3/4	15/16	1 1/8	1 1/16	1 3/16	1 3/4	2	2 1/8	2 9/16	3	3 1/2	3 7/8	4 1/4
	Approximate Weight Lbs. Per Foot	.50	.80	1.15	1.70	2.10	2.70	3.35	4.30	6.15	8.20	10.30	13.60	16.60
	Safe Load in Thousand Lbs.	.55	.82	1.50	2.00	2.75	3.50	4.40	5.37	7.75	10.50	14.25	18.00	21.50
BBB or Crane Quality Chain	Length of Link Inches (Outside)	1 1/8	1 3/8	1 5/8	1 7/8	2 1/8	2 3/8	2 3/4	3	3 1/2	4 1/16	4 5/8	5 1/8	5 3/4
	Width of Link Inches (Outside)	3/4	15/16	1 1/8	1 1/16	1 3/16	1 3/4	2	2 1/8	2 9/16	3	3 1/2	3 7/8	4 1/4
	Approximate Weight Lbs. Per Foot	.52	.83	1.18	1.75	2.15	2.75	3.40	4.35	6.20	8.30	10.40	14.00	16.65
	Safe Load in Thousand Lbs.	.60	.87	1.70	2.25	3.15	4.00	5.00	6.25	8.87	12.00	15.67	19.00	23.50

DIMENSIONS OF CRANE HOOKS.



	Capacity of Hooks in Tons.											
	1/8	1/4	1/2	1	1 1/2	2	3	4	5	6	8	10
	Dimensions Common to Swivel Hooks, Inches											
A	.625	.687	.75	1.062	1.25	1.375	1.75	2.0	2.25	2.5	2.875	3.25
B	.156	.171	.187	.265	.312	.343	.437	.5	.562	.625	.718	.812
C	.546	.625	.656	.937	1.093	1.218	1.531	1.75	1.968	2.187	2.5	2.812
D	1.312	1.375	1.5	1.75	2.	2.25	2.75	3.25	3.75	4.25	5.25	6.25
E	.687	.75	.812	1.156	1.359	1.5	1.890	2.171	2.437	2.703	3.125	3.5
F	.843	.921	1.0	1.421	1.671	1.843	2.343	2.671	3.0	3.343	3.843	4.343
G	.75	.828	.906	1.281	1.5	1.656	2.109	2.406	2.703	3.0	3.453	3.906
H	.718	.781	.859	1.203	1.421	1.562	1.984	2.265	2.546	2.843	3.25	3.687
I	.562	.625	.687	.937	1.125	1.25	1.562	1.75	2.0	2.187	2.5	2.875
J	.812	.875	.937	1.375	1.562	1.75	2.187	2.5	2.812	3.125	3.625	4.0
K	.937	.968	1.062	1.218	1.375	1.562	1.875	2.25	2.562	2.875	3.562	4.25
L	1.0	1.062	1.125	1.312	1.5	1.687	2.0	2.437	2.812	3.187	3.937	4.687
M	.312	.343	.375	.531	.625	.687	.875	1.0	1.125	1.25	1.437	1.625
N	.328	.375	.437	.640	.796	.906	1.187	1.328	1.546	1.703	1.968	2.281
O	.562	.625	.687	.875	1.062	1.25	1.625	2.0	2.375	2.75	3.5	4.25
P	.656	.734	.796	1.125	1.312	1.453	1.843	2.109	2.375	2.625	3.031	3.437
Q	1.687	1.75	1.937	2.25	2.562	2.937	3.562	4.187	4.812	5.5	6.75	8.0
R	1.687	1.75	1.937	2.25	2.562	2.937	3.562	4.187	4.812	5.5	6.75	8.0

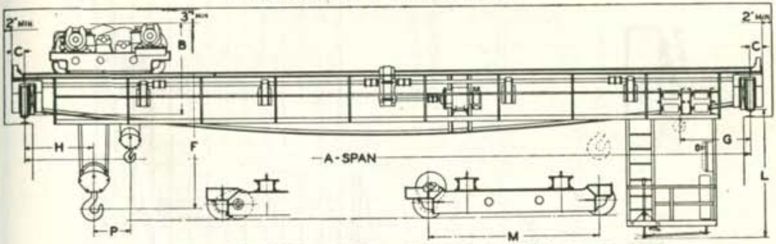
The safe working loads for steel chains are approximately one-fourth of the ultimate breaking strength. The approximate ultimate breaking load on a chain is obtained from the formula.

$W = 54000\ D^2$. W = breaking load in pounds. D = diameter of link bar in inches.

The best material to be used for chains is wrought iron; steel has a higher tensile strength but wrought iron has a relatively greater elastic limit and will always show signs of bending or stretching before finally breaking. Heavy Duty Dredge Chains are made of special wrought iron.

INDUSTRIAL TRAVELING CRANES

Harnischfeger Corporation *



P & H—STANDARD TYPE "H" CRANE

CLEARANCE DIMENSIONS

Capacity Tons	A Span	B	C	F	G	H	L	M	P	Max. load/whl.	Runway Rail
4 MOTOR—TYPE HR—HR I BEAM GIRDERS											
10	30'	5'4"	8½"	6'11"	2'6"	3'0"	7'9"	9'6"	3'6"	21,500	50#/yd
3 Ton	40'	5'10"	8¾"	6'11"	2'6"	3'0"	7'9"	9'10"	3'6"	22,800	50 "
Aux.	50'	5'10"	8¾"	6'11"	2'6"	3'0"	7'8"	9'10"	3'6"	25,000	50 "
15	30'	5'11"	8¾"	7'4"	2'6"	2'9"	7'9"	10'10"	3'2"	28,800	50 "
3 Ton	40'	6'2"	8¾"	7'7"	2'6"	2'9"	7'9"	10'10"	3'2"	31,000	50 "
Aux.	50'	6'2"	8¾"	7'7"	2'6"	2'9"	7'9"	10'10"	3'2"	32,500	60 "
20	30'	6'4"	9 "	8'2"	2'9"	3'3"	7'9"	11'3"	4'0"	36,500	60 "
3 or 5 Ton	40'	6'4"	9 "	8'2"	2'9"	3'3"	7'9"	11'3"	4'0"	37,500	60 "
Aux.	50'	6'4"	9 "	8'2"	2'9"	3'3"	7'9"	11'3"	4'0"	39,500	60 "
25	30'	6'6"	9¼"	8'5"	2'9"	3'3"	7'9"	11'3"	4'0"	45,500	70 "
3 or 5 Ton	40'	6'6"	9¼"	8'5"	2'9"	3'3"	7'9"	11'3"	4'0"	46,500	70 "
Aux.	50'	6'6"	9¼"	8'5"	2'9"	2'3"	7'9"	11'3"	4'0"	48,500	70 "
30	30'	7'1"	10¼"	9'0"	2'9"	3'6"	7'9"	11'6"	4'5"	53,700	70 "
5 or 10 Ton	40'	7'1"	10¼"	9'0"	2'9"	3'6"	7'9"	11'6"	4'5"	54,800	70 "
Aux.	50'	7'1"	10¼"	9'0"	2'9"	3'6"	7'9"	11'6"	4'5"	58,000	80 "
TYPE HR—HR BOX GIRDERS											
10	40'	5'5"	8½"	6'11"	2'9"	3'0"	7'9"	10'3"	3'6"	33,000	50 "
3 Ton	50'	5'11"	8¾"	6'11"	2'11"	2'11"	7'9"	10'9"	3'6"	24,800	50 "
Aux.	60'	5'11"	8¾"	6'11"	2'11"	2'11"	7'9"	10'11"	3'6"	25,800	50 "
15	40'	5'11"	8¾"	7'4"	2'3"	2'8"	7'9"	11'7"	3'5"	31,000	50 "
3 Ton	50'	5'11"	8¾"	7'4"	2'3"	2'8"	7'9"	11'9"	3'5"	32,500	50 "
Aux.	60'	6'3"	9¼"	7'4"	2'3"	2'8"	7'9"	12'2"	3'5"	34,700	60 "
20	40'	6'6"	9¼"	8'1"	2'6"	2'10"	7'9"	11'10"	4'0"	36,500	60 "
3 or 5 Ton	50'	6'6"	9¼"	8'1"	2'6"	2'10"	7'9"	12'0"	4'0"	39,500	60 "
Aux.	60'	6'6"	9¼"	8'1"	2'6"	2'10"	7'9"	12'2"	4'0"	41,200	60 "
	80'	6'10"	9¼"	8'1"	2'6"	2'10"	7'9"	13'0"	4'0"	48,000	70 "
25	50'	6'6"	9¼"	8'5"	2'6"	2'10"	7'9"	12'0"	4'0"	49,000	70 "
3 or 5 Ton	60'	6'9"	9¼"	8'5"	2'6"	2'10"	7'9"	12'3"	4'0"	51,500	70 "
Aux.	80'	7'2"	9¼"	8'5"	2'6"	2'10"	7'9"	13'0"	4'0"	57,000	80 "
30	50'	7'1"	9¼"	9'0"	2'10"	3'4"	7'9"	11'8"	4'5"	58,000	80 "
5 or 10 Ton	60'	7'1"	9¼"	9'0"	2'10"	3'4"	7'9"	12'2"	4'5"	60,500	80 "
Aux.	80'	7'8"	10¼"	9'0"	2'10"	3'4"	7'9"	13'2"	4'5"	68,000	80 "
40	50'	7'6"	10¼"	10'3"	3'1"	3'6"	7'9"	13'4"	4'10"	73,000	80 "
10 or 15 Ton	60'	7'6"	10¼"	10'3"	3'1"	3'6"	7'9"	13'6"	4'10"	76,000	100 "
Aux.	80'	8'3"	10¼"	10'3"	3'1"	3'6"	7'9"	13'9"	4'10"	83,000	100 "

Impact Values—With the trolley in position to produce maximum bridge wheel loads, the impact load on the bridge will be considered as .5% of the maximum hook load for each foot per minute of the full load hoist speed, but not to exceed 50% or to be less than 20% of the maximum hook load. This load will be distributed to the runways in proportion to the position of the hook in relation to the runway rails.

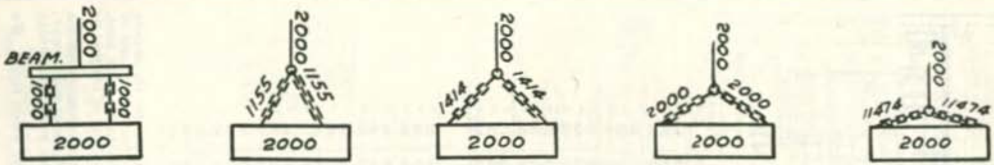
Lateral load on runway due to trolley movement equals 10% of the weight of the trolley with full oad (75% of this lateral load on one runway), this load to be resisted by the top flange of the runway.

Longitudinal load on runway due to bridge movement equals 10% of the maximum bridge wheel load on one runway.

* Crane manufacturers have not standardized on clearances, dimensions, lift, nor wheel loads. We believe P. & H. cranes are typical for design data.

For Additional Information Send for Catalog—Address—See Index.

SAFE LOADS FOR SLING CHAINS



60 DEGREES 45 DEGREES 30 DEGREES 5 DEGREES

The Above Illustrations Show the Increase of Loads When Angle Between the Load and Chain is Decreased

SAFE LOADS FOR DOUBLE SLING CHAINS

*	86%	70%	50%	34%	25%	17%	8½%	
SIZE OF CHAIN	60 Degrees.	45 Degrees.	30 Degrees.	20 Degrees.	15 Degrees.	10 Degrees.	5 Degrees.	Safe Working Loads For Single Strand Chain
⅜	5108	4158	2970	2020	1485	1010	505	2970
½	8514	6930	4950	3366	2475	1683	841	4950
⅝	13106	10668	7620	5182	3810	2591	1295	7620
¾	19195	15624	11160	7589	5580	3794	1897	11160
⅞	26488	21560	15400	10472	7700	5236	2618	15400
1	35191	28644	20460	13913	10230	6956	3478	20460
1⅛	44273	36036	25740	17503	12870	8752	4376	25740
1¼	54490	44352	31680	21542	15840	10771	5386	31680
1⅜	65274	53130	37950	25806	18975	12903	6451	37950
1½	77228	62860	44900	30532	22450	15266	7633	44900
1⅝	88064	71680	51200	34816	25600	17408	8704	51200
1¾	99416	80920	57800	39304	28900	19652	9826	57800
2	126076	102620	73300	49844	36650	24922	12461	73300

*This figure gives percent of load in each sloping strand to bring stress to safe working load in each strand.

NOTES—
1—Distribute load evenly on both legs.
2—A clean chain lasts longer.
3—Keep chain free of twists or knots.
4—Inspect chain at regular intervals.
5—Every time a chain is overloaded, it is weakened.

WIRE AND SHEET METAL GAGES

IN DECIMALS OF AN INCH

Name of Gage	United States Standard Gage*		The United States Steel Wire Gage	American or Brown & Sharpe Wire Gage	New Birmingham Standard Sheet & Hoop Gage	British Imperial or English Legal Standard Wire Gage	Birmingham or Stubs Iron Wire Gage	Name of Gage
Principal Use	Uncoated Steel Sheets and Light Plates		Steel Wire except Music Wire	Non-Ferrous Sheets and Wire	Iron and Steel Sheets and Hoops	Wire	Strips, Bands, Hoops and Wire	Principal Use
Gage No.	Weight Oz. per Sq. Ft.	Approx. Thickness Inches	Thickness, Inches					Gage No.
7/0's			.4900		.6666	.500		7/0's
6/0's			.4615	.5800	.625	.464		6/0's
5/0's			.4305	.5165	.5883	.432	.500	5/0's
4/0's			.3938	.4600	.5416	.400	.454	4/0's
3/0's			.3625	.4096	500	.372	.425	3/0's
2/0's			.3310	.3648	.4452	.348	.380	2/0's
0			.3065	.3249	.3964	.324	.340	0
1			.2830	.2893	.3532	.300	.300	1
2			.2625	.2576	.3147	.276	.284	2
3	160	.2391	.2437	.2294	.2804	.252	.259	3
4	150	.2242	.2253	.2043	.250	.232	.238	4
5	140	.2092	.2070	.1819	.2225	.212	.220	5
6	130	.1943	.1920	.1620	.1981	.192	.203	6
7	120	.1793	.1770	.1443	.1764	.176	.180	7
8	110	.1644	.1620	.1285	.1570	.160	.165	8
9	100	.1495	.1483	.1144	.1398	.144	.148	9
10	90	.1345	.1350	.1019	.1250	128	.134	10
11	80	.1196	.1205	.0907	.1113	.116	.120	11
12	70	.1046	.1055	.0808	.0991	.104	.109	12
13	60	.0897	.0915	.0720	.0882	.092	.095	13
14	50	.0747	.0800	.0641	.0785	.080	.083	14
15	45	.0673	.0720	.0571	.0699	.072	.072	15
16	40	0598	.0625	.0508	.0625	.064	.065	16
17	36	.0538	.0540	.0453	.0556	.056	.058	17
18	32	.0478	.0475	.0403	.0495	.048	.049	18
19	28	.0418	.0410	.0359	.0440	.040	.042	19
20	24	.0359	.0348	.0320	.0392	.036	.035	20
21	22	0329	.0318	.0285	.0349	.032	.032	21
22	20	.0299	.0286	.0253	.0313	.028	.028	22
23	18	.0269	.0258	.0226	.0278	.024	.025	23
24	16	.0239	.0230	.0201	.0248	.022	.022	24
25	14	.0209	.0204	.0179	.0220	.020	.020	25
26	12	0179	.0181	.0159	.0196	.018	.018	26
27	11	.0164	.0173	.0142	.0175	.0164	.016	27
28	10	.0149	.0162	.0126	.0156	.0148	.014	28
29	9	.0135	.0150	.0113	.0139	.0136	.013	29
30	8	.0120	.0140	.0100	.0123	.0124	.012	30
31	7	.0105	.0132	.0089	.0110	.0116	.010	31
32	6.5	.0097	.0128	.0080	.0098	.0108	.009	32
33	6	.0090	.0118	.0071	.0087	.0100	.008	33
34	5.5	.0082	.0104	.0063	.0077	.0092	.007	34
35	5	.0075	.0095	.0056	.0069	.0084	.005	35
36	4.5	.0067	.0090	.0050	.0061	.0076	.004	36
37	4.25	.0064	.0085	.0045	.0054	.0068		37
38	4	.0060	.0080	.0040	.0048	.0060		38
39			.0075	.0035	.0043	.0052		39
40			.0070	.0031	.0039	.0048		40

* U. S. Standard Gage is officially a weight gage, in oz. per sq. ft. as tabulated. The Approx. Thickness shown is the "Manufacturers' Standard" of the American Iron and Steel Institute, based on steel as weighing 501.81 lbs. per cu. ft. (489.6 true weight plus 2.5 percent for average over-run in area and thickness). The A.I.S.I. standard nomenclature for flat rolled carbon steel is as follows:

Widths, Inches	Thicknesses, Inch							
	0.2500 and thicker	0.2499 to 0.2031	0.2030 to 0.1875	0.1874 to 0.0568	0.0567 to 0.0344	0.0343 to 0.0255	0.0254 to 0.0142	0.0141 and thinner
To 3½ incl.	Bar	Bar	Strip	Strip	Strip	Strip	Sheet	Sheet
Over 3½ to 6 incl.	Bar	Bar	Strip	Strip	Strip	Sheet	Sheet	Sheet
" 6 to 12 "	Plate	Strip	Strip	Strip	Sheet	Sheet	Sheet	Sheet
" 12 to 32 "	Plate	Sheet	Sheet	Sheet	Sheet	Sheet	Sheet	Black Plate
" 32 to 48 "	Plate	Sheet	Sheet	Sheet	Sheet	Sheet	Sheet	Sheet
" 48	Plate	Plate	Plate	Sheet	Sheet	Sheet	Sheet	—

SAFE LOADS IN THOUSANDS OF POUNDS

FOR RECTANGULAR WOOD COLUMNS.
UNIT STRESS = 1000 LBS. PER SQ. IN.

$$P = C\left(1 - \frac{l}{70d}\right)$$

P = Allowable load per sq. in. C = allowable unit compressive stress per square inch. l = length of columns in inches. d = least side in inches. For any other unit compressive stress divide the load given for any particular column by 1000 and multiply by the new unit stress

For example we want to find the safe load carried by an 8"x8" spruce column 12 feet long at a unit stress of 800 lbs. per square inch. The tabular load is 47500, hence:

$\frac{47500}{1000}$ x 800 = 38000 = safe load carried by spruce column.

For unit stress adopted by several cities see pages 236–237.

Length in feet \ Size in Inches	6x6	6x8	6x10	8x8	8x10	8x12	10x10	10x12	10x14	12x12	12x14	12x16	14x14	16x16	18x18	20x20
6	28.8	39.8	49.8	55.8	69.8	83.7	89.8	107.8	125.7	131.8	153.7	175.8	181.6	239.5	304.2	378.0
7	28.8	38.4	48.0	54.4	68.0	81.6	88.0	105.6	123.0	129.4	151.1	172.9	179.0	236.7	302.6	376.0
8	27.8	37.0	46.4	53.0	66.4	79.5	86.3	103.5	120.1	127.5	148.8	170.0	176.7	234.0	299.2	372.8
9	26.7	35.6	44.5	51.6	64.5	77.5	84.5	104.4	118.2	125.4	146.3	167.1	174.2	231.5	296.0	369.2
10	25.7	34.2	42.8	50.3	63.0	75.5	82.8	99.5	116.0	123.4	144.0	164.6	172.0	228.6	293.4	365.6
11	24.8	32.9	41.1	48.8	61.0	73.2	81.1	97.3	113.4	121.3	141.6	161.9	169.6	225.8	290.0	362.4
12	23.7	31.6	39.4	47.5	59.4	71.2	79.4	95.4	111.0	119.3	139.1	159.1	167.1	222.9	287.0	358.8
13	22.6	30.2	37.7	46.2	57.6	69.2	77.7	93.4	108.7	117.1	136.7	156.2	164.8	220.2	283.9	355.6
14	21.6	28.8	36.0	44.8	56.0	67.2	76.0	91.2	106.4	115.1	134.4	153.6	162.3	217.5	280.9	35.02
15	20.6	27.4	34.4	43.5	54.2	65.1	74.3	89.3	104.0	113.1	132.0	150.9	159.9	215.0	278.0	348.8
16	19.5	26.1	32.6	42.0	52.6	63.1	72.6	87.2	101.6	111.1	129.7	148.2	157.5	212.1	275.0	345.2
17	18.5	24.6	30.8	40.7	50.9	61.0	70.8	85.1	99.2	109.0	127.1	145.4	155.0	209.4	271.9	342.0
18	17.5	23.3	29.2	39.3	49.1	59.0	69.2	83.0	97.0	107.0	124.7	142.7	152.9	206.2	268.5	338.4
19	16.4	21.9	27.4	38.0	47.5	56.9	67.4	81.0	94.4	104.8	122.4	139.7	150.3	203.9	265.2	334.8
20	15.4	20.6	25.6	36.6	45.7	55.0	65.6	78.7	92.0	102.8	119.1	137.0	147.2	201.2	262.3	331.6
21	14.4	19.2	24.0	35.2	44.0	52.8	64.0	76.8	89.6	100.8	117.6	134.3	145.6	198.4	259.2	328.0
22	13.4	17.8	22.3	33.8	42.2	50.7	62.2	74.6	87.0	98.8	115.2	131.7	143.1	195.4	256.0	324.8
23	12.4	16.5	20.6	32.2	40.3	48.3	60.6	78.2	84.9	96.6	112.8	128.8	140.8	193.0	253.5	321.2
24	11.3	15.1	18.8	31.0	38.6	46.6	58.8	70.6	82.5	94.5	110.2	126.0	138.2	190.2	251.0	317.6

SAFE SUPERIMPOSED LOAD IN POUNDS UNIFORMLY DISTRIBUTED FOR DOUGLAS FIR BEAMS

Values in this table are based on surfaced sizes. For values of rough sizes, multiply given values by factors in Column F.

Unit stress allowed=1200 lbs. per sq. in. E=1643000 lbs. per sq. in.

For values to the right of heavy line the deflection will crack plastered ceiling.

SIZES		SPAN IN FEET														Factor
Rough	S4S	4	6	8	10	12	14	16	18	20	22	24	26	28	30	F
2x 4	1⅝x 3⅝	700	450	350	250	200	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.50
2x 6	1⅝x 5⅝	1700	1100	800	650	550	450	400	.....	.....	.....	.....	.....	.....	.....	1.40
2x 8	1⅝x 7½	.....	2000	1500	1200	1000	800	700	600	.....	.....	.....	.....	.....	.....	1.40
2x10	1⅝x 9½	.....	.....	2400	1900	1600	1350	1150	1000	900	.....	.....	.....	.....	.....	1.36
2x12	1⅝x11½	.....	.....	3550	2800	2300	2000	1700	1500	1300	1200	1050	.....	.....	.....	1.34
2x14	1⅝x13½	.....	.....	.....	3900	3200	2700	2350	2100	1850	1650	1500	1350	1250	.....	1.32
2x16	1⅝x15½	.....	.....	.....	.....	4250	3600	3150	2750	2450	2200	2000	1800	1650	1500	1.31
3x10	2½x 9½	.....	.....	3700	2950	2400	2050	1800	1550	1350	.....	.....	.....	.....	.....	1.33
3x12	2½x11½	.....	.....	5450	4300	3600	3050	2600	2300	2050	1800	1650	.....	.....	.....	1.31
3x14	2½x13½	.....	.....	.....	6000	4950	4200	3650	3200	2850	2550	2300	2100	.....	.....	1.29
4x12	3½x11½	.....	.....	7600	6050	5000	4250	3700	3200	2850	2550	2300	.....	.....	.....	1.25
4x16	3½x15½	.....	.....	.....	.....	9100	7800	6800	5900	5300	4800	4300	3850	3500	.....	1.22
6x12	5½x11½	.....	.....	12000	9500	7800	6700	5800	5100	4500	4000	3600	.....	.....	.....	1.19
6x16	5½x15½	.....	.....	.....	.....	14250	12250	10650	9300	8350	7400	6700	6000	5500	.....	1.16
8x10	7½x 9½	.....	.....	11100	8800	7200	6200	5350	4700	4100	.....	.....	.....	.....	.....	1.18
8x12	7½x11½	.....	.....	16350	13000	10650	9100	7900	6900	6150	5500	4900	.....	.....	.....	1.16
8x14	7½x13½	.....	.....	.....	17950	14750	12650	10950	9550	8550	7600	6850	6150	.....	.....	1.15
10x10	9½x 9½	.....	.....	14100	11200	9100	7800	6750	5900	5250	.....	.....	.....	.....	.....	1.17
10x12	9½x11½	.....	.....	20700	16450	13400	11550	10000	8700	7800	6900	6200	.....	.....	.....	1.15
10x14	9½x13½	.....	.....	.....	22700	18600	16000	14200	12100	10850	9650	8700	7750	.....	.....	1.13
10x16	9½x15½	.....	.....	.....	.....	24650	21200	18400	16000	14450	12850	11600	10400	9550	.....	1.12
12x12	11½x11½	.....	.....	25050	19900	16300	14000	12100	10550	9250	8250	7500	.....	.....	.....	1.14
12x14	11½x13½	.....	.....	.....	27550	22600	19400	16800	14600	13150	11700	10550	9400	.....	.....	1.12
12x16	11½x15½	.....	.....	.....	.....	29800	25650	22250	19400	17450	15550	14050	12600	11550	.....	1.11
12x20	11½x19½	.....	.....	.....	.....	.....	40700	35500	31000	27950	24900	22600	20300	18750	17150	1.10
14x16	13½x15½	.....	.....	.....	.....	35000	30100	26150	22800	20500	18250	16500	14550	13600	.....	1.11
14x20	13½x19½	.....	.....	.....	.....	.....	47800	41600	36350	32800	29250	26550	23850	22000	20150	1.09

GEARS AND PINIONS

Modern cut gears, made of various materials to meet different requirements, are 20% to 50% more silent and efficient in the operation of present high speed machinery than former gears.

Practically all gears have involute teeth with a 14½ degree pressure angle, the rack teeth having straight sides at an angle of 14½ degrees from the vertical to mesh with gears or pinions.

RULES FOR GEAR CALCULATIONS:

OUTLINE FACTORS Y FOR CALCULATING STRENGTH OF GEAR TEETH. TABLE 1.

No. of Teeth...	15	16	17	18	19	20	21	23	25	27	30
Factor Y......	.236	.242	.251	.261	.273	.283	.289	.295	.305	.314	.320
No. of Teeth...	34	38	43	50	60	75	100	150	300	Rack	
Factor Y......	.327	.336	.346	.352	.358	.364	.371	.377	.383	.390	

Allowable working stresses S in lbs. per sq. in. for calculating strength of gear teeth—without allowance for impact or variable loads. Table 2.

V	Ft. per Min.....	0	100	200	300	450	600	900	1200	1800	2400
S	Cast Iron.......	8000	6850	6000	5350	4550	4000	3200	2650	2000	1600
	Steel..........	20000	17100	15000	13300	11400	10000	8000	6650	5000	4000

V = Velocity in ft. per min. at pitch line. See table 2.
S = Allowable unit stress for material at given velocity. See table 2.
A = Width of face in inches.
Y = Outline factor. See table 1.
P = Diametral pitch.
W = Max. safe load in lbs. at pitch line.
Hp = Max. safe horse power Gear will Transmit.

$$W = \frac{SAY}{P}$$

$$H.P. = \frac{WV}{33{,}000}$$

For pitch diameter— divide number of teeth by the diametral pitch.

For center distance between gears — add the number of teeth in both gears and divide the sum by diametral pitch x 2.

For outside diameter— add 2 to the number of teeth and divide the sum by the diametral pitch.

For diametral pitch— divide number of teeth by pitch diameter.

For circular pitch— divide 3.1416 by the diametral pitch.

For length of rack— multiply number of teeth in rack by circular pitch of gear.

When ordering gears, the following information must be given:—

Number required
Number of teeth
Circular pitch
Diametral pitch
Face
Bore
Pitch Diameter
Diameter of hub
Length of hub
Projection of hub on one or both sides
No. and size of keys
Material

If these dimensions cannot be determined, or are not all fixed by requirements we can usually make satisfactory gears if the distance between centers—number of teeth in each gear—face—bore—etc., are given, and if the number of teeth cannot be determined, give R. P. M. of each gear—distance between centers—and H. P. to be transmitted.

Proper lubrication for exposed or enclosed gears is of importance to obtain minimum wear, least noise, and highest efficiency.

SPROCKETS AND CHAINS

Where the distance between driving and driven shafts is too great for gears and too short for belt transmission, the use of chain and sprockets is satisfactory. Although slightly higher in initial cost, chain transmission is warranted for its positive and powerful action and its compactness, over belt transmission. There are several types of chains—block, roller, bushing, and silent chains, each adapted to a particular variety of load, velocity, and drive.

INFORMATION REQUIRED WHEN ORDERING CHAINS AND SPROCKETS:

Sketch of drive, showing whether horizontal, vertical, or slanting. Chains should not be used on vertical drives if avoidable.

Mark drive sprocket A, and driven sprocket B, and give direction of drive by arrow.

Horse power to be transmitted—is load steady, irregular or pulsating, and does the drive start or stop suddenly.

Give distance between centers of shafts with amount of variation for adjustment.

Type of chain, whether roller, block, or silent.

Pitch of chain, its number and width.

Sprocket hub bore.

Sprocket—kind of material.

Number of teeth.

Number and size of keys or of set screws.

BELTS AND PULLEYS

Running under rapid load variations and at high speed, narrow thick belts are more desirable than wide thin belts because of the latter's sideway slip and wave motion on the slack side.

Belts on pulleys 12" in diameter or larger should be two ply, pulleys over 20" in diameter should be three ply, and on pulleys 30" or over, four ply. The life of a belt depends upon the power transmitted, its splice, and the care given it, and not necessarily upon its speed, when this is under 2,500 feet per minute. Oak tanned leather belts run with greatest transmission efficiency at 65 to 80 feet per second, and chromium treated leather belts at about 100 feet per second, and under tension of from 575 to 850 lbs. per square inch of section respectively. The thickness should be from $\frac{1}{20}$ to $\frac{1}{30}$ of the radius of the pulley with $\frac{1}{15}$ permissible to chromium leather. Rubber belts are desirable where exposed to weather, steam or vapors, as they are less absorbent and stretch less. In strength, a three or four ply, a five or six ply, and a seven or eight ply rubber belt, is respectively equal to a single, double, or triple ply leather belt. Belts should not be run faster than 4,400 to 4,800 feet per minute and the pulling stresses per inch of width for a $\frac{5}{16}$" single ply, $\frac{3}{8}$" double ply, $\frac{9}{16}$" triple ply, and $\frac{3}{4}$" four ply leather belt, should be 45 lbs., 80 lbs., 110 lbs., and 145 lbs., respectively, to be most effective.

The horse power transmitted by leather and rubber belts of given width is calculated thus,

Leather Belt

$$H.P. = \frac{SDRW}{132000}$$

Rubber Belt

$$H.P. = \frac{PWDR}{12000}$$

Where H. P. = horse power, S = effective pull of belt per inch of width in lbs. as given above, D = diameter of driving pulley in inches, R = number of revolutions of pulley per minute, W = width of belt in inches, P = number of plies of belt, all based on contact arc on pulley of not less than 180 degrees.

INFORMATION REQUIRED WHEN ORDERING PULLEYS:

Kind of belt, ply and width.

Pulley solid or split, crowned or straight face, loose or tight on shaft.

Kind of hub, set screw, key seat, or special.

Pulley to be bushed, babbited, or left open.

Cast iron belt pulleys should not be run at a higher rim velocity than 100 feet per second.

ROPE DRIVES

For power transmission, where requirements are beyond the efficient operation of belts, the American system of rope drives can be economically used. High grade manila rope running in machined grooved sheaves is successful for steady transmission of power in like or different planes at long distances between shafts.

HORSE POWER TRANSMITTED FOR ROPE DRIVES:

$$\text{H. P.} = \frac{2V\ (T-F)}{3 \times 550} \qquad T = 160D^2 \qquad F = \frac{WV^2}{32}$$

Where H. P. = horse power transmitted per rope, V = velocity of rope in feet per second, T = safe working tension in lbs. per rope, F = centrifugal tension in lbs. per rope, W = weight of rope per foot, D = nominal diameter of rope.

SHAFTING

Cold rolled steel shafting, smooth, strong and uniform in section, is carried in stock in variations of ¼" diameters to suit bearings, couplings, pulleys, gears, sprockets, etc.

Calculate the horse power transmitted by cold rolled steel shafting thus,

For main power drive shafts: $\text{H. P.} = \frac{D^3R}{125}$

For line shafts carrying pulleys: $\text{H. P.} = \frac{D^3R}{75}$

For small short shafts: $\text{H. P.} = \frac{D^3R}{50}$

Where H. P. = horse power, D = diameter of shaft in inches. R = R. P. M.

Shafting under sudden variations of load should be increased in area and where greater stiffness is desired, i. e., a twist of not over five minutes or about .08 degrees per foot of length of shaft, use the following formula,

$$D = 4.6 \sqrt[4]{\frac{\text{H.P.}}{R}}$$

The allowable distance between hangers or bearings with a maximum linear deflection of .01 inch per foot of length of shaft, (L being maximum distance between bearings in feet) is obtained thus,

For bare shafts: $L = \sqrt[3]{720D^2}$.
For shafts carrying pulleys, etc.; $L = \sqrt[3]{140D^2}$

TYPICAL CONSTRUCTION—DETAILS

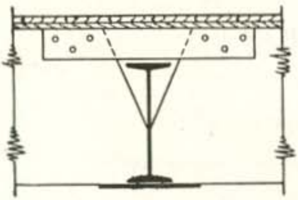


Fig. 177

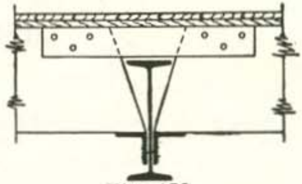


Fig. 178

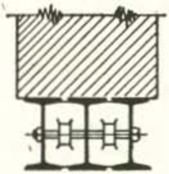


Fig. 179

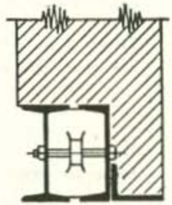


Fig. 180

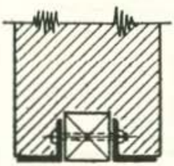


Fig. 181

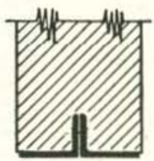


Fig. 182

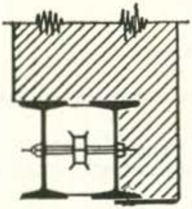


Fig. 183

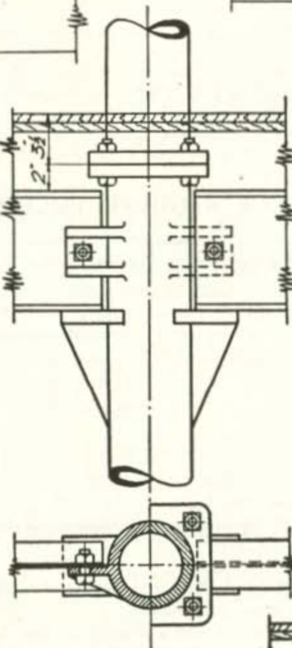


Fig. 185

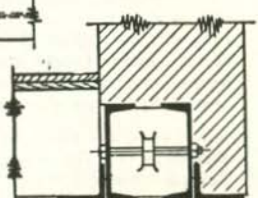


Fig. 184

In the above details Figures 177 and 178 show two methods of supporting wood joists on steel beams with plates or angles. In Figure 177 the beam is flush with the ceiling, while in Figure 178 the steel beam would show as a plastered beam in the ceiling. Figures 179 to 184 show different types of lintels for the support of brick walls over openings. Figure 185 shows a typical detail of cast iron column and beam construction with minimum dimensions.

MENSURATION

LENGTH

Circumference of circle = diameter × 3.1416 or diameter × $3\frac{1}{7}$ approx.

Diameter of circle=circumference ×.3183 or $\frac{7}{22}$ of circumference approx.

Side of square of equal periphery as circle = diameter × .7854.
Diameter of circle of equal periphery as square = side × 1.2732
Side of inscribed square = diameter of circle × .7071.
Length of arc = No. of degrees × diameter × .008727
Radius = .5642 $\sqrt{\text{area}}$.

AREA OF REGULAR POLYGONS

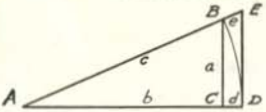
Regular polygon = sum of sides × half perpendicular distance from center to sides.
Square the length of one side and multiply by proper number in following table.

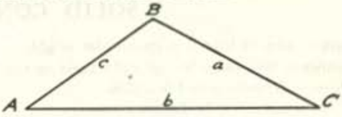
Name	No. of sides	Multiply
Triangle	3	.433
Square	4	1.
Pentagon	5	1.720
Hexagon	6	2.598
Heptagon	7	3.634
Octagon	8	4.828
Nonagon	9	6.182
Decagon	10	7.694

Triangle = base × ½ perpendicular height.
Trapezoid = half the sum of parallel sides × perpendicular height.
Circle = diameter squared × 0.7854.
= circumference squared × .07958.
Ring = .7854 × [square of outside diameter—square of inside diameter.]
Sector of circle = Length of arc × ½ radius.
Segment of circle = Area of sector— area of triangle when the segment is less and + the area of the triangle when segment is greater than semicircle.

Side of square that shall equal area of circle = diameter × .8862; circumference × .2821.
Diameter of circle that shall equal area of square = side of square × 1.1284.
Parabola = base × ⅔ height.
Ellipse = long diameter × short diameter × .7854.
Surface of cylinder = circumference × height + area of both ends.
Surface of sphere = diameter squared × 3.1416. or = circumference × diameter

TRIGONOMETRIC FORMULAE





SOLUTION OF RIGHT TRIANGLES

1. $\sin A = \frac{a}{c} = \cos B$
2. $\cos A = \frac{b}{c} = \sin B$
3. $\tan A = \frac{a}{b} = \cot B$
4. $\cot A = \frac{b}{a} = \tan B$
5. $\sec A = \frac{c}{b} = \operatorname{cosec} B$
6. $\operatorname{cosec} A = \frac{c}{a} = \sec B$
7. $\operatorname{vers} A = \frac{c-b}{c} = \frac{d}{c} = \operatorname{covers} B$
8. $\operatorname{exsec} A = \frac{e}{c}$
9. $a = c \sin A = b \tan A = c \cos B = b \cot B = \sqrt{(c+b)(c-b)}$
10. $b = c \cos A = a \cot A = c \sin B = a \tan B = \sqrt{(c+a)(c-a)}$
11. $d = c \operatorname{vers} A$
12. $e = c \operatorname{exsec} A$
13. $c = \frac{a}{\cos B} = \frac{b}{\sin B} = \frac{a}{\sin A} = \frac{b}{\cos A} = \frac{d}{\operatorname{vers} A} = \frac{e}{\operatorname{exsec} A}$

SOLUTION OF OBLIQUE TRIANGLES

GIVEN	SOUGHT	FORMULAES
14 A, B, a,	b, c.	$b = \frac{a}{\sin A} \cdot \sin B \qquad c = \frac{a}{\sin A} \cdot \sin (A+B)$
15 A, a, b	B, c	$\sin B = \frac{\sin A}{a} \cdot b \qquad c = \frac{a}{\sin A} \cdot \sin C$
16 C, a, b	A, B	$\tan \frac{1}{2}(A-B) = \frac{a-b}{a+b} \cdot \tan \frac{1}{2}(A+B)$
17 a, b, c	A	Let $s = \frac{1}{2}(a+b+c)$; $\sin \frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{bc}}$
18		$\cos \frac{1}{2} A = \sqrt{\frac{s(s-a)}{bc}}$; $\tan \frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}}$
19		$\sin A = 2\sqrt{\frac{s(s-a)(s-b)(s-c)}{bc^2}}$
20.		$\operatorname{vers} A = \frac{2(s-b)(s-c)}{bc}$
21	AREA	$\text{AREA} = \sqrt{s(s-a)(s-b)(s-c)}$
22. A, B, C, a	AREA	$\text{AREA} = \frac{a^2 \sin B \sin C}{2 \sin A}$
23. C, a, b	AREA	$\text{AREA} = \frac{1}{2} a b \sin C$

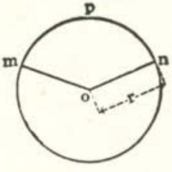
QUADRANT	I	II	III	IV	ANGLES		
ANGLES	0° to 90°	90° to 180°	180° to 270°	270° to 360°	30°	45°	60°
FUNCTIONS	VALUES VARY FROM				EQUIVALENT VALUES		
SIN.	+0 to +1	+1 to +0	−0 to −1	−1 to −0	$\frac{1}{2}$	$\frac{1}{2}\sqrt{2}$	$\frac{1}{2}\sqrt{3}$
COS.	+1 to +0	−0 to −1	−1 to −0	+0 to +1	$\frac{1}{2}\sqrt{3}$	$\frac{1}{2}\sqrt{2}$	$\frac{1}{2}$
TAN.	+0 to +∞	−∞ to −0	+0 to +∞	−∞ to −0	$\frac{1}{3}\sqrt{3}$	1	$\sqrt{3}$
COT.	+∞ to +0	−0 to −∞	+∞ to +0	−0 to −∞	$\sqrt{3}$	1	$\frac{1}{3}\sqrt{3}$

ANGLE a <90°				
ANGLE	SINE	COS	TAN.	COT.
φ°	φ°	φ°	φ°	φ°
$0° \pm a$	$\pm \sin a$	$+\cos a$	$\pm \tan a$	$\pm \cot a$
$90° \pm a$	$+\cos a$	$\mp \sin a$	$\mp \cot a$	$\mp \tan a$
$180° \pm a$	$\mp \sin a$	$-\cos a$	$\pm \tan a$	$\pm \cot a$
$270° \pm a$	$-\cos a$	$\pm \sin a$	$\mp \cot a$	$\mp \tan a$

SOLID CONTENTS

Prism = area of base × perpendicular neight.
Cylinder = area of section at right angle to side × length of side.
Sphere = diameter cubed × .5236.
    = surface × $\frac{1}{6}$ diameter.
Pyramid or Cone = area of base × $\frac{1}{3}$ perpendicular height.

AREA OF CIRCULAR SECTIONS

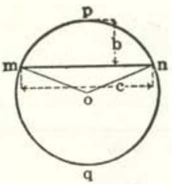


Circular Sector, m o n p

Area = $\frac{1}{2}$ (length of arc, m p n x radius, r)

$= \text{area of circle} \times \dfrac{\text{arc, m p n, in degrees}}{360}$

$= 0.0087266 \times$ square of radius, $r^2 \times$ angle of arc, m p n, in degrees.



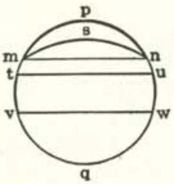
Circular Segment, m p n, less than half circle.

Area = area of sector, m o n p–area of triangle, m o n

$= \dfrac{\text{(length of arc,mpnx radius,r)} - \text{(radius,r,–rise,b)xchord,c}}{2}$

Circular Segment, m q n, greater than half circle.

Area = area of circle–area of segment, m n p

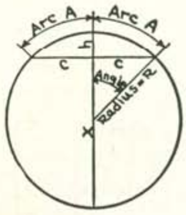


Circular Zone, t u w v

Area = area of circle—(area of segment, tpu + area of segment, vqw).

Circular Lune, m p n s

Area = segment, m p n–segment, m s n.



Formulae To Figure Bowstring Trusses

To determine radius—R

First figure $x = \dfrac{c^2}{h}$

And $R = \dfrac{x + h}{2}$

Sine of Angle $= \dfrac{C}{R}$

Then to find arc see page 287

MEMO

DECIMAL EQUIVALENTS FOR VULGAR FRACTIONS

The figures in central columns give the decimal parts in inches of the fraction at the left in column marked inches, and decimal parts of one foot for inches and fractions of inches shown in column to the right, marked foot.

Example, 1/8 inches=.1250 inches. 1 1/2 inches=.1250 feet.

Inches	Decimal	Foot	Inches	Decimal	Foot	Inches	Decimal	Foot	Inches	Decimal	Foot
	.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		.5417	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
	.0673	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 9/16
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	.25000	3	1/2	.5000	6	3/4	.7500	9	1	1.0000	12

LENGTH OF CIRCULAR ARCS FOR UNIT RADIUS

By the use of this table, the length of any arc may be found if the length of the radius and the angle of the segment are known.

Example:—Required the length of arc of segment of 32° 15' 27" with radius of 24 feet 3 inches.

From table: Length of arc (Radius 1) for 32° = .5585054
15' = .0043633
27" = .0001309
.5629996

.5629996 × 24.25 (length of radius) = 13.65 feet.

DEGREES						MINUTES		SECONDS	
1°	.017 4533	61°	1.064 6508	121°	2.111 8484	1'	.000 2909	1"	.000 0048
2	.034 9066	62	1.082 1041	122	2.129 3017	2	.000 5818	2	.000 0097
3	.052 3599	63	1.099 5574	123	2.146 7550	3	.000 8727	3	.000 0145
4	.069 8132	64	1.117 0107	124	2.164 2083	4	.001 1636	4	.000 0194
5	.087 2665	65	1.134 4640	125	2.181 6616	5	.001 4544	5	.000 0242
6	.104 7198	66	1.151 9173	126	2.199 1149	6	.001 7453	6	.000 0291
7	.122 1730	67	1.169 3706	127	2.216 5682	7	.002 0362	7	.000 0339
8	.139 6263	68	1.186 8239	128	2.234 0214	8	.002 3271	8	.000 0388
9	.157 0796	69	1.204 2772	129	2.251 4747	9	.002 6180	9	.000 0436
10	.174 5329	70	1.221 7305	130	2.268 9280	10	.002 9089	10	.000 0485
11	.191 9862	71	1.239 1838	131	2.286 3813	11	.003 1998	11	.000 0533
12	.209 4395	72	1.256 6371	132	2.303 8346	12	.003 4907	12	.000 0582
13	.226 8928	73	1.274 0904	133	2.321 2879	13	.003 7815	13	.000 0630
14	.244 3461	74	1.291 5436	134	2.338 7412	14	.004 0724	14	.000 0679
15	.261 7994	75	1.308 9969	135	2.356 1945	15	.004 3633	15	.000 0727
16	.279 2527	76	1.326 4502	136	2.373 6478	16	.004 6542	16	.000 0776
17	.296 7060	77	1.343 9035	137	2.391 1011	17	.004 9451	17	.000 0824
18	.314 1593	78	1.361 3568	138	2.408 5544	18	.005 2360	18	.000 0873
19	.331 6126	79	1.378 8101	139	2.426 0077	19	.005 5269	19	.000 0921
20	.349 0659	80	1.396 2634	140	2.443 4610	20	.005 8178	20	.000 0970
21	.366 5191	81	1.413 7167	141	2.460 9142	21	.006 1087	21	.000 1018
22	.383 9724	82	1.431 1700	142	2.478 3675	22	.006 3995	22	.000 1067
23	.401 4257	83	1.448 6233	143	2.495 8208	23	.006 6904	23	.000 1115
24	.418 8790	84	1.466 0766	144	2.513 2741	24	.006 9813	24	.000 1164
25	.436 3323	85	1.483 5299	145	2.530 7274	25	.007 2722	25	.000 1212
26	.453 7856	86	1.500 9832	146	2.548 1807	26	.007 5631	26	.000 1261
27	.471 2389	87	1.518 4364	147	2.565 6340	27	.007 8540	27	.000 1309
28	.488 6922	88	1.535 8897	148	2.583 0873	28	.008 1449	28	.000 1357
29	.506 1455	89	1.553 3430	149	2.600 5406	29	.008 4358	29	.000 1406
30	.523 5988	90	1.570 7963	150	2.617 9939	30	.008 7266	30	.000 1454
31	.541 0521	91	1.588 2496	151	2.635 4472	31	.009 0175	31	.000 1503
32	.558 5054	92	1.605 7029	152	2.652 9005	32	.009 3084	32	.000 1551
33	.575 9587	93	1.623 1562	153	2.670 3538	33	.009 5993	33	.000 1600
34	.593 4119	94	1.640 6095	154	2.687 8070	34	.009 8902	34	.000 1648
35	.610 8652	95	1.658 0628	155	2.705 2603	35	.010 1811	35	.000 1697
36	.628 3185	96	1.675 5161	156	2.722 7136	36	.010 4720	36	.000 1745
37	.645 7718	97	1.692 9694	157	2.740 1669	37	.010 7629	37	.000 1794
38	.663 2251	98	1.710 4227	158	2.757 6202	38	.011 0538	38	.000 1842
39	.680 6784	99	1.727 8760	159	2.775 0735	39	.011 3446	39	.000 1891
40	.698 1317	100	1.745 3293	160	2.792 5268	40	.011 6355	40	.000 1939
41	.715 5850	101	1.762 7825	161	2.809 9801	41	.011 9264	41	.000 1988
42	.733 0383	102	1.780 2358	162	2.827 4334	42	.012 2173	42	.000 2036
43	.750 4916	103	1.797 6891	163	2.844 8867	43	.012 5082	43	.000 2085
44	.767 9449	104	1.815 1424	164	2.862 3400	44	.012 7991	44	.000 2133
45	.785 3982	105	1.832 5957	165	2.879 7933	45	.013 0900	45	.000 2182
46	.802 8515	106	1.850 0490	166	2.897 2466	46	.013 3809	46	.000 2230
47	.820 3047	107	1.867 5023	167	2.914 6999	47	.013 6717	47	.000 2279
48	.837 7580	108	1.884 9556	168	2.932 1531	48	.013 9626	48	.000 2327
49	.855 2113	109	1.902 4089	169	2.949 6064	49	.014 2535	49	.000 2376
50	.872 6646	110	1.919 8622	170	2.967 0597	50	.014 5444	50	.000 2424
51	.890 1179	111	1.937 3155	171	2.984 5130	51	.014 8353	51	.000 2473
52	.907 5712	112	1.954 7688	172	3.001 9663	52	.015 1262	52	.000 2521
53	.925 0245	113	1.972 2221	173	3.019 4196	53	.015 4171	53	.000 2570
54	.942 4778	114	1.989 6753	174	3.036 8729	54	.015 7080	54	.000 2618
55	.959 9311	115	2.007 1286	175	3.054 3262	55	.015 9989	55	.000 2666
56	.977 3844	116	2.024 5819	176	3.071 7795	56	.016 2897	56	.000 2715
57	.994 8377	117	2.042 0352	177	3.089 2328	57	.016 5806	57	.000 2763
58	1.012 2910	118	2.059 4885	178	3.106 6861	58	.016 8715	58	.000 2812
59	1.029 7443	119	2.076 9418	179	3.124 1394	59	.017 1624	59	.000 2860
60	1.047 1976	120	2.094 3951	180	3.141 5927	60	.017 4533	60	.000 2909

See page 284 for application.

CIRCUMFERENCES AND AREAS OF CIRCLES

Diam.	Circum.	Area
1/64	.04909	.00019
1/32	.09818	.00077
3/64	.14726	.00173
1/16	.19635	.00307
3/32	.29452	.00690
1/8	.39270	.01227
5/32	.49087	.01917
3/16	.58905	.02761
7/32	.68722	.03758
1/4	.78540	.04909
9/32	.88357	.06213
5/16	.98175	.07670
11/32	1.0799	.09281
3/8	1.1781	.11045
13/32	1.2763	.12962
7/16	1.3744	.15033
15/32	1.4726	.17257
1/2	1.5708	.19635
17/32	1.6690	.22166
9/16	1.7671	.24850
19/32	1.8653	.27688
5/8	1.9635	.30680
21/32	2.0617	.33824
11/16	2.1598	.37122
23/32	2.2580	.40574
3/4	2.3562	.44179
25/32	2.4544	.47937
13/16	2.5525	.51849
27/32	2.6507	.55914
7/8	2.7489	.60132
29/32	2.8471	.64504
15/16	2.9452	.69029
31/32	3.0434	.73708
1	3.1416	.7854
1 1/16	3.3379	.8866
1 1/8	3.5343	.9940
1 3/16	3.7306	1.1075
1 1/4	3.9270	1.2272
1 5/16	4.1233	1.3530
1 3/8	4.3197	1.4849
1 7/16	4.5160	1.6230
1 1/2	4.7124	1.7671
1 9/16	4.9087	1.9175
1 5/8	5.1051	2.0739
1 11/16	5.3014	2.2365
1 3/4	5.4978	2.4053
1 13/16	5.6941	2.5802
1 7/8	5.8905	2.7612
1 15/16	6.0868	2.9483
2	6.2832	3.1416
2 1/16	6.4795	3.3410
2 1/8	6.6759	3.5466
2 3/16	6.8722	3.7583
2 1/4	7.0686	3.9761
2 5/16	7.2649	4.2000
2 3/8	7.4613	4.4301

Diam.	Circum.	Area
2 7/16	7.6576	4.6664
2 1/2	7.8540	4.9087
2 9/16	8.0503	5.1572
2 5/8	8.2467	5.4119
2 11/16	8.4430	5.6727
2 3/4	8.6394	5.9396
2 13/16	8.8357	6.2126
2 7/8	9.0321	6.4918
2 15/16	9.2284	6.7771
3	9.4248	7.0686
3 1/16	9.6211	7.3662
3 1/8	9.8175	7.6699
3 3/16	10.014	7.9798
3 1/4	10.210	8.2958
3 5/16	10.407	8.6179
3 3/8	10.603	8.9462
3 7/16	10.799	9.2806
3 1/2	10.996	9.6211
3 9/16	11.192	9.9678
3 5/8	11.388	10.321
3 11/16	11.585	10.680
3 3/4	11.781	11.045
3 13/16	11.977	11.416
3 7/8	12.174	11.973
3 15/16	12.370	12.177
4	12.566	12.566
4 1/16	12.763	12.962
4 1/8	12.959	13.364
4 3/16	13.155	13.772
4 1/4	13.352	14.186
4 5/16	13.548	14.607
4 3/8	13.744	15.033
4 7/16	13.941	15.466
4 1/2	14.137	15.904
4 9/16	14.334	16.349
4 5/8	14.530	16.800
4 11/16	14.726	17.257
4 3/4	14.923	17.721
4 13/16	15.119	18.190
4 7/8	15.315	18.665
4 15/16	15.512	19.147
5	15.708	19.635
5 1/16	15.904	20.129
5 1/8	16.101	20.629
5 3/16	16.297	21.135
5 1/4	16.493	21.648
5 5/16	16.690	22.166
5 3/8	16.886	22.691
5 7/16	17.082	23.221
5 1/2	17.279	23.758
5 9/16	17.475	24.301
5 5/8	17.671	24.850
5 11/16	17.686	25.406
5 3/4	18.064	25.967
5 13/16	18.261	26.535
5 7/8	18.457	27.109
5 15/16	18.653	27.688

Diam.	Circum.	Area
6	18.850	28.274
6 1/8	19.242	29.465
6 1/4	19.635	30.680
6 3/8	20.028	31.919
6 1/2	20.420	33.183
6 5/8	20.813	34.472
6 3/4	21.206	35.785
6 7/8	21.598	37.122
7	21.991	38.485
7 1/8	22.384	39.871
7 1/4	22.776	41.282
7 3/8	23.169	42.718
7 1/2	23.562	44.179
7 5/8	23.955	45.664
7 3/4	24.347	47.173
7 7/8	24.740	48.707
8	25.133	50.265
8 1/8	25.525	51.849
8 1/4	25.918	53.456
8 3/8	26.311	55.088
8 1/2	26.704	56.745
8 5/8	27.096	58.426
8 3/4	27.489	60.132
8 7/8	27.882	61.862
9	28.274	63.617
9 1/8	28.667	65.397
9 1/4	29.060	67.201
9 3/8	29.452	69.029
9 1/2	29.845	70.882
9 5/8	30.238	72.760
9 3/4	30.631	74.662
9 7/8	31.023	76.589
10	31.416	78.540
10 1/8	31.809	80.516
10 1/4	32.201	82.516
10 3/8	32.594	84.541
10 1/2	32.987	86.590
10 5/8	33.379	88.664
10 3/4	33.772	90.763
10 7/8	34.165	92.886
11	34.558	95.033
11 1/8	34.950	97.205
11 1/4	35.343	99.402
11 3/8	35.736	101.62
11 1/2	36.128	103.87
11 5/8	36.521	106.14
11 3/4	36.914	108.43
11 7/8	37.306	110.75
12	37.699	113.10
12 1/8	38.092	115.47
12 1/4	38.485	117.86
12 3/8	38.877	120.28
12 1/2	39.270	122.72
12 5/8	39.663	125.19
12 3/4	40.055	127.68

Diam.	Circum.	Area
12 7/8	40.448	130.19
13	40.841	132.73
13 1/8	41.233	135.30
13 1/4	41.626	137.89
13 3/8	42.019	140.50
13 1/2	42.412	143.14
13 5/8	42.804	145.80
13 3/4	43.197	148.49
13 7/8	43.590	151.20
14	43.982	153.94
14 1/8	44.375	156.70
14 1/4	44.768	159.48
14 3/8	45.160	162.30
14 1/2	45.553	165.13
14 5/8	45.946	167.99
14 3/4	46.338	170.87
14 7/8	46.731	173.78
15	47.124	176.71
15 1/8	47.517	179.67
15 1/4	47.909	182.65
15 3/8	48.302	185.66
15 1/2	48.695	188.69
15 5/8	49.087	191.75
15 3/4	49.480	194.83
15 7/8	49.873	197.93
16	50.265	201.06
16 1/8	50.658	204.22
16 1/4	51.051	207.39
16 3/8	51.444	210.60
16 1/2	51.836	213.82
16 5/8	52.229	217.08
16 3/4	52.622	220.35
16 7/8	53.014	223.65
17	53.407	226.98
17 1/8	53.800	230.33
17 1/4	54.192	233.71
17 3/8	54.585	237.10
17 1/2	54.978	240.53
17 5/8	55.371	243.98
17 3/4	55.763	247.45
17 7/8	56.156	250.95
18	56.549	254.47
18 1/8	56.941	258.02
18 1/4	57.334	261.59
18 3/8	57.727	265.18
18 1/2	58.119	268.80
18 5/8	58.512	272.45
18 3/4	58.905	276.12
18 7/8	59.298	279.81
19	59.690	283.53
19 1/8	60.083	287.27
19 1/4	60.476	291.04
19 3/8	60.868	294.83

Courtesy Ryerson & Son.

CIRCUMFERENCES AND AREAS OF CIRCLES —Continued

Diam.	Circum.	Area
19½	61.261	298.65
19⅝	61.654	302.49
19¾	62.046	306.35
19⅞	62.439	310.24
20	62.832	314.16
20⅛	63.225	318.10
20¼	63.617	322.06
20⅜	64.010	326.05
20½	64.403	330.06
20⅝	64.795	334.10
20¾	65.188	338.16
20⅞	65.581	342.25
21	65.973	346.36
21⅛	66.366	350.50
21¼	66.759	354.66
21⅜	67.152	358.84
21½	67.544	363.05
21⅝	67.937	367.28
21¾	68.330	371.54
21⅞	68.722	375.83
22	69.115	380.13
22⅛	69.508	384.46
22¼	69.900	388.82
22⅜	70.293	393.20
22½	70.686	397.61
22⅝	71.079	402.04
22¾	71.471	406.49
22⅞	71.864	410.97
23	72.257	415.48
23⅛	72.649	420.00
23¼	73.042	424.56
23⅜	73.435	429.13
23½	73.827	433.74
23⅝	74.220	438.36
23¾	74.613	443.01
23⅞	75.006	447.69
24	75.398	452.39
24⅛	75.791	457.11
24¼	76.184	461.86
24⅜	76.576	466.64
24½	76.969	471.44
24⅝	77.362	476.26
24¾	77.754	481.11
24⅞	78.147	485.98
25	78.540	490.87
25⅛	78.933	495.79
25¼	79.325	500.74
25⅜	79.718	505.71
25½	80.111	510.71
25⅝	80.503	515.72
25¾	80.896	520.77
25⅞	81.289	525.84
26	81.681	530.93

Diam.	Circum.	Area
26⅛	82.074	536.05
26¼	82.467	549.11
26⅜	82.860	546.35
26½	83.252	551.55
26⅝	83.645	556.76
26¾	84.038	562.00
26⅞	84.430	567.27
27	84.823	572.56
27⅛	85.216	577.87
27¼	85.608	583.21
27⅜	86.001	588.57
27½	86.394	593.96
27⅝	86.786	599.37
27¾	87.179	604.81
27⅞	87.572	610.27
28	87.965	615.75
28⅛	88.357	621.26
28¼	88.750	626.80
28⅜	89.143	632.36
28½	89.535	637.94
28⅝	89.928	643.55
28¾	90.321	649.18
28⅞	90.713	654.84
29	91.106	660.52
29⅛	91.499	666.23
29¼	91.892	671.96
29⅜	92.284	677.71
29½	92.677	683.49
29⅝	93.070	689.30
29¾	93.462	695.13
29⅞	93.855	700.98
30	94.248	706.86
30⅛	94.640	712.70
30¼	95.033	718.69
30⅜	95.426	724.64
30½	95.819	730.62
30⅝	96.211	736.62
30¾	96.604	742.64
30⅞	96.997	748.69
31	97.389	754.77
31⅛	97.782	760.87
31¼	98.175	766.99
31⅜	98.567	773.14
31½	98.960	779.31
31⅝	99.353	785.51
31¾	99.746	791.73
31⅞	100.138	797.98
32	100.531	804.25
32⅛	100.924	810.54
32¼	101.316	816.86
32⅜	101.709	823.21
32½	102.102	829.58
32⅝	102.494	835.97
32¾	102.887	842.39
32⅞	103.280	848.83

Diam.	Circum.	Area
33	103.673	855.30
33⅛	104.065	861.79
33¼	104.458	868.31
33⅜	104.851	874.85
33½	105.243	881.41
33⅝	105.636	888.00
33¾	106.029	894.62
33⅞	106.421	901.26
34	106.814	907.92
34⅛	107.207	914.61
34¼	107.600	921.32
34⅜	107.992	928.06
34½	108.385	934.82
34⅝	108.778	941.61
34¾	109.170	948.42
34⅞	109.563	955.25
35	109.956	962.11
35⅛	110.348	969.00
35¼	110.741	975.91
35⅜	111.134	982.84
35½	111.527	989.80
35⅝	111.919	996.87
35¾	112.312	1003.8
35⅞	112.705	1010.8
36	113.097	1017.9
36⅛	113.490	1025.0
36¼	113.883	1032.1
36⅜	114.275	1039.2
36½	114.668	1046.3
36⅝	115.061	1053.5
36¾	115.454	1060.7
36⅞	115.846	1068.0
37	116.239	1075.2
37⅛	116.632	1082.5
37¼	117.024	1089.8
37⅜	117.417	1097.1
37½	117.810	1104.5
37⅝	118.202	1111.8
37¾	118.596	1119.2
37⅞	118.988	1126.7
38	119.381	1134.1
38⅛	119.773	1141.0
38¼	120.166	1149.1
38⅜	120.559	1156.6
38½	120.951	1164.2
38⅝	121.344	1171.7
38¾	121.737	1179.3
38⅞	122.129	1186.9
39	122.522	1194.6
39⅛	122.915	1202.3
39¼	123.308	1210.0
39⅜	123.700	1217.7
39½	124.093	1225.4
39⅝	124.486	1233.2
39¾	124.878	1241.0

Diam.	Circum.	Area
39⅞	125.271	1248.8
40	125.664	1256.6
40⅛	126.056	1264.5
40¼	126.449	1272.4
40⅜	126.842	1280.3
40½	127.235	1288.2
40⅝	127.627	1296.2
40¾	128.020	1304.2
40⅞	128.413	1312.2
41	128.805	1320.3
41⅛	129.198	1328.3
41¼	129.591	1336.4
41⅜	129.983	1344.5
41½	130.376	1352.7
41⅝	130.769	1360.8
41¾	131.161	1369.0
41⅞	131.554	1377.2
42	131.947	1385.4
42⅛	132.340	1393.7
42¼	132.732	1402.0
42⅜	133.125	1410.3
42½	133.518	1418.6
42⅝	133.910	1427.0
42¾	134.303	1435.4
42⅞	134.696	1443.8
43	135.088	1452.2
43⅛	135.481	1460.7
43¼	135.874	1469.1
43⅜	136.267	1477.6
43½	136.659	1486.2
43⅝	137.052	1494.3
43¾	137.445	1503.7
43⅞	137.837	1511.9
44	138.230	1520.5
44⅛	138.623	1529.2
44¼	139.015	1537.9
44⅜	139.408	1546.6
44½	139.801	1555.3
44⅝	140.194	1564.0
44¾	140.586	1572.8
44⅞	140.979	1581.6
45	141.372	1590.4
45⅛	141.764	1599.3
45¼	142.157	1608.2
45⅜	142.550	1617.0
45½	142.942	1626.0
45⅝	143.335	1634.9
45¾	143.728	1643.9
45⅞	144.121	1652.9
46	144.513	1661.9
46⅛	144.906	1670.9
46¼	145.299	1680.0
46⅜	145.691	1689.1

Courtesy Ryerson & Son.

CIRCUMFERENCES AND AREAS OF CIRCLES —Continued

Diam.	Circum.	Area
46½	146.084	1698.2
46⅝	146.477	1707.4
46¾	146.869	1716.5
46⅞	147.262	1725.7
47	147.655	1734.9
47⅛	148.048	1744.2
47¼	148.440	1753.5
47⅜	148.833	1762.7
47½	149.226	1772.1
47⅝	149.618	1781.4
47¾	150.011	1790.8
47⅞	150.404	1800.1
48	150.796	1809.6
48⅛	151.189	1819.0
48¼	151.582	1828.5
48⅜	151.975	1837.9
48½	152.367	1847.5
48⅝	152.760	1857.0
48¾	153.153	1866.5
48⅞	153.545	1876.1
49	153.938	1885.7
49⅛	154.331	1895.4
49¼	154.723	1905.0
49⅜	155.116	1914.7
49½	155.509	1924.4
49⅝	155.902	1934.2
49¾	156.294	1943.9
49⅞	156.687	1953.7
50	157.080	1963.5
50⅛	157.472	1973.3
50¼	157.865	1983.2
50⅜	158.258	1993.1
50½	158.650	2003.0
50⅝	159.043	2012.9
50¾	159.436	2022.8
50⅞	159.829	2032.8
51	160.221	2042.8
51⅛	160.614	2052.8
51¼	161.007	2062.9
51⅜	161.399	2073.0
51½	161.792	2083.1
51⅝	162.185	2093.2
51¾	162.577	2103.3
51⅞	162.970	2113.5
52	163.363	2123.7
52⅛	163.756	2133.9
52¼	164.148	2144.2
52⅜	164.541	2154.5
52½	164.934	2164.8
52⅝	165.326	2175.1
52¾	165.719	2185.4
52⅞	166.112	2195.8
53	166.504	2206.2
53⅛	166.897	2216.6

Diam.	Circum.	Area
53¼	167.290	2227.0
53⅜	167.683	2237.5
53½	168.075	2248.0
53⅝	168.468	2258.5
53¾	168.861	2269.1
53⅞	169.253	2279.6
54	169.646	2290.2
54⅛	170.039	2300.8
54¼	170.431	2311.5
54⅜	170.824	2322.1
54½	171.217	2332.8
54⅝	171.609	2343.5
54¾	172.002	2354.3
54⅞	172.395	2365.0
55	172.788	2375.8
55⅛	173.180	2386.6
55¼	173.573	2397.5
55⅜	173.966	2408.3
55½	174.358	2419.2
55⅝	174.751	2430.1
55¾	175.144	2441.1
55⅞	175.536	2452.0
56	175.929	2463.0
56⅛	176.322	2474.0
56¼	176.715	2485.0
56⅜	177.107	2496.1
56½	177.500	2507.2
56⅝	177.893	2518.3
56¾	178.285	2529.4
56⅞	178.678	2540.6
57	179.071	2551.8
57⅛	179.463	2563.0
57¼	179.856	2574.2
57⅜	180.249	2585.4
57½	180.642	2596.7
57⅝	181.034	2608.0
57¾	181.427	2619.4
57⅞	181.820	2630.7
58	182.212	2642.1
58⅛	182.605	2653.5
58¼	182.998	2664.9
58⅜	183.390	2676.4
58½	183.783	2687.8
58⅝	184.176	2699.3
58¾	184.569	2710.9
58⅞	184.961	2722.4
59	185.354	2734.0
59⅛	185.747	2745.6
59¼	186.139	2757.2
59⅜	186.532	2768.8
59½	186.925	2780.5
59⅝	187.317	2792.2
59¾	187.710	2803.9
59⅞	188.103	2815.7

Diam.	Circum.	Area
60	188.496	2827.4
60⅛	188.888	2839.2
60¼	1 9.281	2851.0
60⅜	189 674	2862.9
60½	190.006	2874.8
60⅝	190.459	2886.6
60¾	190.852	2898.6
60⅞	191.244	2910.5
61	191.637	2922.5
61⅛	192.030	2934.5
61¼	192.423	2946.5
61⅜	192.815	2958.5
61½	193.208	2970.6
61⅝	193.601	2982.7
61¾	193.993	2994.8
61⅞	194.386	3006.9
62	194.779	3019.1
62⅛	195.171	2031.3
62¼	195.564	3043.5
62⅜	195.957	3055.7
62½	196.350	3068.0
62⅝	196. 42	3080.3
62¾	197.135	3092.6
62⅞	197.528	3104.9
63	197.920	3117.2
63⅛	198.313	3129.6
63¼	198.706	3142.0
63⅜	199.098	3154.5
63½	199.491	3166.9
63⅝	199.884	3179.4
63¾	200.277	3191.9
63⅞	200.669	3204.4
64	201.062	3217.0
64⅛	201.4 5	3229.6
64¼	201.847	3242.2
64⅜	202.240	3254.8
64½	202.633	3267.5
64⅝	203.025	3280.1
64¾	203.418	3292.8
64⅞	203.811	3305.6
65	204.204	3318.3
65⅛	204.596	3331.1
65¼	204.989	3343.9
65⅜	205.382	3356.7
65½	205.774	3369.6
65⅝	206.167	3382.4
65¾	206.560	3395.3
65⅞	206.952	3408.2
66	207.345	3421.2
66⅛	207.738	3434.2
66¼	208.131	3447.2
66⅜	208.523	3460.2
66½	208.916	3473.2
66⅝	209.309	3486.3
66¾	209.701	3499.4

Diam.	Circum.	Area
66⅞	210.094	3512.5
67	210.487	3525.7
67⅛	210.879	3538.8
67¼	211.272	3552.0
67⅜	211.665	3565.2
67½	212.058	3578.5
67⅝	212.450	3591.7
67¾	212.843	3605.0
67⅞	213.236	3618.3
68	213.628	3631.7
68⅛	214.021	3645.0
68¼	214.414	3658.4
68⅜	214.806	3671.8
68½	215.199	3685.3
68⅝	215.592	3698.7
68¾	215.984	3712.2
68⅞	216.377	3725.7
69	216.770	3739.3
69⅛	217.163	3752.8
69¼	217.555	3766.4
69⅜	217.948	3780.0
69½	218.341	3793.7
69⅝	218.733	3807.3
69¾	219.126	3821.0
69⅞	219.519	3834.7
70	219.911	3848.5
70⅛	220.304	3862.2
70¼	220.697	3876.0
70⅜	221.090	3889.8
70½	221.482	3903.6
70⅝	221.875	3917.5
70¾	222.268	3931.4
70⅞	222.660	3945.3
71	223.053	3959.2
71⅛	223.446	3973.1
71¼	223.838	3987.1
71⅜	224.231	4001.1
71½	224.624	4015.2
71⅝	225.017	4029.2
71¾	225.409	4043.3
71⅞	225.802	4057.4
72	226.195	4071.5
72⅛	226.587	4085.7
72¼	226.980	4099.8
72⅜	227.373	4114.0
72½	227.765	4128.2
72⅝	228.158	4142.5
72¾	228.551	4156.8
72⅞	228.944	4171.1
73	229.336	4185.4
73⅛	229.729	4199.7
73¼	230.122	4214.1
73⅜	230.514	4228.5

Courtesy Ryerson & Son.

CIRCUMFERENCES AND AREAS OF CIRCLES —Continued

Diam.	Circum.	Area	Diam.	Circum.	Area	Diam.	Circum.	Area	Diam.	Circum.	Area
73½	230.907	4242.9	80⅛	251.720	5042.3	86⅞	272.926	5927.6	93½	293.739	6866.1
73⅝	231.300	4257.4	80¼	252.113	5058.0				93⅝	294.132	6884.5
73¾	231.692	4271.8	80⅜	252.506	5073.8	87	273.319	5944.7	93¾	294.524	6902.9
73⅞	232.085	4286.3	80½	252.898	5089.6	87⅛	273.711	5961.8	93⅞	294.917	6921.3
			80⅝	253.291	5105.4	87¼	274.104	5978.9			
74	232.478	4300.8	80¾	253.684	5121.2	87⅜	274.497	5996.0	94	295.310	6939.8
74⅛	232.871	4315.4	80⅞	254.076	5137.1	87½	274.889	6013.2	94⅛	295.702	6958.2
74¼	233.263	4329.9				87⅝	275.282	6030.4	94¼	296.095	6976.7
74⅜	233.656	4344.5	81	254.469	5153.0	87¾	275.675	6047.6	94⅜	296.488	6995.3
74½	234.049	4359.2	81⅛	254.862	5168.9	87⅞	276.067	6064.9	94½	296.881	7013.8
74⅝	234.441	4373.8	81¼	255.254	5184.9				94⅝	297.273	7032.4
74¾	234.834	4388.5	81⅜	255.647	5200.8	88	276.460	6082.1	94¾	297.666	7051.0
74⅞	235.227	4403.1	81½	256.040	5216.8	88⅛	276.853	6099.4	94⅞	298.059	7069.6
			81⅝	256.433	5232.8	88¼	277.246	6116.7			
75	235.619	4417.9	81¾	256.825	5248.9	88⅜	277.638	6134.1	95	298.451	7088.2
75⅛	236.012	4432.6	81⅞	257.218	5264.9	88½	278.031	6151.4	95⅛	298.844	7106.9
75¼	236.405	4447.4				88⅝	278.424	6168.8	95¼	299.237	7125.6
75⅜	236.798	4462.2	82	257.611	5281.0	88¾	278.816	6186.2	95⅜	299.629	7144.3
75½	237.190	4477.0	82⅛	258.003	5297.1	88⅞	279.209	6203.7	95½	300.022	7163.0
75⅝	237.583	4491.8	82¼	258.396	5313.3				95⅝	300.415	7181.8
75¾	237.976	4506.7	82⅜	258.789	5329.4	89	279.602	6221.1	95¾	300.807	7200.6
75⅞	238.368	4521.5	82½	259.181	5345.6	89⅛	279.994	6238.6	95⅞	301.200	7219.4
			82⅝	259.574	5361.8	89¼	280.387	6256.1			
76	238.761	4536.5	82¾	259.967	5378.1	89⅜	280.780	6273.7	96	301.593	7238.2
76⅛	239.154	4551.4	82⅞	260.359	5394.3	89½	281.173	6291.2	96⅛	301.986	7257.1
76¼	239.546	4566.4				89⅝	281.565	6308.8	96¼	302.378	7276.0
76⅜	239.939	4581.3	83	260.752	5410.6	89¾	281.958	6326.4	96⅜	302.771	7294.9
76½	240.332	4596.3	83⅛	261.145	5426.9	89⅞	282.351	6344.1	96½	303.164	7313.8
76⅝	240.725	4611.4	83¼	261.538	5443.3				96⅝	303.556	7332.8
76¾	241.117	4626.4	83⅜	261.930	5459.6	90	282.743	6361.7	96¾	303.949	7351.8
76⅞	241.510	4641.5	83½	262.323	5476.0	90⅛	283.136	6379.4	96⅞	304.342	7370.8
			83⅝	262.716	5492.4	90¼	283.529	6397.1			
77	241.903	4656.6	83¾	263.108	5508.8	90⅜	283.921	6414.9	97	304.734	7389.8
77⅛	242.295	4671.8	83⅞	263.501	5525.3	90½	284.314	6432.6	97⅛	305.127	7408.9
77¼	242.688	4686.9				90⅝	284.707	6450.4	97¼	305.520	7428.0
77⅜	243.081	4702.1	84	263.894	5541.8	90¾	285.100	6468.2	97⅜	305.913	7447.1
77½	243.473	4717.3	84⅛	264.286	5558.3	90⅞	285.492	6486.0	97½	306.305	7466.2
77⅝	243.866	4732.5	84¼	264.679	5574.8				97⅝	306.698	7485.3
77¾	244.259	4747.8	84⅜	265.072	5591.4	91	285.885	6503.9	97¾	307.091	7504.5
77⅞	244.652	4763.1	84½	265.465	5607.9	91⅛	286.278	6521.8	97⅞	307.483	7523.7
			84⅝	265.857	5624.5	91¼	286.670	6539.7			
78	245.044	4778.4	84¾	266.250	5641.2	91⅜	287.063	6575.6	98	307.876	7543.0
78⅛	245.437	4793.7	84⅞	266.643	5657.8	91½	287.456	6575.5	98⅛	308.269	7562.2
78¼	245.830	4809.0				91⅝	287.848	6593.5	98¼	308.661	7581.5
78⅜	246.222	4824.4	85	267.035	5674.5	91¾	288.241	6611.5	98⅜	309.054	7600.8
78½	246.615	4839.8	85⅛	267.428	5691.2	91⅞	288.634	6629.6	98½	309.447	7620.1
78⅝	247.008	4855.2	85¼	267.821	5707.9				98⅝	309.840	7639.5
78¾	247.400	4870.7	85⅜	268.213	5724.7	92	289.027	6647.6	98¾	310.232	7658.9
78⅞	247.793	4886.2	85½	268.606	5741.5	92⅛	289.419	6665.7	98⅞	310.625	7678.3
			85⅝	268.999	5758.3	92¼	289.812	6683.8			
79	248.186	4901.7	85¾	269.392	5775.1	92⅜	290.205	6701.9	99	311.018	7697.7
79⅛	248.579	4917.2	85⅞	269.784	5791.9	92½	290.597	6720.1	99⅛	311.410	7717.1
79¼	248.971	4932.7				92⅝	290.990	6738.2	99¼	311.803	7736.6
79⅜	249.364	4948.3	86	270.177	5808.8	92¾	291.383	6756.4	99⅜	312.196	7756.1
79½	249.757	4963.9	86⅛	270.570	5825.7	92⅞	291.775	6774.7	99½	312.588	7775.6
79⅝	250.149	4979.5	86¼	270.962	5842.6				99⅝	312.981	7795.2
79¾	250.542	4995.2	86⅜	271.355	5859.6	93	292.168	6792.9	99¾	313.374	7814.8
79⅞	250.935	5010.9	86½	271.748	5876.5	93⅛	292.561	6811.2	99⅞	313.767	7834.4
			86⅝	272.140	5893.5	93¼	292.954	6829.5			
80	251.327	5026.5	86¾	272.533	5910.6	93⅜	293.346	6847.8	100	314.159	7854.0

Courtesy Ryerson & Son.

EQUIVALENTS OF MEASURE

Lengths

1 meter, m = 10 decimeters, dm = 100 centimeters, cm = 1000 millimeters, mm.
1 meter, m = 0.1 decameter, dkm = 0.01 hectometer, hm = 0.001 kilometer, km.
1 meter, m = 39.37 inches, U. S. Standard = 39.370113 inches, British Standard.
1 millimeter, mm = 1000 microns, μ = 0.03937 inch = 39.37 mils.

Meters, m	Inches, in.	Feet, ft.	Yard, yd.	Rods, r.	Chains, ch.	Miles, U. S. Statute	Miles, U. S. Nautical	Kilos. km.
1	39.37	3.28083	1.09361	0.19884	0.04971	$0.{}^{3}_{0}6214$	$0.{}^{3}_{0}5396$	0.001
0.02540	1	0.08333	0.02778	$0.{}^{2}_{0}5051$	$0.{}^{2}_{0}1263$	$0.{}^{4}_{0}1578$	$0.{}^{4}_{0}1371$	$0.{}^{4}_{0}2540$
0.30480	12	1	0.33333	0.06061	0.01515	$0.{}^{3}_{0}1894$	$0.{}^{3}_{0}1645$	$0.{}^{3}_{0}3048$
0.91440	36	3	1	0.18182	0.04545	$0.{}^{3}_{0}5682$	$0.{}^{3}_{0}4934$	$0.{}^{3}_{0}9144$
5.02921	198	16.5	5.5	1	0.25	$0.{}^{2}_{0}3125$	$0.{}^{2}_{0}2714$	$0.{}^{2}_{0}5029$
20.1168	792	66	22	4	1	0.01250	0.01085	0.02012
1609.35	63360	5280	1760	320	80	1	0.86839	1.60935
1853.25	72962.5	6080.20	2026.73	368.497	92.1243	1.15155	1	1.85325
1000	39370	3280.83	1093.61	198.838	49.7096	0.62137	0.53959	1

1 yard, U. S. = 1.0000029 yards British   1 yard British = 0.9999971 yard U. S.
1 chain, Gunter's = 100 links   1 link = 7.92 inches.
1 cable length, U. S. = 120 fathoms = 960 spans = 720 feet = 219.457 meters.
1 league, U. S. = 3 statute miles = 24 furlongs.
1 international geographical mile = $\frac{1}{15}^{\circ}$ at equator = 7422 m = 4.611808 U. S. statute miles.
1 international nautical mile = $\frac{1}{60}^{\circ}$ at meridian = 1852 m = 0.999326 U. S. nautical miles.
1 U. S. nautical mile = $\frac{1}{60}^{\circ}$ of circumference of sphere whose surface equals that of the earth = 6080.27 feet = 1.15155 statute miles = 1853.27 meters.
1 British nautical mile = 6080.00 feet = 1.15152 statute miles = 1853.19 meters.

SURFACES AND AREAS

1 sq. meter, m^3 = 1000 sq. decimeters, dm^3 = 10000 sq. centimeters, cm^2.
1 sq. meter, m^3 = 0.01 are, a = 0.0001 hectare, ha.
1 sq. millimeter, mm^2 = 0.01 cm^2 = 0.00155 sq. inch = 1973.5 circular mils.
1 are, a = 1 sq. decameter, dkm = 0.0247104 acre.

Sq. Meters m^3	Sq. Inches sq. in.	Sq. Feet, sq. ft.	Sq. Yards sq. yd.	Sq. Rods sq. r.	Acres, A	Hectares, ha.	Sq. Miles, Statute	Sq. Kilos. km^3
1	1550.00	10.7639	1.19599	0.03954	$0.{}^{3}_{0}2471$	0.0001	$0.{}^{6}_{0}3861$	$0.{}^{5}_{0}1$
$0.{}^{3}_{0}6452$	1	$0.{}^{2}_{0}6944$	$0.{}^{3}_{0}7716$	$0.{}^{4}_{0}2551$	$0.{}^{6}_{0}1594$	$0.{}^{7}_{0}6452$	$0.{}^{9}_{0}2491$	$0.{}^{9}_{0}6452$
0.09290	144	1	0.11111	$0.{}^{2}_{0}3673$	$0.{}^{4}_{0}2296$	$0.{}^{5}_{0}9290$	$0.{}^{7}_{0}3587$	$0.{}^{7}_{0}9290$
0.83613	1296	9	1	0.03306	$0.{}^{3}_{0}2066$	$0.{}^{4}_{0}8361$	$0.{}^{6}_{0}3228$	$0.{}^{6}_{0}8361$
25.293)	39204	272.25	30.25	1	0.00625	$0.{}^{2}_{0}2529$	$0.{}^{5}_{0}9766$	$0.{}^{4}_{0}2529$
4046.87	6272640	43560	4840	160	1	0.40469	$0.{}^{2}_{0}1563$	$0.{}^{2}_{0}4047$
10000	15499969	107639	11959.9	395.366	2.47104	1	$0.{}^{2}_{0}3861$	0.01
2589999		27878400	3097600	102400	640	259.000	1	2.59000
1000000		10763867	1195985	39536.6	247.104	100	0.38610	1

1 sq. rod, sq. pole, or sq. perch = 625 sq. links = 1/160 acre.
1 sq. chain, Gunter's = 16 sq. rods = 1/10 acre.
1 acre = 4 sq. roods = 160 sq. rods.   Square of 1 acre = 208.7103 feet square.

Notations ${}^{2}_{0}, {}^{3}_{0}, {}^{4}_{0}$, etc., indicate that the ${}^{2}_{0}, {}^{3}_{0}, {}^{4}_{0}$, etc., are to be replaced by 2, 3, 4, etc., ciphers.

Example—1 sq. rod = $0.{}^{5}_{0}9766$ = 0.000009766 sq. miles.

Courtesy Carnegie Steel Co.

EQUIVALENTS OF MEASURE

VOLUME AND CAPACITY

1 cu. meter, m^3 = 1000 cu. decimeter, dm^3 = 1000000 cu. centimeters, cm^3. 1 liter, 1 = 10 deciliters, dl = 100 centiliters, cl = 1000 milliliters, ml = 1000 cu. centimeters, cm^3. or cc. 1 liter, 1 = 0.1 decaliter, dkl = 0.01 hectoliter, hl = 1 cu. decimeter, dm^3.

Cubic Decimeter dm^3, l	Cubic Inches cu. in.	Cubic Feet, cu. ft.	Cubic Yards, cu. yd.	U. S. Quarts		U. S. Gallons		U. S. Bushels, bu.
				Liquid, l. qt.	Dry, d. qt.	Liquid, l. gal.	Dry, d. gal.	
1	61.0234	0.03531	$0.{}^{2}_{0}1308$	1.05668	0.90808	0.26417	0.22702	0.02838
0.01639	1	$0.{}^{3}_{0}5787$	$0.{}^{4}_{0}2143$	0.01732	0.01488	$0.{}^{2}_{0}4329$	$0.{}^{2}_{0}3720$	$0.{}^{3}_{0}4650$
28.3170	1728	1	0.03704	29.9221	25.7140	7.48055	6.42851	0.80356
764.559	46656	27	1	807.896	694.279	201.974	173.570	21.6962
0.94636	57.75	0.03342	$0.{}^{2}_{0}1238$	1	0.85937	0.25	0.21484	0.02686
1.10123	67.2006	0.03889	$0.{}^{2}_{0}1440$	1.16365	1	0.29091	0.25	0.03125
3.78543	231	0.13368	$0.{}^{2}_{0}4951$	4	3.43747	1	0.85937	0.10742
4.40492	268.803	0.15556	$0.{}^{2}_{0}5761$	4.65460	4	1.16365	1	0.125
35.2393	2150.42	1.24446	0.04609	37.2368	32	9.30920	8	1

U. S. Dry Measure: 1 bushel = 4 pecks = 8 gallons = 32 quarts = 64 pints.
U. S. Liquid Measure: 1 gallon = 4 quarts = 8 pints = 32 gills = 128 fluid ounces.
U. S. Apoth. Measure: 1 fl. ounce, f℥ = 8 fl. drams, fʒ = 480 minims, m = 29.574 cm^3.
British Imperial gallon dry and liquid measure = 1.03202 U. S. dry gallon = 1.20091 U. S liquid gallons.
British Imperial gallon = 277.410 cu. in. = 4545.9631 cm^3.

Weight of water at maximum density, 4°C, 45° Lat., and sea level.

1 cu. ft. = 62.4283 lbs. av. = 28.3170 kg. 1 cu in.. = 0.57804 oz. av. = 16.3872 g.
1 gallon, U. S. liquid = 8.34545 lbs. = 3.78543 kg.
1 gallon, British Imperial = 10.0221 lbs. = 4.5459631 kg.

MASSES AND WEIGHTS

1 gram, g = 10 decigrams, dg = 100 centigrams, cg = 1000 milligrams, mg.
1 gram, g = 0.1 decagram, dkg = 0.01 hectogram, hg = 0.001 kilogram, kg.
1 kilogram, kg = 1 cu. decimeter of water or liter, 4°C, 45° Lat. and sea level. = 15432.35639 grains, U. S. and British Standard.

Kilo-grams, kg.	Grains, gr.	Ounces		Pounds		Tons		
		Troy, oz. t.	Avoir., oz. av.	Troy, lb. t.	Avoir., lb. av.	Net, Short 2000 lbs.	Gross, Long, 2240 lbs.	Metric, 1000 kg.
1	15432.4	32.1507	35.2740	2.67923	2.20462	$0.{}^{2}_{0}1102$	$0.{}^{3}_{0}9842$	0.001
$0.{}^{4}_{0}6480$	1	$0.{}^{2}_{0}2083$	$0.{}^{2}_{0}2286$	$0.{}^{3}_{0}1736$	$0.{}^{3}_{0}1429$	$0.{}^{7}_{0}7143$	$0.{}^{7}_{0}6378$	$0.{}^{7}_{0}6480$
0.03110	480	1	1.09714	0.08333	0.06857	$0.{}^{4}_{0}3429$	$0.{}^{4}_{0}3061$	$0.{}^{4}_{0}3110$
0.02835	437.5	0.91146	1	0.07595	0.06250	$0.{}^{4}_{0}3125$	$0.{}^{4}_{0}2790$	$0.{}^{4}_{0}2835$
0.37324	5760	12	13.1657	1	0.82286	$0.{}^{3}_{0}4114$	$0.{}^{3}_{0}3674$	$0.{}^{3}_{0}3732$
0.45359	7000	14.5833	16	1.21528	1	0.00050	$0.{}^{3}_{0}4464$	$0.{}^{3}_{0}4532$
907.185	14000000	29166.7	32000	2430.56	2000	1	0.89286	0.90719
1016.05	15680000	32666.7	35840	2722.22	2240	1.12	1	1.01605
1000	15432356	32150.7	35274.0	2679.23	2204.62	1.10231	0.98421	1

1 ounce avoir. = 16 drams, avoir. 1 ounce troy = 20 pennyweight, dwt.
1 ounce apoth., ℥ = 8 drams, ʒ = 24 scruples, ℈ = 480 grains, gr = 31.1035 g.
1 hundredweight = 1/20 long ton = 4 quarters = 8 stone = 112 lbs. = 50.8024 kg.

Notations ${}^{2}_{0},{}^{3}_{0},{}^{4}_{0}$, etc., indicate that the ${}^{2}_{0},{}^{3}_{0},{}^{4}_{0}$, etc., are to be replaced by 2, 3, 4, etc., ciphers
Example—1 grain = $0.{}^{2}_{0}2083$ = .002083 oz. t. 1 grain = $0.{}^{4}_{0}6480$ = 0.00006480 kg.

EQUIVALENTS OF MEASURE

FORCES OR WEIGHTS PER UNITS OF LENGTH, LINEAR WEIGHTS

1 dyne per centimeter = 0.00101979 g/cm = 0.000183719 poundal/in.
1 gram per centimeter = 980.5966 dynes/cm = 0.180154 poundal/in.
1 poundal per inch = 5443.11 dynes/cm = 5.55081 g/cm = 0.0310832 pound/in.

Grams per Centimeter g/cm	Grains per Inch gr./in.	Pounds per Inch, lb./in.	Pounds per Foot, lb./ft.	Pounds per Yard, lb./yd.	Kilograms per Meter kg/m	Net Tons 2000 lbs., per Mile	Gross Tons, 2240 lbs., per Mile	Metric Tons, 1000 kg, per Kilo.
1	39.1983	$0.\overset{2}{0}5600$	0.06720	0.20159	0.10	0.17740	0.15839	0.10
0.02551	1	$0.\overset{3}{0}1429$	$0.\overset{2}{0}1714$	$0.\overset{2}{0}5143$	$0.\overset{2}{0}2551$	$0.\overset{2}{0}4526$	$0.\overset{2}{0}4041$	$0.\overset{2}{0}2551$
178.579	7000	1	12	36	17.8579	31.6800	28.2857	17.8579
14.8816	583.333	0.08333	1	3	1.48816	2.64000	2.35714	1.48816
4.96054	194.444	0.02778	0.33333	1	0.49605	0.88000	0.78571	0.49605
10	391.983	0.05600	0.67197	2.01591	1	1.77400	1.58393	1
5.63698	220.960	0.03157	0.37879	1.13636	0.56370	1	0.89286	0.56370
6.31342	247.475	0.03535	0.42424	1.27273	0.63134	1.12	1	0.63134

FORCES OR WEIGHTS PER UNITS OF AREA, PRESSURE

1 dyne per sq. centimeter = 0.00101979 g/cm² = 0.000466646 poundals/in².
1 gram per sq. centimeter = 980.5966 dynes/cm² = 0.457592 poundals/in².
1 poundal per sq. inch = 2142.95 dynes/cm² = 2.18536 g/cm² = 0.0310832 pound/in².

Kil'grams per Sq. Centimeter, kg/cm²	Pounds per Sq. Inch, lb./in.²	Pounds per Sq. Foot, lb./ft.²	Net Tons 2000 lbs. per Sq. Foot	Atmospheres, Standard, 760 mm	Columns of Mercury Hg. 13.59593 Sp.G.		Columns of Water, Max. Density 4°C	
					Millimeters	Inches	Meters	Feet
1	14.2234	2048.17	1.02408	0.96778	735.514	28.9572	10	32.8083
0.97031	1	144	0.07200	0.06804	51.7116	2.03588	0.70307	2.30665
$0.\overset{3}{0}4882$	$0.\overset{2}{0}6944$	1	.000050	$0.\overset{3}{0}4725$	0.35911	0.01414	$0.\overset{2}{0}4882$	0.01602
0.97648	13.8889	2000	1	0.94502	718.216	28.2762	9.76482	32.0367
1.03329	14.6969	2116.35	1.05818	1	760	29.9212	10.3329	33.9006
$0.\overset{2}{0}1360$	0.01934	2.78468	$1.\overset{2}{0}1392$	$0.\overset{2}{0}1316$	1	0.03937	0.01360	0.04461
0.03453	0.49119	70.7310	0.03537	0.03342	25.4001	1	0.34534	1.13299
0.10	1.42234	204.817	0.10241	0.09678	73.5514	2.89572	1	3.28083
0.03048	0.43353	62.4283	0.03121	0.02950	22.4185	0.88262	0.30480	1

FORCES OR WEIGHTS PER UNITS OF VOLUME, DENSITY

1 dyne per cu. centimeter = 0.00101979 gram/cm³ = 0.00118528 poundals/in³.
1 gram per cu. centimeter = 980.5966 dynes/cm³ = 1.162283 poundals/in³.
1 poundal per cu. inch = 843.683 dynes/cm³ = 0.860378 g/cm³ = 0.0310832 pound/in³.

Grams per Cu. Centimeter, g/cm³	Pounds per Cu. Inch, lb./in.³	Pounds per Cu. Foot, lb./ft.³	Pounds per Cu. Yard, lb./yd.³	Kilograms per Cu. Meter kg/m³	Pounds per Bushel, U. S.	Pounds per Gallon, Dry, U. S.	Pounds per Gallon, Liquid, U. S.	Kilograms per Hectoliter, kg/hl
1	0.03613	62.4283	1685.56	1000	77.6893	9.71116	8.34545	100
27.6797	1	1728	46656	27679.7	2150.42	268.803	231	2767.97
0.01602	$0.\overset{3}{0}5787$	1	27	16.0184	1.24446	0.15556	0.13368	1.60184
$0.\overset{3}{0}5933$	$0.\overset{4}{0}2143$	0.03704	1	0.59327	0.04609	$0.\overset{2}{0}5762$	$0.\overset{2}{0}4951$	0.05933
0.001	$0.\overset{4}{0}3613$	0.06243	1.68556	1	0.07769	$0.\overset{2}{0}9711$	$0.\overset{2}{0}8345$	0.10
0.01287	$0.\overset{3}{0}4650$	0.80356	21.6962	12.8718	1	0.125	0.10742	1.28718
0.10297	$0.\overset{2}{0}3720$	6.42851	173.570	102.974	8	1	0.85937	10.2974
0.11983	$0.\overset{2}{0}4329$	7.48052	210.974	119.826	9.30920	1.16365	1	11.9826
0.01	$0.\overset{3}{0}3613$	0.62428	16.8557	10	0.77689	0.09711	0.08345	1

Notations $\overset{2}{0}$, $\overset{3}{0}$, $\overset{4}{0}$, etc., indicate that the $\overset{2}{0}$, $\overset{3}{0}$, $\overset{4}{0}$, etc., are to be replaced by 2, 3, 4, etc., ciphers

Example—1 kg/m³ = $0.\overset{4}{0}3613$ = 0.00003613 lb./in³.

Courtesy Carnegie Steel Co.

EQUIVALENTS OF MEASURE

ENERGY, WORK, HEAT

1 dyne-centimeter = 1 erg = 0.00101979 gram-centimeter = $0.\overset{7}{0}737612$ foot-pound.

1 gram-centimeter = 980.5966 ergs = $0.\overset{4}{0}7233$ foot-pound.

1 foot-pound = 13557300 ergs = 13825.5 gram-centimeters.

Kilogram-meters, kg-m	Foot-Pounds, ft.-lbs.	Horsepower-hour U. S., H. P.-h	Horsepower-hour Metric, 75 kg-m-h	Poncelet-hours, 100 kg-m-h	Kilowatt-hours, kw-h	Joules, 10^7 ergs, j-s	Thermal Units B. T. U. b. t. u.	Thermal Units Calorie, kg-cal
1	7.23300	$0.\overset{5}{0}3653$	$0.\overset{5}{0}3704$	$0.\overset{5}{0}2778$	$0.\overset{5}{0}2724$	9.80597	$0.\overset{2}{0}9296$	$0.\overset{2}{0}2342$
0.13826	1	$0.\overset{6}{0}5051$	$0.\overset{6}{0}5121$	$0.\overset{6}{0}3840$	$0.\overset{6}{0}3766$	1.35573	$0.\overset{2}{0}1285$	$0.\overset{3}{0}3239$
273745	1980000	1	1.01387	0.76040	0.74565	2684340	2544.65	641.240
270000	1952910	0.98632	1	0.75	0.73545	2647610	2509.83	632.467
360000	2603880	1.31509	1.33333	1	0.98060	3530147	3346.44	843.289
367123	2655403	1.34111	1.35972	1.01979	1	3600000	3412.66	859.975
0.10198	0.73761	$0.\overset{6}{0}3725$	$0.\overset{6}{0}3777$	$0.\overset{6}{0}2833$	$0.\overset{6}{0}2778$	1	$0.\overset{3}{0}9480$	$0.\overset{3}{0}2389$
107.577	778.104	$0.\overset{3}{0}3930$	$0.\overset{3}{0}3984$	$0.\overset{3}{0}2988$	$0.\overset{3}{0}2930$	1054.90	1	0.25200
426.900	3087.77	$0.\overset{2}{0}1559$	$0.\overset{2}{0}1581$	$0.\overset{2}{0}1186$	$0.\overset{2}{0}1163$	4186.17	3.96832	1

POWER, RATE OF ENERGY AND HEAT

1 erg per sec. = 1 dyne-cm/sec. = 0.00101979 gram-cm/sec. = $0.\overset{7}{0}737612$ foot-pounds/sec.

1 gram-centimeter per second = 980.5966 ergs/sec. = $0.\overset{4}{0}7238$ foot-pounds/sec.

1 foot-pound per second = 13557300 ergs/sec = 13825.5 gram-cm/sec.

Kilogram-meters per Second, kg-m/s	Foot-pounds per Second, ft.-lbs./s	Horsepower U. S., 550 ft.-lbs./s	Horsepower Metric, 75 kg-m/s	Poncelet, 100 kg-m/s	Kilowatt, kw.	Watts, 10^7ergs/s	Thermal Units per Sec. B. T. U. btu/s	Thermal Units per Sec. Calorie kg-cal/s
1	7.23300	0.01315	0.01333	0.01	$0.\overset{2}{0}9806$	9.80597	$0.\overset{2}{0}9296$	$0.\overset{2}{0}2342$
0.13826	1	$0.\overset{2}{0}1818$	$0.\overset{2}{0}1843$	$0.\overset{2}{0}1383$	$0.\overset{2}{0}1356$	1.35573	$0.\overset{2}{0}1285$	$0.\overset{3}{0}3237$
76.0404	550	1	1.01387	0.76040	0.74565	745.650	0.70685	0.17812
75	542.475	0.98632	1	0.75	0.73545	735.448	0.69718	0.17569
100	723.300	1.31509	1.33333	1	0.98060	980.597	0.92957	0.23425
101.979	737.612	1.34111	1.35972	1.01979	1	1000	0.94796	0.23888
0.10198	0.73761	$0.\overset{2}{0}1341$	$0.\overset{2}{0}1360$	$0.\overset{2}{0}1020$	0.001	1	$0.\overset{3}{0}9480$	$0.\overset{3}{0}2389$
107.577	778.104	1.41474	1.43436	1.07577	1.05490	1054.90	1	0.25200
426.900	3087.77	5.61412	5.69200	4.26900	4.18617	4186.17	3.96832	1

VELOCITIES AND ACCELERATIONS

1 kine = 1 centimeter per second = 0.0328083 foot per second.

1 radian per second = 57.2958 degrees per sec. = 0.159155 revolutions per sec.

1 gravity = 980.5966 centimeters per sec. per sec. = 32.1717 feet per sec. per sec.

Meters, per Second, m/s	Feet per Second, ft./s	Miles per Hour, M/h	Knots per Hour, U. S.	Kilo-meters Hour, km/h	Meter per sec/sec m/s^2	Feet per sec/sec $ft./s^2$	Miles per hour/sec M/h-s	Kilo-meter per hour/sec km/h-s
1	3.28083	2.23693	1.94254	3.6				
0.30480	1	0.68182	0.59209	1.09728				
0.44704	1.46667	1	0.86839	1.60935				
.0.51479	1.68894	1.15155	1	1.85325				
0.27778	0.91134	0.62137	0.53959	1				
					1	3.28083	2.23693	3.6
					0.30480	1	0.68182	1.09728
					0.44704	1.46667	1	1.60935
					.0.27778	0.91134	0.62137	1

Notations $\overset{2}{0}$, $\overset{3}{0}$, $\overset{4}{0}$, etc., indicate that the $\overset{2}{0}$, $\overset{3}{0}$, $\overset{4}{0}$, etc., are to be replaced by 2, 3, 4, etc., ciphers.

Example—1 Calorie = $0.\overset{2}{0}1163$ = 0.001163 kilowatt-hours.

Courtesy Carnegie Steel Co.

EXPANSION OF BODIES BY HEAT

The linear coefficient of expansion of a body is the rate at which the unit of length changes, under constant pressure, with an increase of unit or one degree of temperature; the square surface coefficient of expansion is, approximately, two times, and the cubical or volumetric coefficient three times the linear coefficient of expansion. A bar, if not fixed, undergoes a change in length = ltn, where l is the length of the bar in inches, t the number of degrees, n the corresponding linear coefficient; if fixed at both ends, the internal stress per unit of area = tnE, pounds per square inch, where E is the modulus of elasticity, and the total temperature stress = AtnE, pounds, where A is the cross section of the bar in square inches.

To find the increase of a bar due to an increase in temperature, from the table, multiply the length of the bar by the increase in degrees and by the coefficient for 100 degrees, and divide by 100.

COEFFICIENTS OF EXPANSION FOR 100 DEGREES = 100n

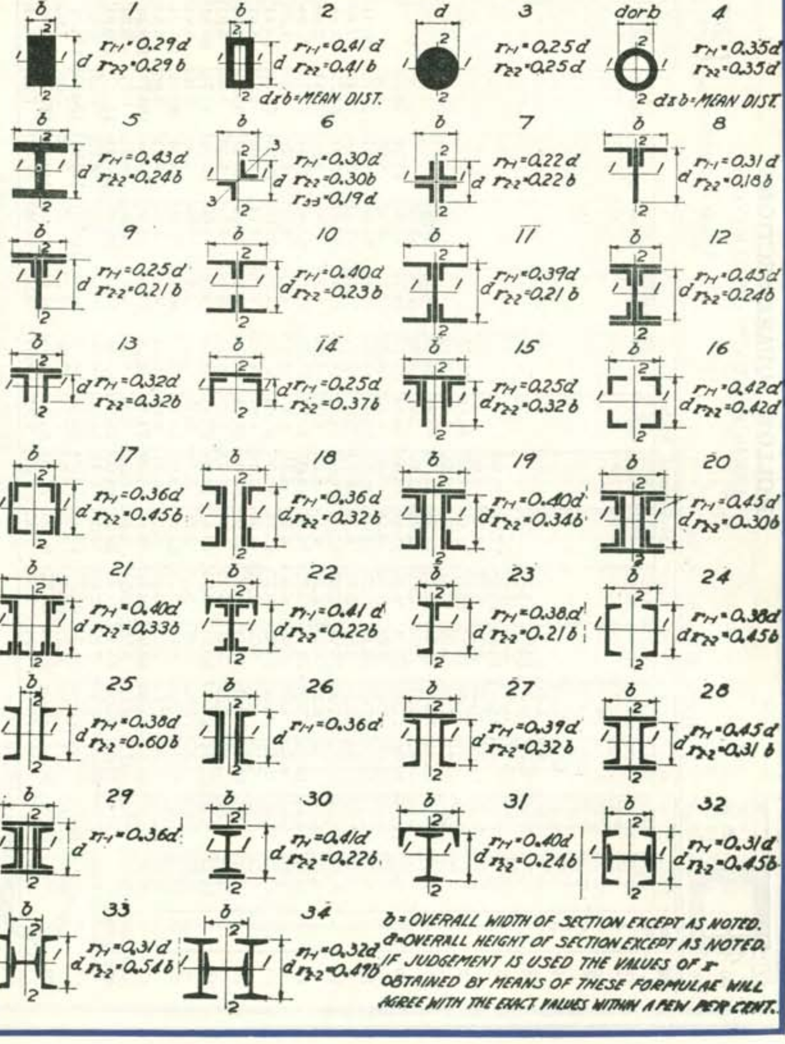
Substance	Linear Expansion		Substance	Linear Expansion	
	Centigrade	Fahrenheit		Centigrade	Fahrenheit
Metals and Alloys			**Stone and Masonry**		
Aluminum, wrought	.00231	.00128	Ashlar masonry	.00063	.00035
Brass	.00188	.00104	Brick masonry	.00055	.00031
" wire	.00193	.00107	Cement, portland	.00107	.00059
Bronze	.00181	.00101	Concrete	.00143	.00079
Copper	.00168	.00093	" masonry	.00120	.00067
German Silver	.00183	.00102	Granite	.00084	.00047
Gold	.00150	.00083	Limestone	.00080	.00044
Iron, cast, gray	.00106	.00059	Marble	.00100	.00056
" wrought	.01120	.00067	Plaster	.00166	.00092
" wire	.00124	.00069	Rubble masonry	.00063	.00035
Lead	.00286	.00159	Sandstone	.00110	.00061
Nickel	.00126	.00070	Slate	.00104	.00058
Platinum	.00090	.00050	**Timber**		
Platinum-Iridium, 15% Ir.	.00081	.00045	Fir, parallel to fibre	.00037	.00021
Silver	.00192	.00107	Maple	.00064	.00036
Steel, cast	.00110	.00061	Oak	.00049	.00027
" hard	.00132	.00073	Pine	.00054	.00030
" medium	.00120	.00067	Fir, perpendicular to fiber	.0058	.0032
" soft	.00110	.00061	Maple	.0048	.0027
Tin	.00210	.00117	Oak	.0054	.0030
Zinc, rolled	.00311	.00173	Pine	.0034	.0019
Miscellaneous Solids			**Liquid Substances**	**Volumetric Expansion**	
Glass	.00085	.00047	Alcohol	.104	.058
Graphite	.00079	.00044	Acid, nitric	.110	.061
Gutta-percha	.05980	.03322	" sulphuric	.063	.035
Paraffin	.02785	.01547	Mercury	.018	.010
Porcelain	.00036	.00020	Oil, turpentine	.090	.050

EXPANSION OF WATER, MAXIMUM DENSITY = 1

C°	Volume	C°	Volume	C°	Volume	C°	Volume	C°	Volume	C°	Volume
0	1.000126	10	1.000257	30	1.004234	50	1.011877	70	1.022384	90	1.035829
4	1.000000	20	1.001732	40	1.007627	60	1.016954	80	1.029003	100	1.043116

Courtesy Carnegie Steel Co.

APPROXIMATE RADII OF GYRATION
COMMON BUILDING AND BRIDGE SECTIONS

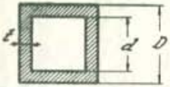


	r_{1-1}	r_{2-2}	
1	$0.29d$	$0.29b$	
2	$0.41d$	$0.41b$	d & b = MEAN DIST.
3	$0.25d$	$0.25d$	
4	$0.35d$	$0.35d$	d or b; d & b = MEAN DIST.
5	$0.43d$	$0.24b$	
6	$0.30d$	$0.30b$	$r_{3-3} = 0.19d$
7	$0.22d$	$0.22b$	
8	$0.31d$	$0.18b$	
9	$0.25d$	$0.21b$	
10	$0.40d$	$0.23b$	
11	$0.39d$	$0.21b$	
12	$0.45d$	$0.24b$	
13	$0.32d$	$0.32b$	
14	$0.25d$	$0.37b$	
15	$0.25d$	$0.32b$	
16	$0.42d$	$0.42d$	
17	$0.36d$	$0.45b$	
18	$0.36d$	$0.32b$	
19	$0.40d$	$0.34b$	
20	$0.45d$	$0.30b$	
21	$0.40d$	$0.33b$	
22	$0.41d$	$0.22b$	
23	$0.38d$	$0.21b$	
24	$0.38d$	$0.45b$	
25	$0.38d$	$0.60b$	
26	$0.36d$		
27	$0.39d$	$0.32b$	
28	$0.45d$	$0.31b$	
29	$0.36d$		
30	$0.41d$	$0.22b$	
31	$0.40d$	$0.24b$	
32	$0.31d$	$0.45b$	
33	$0.31d$	$0.54b$	
34	$0.32d$	$0.49b$	

b = OVERALL WIDTH OF SECTION EXCEPT AS NOTED.
d = OVERALL HEIGHT OF SECTION EXCEPT AS NOTED.
IF JUDGEMENT IS USED THE VALUES OF r OBTAINED BY MEANS OF THESE FORMULAE WILL AGREE WITH THE EXACT VALUES WITHIN A FEW PER CENT.

HOLLOW SQUARE SECTIONS

AREAS AND RADII OF GYRATION



Area = $(D^2 - d^2)$ sq. in.

Radius of Gyration = $\sqrt{\frac{D^2 + d^2}{12}}$ in.

Side D, In.	Elements	Thickness, t, Inches															
		1/4	5/16	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2
2	A	1.75	2.11														
	r	.72	.70														
3	A	2.75	3.36														
	r	1.13	1.10														
4	A	3.75	4.61	5.44	7.00												
	r	1.53	1.51	1.49	1.44												
5	A	4.75	5.86	6.94	9.00	10.94	12.75										
	r	1.94	1.92	1.89	1.85	1.80	1.76										
6	A	5.75	7.11	8.44	11.00	13.44	15.75	17.94	20.00								
	r	2.35	2.33	2.30	2.25	2.21	2.17	2.12	2.08								
7	A	6.75	8.36	9.94	13.00	15.94	18.75	21.44	24.00	26.44	28.75						
	r	2.76	2.73	2.71	2.66	2.62	2.57	2.53	2.48	2.44	2.40						
8	A	7.75	9.61	11.44	15.00	18.44	21.75	24.94	28.00	30.94	33.75	36.44	39.00				
	r	3.17	3.14	3.12	3.07	3.02	2.98	2.93	2.89	2.84	2.80	2.76	2.72				
9	A	8.75	10.86	12.94	17.00	20.94	24.75	28.44	32.00	35.44	38.75	41.94	45.00	47.94	50.75		
	r	3.57	3.55	3.53	3.48	3.43	3.38	3.34	3.29	3.25	3.20	3.16	3.12	3.08	3.05		
10	A	9.75	12.11	14.44	19.00	23.44	27.75	31.94	36.00	39.94	43.75	47.44	51.00	54.44	57.75	60.94	64.00
	r	3.98	3.96	3.93	3.88	3.84	3.79	3.74	3.70	3.65	3.61	3.57	3.52	3.48	3.44	3.40	3.37
11	A	10.75	13.36	15.94	21.00	25.94	30.75	35.44	40.00	44.44	48.75	52.94	57.00	60.94	64.75	68.44	72.00
	r	4.39	4.37	4.34	4.29	4.24	4.20	4.15	4.10	4.06	4.01	3.97	3.93	3.88	3.84	3.80	3.76
12	A	11.75	14.61	17.44	23.00	28.44	33.75	38.94	44.00	48.94	53.75	58.44	63.00	67.44	71.75	75.94	80.00
	r	4.80	4.77	4.75	4.70	4.65	4.60	4.56	4.51	4.46	4.42	4.37	4.33	4.29	4.25	4.20	4.16
13	A	12.75	15.86	18.94	25.00	30.94	36.75	42.44	48.00	53.44	58.75	63.94	69.00	73.94	78.75	83.44	88.00
	r	5.21	5.18	5.16	5.11	5.06	5.01	4.96	4.92	4.87	4.82	4.78	4.74	4.69	4.65	4.61	4.56
14	A	13.75	17.11	20.44	27.00	33.44	39.75	45.94	52.00	57.94	63.75	69.44	75.00	80.44	85.75	90.94	96.00
	r	5.61	5.59	5.56	5.51	5.47	5.42	5.37	5.32	5.28	5.23	5.18	5.14	5.10	5.05	5.01	4.97
15	A	14.75	18.36	21.94	29.00	35.94	42.75	49.44	56.00	62.44	68.75	74.94	81.00	86.94	92.75	98.44	104.00
	r	6.02	6.00	5.97	5.92	5.87	5.83	5.78	5.73	5.68	5.64	5.59	5.55	5.50	5.46	5.41	5.37
16	A	15.75	19.61	23.44	31.00	38.44	45.75	52.94	60.00	66.94	73.75	80.44	87.00	93.44	99.75	105.94	112.00
	r	6.43	6.41	6.38	6.33	6.28	6.23	6.19	6.14	6.09	6.04	6.00	5.95	5.91	5.86	5.82	5.77
17	A	16.75	20.86	24.94	33.00	40.94	48.75	56.44	64.00	71.44	78.75	85.94	93.00	99.94	106.75	113.44	120.00
	r	6.84	6.81	6.79	6.74	6.69	6.64	6.59	6.54	6.50	6.45	6.40	6.36	6.31	6.27	6.23	6.18
18	A	17.75	22.11	26.44	35.00	43.44	51.75	59.94	68.00	75.94	83.75	91.44	99.00	106.44	113.75	120.94	128.00
	r	7.25	7.22	7.20	7.15	7.10	7.05	7.00	6.95	6.90	6.86	6.81	6.76	6.72	6.67	6.63	6.58
19	A	18.75	23.36	27.94	37.00	45.94	54.75	63.44	72.00	80.44	88.75	96.94	105.00	112.94	120.75	128.44	136.00
	r	7.66	7.63	7.61	7.56	7.51	7.46	7.41	7.36	7.31	7.26	7.22	7.17	7.12	7.08	7.03	6.99
20	A	19.75	24.61	29.44	39.00	48.44	57.75	66.94	76.00	84.94	93.75	102.44	111.00	119.44	127.75	135.94	144.00
	r	8.06	8.04	8.01	7.96	7.91	7.87	7.82	7.77	7.72	7.67	7.62	7.58	7.52	7.49	7.44	7.39

Courtesy Carnegie Steel Co.

HOLLOW ROUND SECTIONS

AREAS AND RADII OF GYRATION

Area $= \frac{\pi (D^2-d^2)}{4} = 0.7854\ (D^2-d^2)$ sq. in. Radius of Gyration $= \frac{\sqrt{D^2+d^2}}{4}$ in.

Dia. D, In.	Elements	Thickness in Inches ¼	$\frac{5}{16}$	⅜	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2
2	A	1.37	1.66														
	r	0.63	0.61														
3	A	2.16	2.64														
	r	0.98	0.96														
4	A	2.95	3.62	4.27	5.50												
	r	1.33	1.31	1.29	1.25												
5	A	3.73	4.60	5.45	7.07	8.59	10.01										
	r	1.68	1.66	1.64	1.60	1.56	1.53										
6	A	4.52	5.58	6.63	8.64	10.55	12.37	14.09	15.71								
	r	2.03	2.01	1.99	1.95	1.91	1.88	1.84	1.80								
7	A	5.30	6.57	7.80	10.21	12.52	14.73	16.84	18.85	20.76	22.58						
	r	2.39	2.37	2.35	2.30	2.27	2.23	2.19	2.15	2.12	2.08						
8	A	6.09	7.55	8.98	11.78	14.48	17.08	19.59	21.99	24.30	26.51	28.62	30.63				
	r	2.74	2.72	2.70	2.66	2.62	2.58	2.54	2.50	2.46	2.43	2.39	2.36				
9	A	6.87	8.53	10.16	13.35	16.44	19.44	22.33	25.13	27.83	30.43	32.94	35.34	37.65	39.86		
	r	3.09	3.07	3.05	3.01	2.97	2.93	2.89	2.85	2.81	2.78	2.74	2.70	2.67	2.64		
10	A	7.66	9.51	11.34	14.92	18.41	21.79	25.08	28.27	31.37	34.36	37.26	40.06	42.76	45.36	47.86	50.27
	r	3.45	3.43	3.41	3.36	3.32	3.28	3.24	3.20	3.16	3.13	3.09	3.05	3.02	2.98	2.95	2.92
11	A	8.44	10.49	12.52	16.49	20.37	24.15	27.83	31.42	34.90	38.29	41.58	44.77	47.86	50.85	53.75	56.55
	r	3.80	3.78	3.76	3.72	3.67	3.63	3.59	3.55	3.51	3.48	3.44	3.40	3.36	3.33	3.29	3.26
12	A	9.23	11.47	13.70	18.06	22.33	26.51	30.58	34.56	38.44	41.22	45.90	49.48	52.97	56.35	59.64	62.83
	r	4.16	4.13	4.11	4.07	4.03	3.99	3.95	3.91	3.87	3.83	3.79	3.75	3.71	3.68	3.64	3.61
13	A	10.01	12.46	14.87	19.63	24.30	28.86	33.33	37.70	41.97	46.14	50.22	54.19	58.07	61.85	65.53	69.12
	r	4.51	4.49	4.47	4.42	4.38	4.34	4.30	4.26	4.22	4.18	4.14	4.10	4.06	4.03	5.99	3.95
14	A	10.80	13.44	16.05	21.21	26.26	31.22	36.08	40.84	45.50	50.07	54.54	58.91	63.18	67.35	71.42	75.40
	r	4.86	4.84	4.82	4.78	4.73	4.69	4.65	4.61	4.57	4.53	4.49	4.45	4.41	4.38	4.34	4.30
15	A	11.58	14.42	17.23	22.78	28.23	33.58	38.83	43.98	49.04	54.00	58.86	63.62	68.28	72.85	77.31	81.68
	r	5.22	5.19	5.17	5.13	5.09	5.05	5.00	4.96	4.92	4.88	4.84	4.80	4.76	4.73	4.69	4.65
16	A	12.37	15.40	18.41	24.35	30.19	35.93	41.58	47.12	52.57	57.92	63.18	68.33	73.39	78.34	83.20	87.97
	r	5.57	5.55	5.53	5.48	5.44	5.40	5.36	5.32	5.27	5.23	5.19	5.15	5.11	5.08	5.04	5.00
17	A	13.16	16.38	19.59	25.92	32.15	38.29	44.33	50.27	56.11	61.85	67.50	73.04	78.49	83.84	89.09	94.25
	r	5.92	5.90	5.88	5.84	5.79	5.75	5.71	5.67	5.63	5.59	5.55	5.51	5.47	5.43	5.39	5.35
18	A	13.94	17.36	20.76	27.49	34.12	40.64	47.07	53.41	59.64	65.78	71.82	77.75	83.60	89.34	94.98	100.53
	r	6.28	6.25	6.23	6.19	6.15	6.10	6.06	6.02	5.98	5.94	5.90	5.86	5.82	5.78	5.74	5.70
19	A	14.73	18.35	21.94	29.06	36.08	43.00	49.82	56.55	63.18	69.70	76.13	82.47	88.70	94.84	100.87	106.82
	r	6.63	6.61	6.59	6.54	6.50	6.46	6.42	6.37	6.33	6.29	6.25	6.21	6.17	6.13	6.09	6.05
20	A	15.51	19.33	23.12	30.63	38.04	45.36	52.57	59.69	66.71	73.63	80.45	87.18	93.81	100.33	106.77	113.10
	r	6.98	6.96	6.94	6.90	6.85	6.81	6.77	6.73	6.69	6.64	6.60	6.56	6.52	6.48	6.44	6.40

Courtesy Carnegie Steel Co.

APPENDIX

NOTES ON RIVETED GIRDERS

Riveted girders are used where the load to be carried exceeds the capacity of single I beams, or girders composed of two or more I beams with separators and bolts, or with plates riveted to the top and bottom flanges.

On pages 302 to 307 are tables giving the safe loads for riveted plate and angle girders based on an extreme fibre stress, due to bending, of 18,000 lbs. on the net area of the sections. Where the girders span a distance exceeding twenty times the width of their flange, they must be braced laterally. Web stiffeners must also be provided at the points of bearing and of concentrated loads. Where the distance between the flanges is equal to or greater than sixty times the thickness of the web, intermediate stiffness must be provided at distances approximately equal to the depth of the web, but not to exceed 6 feet; these will prevent buckling of the web. The depth of girders should be about one-tenth of the span in feet.

Care should also be taken in arranging the rivet spacing for connecting the flange angles to the web, so that sufficient rivets are provided to transmit stresses which act between these two portions of the construction. The spacing at any point along the girder may be obtained by the following formula:

$$p = \frac{rh}{S}$$

Where p = the pitch of the rivets in the flange angles, in inches.
r = the value of one rivet in bearing or shear.
h = the distance between the center lines of the extreme rivets.
S = the total vertical shear in pounds at the point under consideration.

The above formula gives the theoretical spacing; the rivets should not be spaced to exceed 6 inches in any panel, and the pitch obtained for the maximum load in any panel is usually maintained throughout that panel. Where concentrated loads are imposed, additional rivets should be added to take care of this load.

At the ends of the girder, and through the end stiffeners, sufficient rivets should be provided to carry the maximum end reaction.

See also Page 227 on girders.

RIVETED PLATE GIRDERS

Safe loads in thousands of pounds—uniformly loaded

Distance Center to Center of Bearings	Web 36x⅜" 4Ls 5x3½		Web 36x⅜" 4Ls 6x4				Web 36x⅜" 4Ls 6x6			Web 36x⅜" 4Ls 5x3½ 2 Plts. 12" Wide		Web 36x⅜" 4Ls 6x4 2 Plts. 14" Wide				Web 36x⅜" 4Ls 6x6 2 Plts. 14" Wide		
	Thickness of Flange Angles in Inches									Thickness of Flange Angles and Plates in Inches								
	½	⅝	⅜	½	⅝	¾	⅜	½	⅝	½	⅝	⅜	½	⅝	¾	⅜	½	⅝
30	123	144	114	142	170	196	125	162	196	204	245	187	240	291	342	198	254	307
31	118	139	110	137	164	190	122	158	189	197	239	181	232	282	331	191	246	297
32	115	136	107	133	159	185	117	153	183	191	231	176	225	273	321	186	239	288
33	111	132	103	129	154	179	114	147	178	185	224	170	218	264	311	180	231	279
34	108	127	100	125	150	173	110	143	172	179	217	165	212	257	302	174	224	271
35	105	124	98	121	145	169	108	140	168	174	210	161	206	250	294	170	218	263
36	102	120	96	118	142	164	105	135	163	170	205	156	200	243	285	164	212	257
37	99	117	92	115	137	159	101	132	159	164	199	152	195	236	277	160	206	249
38	97	115	90	112	134	155	99	128	154	161	194	149	189	230	270	156	200	243
39	94	111	88	109	131	151	97	125	151	156	189	144	185	224	263	152	196	236
40	92	109	85	107	127	147	95	122	146	153	185	141	180	218	257	149	191	231
41	90	106	83	105	124	144	92	119	143	149	180	137	176	213	250	145	187	225
42	88	103	81	101	122	141	90	116	140	145	176	134	171	208	244	142	182	219
43	85	101	80	99	118	137	88	114	136	142	170	131	168	204	239	138	178	215
44	83	99	78	97	116	134	86	111	134	138	168	128	163	198	233	135	173	209
45	81	97	75	95	114	131	83	108	131	135	164	125	160	194	228	132	170	205
46	79	94	73	92	111	127	81	105	127	132	161	122	155	189	224	128	165	200
47	76	92	71	90	109	124	79	101	124	128	158	118	152	185	219	125	162	196
48	74	90	69	88	107	120	77	98	122	125	154	116	149	181	216	122	159	191
49	72	88	66	86	105	118	74	96	119	123	151	114	145	178	213	119	155	188
50	70	85	64	83	102	115	73	93	117	119	149	111	143	174	210	116	153	183
Weight Per foot	100.3	113.1	95.1	110.7	125.9	140.3	105.5	124.3	142.7	141.1	164.1	130.8	158.3	185.4	211.7	141.2	171.9	202.2
Sect. Mod.	309.6	362.7	291.2	358.8	423.8	485.8	319.8	396.6	470.7	491.8	587.4	490.5	574.3	689.9	800.8	484.8	612.3	736.1

The safe load table above is based upon 18,000 lbs. per square inch of net section. From girders with cover plates four ⅞" holes have been deducted from each flange, and two from those without covers.

RIVETED PLATE GIRDERS

Safe loads in thousands of pounds—uniformly loaded

Distance Center to Center of Bearings	Web 36x½" 4Ls 6x4		Web36x½" 4Ls 6x6		Web 36x½" 4Ls 6x4 2 Plts. 14" Wide			Web 36x½" 4Ls 6x6 2 Plts. 14" Wide			Web 42x⅜" 4Ls 6x4					Web 42x⅜" 4Ls 6x6				
	Thickness of Flange Angles in Inches				Thickness of Flange Angles and Plates in Inches						Thickness of Flange Angles in Inches									
	½	⅝	½	⅝	½	⅝	¾	½	⅝	¾	⅜	½	⅝	¾	⅞	⅜	½	⅝	¾	⅞
30	150	178	170	203	248	299	351	262	317	372	138	171	204	235	266	156	196	235	273	311
31	145	172	164	196	241	290	341	252	307	360	134	165	197	227	257	151	190	227	264	300
32	141	167	160	190	233	281	330	245	298	349	129	161	191	221	249	146	183	221	257	290
33	136	161	154	185	226	272	320	239	289	339	126	155	186	214	241	142	178	214	249	281
34	133	156	150	179	219	264	311	232	280	329	122	151	180	208	234	138	173	208	242	273
35	128	152	146	174	213	257	302	225	272	320	118	147	174	203	228	134	167	201	235	266
36	125	147	142	169	207	250	294	218	264	311	115	143	170	197	222	131	163	196	228	259
37	122	144	137	164	201	243	285	213	258	302	113	138	165	191	215	127	159	191	222	251
38	118	141	134	160	196	236	278	207	251	295	109	135	161	186	209	124	155	186	216	245
39	115	136	131	156	191	231	270	201	244	287	106	132	156	181	204	120	151	181	210	239
40	113	133	127	152	186	225	264	197	239	280	104	128	153	177	199	117	147	177	205	233
41	110	129	124	149	181	219	258	191	232	272	101	125	150	172	194	115	143	172	200	227
42	107	127	122	145	177	214	251	187	227	267	99	123	145	168	189	111	141	168	196	222
43	105	124	118	142	173	209	245	183	222	260	97	119	142	164	186	109	137	164	191	216
44	102	122	116	138	169	205	239	179	216	254	95	117	138	160	181	107	134	161	187	212
45	100	118	114	135	165	200	234	174	212	249	92	115	136	156	177	105	131	156	182	207
46	98	115	111	132	161	196	230	170	206	243	90	113	133	152	172	102	127	152	178	203
47	96	111	108	128	158	191	225	165	201	238	88	110	129	149	168	100	124	147	173	198
48	93	108	106	125	154	187	222	161	196	232	86	108	127	145	164	98	120	143	169	194
49	91	105	104	122	152	182	218	158	190	226	83	106	124	142	161	96	117	140	165	189
50	89	102	101	119	150	179	215	154	186	221	81	104	122	138	158	93	115	136	162	185
Weight Per foot	126.0	141.2	139.6	158.0	173.6	200.7	227.0	187.2	217.5	247.4	102.75	118.35	133.55	147.95	162.35	113.15	131.95	150.35	168.35	185.95
Sect. Mod.	382.4	448.2	420.1	494.9	600.5	715.3	826.3	638.1	762.	881.7	357.7	437.6	514.5	587.9	658.	394.	486.5	575.3	660.8	743.4

The safe load table above is based upon 18,000 lbs. per square inch of net section. From girders with cover plates four ⅞" holes have been deducted from each flange, and two from those without covers.

RIVETED PLATE GIRDERS

Safe loads in thousands of pounds—uniformly loaded

Distance Center to Center of Bearings	Web 42x⅜″ 4Ls 6x4 2 Plts. 14″ Wide				Web 42x⅜″ 4Ls 6x6 2 Plts. 14″ Wide			
	Thickness of Flange Angles and Plates in Inches							
	⅜	½	⅝	¾	⅜	½	⅝	¾
35	191	244	295	345	202	260	316	371
36	186	237	287	336	197	253	307	361
37	180	231	279	327	191	245	299	351
38	175	224	271	318	187	239	290	342
39	171	218	264	310	182	233	283	333
40	166	213	259	303	178	227	277	325
41	163	208	252	295	173	222	270	317
42	159	204	246	288	169	216	263	309
43	155	198	241	281	165	211	258	301
44	152	193	235	274	162	207	252	296
45	148	189	229	269	157	201	246	289
46	145	186	225	263	154	198	241	282
47	142	181	219	258	151	193	235	277
48	139	178	215	252	148	189	231	271
49	136	174	211	246	145	186	226	265
50	134	171	207	242	142	182	222	260
52	128	164	198	233	135	175	213	249
54	124	157	189	224	128	169	204	237
56	119	151	180	214	121	162	195	226
58	115	144	171	205	115	155	186	216
60	110	137	162	196	108	148	179	205
Weight Per foot...	138.45	165.95	193.05	219.35	148.85	179.55	209.85	239.75
Sect. Mod.	552.1	695.2	827.3	959.6	588.7	740.	887.9	1031.5

Distance Center to Center of Bearings	Web 42x⅜″ 4Ls 6x4 2 Plts. 16″ Wide					Web 42x⅜″ 4Ls 6x6 2 Plts. 16″ Wide				
	Thickness of Flange Angles and Plates in Inches									
	⅜	½	⅝	¾	⅞	⅜	½	⅝	¾	⅞
35	202	258	314	368	421	214	274	334	393	450
36	197	253	305	358	409	207	267	324	381	438
37	191	244	296	348	397	201	259	315	371	425
38	186	237	288	339	387	197	252	307	361	414
39	181	232	281	330	377	191	245	299	351	403
40	177	226	274	322	368	187	240	292	343	394
41	172	220	267	314	359	182	233	285	334	384
42	169	215	261	306	350	178	228	278	326	375
43	164	210	254	299	342	173	223	271	319	366
44	161	205	249	292	334	170	218	265	312	359
45	157	200	243	286	327	166	213	259	305	350
46	154	196	239	279	319	162	208	253	298	342
47	151	192	234	273	313	159	204	249	292	334
48	147	188	228	268	307	155	200	243	286	327
49	144	184	224	262	300	152	196	239	280	321
50	142	181	219	256	294	150	191	233	274	315
52	135	174	210	245	280	143	182	222	263	304
54	128	168	201	234	267	136	173	210	252	292
56	121	161	192	223	253	129	164	200	241	281
58	115	154	183	213	240	123	155	190	229	271
60	108	148	175	200	226	117	146	180	219	260
Weight Per foot...	143.55	172.75	201.55	229.55	257.55	153.95	186.35	218.35	249.95	281.15
Sect. Mod.	583.7	733.6	880.4	1023.4	1161.4	620.5	782.6	941.	1094.9	1244.9

The safe load table above is based upon 18,000 lbs. per square inch of net section. From girders with cover plates four ⅞″ holes have been deducted from each flange, and two from those without covers.

For loads above black lines webs must be reinforced at bearings.

RIVETED PLATE GIRDERS

Safe loads in thousands of pounds—uniformly loaded

Distance Center to Center of Bearings	Web 42x½" 4Ls 6x4"			Web 42x½" 4Ls 6x6"			Web 42x½" 4Ls 6x4" 2 Plates 14" Wide			Web 42x½" 4Ls 6x6" 2 Plates 14" Wide			Web 42x½" 4Ls 6x4" 2 Plates 16" Wide				Web 42x½" 4Ls 6x6" 2 Plates 16" Wide			
	Thickness of Flange Angles in Inches						Thickness of Flange Angles and Plates in Inches						Thickness of Flange Angles and Plates in Inches							
	½	⅝	¾	½	⅝	¾	½	⅝	¾	½	⅝	¾	½	⅝	¾	⅞	½	⅝	¾	⅞
35	156	185	210	177	210	243	253	305	356	269	325	380	268	323	377	431	284	343	401	459
36	152	179	205	172	205	236	246	297	345	262	316	370	261	314	367	419	276	333	390	447
37	147	174	199	168	199	230	240	288	335	254	307	360	253	306	356	407	268	324	379	434
38	143	170	194	163	195	223	233	280	327	248	299	350	246	297	348	396	261	315	369	423
39	140	165	189	159	189	218	227	273	318	241	291	341	241	289	339	386	254	307	360	412
40	136	161	185	155	185	213	222	267	311	235	285	333	234	282	330	377	248	299	351	402
41	133	156	180	151	180	208	216	260	303	230	277	324	228	276	322	367	241	291	342	392
42	131	153	176	147	176	203	210	254	296	224	271	317	223	269	314	359	235	286	334	383
43	127	150	171	144	171	198	206	249	289	219	264	309	218	262	307	351	231	279	326	374
44	124	146	168	141	168	194	201	243	282	214	259	303	213	257	300	342	225	272	318	365
45	122	143	164	137	164	189	197	238	277	209	253	296	208	251	293	334	221	267	312	357
46	118	140	160	135	160	185	192	232	270	205	248	289	204	245	287	327	216	261	305	349
47	116	137	156	132	156	181	188	227	264	200	242	284	199	241	280	321	210	255	299	342
48	114	134	154	129	154	178	185	223	259	196	236	278	196	235	275	314	206	250	293	335
49	111	132	151	126	151	174	181	218	254	192	232	272	191	231	269	307	203	244	286	327
50	109	128	147	124	147	170	177	214	249	188	227	266	188	226	261	302	198	240	281	321
52	105	122	141	117	141	161	169	205	238	180	218	252	179	217	245	290	189	231	272	305
54	100	115	134	113	134	152	160	196	226	171	209	239	170	208	230	279	180	222	263	289
56	96	108	127	107	127	145	153	189	216	164	200	227	161	199	216	268	173	213	254	276
58	91	101	120	102	120	138	146	182	207	158	191	216	152	190	203	259	167	204	245	262
60	87	97	114	98	114	132	140	176	198	151	182	205	143	181	191	250	159	195	236	249
Weight Per foot....	136.2	151.4	165.8	149.8	168.2	186.2	183.8	210.9	237.2	197.4	227.7	257.6	190.6	219.4	247.4	275.4	204.2	236.2	267.8	299.0
Sect. Mod.	470.1	547.2	622.6	518.9	607.8	693.3	726.7	862.6	994.2	775.4	922.9	1066.1	769.	915.7	1057.9	1196.1	817.9	976.	1129.9	1279.6

The safe load table above is based upon 18,000 lbs. per square inch of net section. From girders with cover plates four ⅞" holes have been deducted from each flange, and two from those without covers.

RIVETED PLATE GIRDERS

Safe loads in thousands of pounds—uniformly loaded

Distance Center to Center of Bearings	Web 48x⅜" 4Ls 6x4"			Web 48x⅜" 4Ls 6x6"			Web 48x⅜" 4Ls 6x4 2 Plates 14" Wide				Web 48x⅜" 4Ls 6x6" 2 Plates 14" Wide				Web 48x⅜" 4Ls 6x4" 2 Plates 16" Wide					Web 48x⅜" 4Ls 6x6" 2 Plates 16" Wide				
	Thickness of Flange Angles in Inches						Thickness of Flange Angles and Plates in Inches								Thickness of Flange Angles and Plates in Inches									
	⅜	½	⅝	⅜	½	⅝	⅜	½	⅝	¾	⅜	½	⅝	¾	⅜	½	⅝	¾	⅞	⅜	½	⅝	¾	⅞
40	122	152	179	138	173	207	194	247	299	349	208	265	322	377	206	262	317	371	424	218	279	338	398	456
41	119	147	174	135	169	202	189	241	291	340	202	259	313	367	200	255	309	362	414	212	272	331	387	444
42	117	144	171	133	165	198	185	235	284	333	198	252	306	359	196	250	301	353	404	208	265	323	378	434
43	115	140	166	129	162	193	181	229	278	324	193	246	299	350	191	243	295	345	395	202	259	315	370	423
44	111	138	163	126	157	189	176	225	272	317	189	241	292	342	187	238	288	337	386	198	253	308	362	414
45	109	135	160	124	154	184	173	219	265	310	184	235	286	334	183	233	281	329	377	193	247	301	353	405
46	107	131	156	121	151	180	170	215	260	304	180	230	279	327	179	227	275	323	369	189	242	300	345	396
47	104	129	153	118	147	176	165	210	254	297	176	226	273	320	175	223	270	316	361	185	237	288	338	387
48	102	126	149	116	145	173	162	206	248	291	173	220	268	314	171	218	264	309	353	182	233	282	332	379
49	100	124	146	113	142	170	158	202	244	284	170	216	262	307	167	214	259	302	346	178	227	277	325	371
50	98	121	144	111	138	166	156	198	238	279	167	212	256	301	164	209	253	297	340	174	223	271	318	365
51	97	119	140	109	136	163	153	193	234	274	163	208	252	296	161	206	248	291	333	171	218	265	312	358
52	94	117	138	107	134	160	149	190	229	268	160	203	247	289	158	201	244	286	326	167	214	260	306	350
53	92	115	135	104	131	156	147	187	226	263	156	200	243	284	155	198	239	280	319	164	210	255	300	344
54	91	112	133	102	128	153	144	183	221	259	154	196	238	279	152	193	235	275	314	161	207	251	295	338
55	89	110	129	101	126	149	140	179	217	254	151	192	234	273	149	189	229	270	308	158	202	246	289	331
56	86	108	126	99	124	146	137	174	212	250	147	189	229	268	147	184	225	264	302	156	198	242	283	324
57	84	106	122	97	121	143	135	171	209	246	145	185	225	262	145	180	220	260	297	154	194	237	278	317
58	82	104	120	94	120	140	133	167	206	243	143	182	221	257	143	176	217	255	292	152	191	234	272	311
59	81	103	118	93	119	138	130	165	202	239	140	179	218	253	142	173	214	251	288	151	188	229	268	305
60	80	102	117	92	118	136	129	163	200	237	138	176	216	250	140	170	210	247	283	149	185	226	263	299
Weight Per foot	110	126	141	120	139	158	146	173	200	227	156	187	217	247	151	180	209	237	265	161	194	226	257	288
Sect. Mod.	428	520	609	473	581	684	651	812	969	1122	697	872	1044	1211	688	861	1030	1194	1355	733	921	1104	1283	1458

The safe load table above is based upon 18,000 lbs. per square inch of net section. From girders with cover plates four ⅞" holes have been deducted from each flange, and two from those without covers.

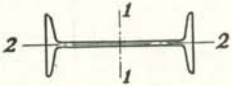
RIVETED PLATE GIRDERS

Safe loads in thousands of pounds—uniformly loaded

Distance Center to Center of Bearings	Web 48x½" 4Ls 6x4"		Web 48x½" 4Ls 6x6"			Web 48x½" 4Ls 6x4" 2 Plts. 14" Wide			Web 48x½" 4Ls 6x6" 2 Plts. 14" Wide			Web 48x½" 4Ls 6x4" 2 Plts. 16" Wide				Web 48x½" 4Ls 6x6" 2 Plts. 16" Wide			
	Thickness of Flange Angles in Inches					Thickness of Flange Angles and Plates in Inches						Thickness of Flange Angles and Plates in Inches							
	½	⅝	½	⅝	¾	½	⅝	¾	½	⅝	¾	½	⅝	¾	⅞	½	⅝	¾	⅞
40	162	190	183	217	251	259	309	360	276	332	387	273	327	382	435	290	350	408	467
41	159	186	179	211	244	252	301	351	269	324	377	265	319	372	424	282	340	398	455
42	154	181	175	207	239	245	295	343	262	316	368	260	313	364	415	276	332	389	444
43	151	177	171	202	233	240	288	335	256	308	360	252	305	355	405	269	324	379	433
44	147	172	168	198	228	235	281	327	251	301	352	249	298	348	395	263	317	371	422
45	144	169	163	193	223	229	276	321	245	295	344	243	291	340	387	258	310	363	414
46	141	165	160	189	218	225	269	313	240	288	336	237	285	332	378	252	304	355	405
47	138	162	156	184	214	219	263	307	234	282	330	233	279	325	370	246	297	348	396
48	135	159	153	181	209	215	258	300	229	277	323	227	273	318	363	241	291	341	388
49	133	155	150	178	205	210	253	295	225	271	316	223	268	312	355	236	286	333	380
50	129	152	147	174	200	207	247	288	220	265	309	218	262	306	348	232	279	326	373
51	127	150	144	171	197	202	243	282	216	260	304	214	258	301	342	227	273	321	366
52	125	146	142	168	192	198	239	277	211	255	298	209	252	294	335	223	268	314	359
53	123	143	138	164	189	195	234	272	208	251	292	206	247	288	328	218	263	308	352
54	120	141	136	161	186	191	229	267	204	246	287	202	243	282	322	215	259	303	345
55	118	138	134	159	182	188	225	262	200	241	281	198	239	278	316	210	254	297	339
56	116	136	132	156	179	184	220	258	197	236	276	195	234	273	310	206	250	291	332
57	115	134	129	154	175	181	216	253	193	232	271	191	231	269	306	202	246	287	326
58	114	132	127	152	173	179	213	249	191	227	267	189	227	264	301	199	243	282	321
59	111	130	126	150	171	177	209	245	189	224	263	187	224	261	297	196	240	278	316
60	110	129	125	148	169	174	207	242	187	220	260	184	220	258	294	192	237	274	313
Weight Per ft.	146.4	161.6	160.0	178.4	196.4	194.0	221.1	247.4	207.6	232.9	267.8	200.8	229.6	257.6	285.6	214.4	246.4	278.0	309.2
Sect. Mod.	563.7	652.8	623.9	727.8	827.8	858.9	1016	1168.2	919.1	1090.4	1257	907.4	1076.6	1241.	1400.9	967.6	1151.1	1329.8	1504.1

The safe load table above is based upon 18,000 lbs. per square inch of net section. From girders with cover plates four ⅞" holes have been deducted from each flange and two from those without covers.

I BEAM COLUMNS
SAFE LOADS IN POUNDS



Based on Formula $S = \dfrac{18000}{1 + \dfrac{l^2}{18000\ r^2}}$

Loads given are for least radius of gyration Axis 2-2.

STANDARD I BEAMS

Depth of Beam	Weight per foot pounds	Area of Section Sq. Inches	Radius of Gyration Axis-2-2	Radius of Gyration Axis 1-1	Length in Feet.							
					4	6	8	10	12	14	16	18
4	7.7	2.21	.59	1.64	29150	21770	16100	......	......	......	......	......
5	10.0	2.87	.65	2.05	39600	30600	23300	17800	......	......	......	......
6	12.5	3.61	.72	2.46	52000	41770	32770	25400	......	......	......	......
7	15.3	4.43	.78	2.86	66000	54200	43300	34400	......	......	......	......
8	18.4	5.34	.84	3.26	80100	68100	55800	45000	36600	......	......	......
10	25.4	7.38	.97	4.07	110700	101800	86000	71600	59900	49800	......	......
12	31.8	9.26	1.01	4.83	138900	130200	111000	93300	78600	65800	......	......
12	40.8	11.84	1.08	4.77	177600	170600	148000	126500	107500	91200	......	......
12	50.0	14.57	1.05	4.55	218500	207400	179600	152200	128400	108200	......	......
15	42.9	12.49	1.08	5.95	187300	179900	156100	133500	113400	96200	......	......
15	50.0	14.59	1.05	5.74	218800	207700	179900	152500	128600	108400	......	......

Loads given to the right of heavy lines are for lengths where $\frac{l}{r}$ is greater than 120 and should not be used unless beams are stiffened or braced sideways.

Because of their narrower flange, Standard American I Beams are conveniently used in partitions and other restricted places where heavy concentrated loads require support.

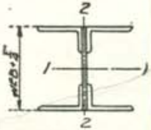
Based on Formula

$$S = \frac{18000}{1 + \frac{l^2}{18000r^2}}$$

PLATE AND ANGLE COLUMNS

Safe loads in thousands of pounds

Loads Given Are For Least Radius of Gyration. Axis 2-2



Plates	6x¼		6x¼		6x5/16		7x¼		7x5/16		8x¼		8x¼		8x5/16		8x5/16		8x⅜		8x½	
Angles	4Ls 3x2		4Ls3x2½		4Ls 3x2½		4Ls 3½x2½		4Ls 3½x2½		4Ls 3½x2½		4Ls 4x3		4Ls 3½x2½		4Ls 4x3		4Ls 4x3		4Ls 4x3	
	¼	5/16	¼	5/16	5/16	⅜	¼	5/16	5/16	⅜	¼	5/16	5/16	⅜	5/16	⅜	5/16	⅜	⅜	½	½	⅝
Area of Column Section Sq. Inches	6.3	7.38	6.7	8.0	8.36	9.56	7.5	8.9	9.31	10.63	7.8	9.1	10.4	11.9	9.6	10.94	10.9	12.4	12.9	16.0	17.0	19.9
Weight of Column Per Lineal Foot	21.5	25.1	23.1	27.1	38.80	32.78	25.55	30.35	31.80	36.40	26.4	31.2	35.6	40.8	32.9	37.3	37.3	42.5	44.2	54.6	58.0	68.0
Rad. of Gyr. Axis 2-2	1.28	1.32	1.24	1.27	1.27	1.31	1.46	1.50	1.49	1.54	1.43	1.49	1.69	1.72	1.47	1.51	1.67	1.71	1.70	1.77	1.76	1.82
Rad. of Gyr. Axis 1-1	2.51	2.50	2.41	2.42	2.39	2.39	2.88	2.89	2.86	2.87	3.31	3.32	3.29	3.29	3.28	3.29	3.25	3.26	3.23	3.23	3.18	3.18
LENGTH IN FEET 6	94.5	110.7	100.5	120.0	125.4	143.4	112.5	133.5	139.6	159.4	117.0	136.5	156.0	178.5	144.0	164.1	163.5	186.0	193.5	240.0	255.0	298.5
7	91.3	108.2	95.9	116.0	121.1	140.1	112.5	133.5	139.6	159.4	117.0	136.5	156.0	178.5	144.0	164.1	163.5	186.0	193.5	240.0	255.0	298.5
8	86.4	102.5	90.7	109.0	113.9	132.7	108.7	130.4	136.5	157.6	112.3	133.4	156.0	178.5	140.0	160.4	163.5	186.0	193.5	240.0	255.0	298.5
9	81.4	96.7	85.0	102.7	107.3	125.2	103.5	124.3	130.1	150.4	106.3	127.1	152.5	175.5	133.3	152.9	158.9	182.8	189.1	238.6	253.5	298.5
10	76.0	91.0	79.2	96.5	100.0	117.0	98.2	118.1	122.8	143.0	100.9	120.8	146.2	168.3	125.8	146.2	152.3	175.4	181.4	229.1	243.4	288.3
11	71.3	85.4	74.2	89.9	94.0	109.8	93.1	112.0	116.4	135.6	95.5	113.7	139.9	161.1	119.7	138.6	145.6	167.9	173.5	219.4	233.1	278.1
12	66.8	80.0	69.0	84.2	88.0	102.9	87.4	106.0	110.0	125.6	89.6	107.6	133.5	153.9	112.7	131.1	139.0	160.3	165.7	211.0	222.8	266.0
13	62.0	74.9	64.0	78.2	81.8	96.3	82.5	100.0	103.9	122.1	84.5	101.6	127.3	146.7	106.3	123.9	132.5	152.8	157.9	201.3	212.5	253.9
14	58.0	70.1	60.0	73.2	76.4	90.1	77.8	94.4	98.0	115.2	79.1	95.8	121.2	139.6	100.3	116.9	125.2	145.5	150.3	191.8	203.8	243.6
16	....	....	....	....	....	....	68.6	83.8	87.0	102.4	70.3	85.1	108.7	126.2	88.5	103.8	113.1	131.5	135.8	174.7	184.3	222.1
18	....	....	....	....	....	....	....	....	....	91.6	....	....	98.0	114.6	....	....	102.0	118.6	122.4	157.6	166.3	200.5
20	....	....	....	....	....	....	....	....	....	....	....	....	....	102.5	....	....	....	106.8	....	142.0	150.9	182.0

Values above heavy line are for $\frac{l}{r}$ less than 120   Values above dotted line are for $\frac{l}{r}$ less than 140.

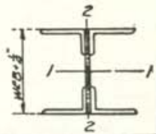
Based on Formula

$$s = \frac{18000}{1 + \frac{l^2}{18000r^2}}$$

PLATE AND ANGLE COLUMNS

Safe loads in thousands of pounds

Loads Given Are For Least Radius of Gyration. Axis 2-2



Plates	10x¼	10x¼	10x¼	10x¼	10x5/16	10x5/16	10x5/16	10x5/16	10x5/16	10x5/16	10x5/16	10x5/16	10x5/16	10x5/16	10x3/8	10x3/8	10x3/8	10x3/8	10x3/8	10x3/8	10x3/8	10x3/8
Angles	4Ls 3½x2½	4Ls 3½x2½	4Ls 4x3	4Ls 5x3	4Ls 3½x2½	4Ls 3½x2½	4Ls 4x3	4Ls 4x3	4Ls 5x3	4Ls 5x3	4Ls 5x3½	4Ls 5x3½	4Ls 6x3½	4Ls 6x3½	4Ls 4x3	4Ls 4x3	4Ls 5x3	4Ls 5x3	4Ls 5x3½	4Ls 5x3½	4Ls 6x3½	4Ls 6x3½
	¼	5/16	5/16	5/16	5/16	3/8	5/16	3/8	5/16	3/8	5/16	3/8	5/16	3/8	3/8	½	3/8	½	3/8	½	3/8	½
Area of Column Section Sq. Inches	8.26	9.62	10.86	12.10	10.25	11.56	11.49	13.05	12.73	14.57	13.37	15.32	14.61	16.81	13.67	16.75	15.19	18.75	15.95	19.75	17.43	21.75
Weight of Column Per Lineal Foot	28.1	32.9	37.3	41.3	35.0	39.4	39.4	44.6	43.4	49.8	45.4	52.2	49.8	57.4	46.8	57.15	51.95	63.95	54.35	67.15	59.55	73.95
Rad. of Gyr. Axis 2-2	1.39	1.45	1.65	2.16	1.42	1.47	1.62	1.67	2.12	2.14	2.08	2.12	2.58	2.64	1.65	1.73	2.15	2.24	2.10	2.19	2.62	2.70
Rad. of Gyr. Axis 1-1	4.13	4.17	4.14	4.24	4.11	4.14	4.09	4.11	4.18	4.20	4.10	4.12	4.19	4.20	4.07	4.12	4.16	4.18	4.08	4.10	4.16	4.18
LENGTH IN FEET 8	117.6	139.4	162.9	181.5	146.8	168.5	172.4	195.8	191.0	218.6	200.6	229.8	219.2	252.2	205.1	251.3	227.8	281.3	239.3	296.3	261.5	326.3
10	105.4	125.2	150.8	181.5	132.5	151.5	158.6	182.4	191.0	218.6	200.6	229.8	219.2	252.2	189.8	238.4	227.8	281.3	239.3	296.3	261.5	326.3
12	92.9	112.1	137.6	174.3	117.8	135.7	143.6	166.5	182.3	209.9	190.3	219.4	219.2	252.2	173.2	218.1	218.8	274.9	228.4	286.2	261.5	326.3
14	82.0	99.1	123.8	162.8	104.0	120.8	129.2	149.9	170.1	196.0	176.4	204.8	213.0	246.4	155.9	198.0	204.3	257.1	211.8	267.4	255.5	322.6
16	72.3	87.9	111.9	151.3	91.7	106.5	116.6	135.4	156.9	180.9	163.6	188.9	201.7	233.4	140.8	179.0	189.9	239.2	196.6	248.5	242.1	305.8
18	....	....	100.1	140.0	....	....	104.3	122.0	145.2	167.4	150.3	174.7	188.9	220.3	126.0	161.4	175.8	223.2	180.6	230.2	228.4	288.8
20	....	....	....	129.3	....	....	....	....	134.0	154.5	138.7	161.3	177.6	207.3	....	145.4	161.1	206.3	166.7	212.6	213.4	271.8
22	....	....	....	119.2	....	....	....	....	122.7	142.5	126.9	147.6	166.6	194.5	....	....	148.6	190.3	152.6	197.5	200.3	255.3
24	....	....	....	109.9	....	....	....	....	113.0	130.3	117.0	136.0	155.0	182.3	....	....	136.9	175.4	140.6	180.6	187.6	239.3
26	....	....	....	....	....	....	....	....	....	....	....	....	145.0	170.6	....	....	....	162.8	....	....	175.6	224.0
28	....	....	....	....	....	....	....	....	....	....	....	....	135.6	159.6	....	....	....	....	....	....	164.3	211.1
30	....	....	....	....	....	....	....	....	....	....	....	....	125.9	149.3	....	....	....	....	....	....	153.6	197.5

Values above heavy line are for $\frac{l}{r}$ less than 120. Values above dotted line are for $\frac{l}{r}$ less than 140.

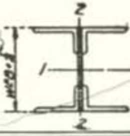
Based on Formula

$$S = \frac{18000}{1 + \frac{l^2}{18000 r^2}}$$

PLATE AND ANGLE COLUMNS

Safe loads in thousands of pounds

Loads Given Are For Least Radius of Gyration. Axis 2-2



Plates	10x½		10x½		10x½		12x¼			12x¼		12x5/16		12x5/16		12x5/16		12x⅜		12x⅜		
Angles	4L's 5x3½		4L's 6x3½		4L's 6x4		4L's 3½x2½	4L's 4x3	4L's 5x3	4L's 6x3½		4L's 4x3		4L's 5x3½		4L's 6x3½		4L's 4x3		4L's 5x3½		
	½	⅝	½	⅝	½	⅝	¼	5/16	5/16	5/16	⅜	5/16	⅜	5/16	⅜	5/16	⅜	⅜	½	⅜	½	⅝
Area of Column Section Sq. Inches	21.00	24.68	23.00	27.20	24.00	28.44	8.76	11.36	12.60	14.48	16.68	12.11	13.67	13.99	15.95	15.23	17.43	14.42	17.50	16.70	20.50	24.18
Weight of Column Per Lineal Foot	71.4	84.2	78.2	92.6	81.8	97.0	29.8	39.0	43.0	49.4	57.0	41.6	46.8	47.6	54.35	51.95	59.55	49.3	59.7	56.9	69.7	82.5
Rad. of Gyr. Axis 2-2	2.16	2.23	2.67	2.75	2.62	2.69	1.35	1.61	2.11	2.58	2.63	1.58	1.63	2.03	2.08	2.53	2.59	1.61	1.70	2.06	2.15	2.21
Rad. of Gyr. Axis 1-1	4.03	4.04	4.12	4.12	4.03	4.04	4.94	4.99	5.10	5.11	5.12	4.91	4.95	4.95	4.98	5.04	5.06	4.89	4.93	4.92	4.96	4.98
LENGTH IN FEET 6	315.0	370.0	345.0	408.0	360.0	426.6	131.4	170.0	189.0	217.0	250.0	181.6	205.0	209.8	239 0	228.4	261.4	216.3	262.5	250.5	307.5	362.7
8	315.0	370.0	345.0	408.0	360.0	426.6	123.2	170.0	189.0	217.0	250.0	180.6	205.0	209.8	239.0	228.4	261.4	216.3	262.5	250.5	307.5	362.7
10	315.0	370.0	345.0	408.0	360.0	426.6	109.0	155.7	189.0	217.0	250.0	165.0	188.6	209.8	239.0	228.4	261.4	199.0	246.0	250.5	307.5	362.7
12	302.5	359.7	345.0	408.0	360.0	426.6	96.3	142.0	180.0	217.0	250.0	149.2	172.0	196.7	227.0	228.4	261.4	180.2	224.7	237.7	295.3	352.5
14	282.5	338.4	339.0	405.7	351.8	421.8	85.0	127.7	167.3	211.0	244.5	134.2	154.8	182.0	210.0	220.7	254.0	162.1	204.0	218.0	275.7	329.5
16	262.5	314.8	321.4	384.8	333.0	400.0	....	114.4	155.3	199.8	231.6	120.2	138.7	167.7	195.0	207.5	240.5	145.2	184.2	203.0	256.0	306.4
18	243.0	291.7	303.4	365.8	314.4	377.6	....	102.4	143.7	187.0	218.0	106.7	124.1	155.0	179.3	195.6	227.0	129.9	166.1	186.0	237.2	283.8
20	224.4	269.0	285.5	344.6	293.8	355.5	....	....	131.6	176.0	205.6	....	....	142.0	165.5	182.5	212.0	....	....	172.0	217.4	262.2
22	206.9	250.0	268.0	323.7	275.7	333.8	....	....	121.4	165.0	193.0	....	....	129.8	151.4	171.2	198.8	....	....	157.3	200.5	243.5
24	190.7	230.8	251.2	303.6	258.0	312.8	....	....	111.8	153.6	180.8	....	....	....	139.5	159.1	186.2	....	....	144.0	184.7	224.4
26	....	212.6	235.1	286.4	241.7	293.0	....	....	....	143.7	168.0	....	....	....	....	146.8	174.0	....	....	....	....	....
28	....	....	220.0	268.0	226.1	274.0	....	....	....	134.4	156.1	....	....	....	....	....	161.8	....	....	....	....	....
30	....	....	205.7	250.6	211.5	256.3	....	....	....	124.7	146.9	....	....	....	....	....	151.3	....	....	....	....	....

Values above heavy line are for $\frac{l}{r}$ less than 120. Values above dotted line are or $\frac{l}{r}$ less than 140.

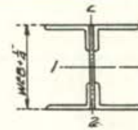
Based on Formula

$$s = \frac{18000}{1 + \frac{l^2}{18000\,r^2}}$$

PLATE AND ANGLE COLUMNS

Safe loads in thousands of pounds

Loads Given Are For Least Radius of Gyration. Axis 2-2



Plates		12x3/8			12x3/8			12x1/2		12x1/2		12x1/2			12x1/2			12x5/8		14x1/4		14x1/4	
Angles		4Ls 6x3½			4Ls 6x4			4Ls 4x3		4Ls 5x3½		4Ls 6x3½			4Ls 6x4			4Ls 6x4		4Ls 4x3		4Ls 5x3	
		3/8	1/2	5/8	3/8	1/2	5/8	1/2	5/8	1/2	5/8	1/2	5/8	3/4	1/2	5/8	3/4	5/8	3/4	5/16	3/8	5/16	3/8
Area of Column Section Sq. Inches		18.18	22.50	26.70	18.94	23.50	27.94	19.00	21.92	22.00	25.68	24.00	28.20	32.24	25.00	29.44	33.76	30.94	35.26	11.86	13.42	13.10	14.94
Weight of Column Per Lineal Foot		62.1	76.5	90.9	64.5	80.1	95.3	64.8	74.8	74.8	87.6	81.6	96.0	110.0	85.2	100.4	114.8	105.5	119.9	40.7	45.9	44.7	51.1
Rad. of Gyr. Axis 2-2		2.56	2.66	2.73	2.51	2.61	2.67	1.67	1.74	2.12	2.19	2.62	2.67	2.78	2.57	2.65	2.72	2.62	2.70	1.58	1.63	2.07	2.13
Rad. of Gyr. Axis 1-1		5.01	5.06	5.06	4.94	4.97	4.98	4.85	4.88	4.88	4.90	4.97	4.99	4.99	4.89	4.91	4.90	4.86	4.85	5.82	5.88	5.94	5.99
LENGTH IN FEET	8	272.7	337.5	400.0	284.1	352.5	419.1	285.0	328.8	330.0	385.2	360.0	423.0	483.6	375.0	441.6	506.4	464.1	528.9	176.9	201.3	196.5	224.1
	10	272.7	337.5	400.0	284.1	352.5	419.1	265.5	312.0	330.0	385.2	360.0	423.0	483.6	375.0	441.6	506.4	464.1	528.9	161.6	185.2	196.5	224.1
	12	272.7	337.5	400.0	284.1	352.5	419.1	242.3	285.4	315.0	372.1	360.0	423.0	483.6	375.0	441.6	506.4	464.1	528.9	146.2	168.9	185.3	213.4
	14	263.5	331.8	396.0	272.8	344.5	412.1	218.3	260.9	294.0	347.7	351.9	415.9	483.6	364.4	434.2	500.7	453.6	523.0	131.4	152.0	172.8	199.2
	16	249.3	314.4	377.8	258.1	324.3	390.5	197.1	235.9	271.2	323.2	333.3	394.0	458.9	342.8	411.4	474.7	429.0	495.8	117.7	136.2	159.3	184.9
	18	235.0	296.8	356.9	241.6	305.9	368.6	177.7	212.8	250.9	299.3	314.4	372.0	433.7	323.2	385.8	451.2	405.4	468.2	104.5	122.7	147.3	171.2
	20	219.5	279.3	336.0	225.5	287.7	346.8	....	191.7	231.7	276.4	293.8	350.0	411.3	303.9	363.0	424.8	378.8	440.7	....	....	134.9	156.9
	22	205.8	262.2	315.6	211.4	269.9	325.6	....	....	212.0	256.8	275.7	328.6	386.5	283.1	340.6	399.0	355.5	413.8	....	....	123.4	144.6
	24	192.8	245.7	298.0	196.5	252.9	305.1	....	....	195.3	236.6	258.3	308.0	365.1	265.1	319.2	374.1	333.0	387.8	....	....	113.7	133.3
	26	179.1	230.0	279.0	183.9	235.0	285.6	....	....	....	....	241.7	288.3	341.9	248.1	298.8	350.2	311.7	363.2	....	....	....	....
	28	167.5	215.2	261.1	170.7	219.8	267.4	....	....	....	....	226.1	269.7	320.0	230.4	279.5	327.7	291.6	342.3	....	....	....	....
	30	....	201.2	244.2	....	....	249.9	....	....	....	....	211.5	252.0	301.5	215.4	261.4	308.8	272.7	320.1	....	....	....	....

Values above heavy line are for $\frac{l}{r}$ less than 120. Values above dotted line are for $\frac{l}{r}$ less than 140.

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ADDRESSES OF MANUFACTURERS

American Abrasive Metals Co.
Arthur Hale
121 W. Rustic Lodge
Minneapolis 9, Minnesota

Bayport-St. Croix Co.
Bayport, Minnesota

Cleveland City Forge Co.
Cleveland 14, Ohio

Detroit Steel Products Company
2250 East Grand Boulevard
Detroit 11, Michigan

Federal Cement Tile Company
608 South Dearborn Street
Chicago 5, Illinois

Harnischfeger Corporation
Milwaukee 14, Wisconsin

Heston & Anderson
Fairfield, Iowa

The Majestic Company
Huntington, Indiana

National Fireproofing Corp.
203 E. Ohio St., N. S.
Pittsburgh 12, Pennsylvania

Overhead Door Co. of Minnesota
2434 University Avenue
St. Paul 4, Minnesota

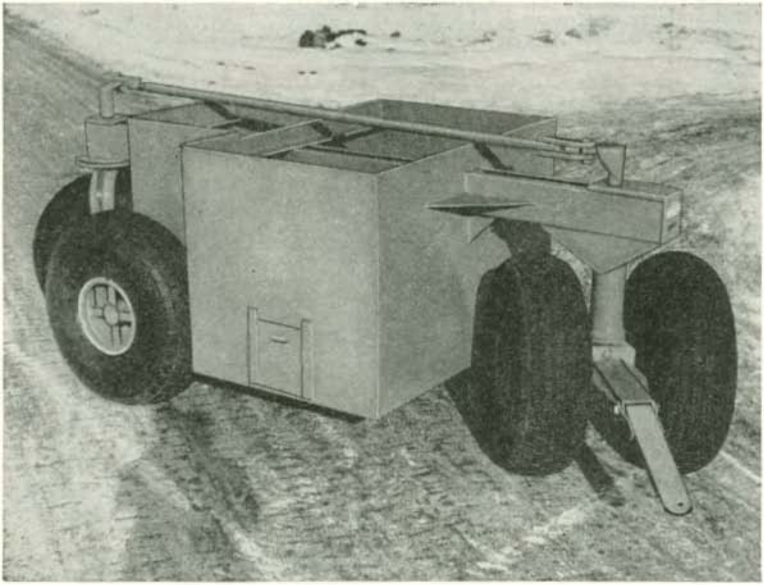
Owens-Illinois Glass Company
Toledo 1, Ohio

United States Gypsum Company
300 West Adams Street
Chicago 6, Illinois

Wheeling Corrugating Company
145 26th Avenue, S. E.
Minneapolis 14, Minnesota

"Cemco"
FLAT-IRON

PNEUMATIC TIRED ROAD ROLLER



5th Wheel Type

C. A. A.—
Approved by Civil Aeronautics Administration for compaction of embankment, base and sub-base.

SPECIFICATIONS

Overall Width	84"
Tires (Five)	17:00x16"
Wheel Bearings	Roller
Compaction Path	72" to 75"
Shipping weight	3450 lbs.
Weight Box capacity (without sideboards)	128 cu. ft.
Weight Loaded (Empirical Range)	4.5 to 9 Tons
Pounds per linear inch of tire	48 to 400

- It is SPEEDY & SAFE.
- And it is ECONOMICAL.
- It is SIMPLE to OPERATE.
- It is easy to MAINTAIN & REPAIR.
- Can be used as a SNOWPACKER, TRAILER and SPRINKLER.

For Additional Information Send for Catalog—Address—See Index.

40′ PORTABLE DUEL WHEEL CONVEYOR

Conveyors are manufactured in 18″, 24″ and 30″ widths

The extra heavy troughing rolls are built to take constant pounding and heavy loads. Troughing and return rolls are 100% anti-friction throughout and the grease is sealed in for the life of the bearings. Roll suspension is braced and counter-braced for additional strength.

The hydraulic lifting system is built into the frame of the conveyor and has ample power. The hydraulic ram can be extended a full 28 inches which gives a 10 to 1 elevation ratio.

The tail pulley is self-cleaning and is equipped with take up blocks. Pulley is furnished with anti-friction roller bearings which are sealed against dirt.

Shovel hoppers such as shown can be quickly and easily installed.

HEAVY DUTY
AGGREGATE STEEL BINS

FITS ALL JOBS

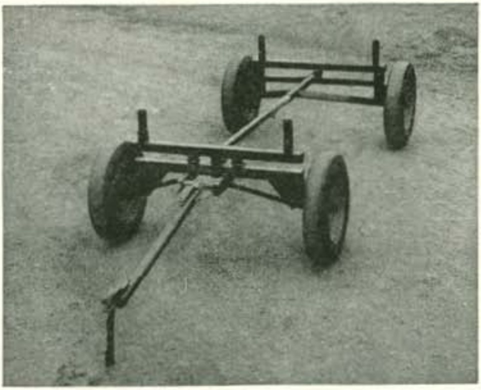
Heavy Duty Aggregate Steel Bins are made of heavy construction to withstand the most rugged conditions in general construction work. Contractors, coal yards, County, Township, Municipal and State Highway Departments can use these types to their benefit for long, steady service.

BINS ARE PORTABLE

Two men can easily and quickly raise or lower bins. The legs are removed and bins can be transported on any 1½ ton gravel truck to be set up at the new location when desired.

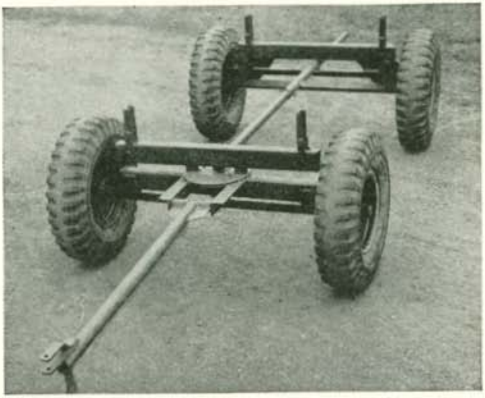
BIN GATES

One-way rolled gate with long handles permits the operator to stand well back from trucks. This type of gate operates with greater ease and eliminates chance of gate lodging.



STANDARD FARM WAGON TRAILER

Capacity 4,000 lbs.—Reach extends 7′ to 11′.



HEAVY DUTY TYPE FARM WAGON TRAILER

Capacity 6,000 lbs.—Reach extends 11′ to 13′.

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McGILL-WARNER CO., SAINT PAUL

5-9-47—1200