Curves for Calculating Beams, Channels and Reactions

SIDNEY DIAMANT

CURVES

FOR CALCULATING

BEAMS, CHANNELS AND REACTIONS

A MANUAL FOR

ENGINEERS, ARCHITECTS, DESIGNERS. DRAUGHTSMEN
BUILDERS AND CONTRACTORS

BY

SIDNEY DIAMANT, E. E.,
STRUCTURAL ENGINEER

NEW YORK
McGRAW PUBLISHING COMPANY
239 WEST 39TH STREET
1908

PREFACE

With a view to supplying a time-saving method as applied to one of the branches of steel design, the results embodied in this book are presented to all interested in structural engineering and building construction in general. It is hoped that, by aid of the charts, those familiar with the calculations involved in the regular method may either eliminate those uninteresting operations or, at least, use this manual as a check on their work; and furthermore that those seeking speedy results without a knowledge of the calculations employed will find in the curves a satisfactory solution of their problem. The curves given are complete in so far as general use and standard beams are concerned, while a method is explained for plotting the results for any beam and any intensity of loading. The author desires to thank the Cambria Steel Company for the privilege of inserting in this manual their table of "Properties of Beams and Channels."

New York City, June, 1908. SIDNEY DIAMANT.

CURVES FOR BEAMS, CHANNELS AND REACTIONS.

The question of the determination of steel floor beams having a uniformly distributed imposed load, while involving no intricate calculations, presents itself for a simple and readily accurate solution by another than analytical method. As a means of comparing the resisting power or strength of beams, no other way is more quickly handled than the graphical one as deduced and exemplified in the present book through the use of beam curves. The graphic method of selection greatly facilitates the more economic design by aiding in the choice of heavy beams with large spacing or light beams with small spacing. It is possible to construct a single chart of beam curves for different intensities of loading, but the great inconvenience attending its use would not warrant it; especially since a whole floor system is generally designed for one intensity of loading, making it an easy matter to use a separate chart in considering another loading. The use of a single combination chart results in much complexity due to reading among different loadings. Furthermore, the operation is cumbersome rather than time-saving, thus defeating the purpose of the graphic method. The present manual assigns a chart to each case considered.

For a given span, a beam is selected from the chart of particular loading, the number required for the entire series ascertained and the total weight calculated. It is frequently more economical to use a larger beam as the fewer number required due to the allowable larger spacing will more than compensate for the increased weight per beam, in addition to which the larger beam offers greater stiffness due to its greater depth. Aside from the absolute strength of a beam, it is often desirable to consider its deflection which might be permanent due to the quiescent load, or temporary due to impact as in the case of a gymnasium floor or an area adjacent to stairs. In either event there would result cracks where plastered ceilings occur. Various suggestions are to be found giving the relation between the depth of a beam and its span to be used where plastered ceiling occurs below. Following is a table for beams, safely loaded, giving figures which have been found to be useful and reliable:—

Depth of beam or channel	Limit of span
3 in.	5 ft. 0 in.
4 "	7 " 0 "
5 "	9 " 0 "
6 "	11 " 0 "
7 "	13 " 0 "
8 "	15 " 0 "
9 "	17 " 0 "
10 "	18 " 6 "
12 "	23 " 0 "
15 "	29 " 0 "
18 "	32 " 0 "
20 "	37 " 0 "
24 "	45 " 0 "

A statement of the values from which the curves are deduced and a method of plotting them, while aiding in the use of the charts, will serve as a help in affording likewise treatment for beams other than those used and under conditions of loading more special than those selected.

In Fig. 1, let D equal the distance in feet from centre to centre of adjacent floor arches, and L equal span or length in feet between supports of the beam. If I equals the intensity of loading, including live load plus dead load, in pounds per square foot, then $D L I = W$ = weight in pounds supported by the

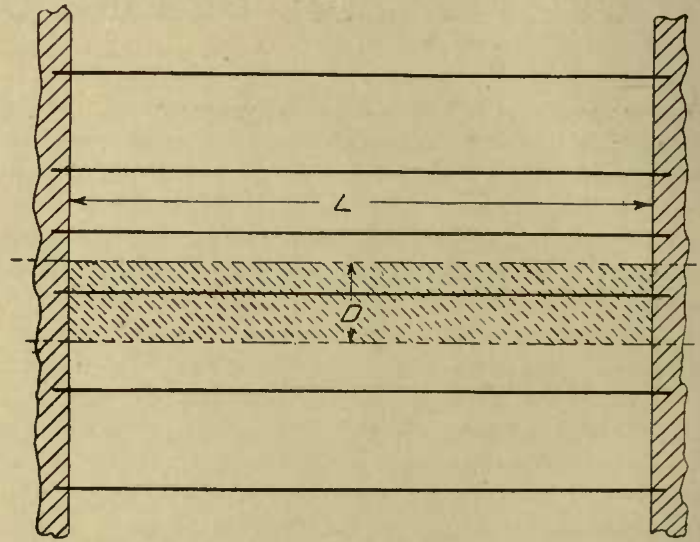


Fig. 1.

beam. These three values together with the strength factor of the beam are all that are necessary in determining a beam.

When the beams are equally spaced the value D is the same throughout the series of arches. In the case of a channel extending parallel to a wall and resting against it, D is the distance from the channel to the centre of the adjacent arch or, in general it is the value for the width of the area supported by the member, channel or beam. (See Fig. 2.)

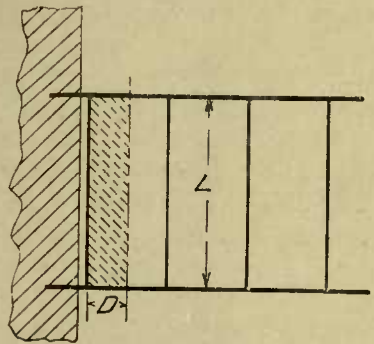


FIG. 2.

Each of the reactions is equal to $W/2$, and the maximum bending moment, which occurs at section x, midway between the supports is equal to

$$M_x = \left(\frac{W}{2}\times\frac{L}{2}\right)-\left(\frac{W}{2}\times\frac{L}{4}\right) = \frac{W\,L}{8} = \frac{D\,L^2\,I}{8}$$

The resisting moment of a beam is expressed by $M_r = K\,S$; wherein K equals the allowable fibre stress in pounds per square inch of section and S equals the section modulus or resistance of the beam taken about axis $1-1$ (see tables) perpendicular to the web. For condition of equilibrium between the forces acting on the beam and its resistance opposing the action

$$M_r = M_x \text{ or } \frac{D\,L^2\,I}{8} = K\,S \text{ or } D = \frac{8\,K\,S}{L^2\,I} \qquad (1)$$

The value S is given in the steel companies' handbooks for any beam while I is selected to conform with the local conditions of construction and use. In the present book K is taken at 16,000 pounds per square inch as recommended and permitted by the building laws.

The charts 1 to 13 inclusive, give the curves for beams and channels most commonly used with the indicated intensity of loading all to develop a working fibre stress of 16,000 pounds per square inch.

Vertically, each of the small spaces is 2 inches and horizontally each of the small spaces is 6 inches, affording interpolation in the values to 1 inch, by a visual subdivision, where necessary. Special attention has been given to the subdivision of these marginal quantities appearing on the charts. The visual subdivision of these quantities in order to read to inches is more desirable than the presence of many very small rectangles which would result in fatigue to the eyes and be no more efficient.

Frequently a scaled drawing is received showing a variation of beam spacing due to the fixed position of vent flues, heating ducts or other openings in the floor. The beam sizes may not be marked and it is desired to make the proper selection. The width of the loaded area for any beam is readily ascertained by using a scale double that of the drawing and scaling the distance between the two beams adjacent to the one in question. This will give direct reading for the distance between the centres of adjacent arches, the halves of which are carried by the beam sought.

To plot a curve from equation (1), proceed as follows:—with a given beam and intensity of loading, insert the values of K, S and I and solve for D giving a more special equation

$$D = \frac{C}{L^2} \qquad (2)$$

wherein C is a constant factor for the curve and equals $\frac{8KS}{I}$. Select a value of L, substitute it in equation (2) and solve for the corresponding value of D. On the vertical line through the value of L, lay off the value of D. This is a point on the curve. If a series of these simultaneous values be plotted the result will be a curve which, by itself, may be used for two purposes: first, when the span is known, to determine the spacing; second, when the spacing is fixed, to determine the maximum allowable span. In either case follow the given value of D or L until it meets the curve. From this point recede from the curve in a direction perpendicular to the first until the marginal figures are reached and read the corresponding value of L or D respectively.

To select a beam from a chart of given loading, such as 150 pounds per square foot, with D equal to 4 ft. 6 in. and L equal to 19 ft. 6 in., follow the horizontal line through 4 ft. 6 in. toward the right until it intersects the vertical line through 19 ft. 6 in. This point of intersection is found to be near the curve for a 10 in. – 25 lb. I beam, the one to be used. Should the point of intersection be not so close to the curve as in the example sighted, arising from other values of D and L, then the designer exercises his judgment in the selection of the next smaller or the next larger beam, being guided by the nearness of the point of intersection to the beam curve. Of course the use of the larger beam would result in a safe design. In considering beams uniformly loaded it is not well to be as lenient as would be permissible with girder beams carrying many concentrations. In the latter case, only by the simultaneous action of all the loads, which seldom occurs, would the calculated bending moment be developed, while in the former case there need be considered only the question of two adjacent arch loads.

In addition to the statement made in the preface regarding load charts not included in the group, the following will be an aid in cases not provided for. With a fixed span L, and a given beam, the distance D, between adjacent arch centres is inversely proportional to the intensity of loading, that is, the greater the loading, the smaller may be the value D and likewise the smaller the loading, the greater may be the value D, so that in selecting a beam from one of the charts, the value of D used for the new loading should be

$$D' = \frac{I}{I'} \times D$$

wherein I and D are from the chart used, and D' is the new value of D for the new loading. Likewise in determining the value D' for a beam on a given load chart, the result obtained should be multiplied or divided respectively, if the new loading is smaller or larger, to obtain the correct spacing for the beams.

The following tables are intended to aid in the selection of the proper intensity of loading to conform with the various conditions of usage and kinds of construction.

Live Loads.

	Pounds per square foot
Dwellings: apartment, tenement, hotel or lodging	60
Schools, carriage houses, stables	75
Office buildings, first floor	150
other floors	75
Theatres, churches, ball-rooms, drill halls	80–125
Public assembly halls	90
Ordinary stores, light manufacturing, light storage	120
Wholesale stores, heavy storage, factories, machine shops	150
Warehouses	150–250
Warehouses for heavy machinery	250–400
Sidewalks between curb and area lines	300
Roofs:—when pitch is less than 20 degrees	50
when pitch is greater than 20 degrees	30

Dead Loads.

Corrugated galvanized iron No. 20	$2\frac{1}{4}$
Copper, 16 oz. standing seam	$1\frac{1}{4}$
Dense tile flat arch, 6 in.–12 in. thick	22–42
Dense tile partition, 3 in.–6 in. thick	15–28
Felt and asphalt	2
Felt and gravel	8–10

Floors, including framing,—	
Brick and concrete	100–130
Hollow tile arch	70–90
Wooden, for dwellings	10–15
Wooden, for offices	25–30
Fire proof floors, including framing,—	
8-in. beams, brick arch	74
8-in. beams, hollow tile	63–74
9-in. beams, brick arch	74
9-in. beams, hollow tile	65–80
10-in. beams, brick arch	81
10-in. beams, hollow tile	68–81
12-in. beams, brick arch	94
12-in. beams, hollow tile	71–93
15-in. beams, brick arch	113
15-in. beams, hollow tile	91–113
Glass $\frac{1}{8}$ in. thick	$1\frac{3}{4}$
Hemlock sheathing, 1 in. thick	2
Lead, $\frac{1}{8}$ in. thick	6–8
Lath and plaster ceiling	6–8
Mackite 1 in. thick with plaster	10
Neponset roofing felt, 2 layers	$\frac{1}{2}$
Plaster, on terra cotta arches	5
Plaster, on lath	7
Porous tile flat arch, 6 in.–15 in. thick	21–43
Porous tile partition, 3 in.–6 in. thick	14–27
Porous tile ceiling, 2 in.–4 in. thick	12–20
Partitions, wooden	15–20
Roofs. including framing,—	
Corrugated iron	8–10
Tar and gravel	10–12
Tile	20–30
Tin	6–8
Shingles	6–10
Slate	12–15
Slate $\frac{3}{16}$ in. thick, 3 in. double lap	$6\frac{3}{4}$
Slate $\frac{1}{8}$ in. " 3 in. " "	$4\frac{1}{2}$
Snow, freshly fallen	7
Snow, wet and packed	15–50
Spruce sheathing 1 in. thick	$2\frac{1}{2}$
Shingles 6 in. by 18 in., $\frac{1}{3}$ to weather	2
Skylight frame and glass, $\frac{3}{16}$ in.–$\frac{1}{2}$ in. thick	4–10
Slag roof, 4 ply	4
Snow,—	
Roof slope over 45 degrees	8
Roof slope under 45 degrees	12
Tin IX	$\frac{3}{4}$
Tiles, corrugated	8–10

Tiles, on concrete slabs.................................30–35
Tiles, plain, 10$\frac{1}{2}$ in. by 6$\frac{1}{4}$ in. by $\frac{5}{8}$ in.–5$\frac{1}{4}$ in. to weather.....18
Tiles, Spanish, 14$\frac{1}{2}$ in. by 10$\frac{1}{2}$ in.–7$\frac{1}{4}$ in. to weather.........8$\frac{1}{2}$
White pine sheathing, 1 in. thick...........................2$\frac{1}{2}$
Yellow pine sheathing, 1 in. thick............................4

General Values for Live Load Plus Dead Load.

Roofs, 3-in. terra cotta book tile...........................80
Wooden floors (eye-beam joists), vault light (inside of area line) 100
Wooden floors (plastered ceilings).........................110
Roofs,—eye-beams and concrete arches..................120
Mezzanine floors (concrete fill)...........................125
Skylight area (yard above vault light)....................140
Floors,—eye-beams, 4 in. brick arches, concrete fill, as school rooms, interior play grounds...........................150
Auditorium floors...165
Grand stands, arches (inside of area line) 175
Light warehouse floors, audience halls, car house floors of conduit construction, gymnasiums, roof play grounds.....200
Warehouses where heavy pieces are moved, shop floors for light machinery...250
Vault light (in sidewalk)...................................300
Arches (in sidewalk)..400
Shop floors for heavy machinery.............300, 400 and 500

Beam Reactions.

As shown in Fig. 3, there are five general cases of common occurrence in which the load at a particular point is sought.

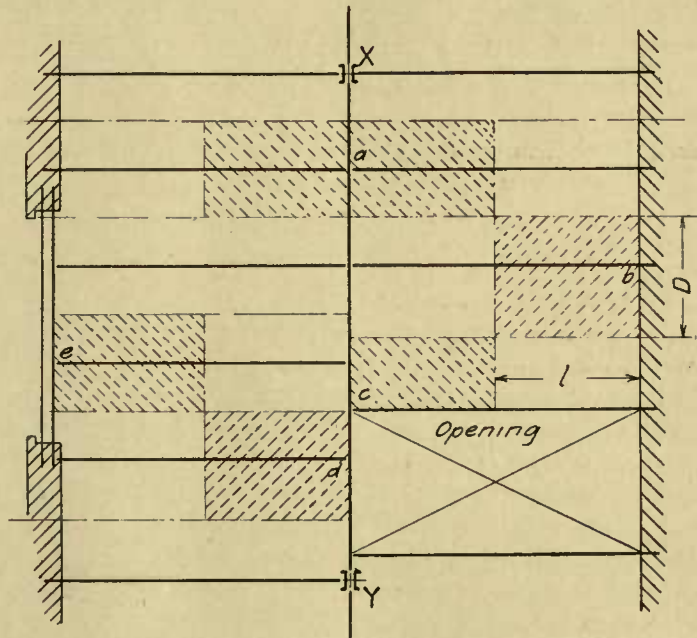


Fig. 3.

Each of these loads is the weight, uniformly distributed, supported by either half of a beam, and in the case of two beams framing opposite, it is the sum of the weights on the two half beams so framing. In considering a single beam, this load may be termed an end load or beam reaction and equals

$$R = D\,l\,I \qquad (3)$$

wherein D = distance from centre to centre of arches, or width of supported area, in feet.

l = $\frac{1}{2}$ the beam span or length of supported area, in feet.

I = intensity of loading in pounds per square foot.

The five cases above referred to are:—

(*a*) where two beams frame opposite into a girder between columns X and Y, the determination of the girder concentrations being necessary for the computation of the girder;

(*b*) where a beam rests on a wall; the sum of all such reactions gives the pier load due to the flooring system or if these beams are equally spaced, the reaction per beam multiplied by the number gives a similar result while the same may be obtained by multiplying the length of the wall by the reaction of a beam considered as supporting one foot width of area;

(*c*) where a beam is adjacent to an opening in which case D equals one half the span of the adjacent arch;

(*d*) where a single beam frames into a girder;

(*e*) where a single beam frames into a lintel over a window or door opening; this reaction in addition to the weight of the wall or panel back over the opening is required in the calculation of the lintel.

The shaded portion, in each case, indicates the loaded area which makes up the reaction. The reaction curves are plotted from equation (3) from which

$$D = \frac{R}{l\,I} \qquad (4)$$

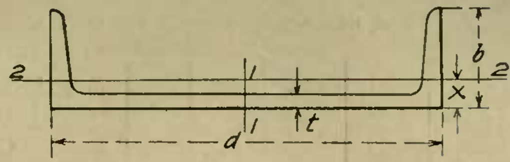
For a chart of given intensity of loading substitute the value of I in equation (4) which gives a general expression for all the curves on that chart. Now to plot a given reaction curve, substitute the value for R which gives an expression in the form of

$$D = \frac{C}{l} \qquad (5)$$

wherein $C = \frac{R}{I}$, a constant quantity.

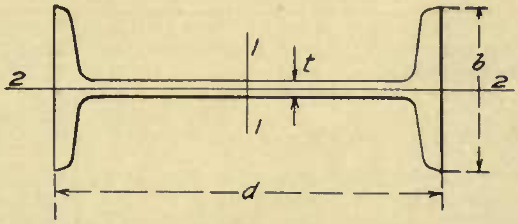
Then substitute in equation (5) a series of values for l and having solved for D, plot these simultaneous values which gives a series of points through which may be drawn a regular curve. In the accompanying reaction charts, the divisions vertically and horizontally are each 3 inches, thus affording readings to an inch by visual sub-division into thirds. In the accompanying charts, the heavy line curves are 1000 pound reactions and are so marked while the unmarked lighter line curves are for 500 pounds. These curves are carried out up to a loading of 400 pounds per square foot, beyond which it is not practicable for reading without confusion and inconvenience because of the closeness of the curves. Furthermore, these loadings cover all cases or at least are so close to them as to warrant their use. For the same reason the one half span is not extended beyond 20 feet for in the case of a greater one half span, say 26 feet, it is more desirable to use 13 for l and multiply the result by two, an operation which is easily performed mentally. These cases are of infrequent occurrence and so the value of the curves is not decreased by the absence of direct values for one half spans over 20 feet. The one common example under this case is the framing of two beams opposite and then l equals one half the sum of the two beam spans.

Because of the many inaccuracies which are included in the assumption for the intensity of loading, the results would not warrant figuring the beam reactions closer than 100 pounds and furthermore the final selection made in the material is subject to variation which is about compensated for in the 100 pound figure. To ascertain the beam reaction for a given loading, D and l, we have only to note the point of intersection of two lines, the horizontal one through the value for D and the vertical one through the value for l. If the point of intersection occurs between two reactions curves, the result is read by interpolation as follows; assume, by eye, a line drawn through the point of intersection and perpendicular to the two adjacent curves between which the point lies. When one of the curves is one designating 500 pounds, note how many fifth divisions are included between the point and the lower curve and add this to the value of the latter. For example, $I = 150$, $l = 12$ ft. 3 in. and $D = 5$ ft. 3 in. The point of intersection of the horizontal line through 5 ft. 3 in. with the vertical line through 12 ft. 3 in. occurs between curves 9.5 and 10. The part of the assumed line between 9.5 and the point is $\frac{2}{5}$,—add the 2 to 9.5 and the reaction is 9.7, read 9700 pounds. As with some of the higher intensities of loading, the point of intersection may occur between two thousand-pound curves. The interpolation is carried out similarly to the case just cited except that the number of visual subdivisions is assumed to be 10. The results are practically instantaneous with the elimination of all possible errors which may arise from the multiplication of the three factors D, l and I. Half divisions of the 3 in. marks may be used when readings of D or l are taken in eighths of a foot as $1\frac{1}{2}$ in., $4\frac{1}{2}$ in., $7\frac{1}{2}$ in. or $10\frac{1}{2}$ in. When the uniformly distributed load on a beam is required, if l is used, the result is multiplied by 2. In the case of a scaled drawing, l is measured by using a scale double that of the drawing over the total span, and similarly D is measured between the two beams on either side of the one in question or if the latter is adjacent to an opening, this measurement is made between this beam and the next one. Charts 14 to 25, inclusive, give the reaction curves. Only the figures within the chart rectangle refer to reaction values.



PROPERTIES OF STANDARD CHANNELS.

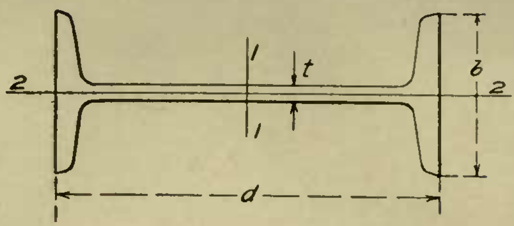
Depth of Channel.	Weight per Foot.	Area of Section.	Thickness of Web.	Width of Flange.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.	Radius of Gyration Axis 1-1.	Moment of Inertia Axis 2-2.	Section Modulus Axis 2-2.	Radius of Gyration Axis 2-2.	Distance of Center of Gravity from Outside of Web.
d		A	t	b	I	S	r	I'	S'	r'	x
Ins.	Pounds.	Sq. Ins.	Inch.	Ins.	Ins.^{4}	Ins.^{3}	Ins.	Ins.^{4}	Ins.^{3}	Inch.	Inch.
3	4.00	1.19	.17	1.41	1.6	1.1	1.17	.20	.21	.41	.44
"	5.00	1.47	.26	1.50	1.8	1.2	1.12	.25	.24	.41	.44
"	6.00	1.76	.36	1.60	2.1	1.4	1.08	.31	.27	.42	.46
4	5.25	1.55	.18	1.58	3.8	1.9	1.56	.32	.29	.45	.46
"	6.25	1.84	.25	1.65	4.2	2.1	1.51	.38	.32	.45	.46
"	7.25	2.13	.33	1.73	4.6	2.3	1.46	.44	.35	.46	.46
5	6.50	1.95	.19	1.75	7.4	3.0	1.95	.48	.38	.50	.49
"	9.00	2.65	.33	1.89	8.9	3.5	1.83	.64	.45	.49	.48
"	11.50	3.38	.48	2.04	10.4	4.2	1.75	.82	.54	.49	.51
6	8.00	2.38	.20	1.92	13.0	4.3	2.34	.70	.50	.54	.52
"	10.50	3.09	.32	2.04	15.1	5.0	2.21	.88	.57	.53	.50
"	13.00	3.82	.44	2.16	17.3	5.8	2.13	1.07	.65	.53	.52
"	15.50	4.56	.56	2.28	19.5	6.5	2.07	1.28	.74	.53	.55
7	9.75	2.85	.21	2.09	21.1	6.0	2.72	.98	.63	.59	.55
"	12.25	3.60	.32	2.20	24.2	6.9	2.59	1.19	.71	.57	.53
"	14.75	4.34	.42	2.30	27.2	7.8	2.50	1.40	.79	.57	.53
"	17.25	5.07	.53	2.41	30.2	8.6	2.44	1.62	.87	.56	.55
"	19.75	5.81	.63	2.51	33.2	9.5	2.39	1.85	.96	.56	.58
8	11.25	3.35	.22	2.26	32.3	8.1	3.10	1.33	.79	.63	.58
"	13.75	4.04	.31	2.35	36.0	9.0	2.98	1.55	.87	.62	.56
"	16.25	4.78	.40	2.44	39.9	10.0	2.89	1.78	.95	.61	.56
"	18.75	5.51	.49	2.53	43.8	11.0	2.82	2.01	1.02	.60	.57
"	21.25	6.25	.58	2.62	47.8	11.9	2.76	2.25	1.11	.60	.59
9	13.25	3.89	.23	2.43	47.3	10.5	3.49	1.77	.97	.67	.61
"	15.00	4.41	.29	2.49	50.9	11.3	3.40	1.95	1.03	.66	.59
"	20.00	5.88	.45	2.65	60.8	13.5	3.21	2.45	1.19	.65	.58
"	25.00	7.35	.61	2.81	70.7	15.7	3.10	2.98	1.36	.64	.62
10	15.00	4.46	.24	2.60	66.9	13.4	3.87	2.30	1.17	.72	.64
"	20.00	5.88	.38	2.74	78.7	15.7	3.66	2.85	1.34	.70	.61
"	25.00	7.35	.53	2.89	91.0	18.2	3.52	3.40	1.50	.68	.62
"	30.00	8.82	.68	3.04	103.2	20.6	3.42	3.99	1.67	.67	.65
"	35.00	10.29	.82	3.18	115.5	23.1	3.35	4.66	1.87	.67	.69
12	20.50	6.03	.28	2.94	128.1	21.4	4.61	3.91	1.75	.81	.70
"	25.00	7.35	.39	3.05	144.0	24.0	4.43	4.53	1.91	.78	.68
"	30.00	8.82	.51	3.17	161.6	26.9	4.28	5.21	2.09	.77	.68
"	35.00	10.29	.64	3.30	179.3	29.9	4.17	5.90	2.27	.76	.69
"	40.00	11.76	.76	3.42	196.9	32.8	4.09	6.63	2.46	.75	.72
15	33.00	9.90	.40	3.40	312.6	41.7	5.62	8.23	3.16	.91	.79
"	35.00	10.29	.43	3.43	319.9	42.7	5.57	8.48	3.22	.91	.79
"	40.00	11.76	.52	3.52	347.5	46.3	5.44	9.39	3.43	.89	.78
"	45.00	13.24	.62	3.62	375.1	50.0	5.32	10.29	3.63	.88	.79
"	50.00	14.71	.72	3.72	402.7	53.7	5.23	11.22	3.85	.87	.80
"	55.00	16.18	.82	3.82	430.2	57.4	5.16	12.19	4.07	.87	.82



PROPERTIES OF STANDARD I-BEAMS.*

Depth of Beam.	Weight per Foot.	Area of Section.	Thick-ness of Web.	Width of Flange.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.	Radius of Gyra-tion Axis 1-1.	Moment of Inertia Axis 2-2.	Radius of Gyra-tion Axis 2-2.
d		A	t	b	I	S	r	I'	r'
Inches.	Pounds.	Sq. Ins.	Inch.	Inches.	Inches.^{4}	Inches.^{3}	Inches.	Inches.^{4}	Inch.
3	5.50	1.63	.17	2.33	2.5	1.7	1.23	.46	.53
"	6.50	1.91	.26	2.42	2.7	1.8	1.19	.53	.52
"	7.50	2.21	.36	2.52	2.9	1.9	1.15	.60	.52
4	7.50	2.21	.19	2.66	6.0	3.0	1.64	.77	.59
"	8.50	2.50	.26	2.73	6.4	3.2	1.59	.85	.58
"	9.50	2.79	.34	2.81	6.7	3.4	1.54	.93	.58
"	10.50	3.09	.41	2.88	7.1	3.6	1.52	1.01	.57
5	9.75	2.87	.21	3.00	12.1	4.8	2.05	1.23	.65
"	12.25	3.60	.36	3.15	13.6	5.4	1.94	1.45	.63
"	14.75	4.34	.50	3.29	15.1	6.1	1.87	1.70	.63
6	12.25	3.61	.23	3.33	21.8	7.3	2.46	1.85	.72
"	14.75	4.34	.35	3.45	24.0	8.0	2.35	2.09	.69
"	17.25	5.07	.47	3.57	26.2	8.7	2.27	2.36	.68
7	15.00	4.42	.25	3.66	36.2	10.4	2.86	2.67	.78
"	17.50	5.15	.35	3.76	39.2	11.2	2.76	2.94	.76
"	20.00	5.88	.46	3.87	42.2	12.1	2.68	3.24	.74
8	18.00	5.33	.27	4.00	56.9	14.2	3.27	3.78	.84
"	20.25	5.96	.35	4.08	60.2	15.0	3.18	4.04	.82
"	22.75	6.69	.44	4.17	64.1	16.0	3.10	4.36	.81
"	25.25	7.43	.53	4.26	68.0	17.0	3.03	4.71	.80
9	21.00	6.31	.29	4.33	84.9	18.9	3.67	5.16	.90
"	25.00	7.35	.41	4.45	91.9	20.4	3.54	5.65	.88
"	30.00	8.82	.57	4.61	101.9	22.6	3.40	6.42	.85
"	35.00	10.29	.73	4.77	111.8	24.8	3.30	7.31	.84
10	25.00	7.37	.31	4.66	122.1	24.4	4.07	6.89	.97
"	30.00	8.82	.45	4.80	134.2	26.8	3.90	7.65	.93
"	35.00	10.29	.60	4.95	146.4	29.3	3.77	8.52	.91
"	40.00	11.76	.75	5.10	158.7	31.7	3.67	9.50	.90
12	31.50	9.26	.35	5.00	215.8	36.0	4.83	9.50	1.01
"	35.00	10.29	.44	5.09	228.3	38.0	4.71	10.07	.99
"	40.00	11.76	.56	5.21	245.9	41.0	4.57	10.95	.96
15	42.00	12.48	.41	5.50	441.8	58.9	5.95	14.62	1.08
"	45.00	13.24	.46	5.55	455.8	60.8	5.87	15.09	1.07
"	50.00	14.71	.56	5.65	483.4	64.5	5.73	16.04	1.04
"	55.00	16.18	.66	5.75	511.0	68.1	5.62	17.06	1.03
"	60.00	17.65	.75	5.84	538.6	71.8	5.52	18.17	1.01

* Reprinted with the permission of the Cambria Steel Co.



PROPERTIES OF STANDARD I-BEAMS.

Depth of Beam.	Weight per Foot.	Area of Section.	Thick-ness of Web.	Width of Flange.	Moment of Inertia Axis 1-1.	Section Modulus Axis 1-1.	Radius of Gyra-tion Axis 1-1.	Moment of Inertia Axis 2-2.	Radius of Gyra-tion Axis 2-2.
d		*A*	*t*	*b*	*I*	*S*	*r*	*I'*	*r'*
Inches.	Pounds.	Sq. Ins.	Inch.	Inches.	Inches.[4]	Inches.[3]	Inches.	Inches [4]	Inch.
18	55.0	15.93	.46	6.00	795.6	88.4	7.07	21.19	1.15
"	60.0	17.65	.56	6.10	841.8	93.5	6.91	22.38	1.13
"	65.0	19.12	.64	6.18	881.5	97.9	6.79	23.47	1.11
"	70.0	20.59	.72	6.26	921.2	102.4	6.69	24.62	1.09
20	65.0	19.08	.50	6.25	1169.5	117.0	7.83	27.86	1.21
"	70.0	20.59	.58	6.33	1219.8	122.0	7.70	29.04	1.19
"	75.0	22.06	.65	6.40	1268.8	126.9	7.58	30.25	1.17
24	80.0	23.32	.50	7.00	2087.2	173.9	9.46	42.86	1.36
"	85.0	25.00	.57	7.07	2167.8	180.7	9.31	44.35	1.33
"	90.0	26.47	.63	7.13	2238.4	186.5	9.20	45.70	1.31
"	95.0	27.94	.69	7.19	2309.0	192.4	9.09	47.10	1.30
"	100.0	29.41	.75	7.25	2379.6	198.3	8.99	48.55	1.28

PROPERTIES OF SPECIAL I-BEAMS.

12	40.0	11.84	.46	5.25	268.9	44.8	4.77	13.81	1.08
"	45.0	13.24	.58	5.37	285.7	47.6	4.65	14.89	1.06
"	50.0	14.71	.70	5.49	303.4	50.6	4.54	16.12	1.05
"	55.0	16.18	.82	5.61	321.0	53.5	4.45	17.46	1.04
15	60.0	17.67	.59	6.00	609.0	81.2	5.87	25.96	1.21
"	65.0	19.12	.69	6.10	636.1	84.8	5.77	27.42	1.20
"	70.0	20.59	.78	6.19	663.7	88.5	5.68	29.00	1.19
"	75.0	22.06	.88	6.29	691.2	92.2	5.60	30.68	1.18
"	80.0	23.53	.98	6.39	718.8	95.8	5.53	32.46	1.17
15	80.0	23.57	.80	6.40	789.1	105.2	5.79	41.31	1.32
"	85.0	25.00	.90	6.50	815.9	108.8	5.71	43.46	1.32
"	90.0	26.47	.99	6.59	843.4	112.5	5.64	45.79	1.32
"	95.0	27.94	1.09	6.69	871.0	116.1	5.58	48.25	1.31
"	100.0	29.41	1.19	6.79	898.6	119.8	5.53	50.84	1.31
20	80.0	23.73	.60	7.00	1466.3	146.6	7.86	45.81	1.39
"	85.0	25.00	.66	7.06	1508.5	150.9	7.77	47.25	1.37
"	90.0	26.47	.74	7.14	1557.5	155.8	7.67	48.98	1.36
"	95.0	27.94	.81	7.21	1606.6	160.7	7.58	50.78	1.35
"	100.0	29.41	.88	7.28	1655.6	165.6	7.50	52.65	1.34

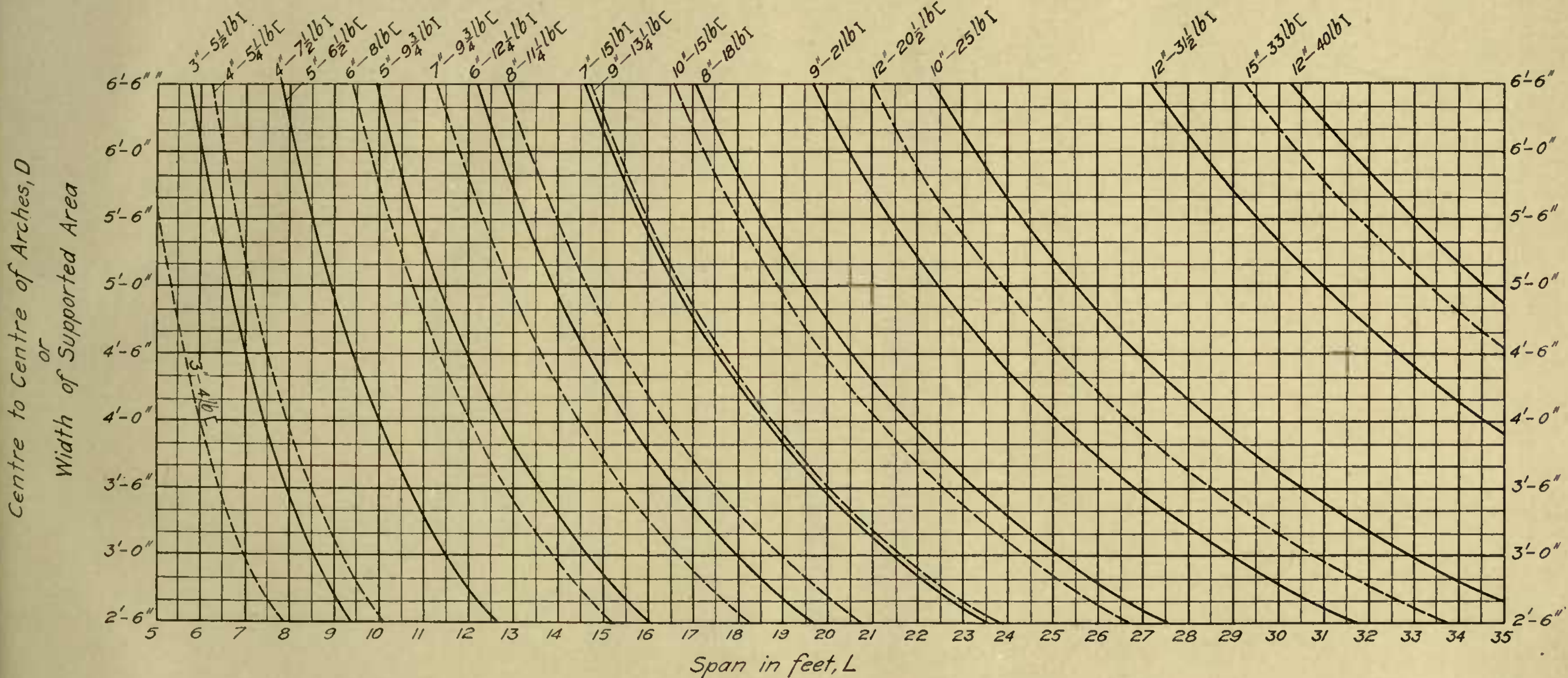


PLATE 1.—80 Pounds per Square Foot.

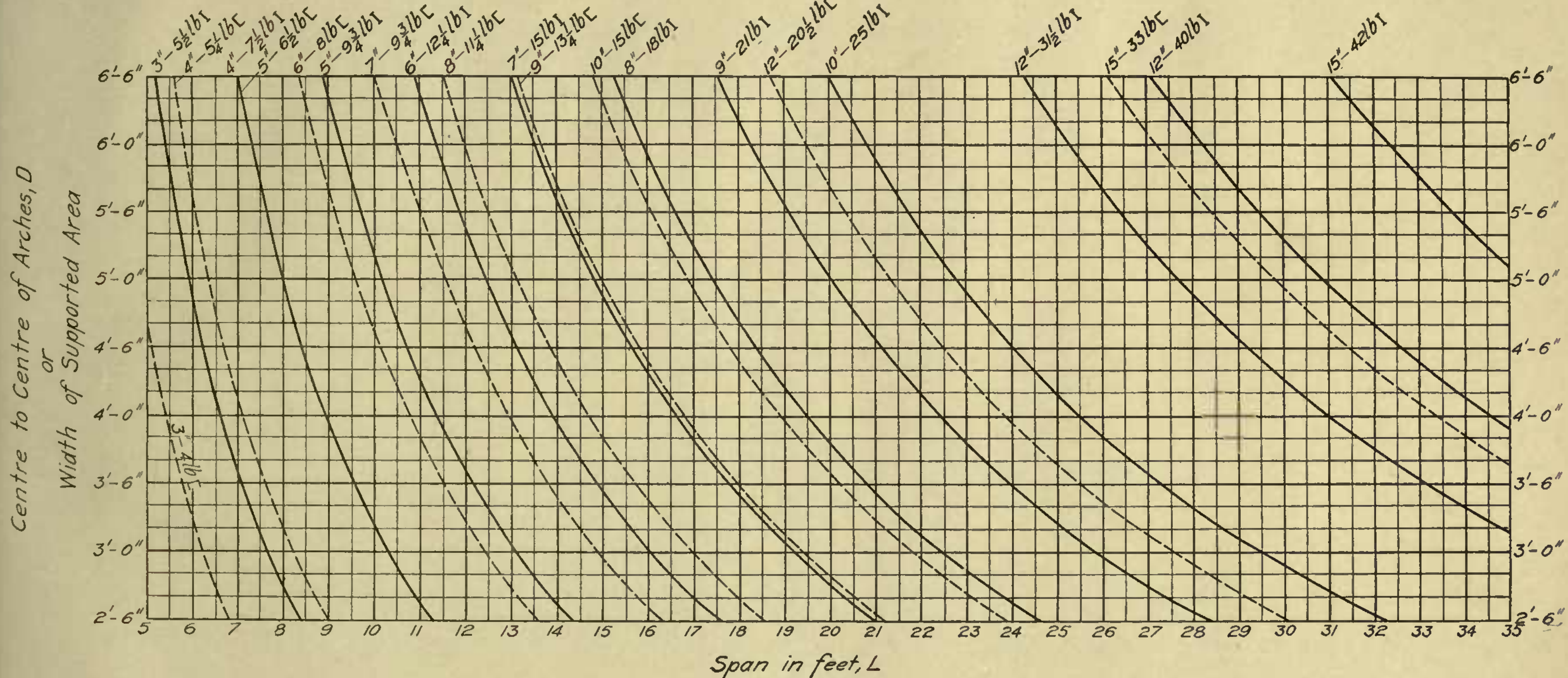


PLATE 2.—100 Pounds per Square Foot.

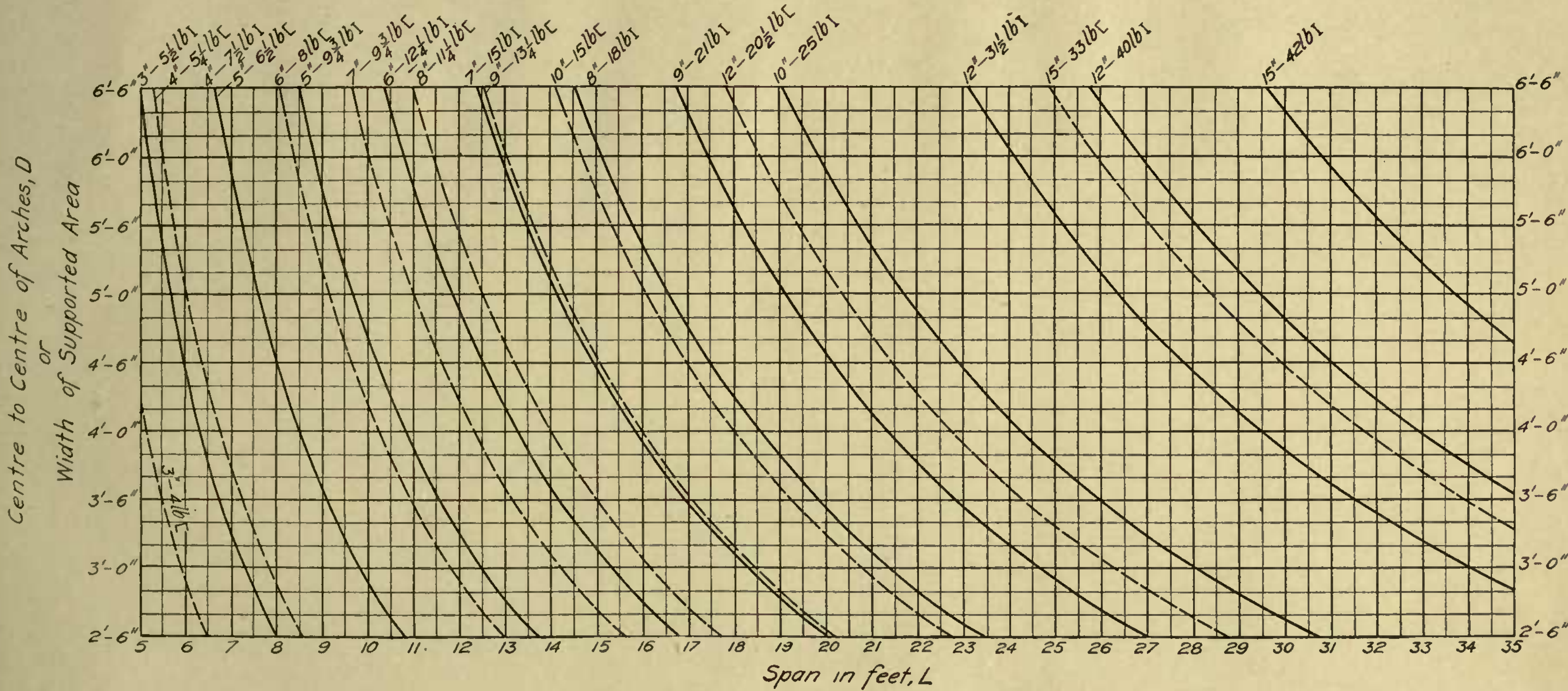


PLATE 3.—110 Pounds per Square Foot.

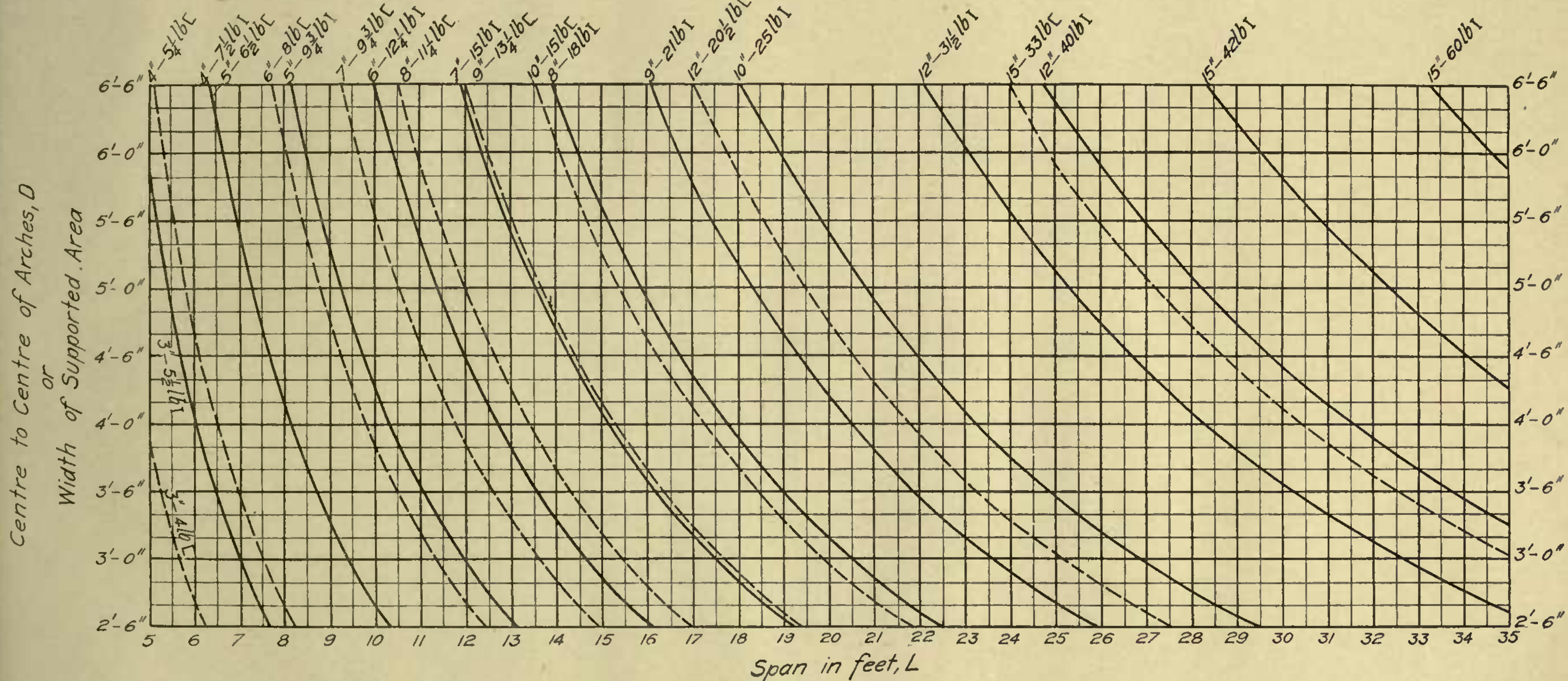


PLATE 4.—120 Pounds per Square Foot.

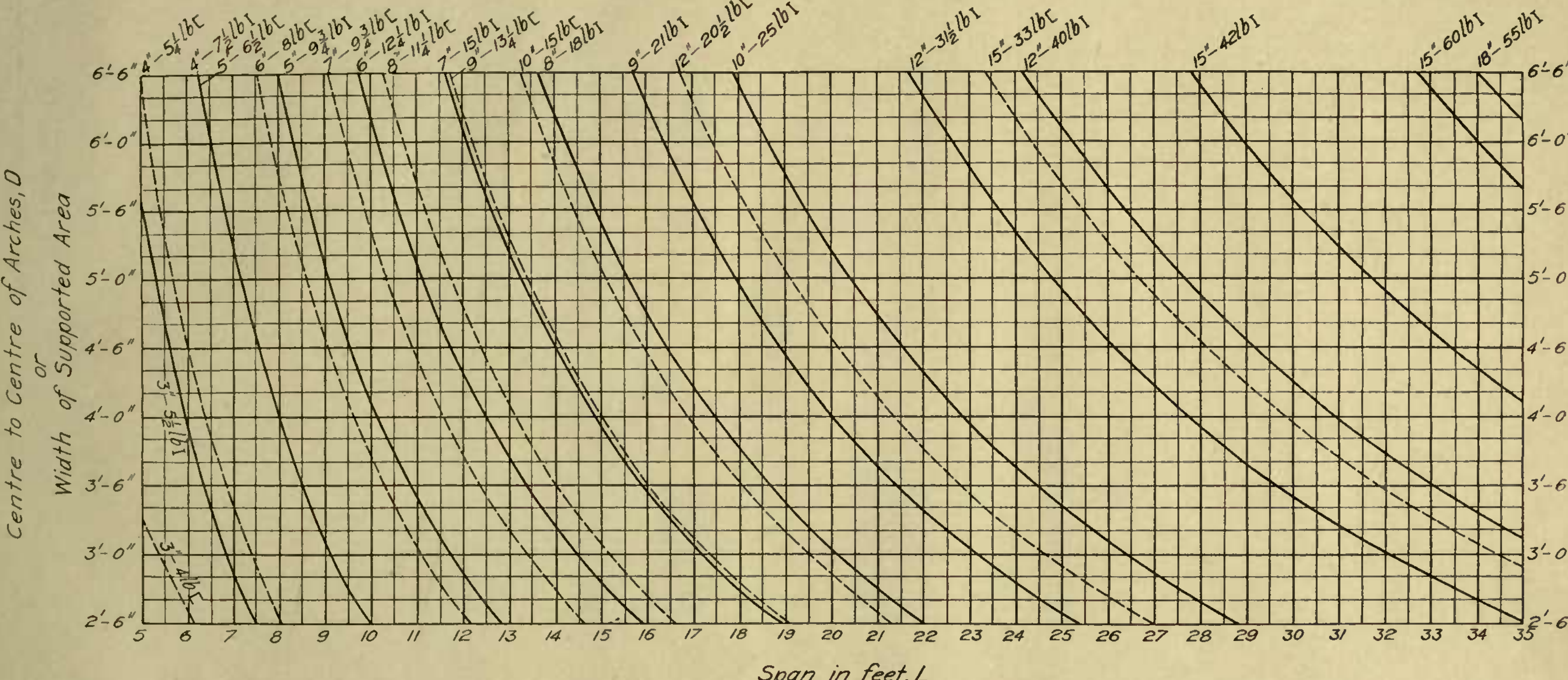


PLATE 5.—125 Pounds per Square Foot.

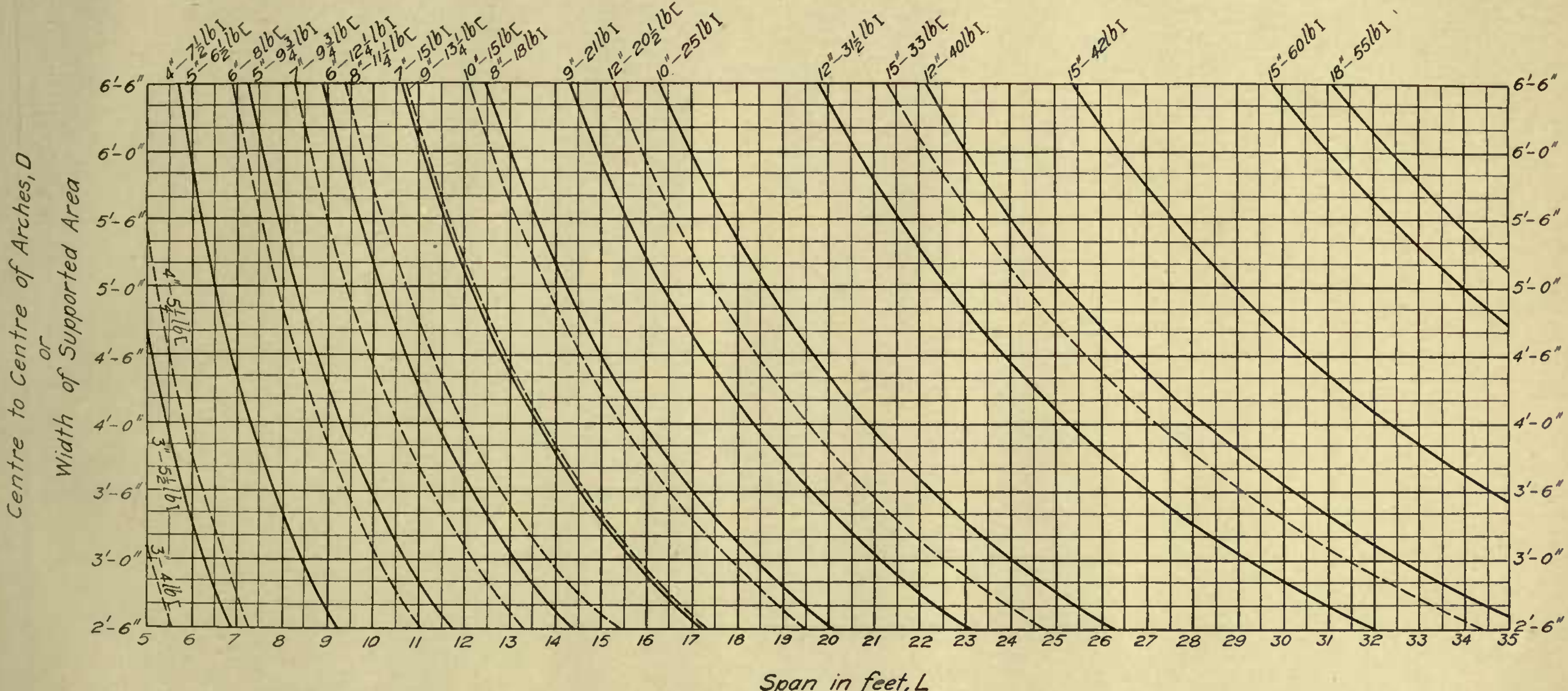


PLATE 6.—150 Pounds per Square Foot.

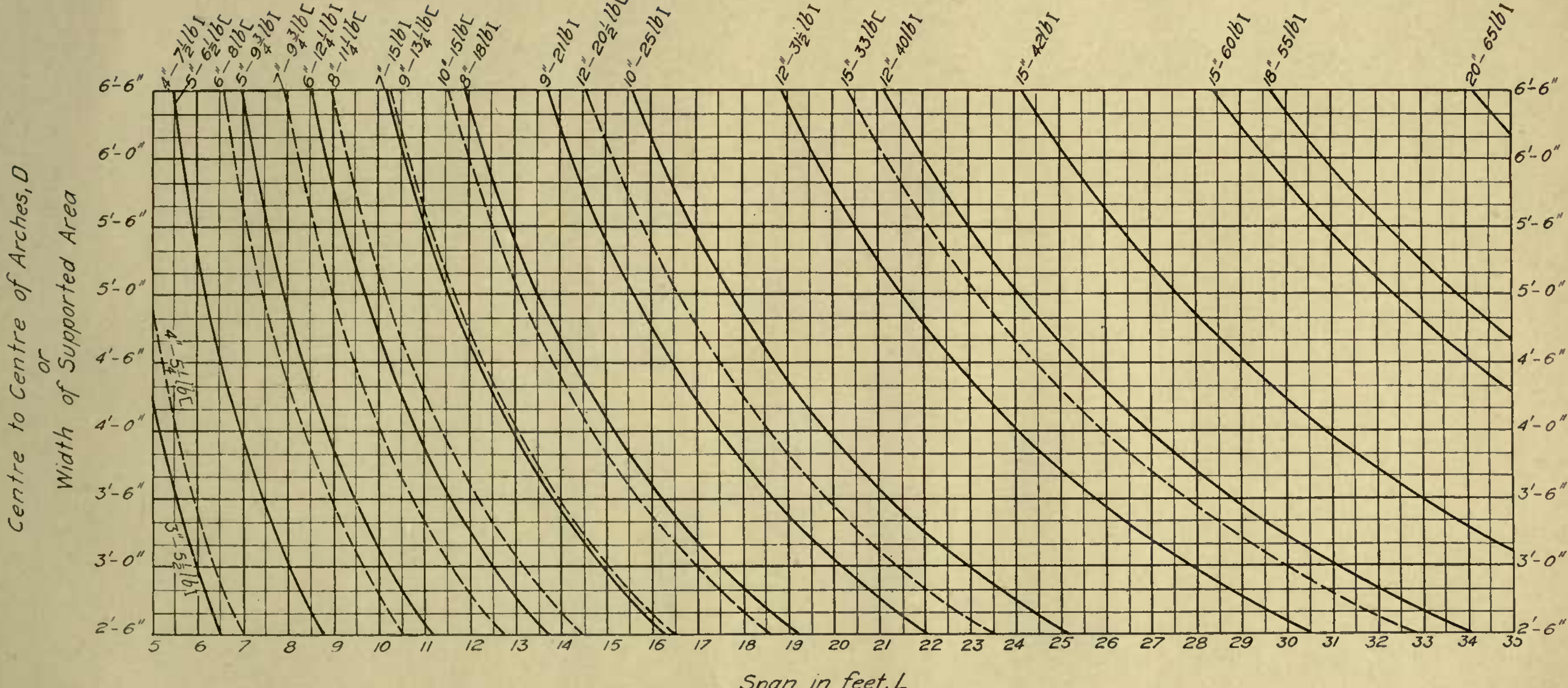


PLATE 7.—165 Pounds per Square Foot.

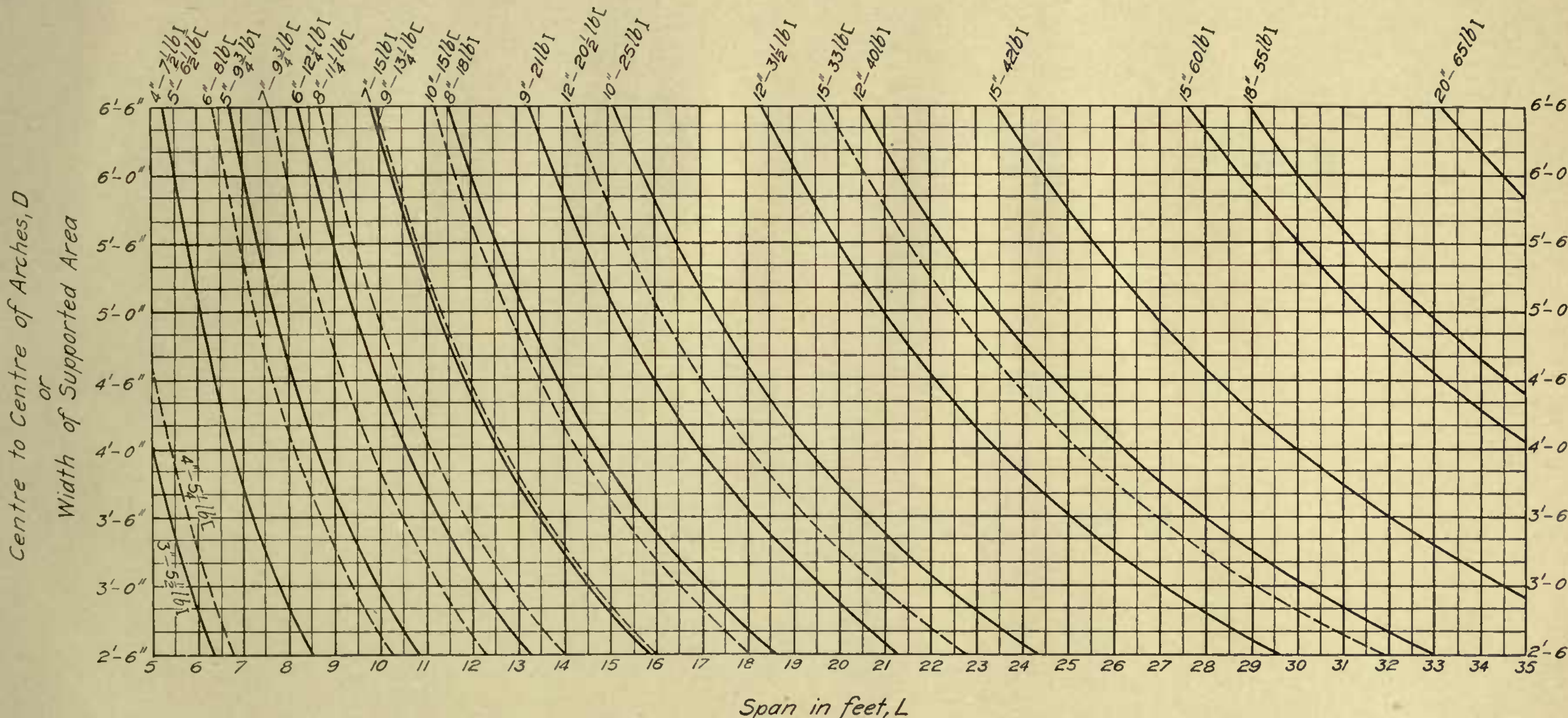


PLATE 8.—175 Pounds per Square Foot.

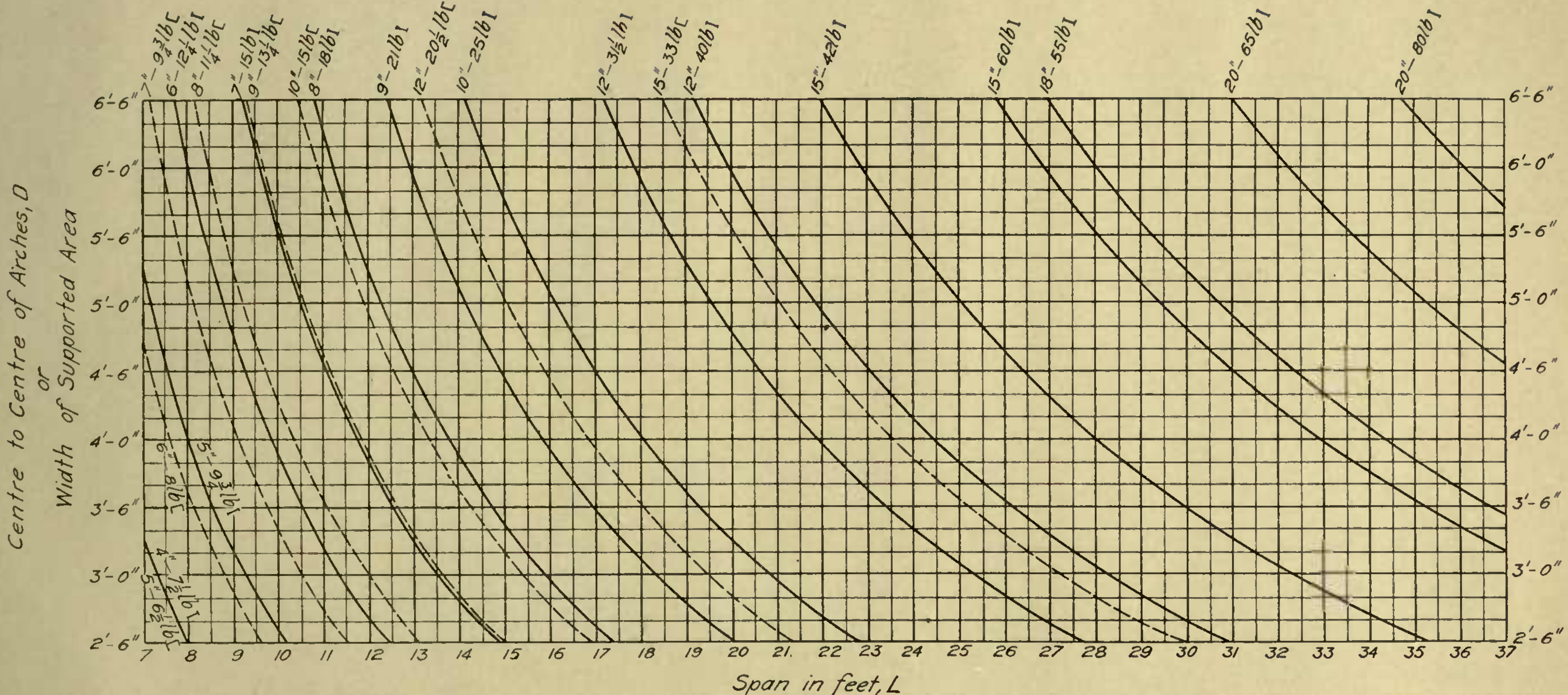


PLATE 9.—200 Pounds per Square Foot.

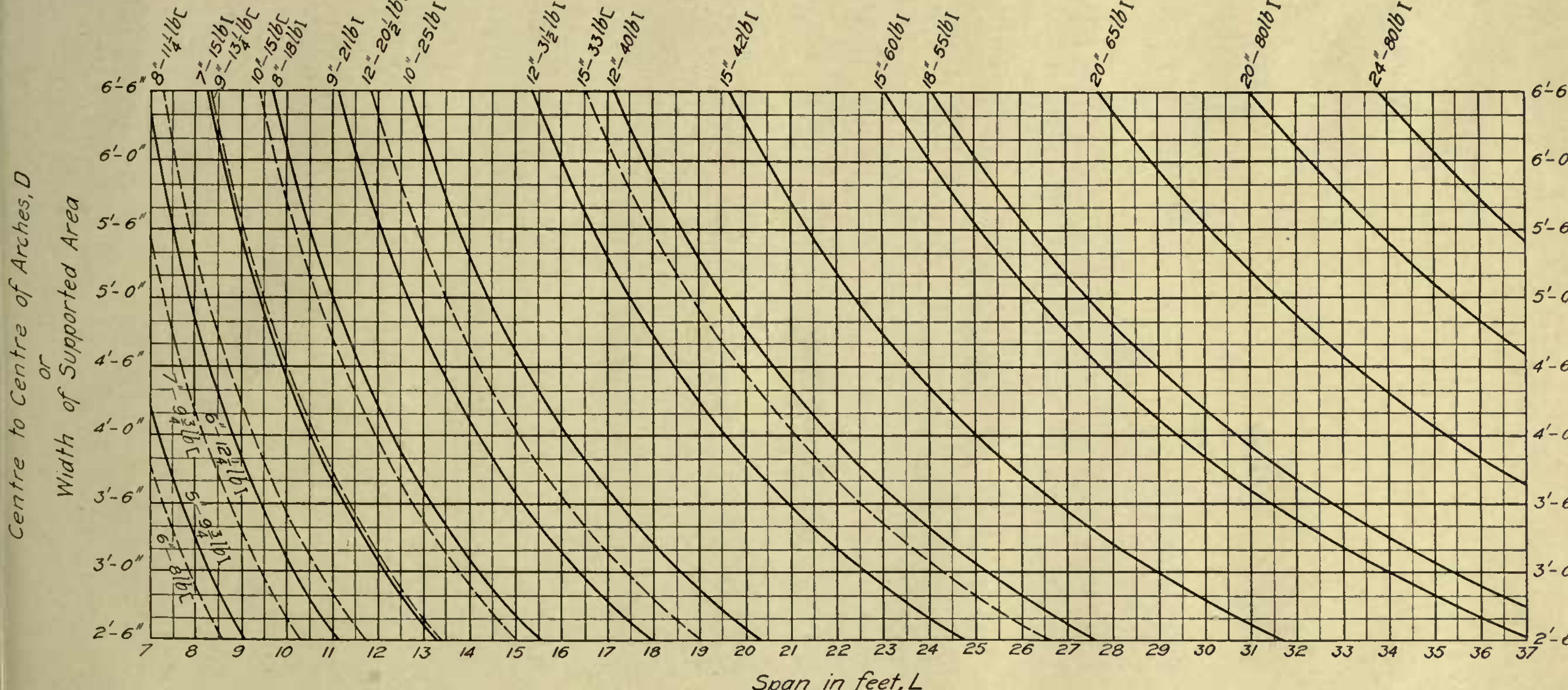


PLATE 10.—250 Pounds per Square Foot.

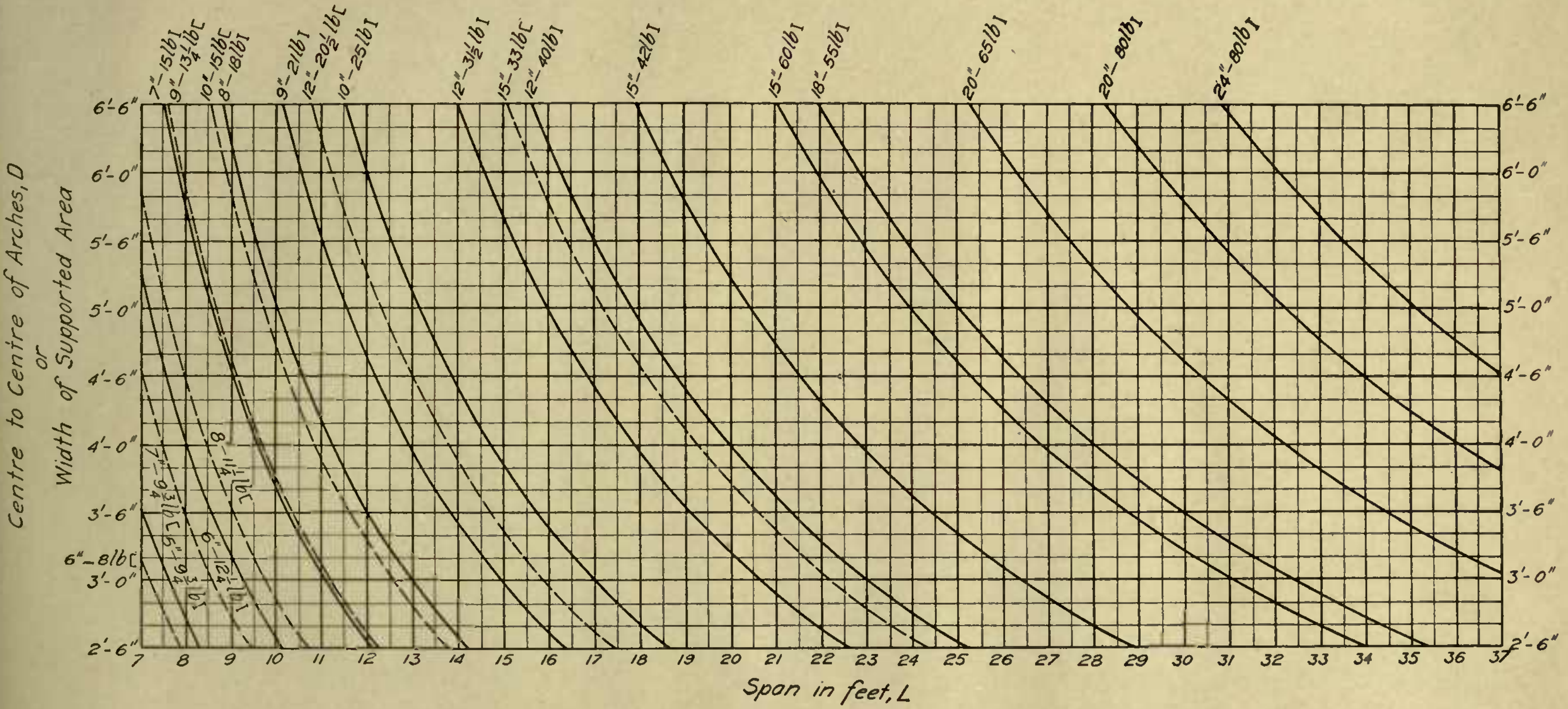


PLATE 11.—300 Pounds per Square Foot.

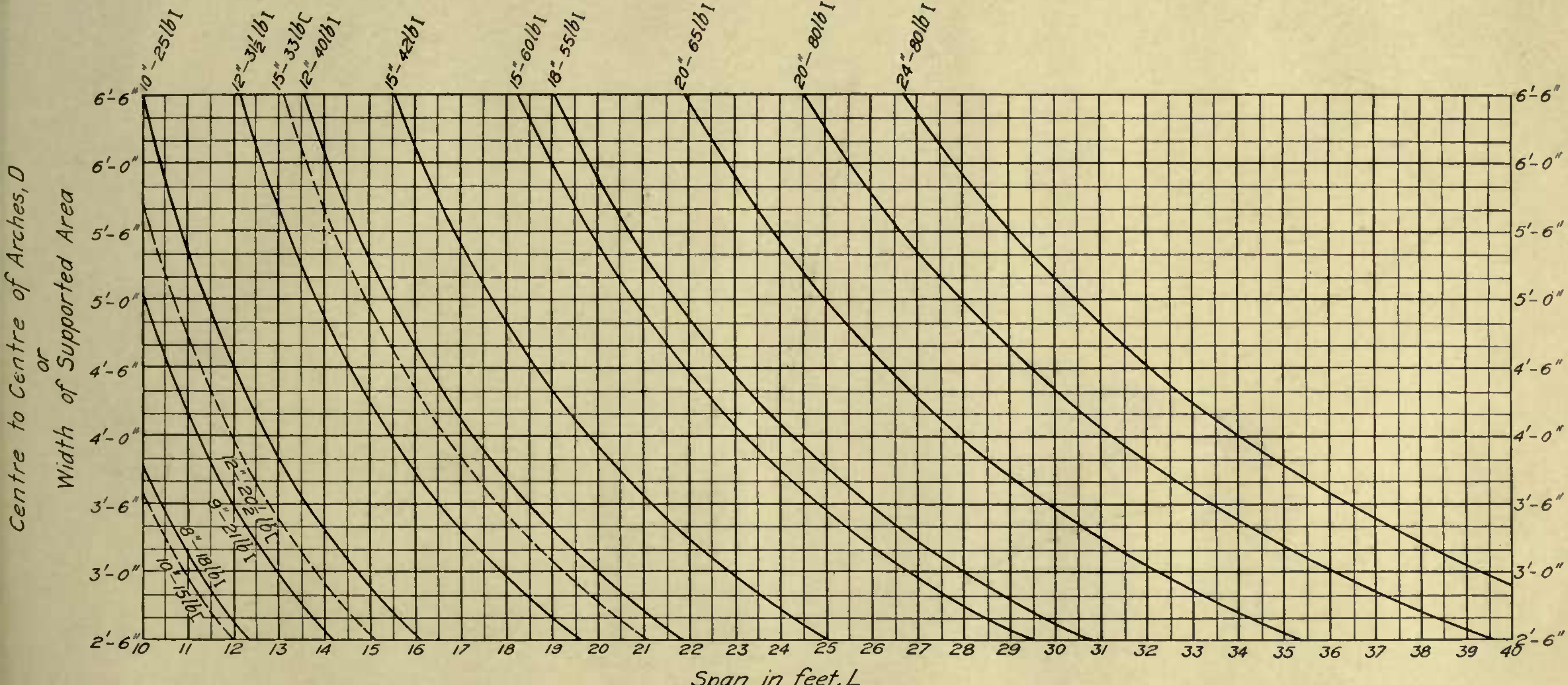


PLATE 12.—400 Pounds per Square Foot.

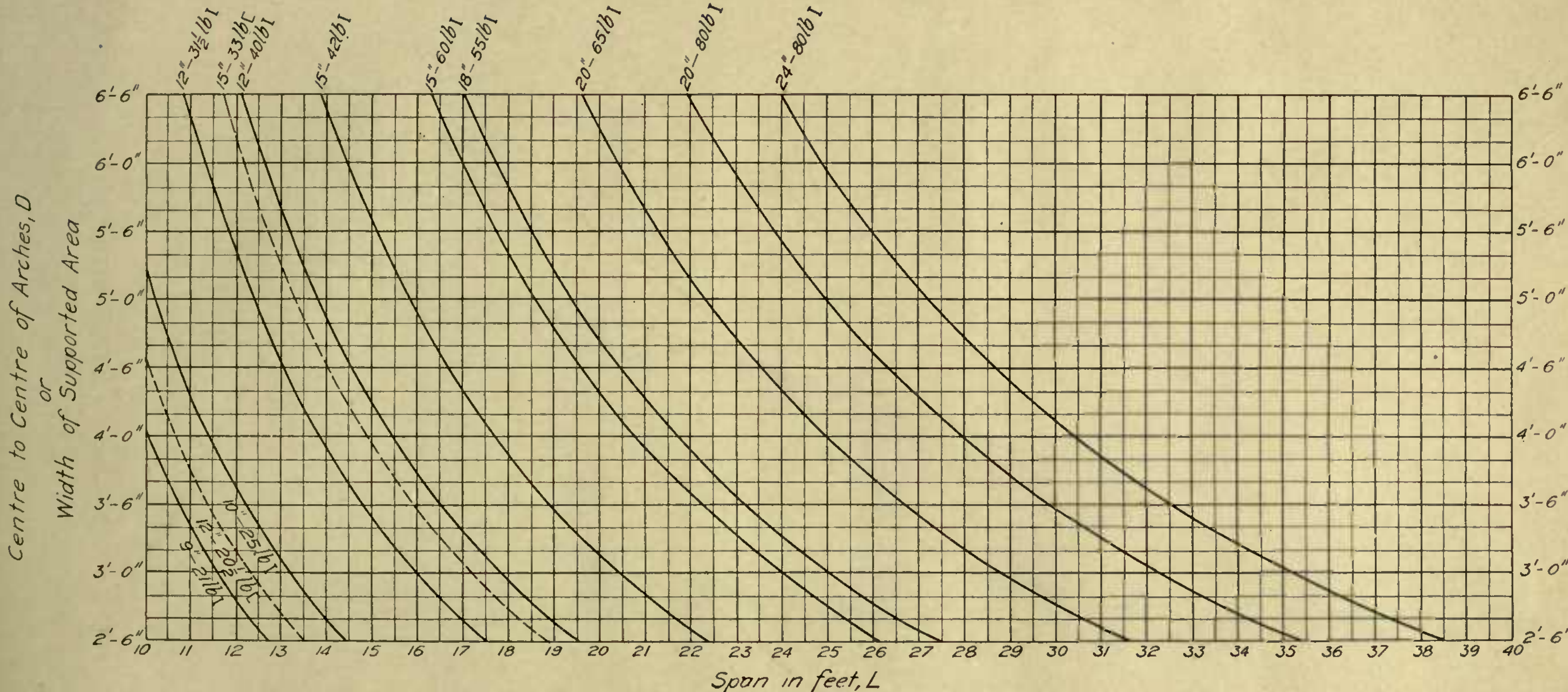


PLATE 13.—500 Pounds per Square Foot

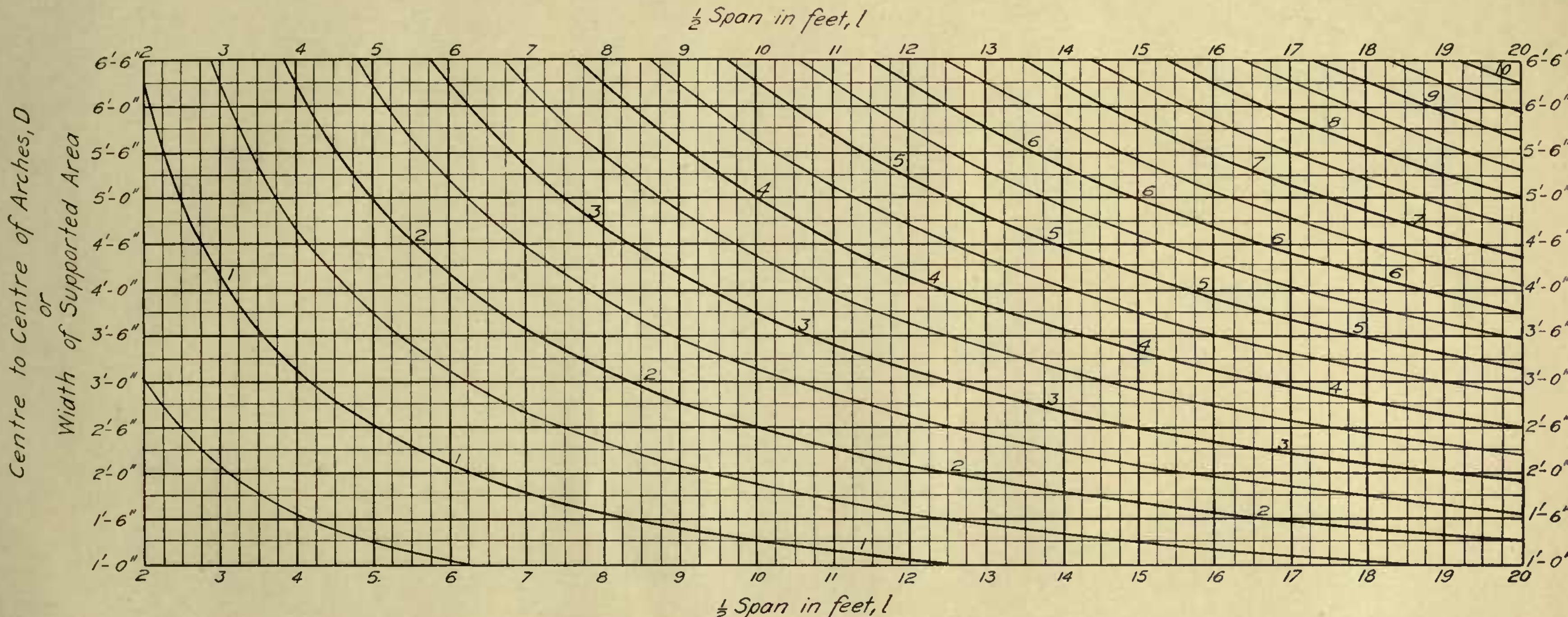


PLATE 14.—80 Pounds per Square Foot.

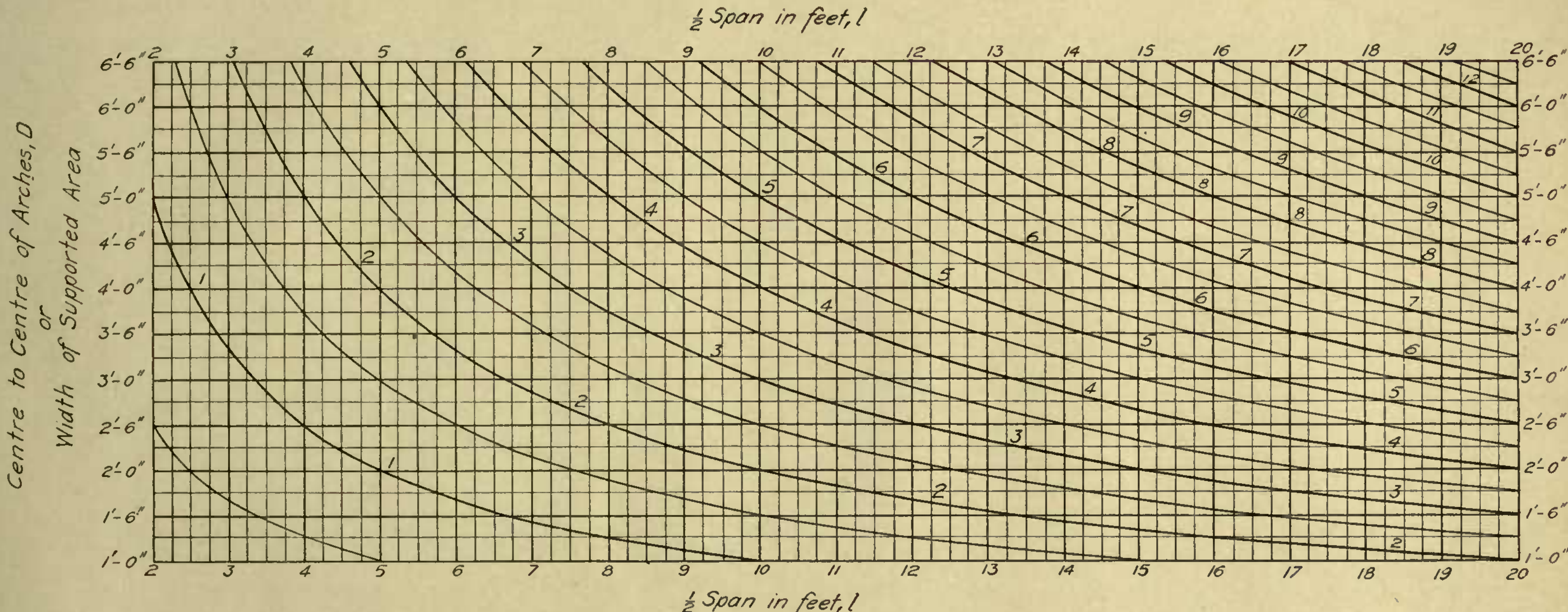


PLATE 15.—100 Pounds per Square Foot.

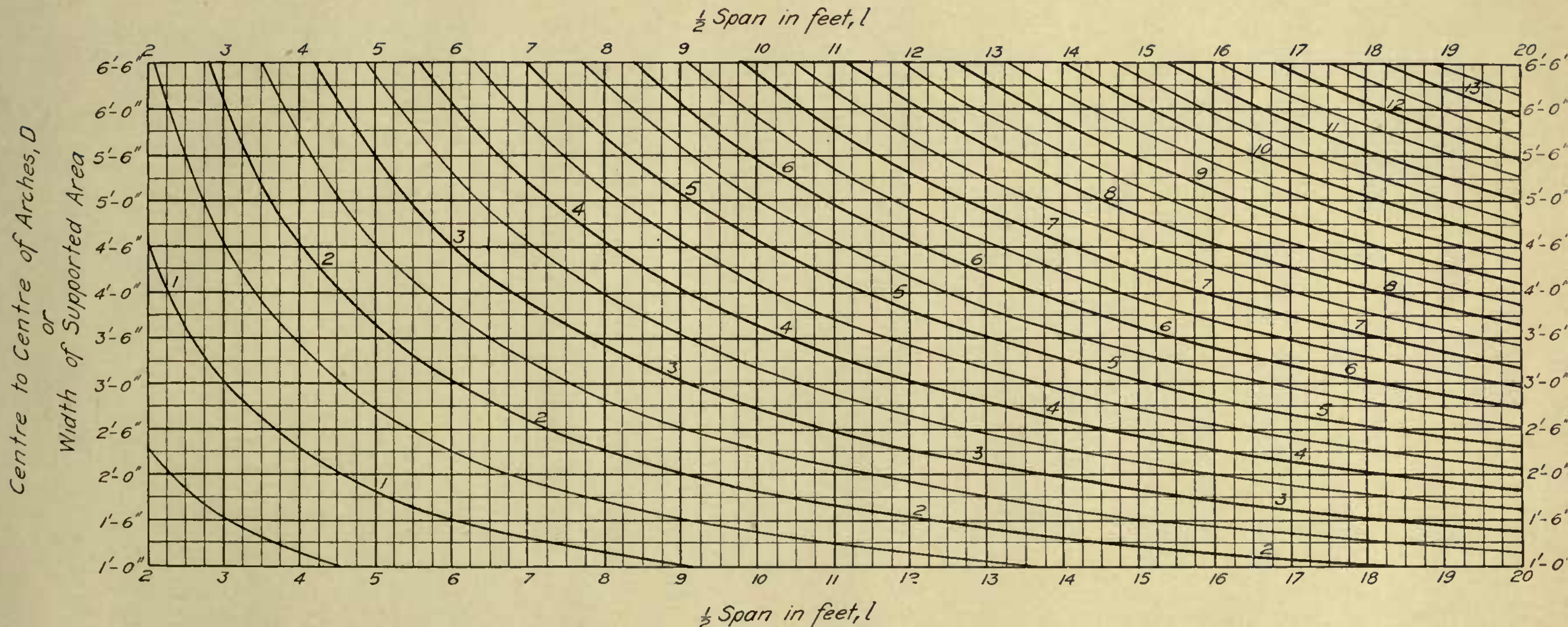


PLATE 16.—110 Pounds per Square Foot.

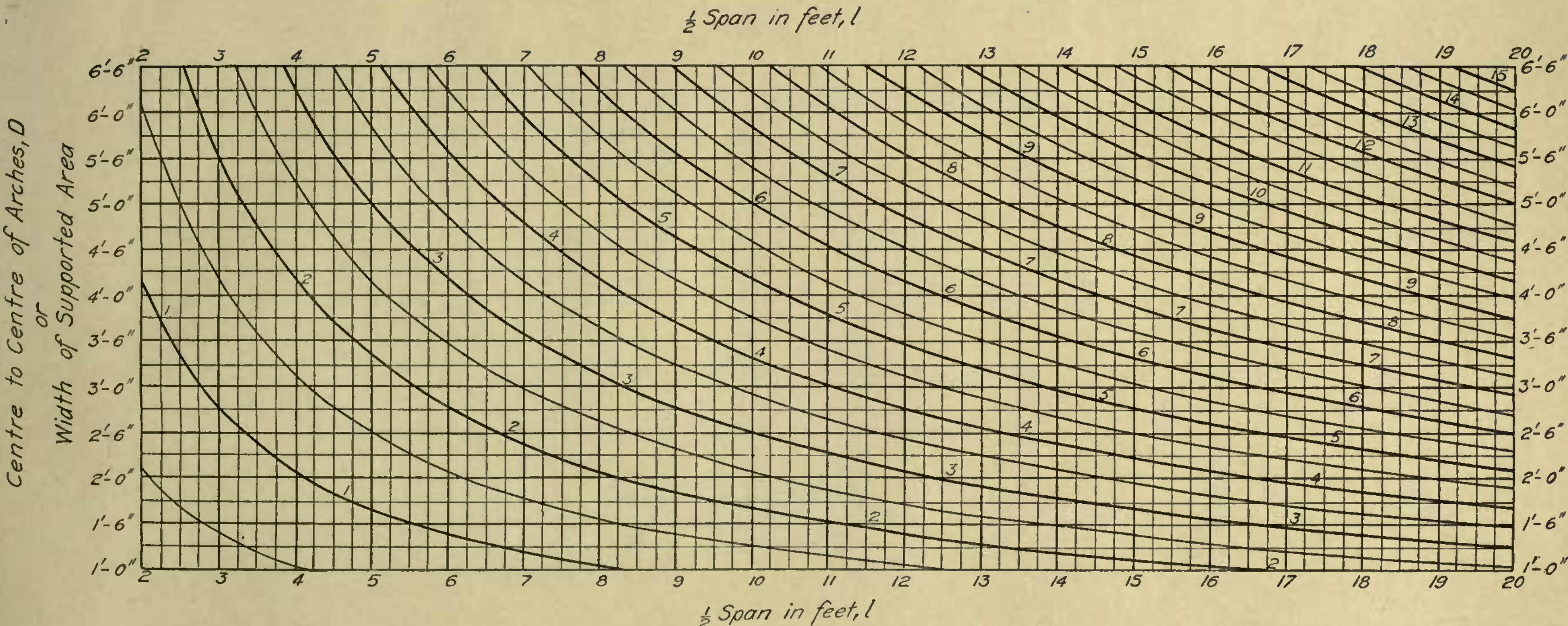


PLATE 17.—120 Pounds per Square Foot.

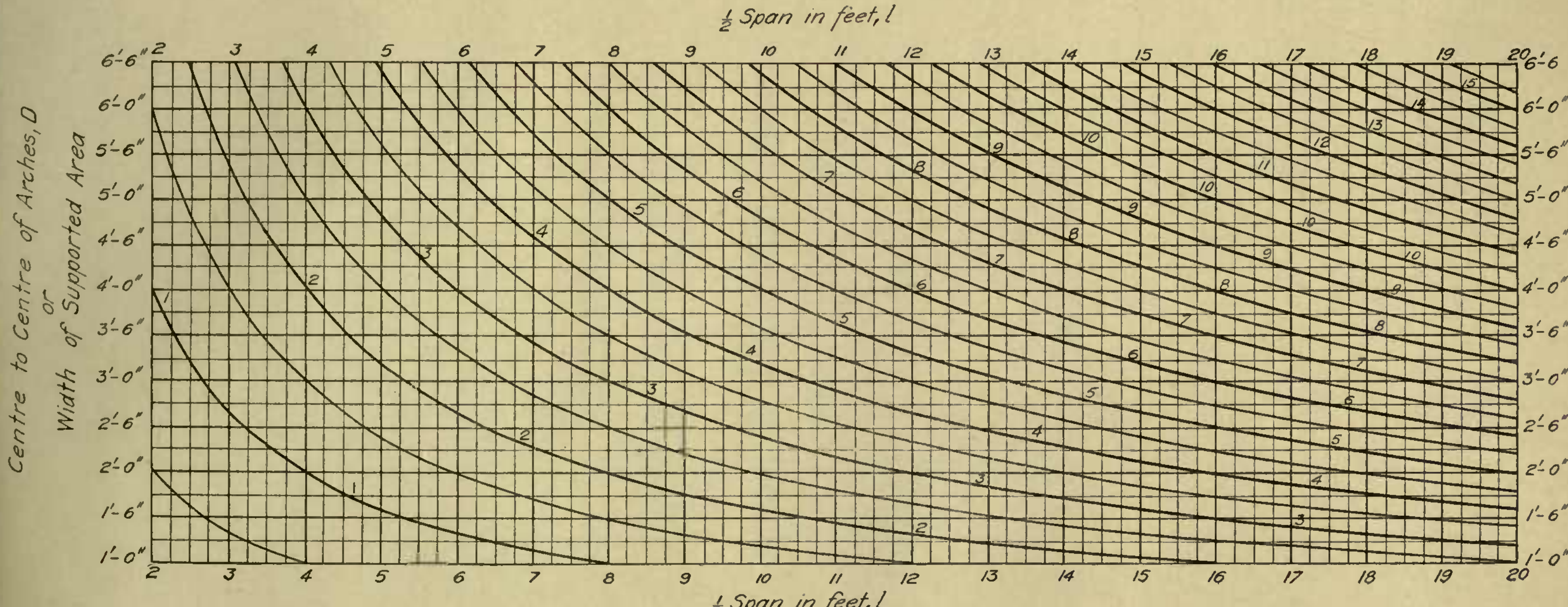


PLATE 18.—125 Pounds per Square Foot.

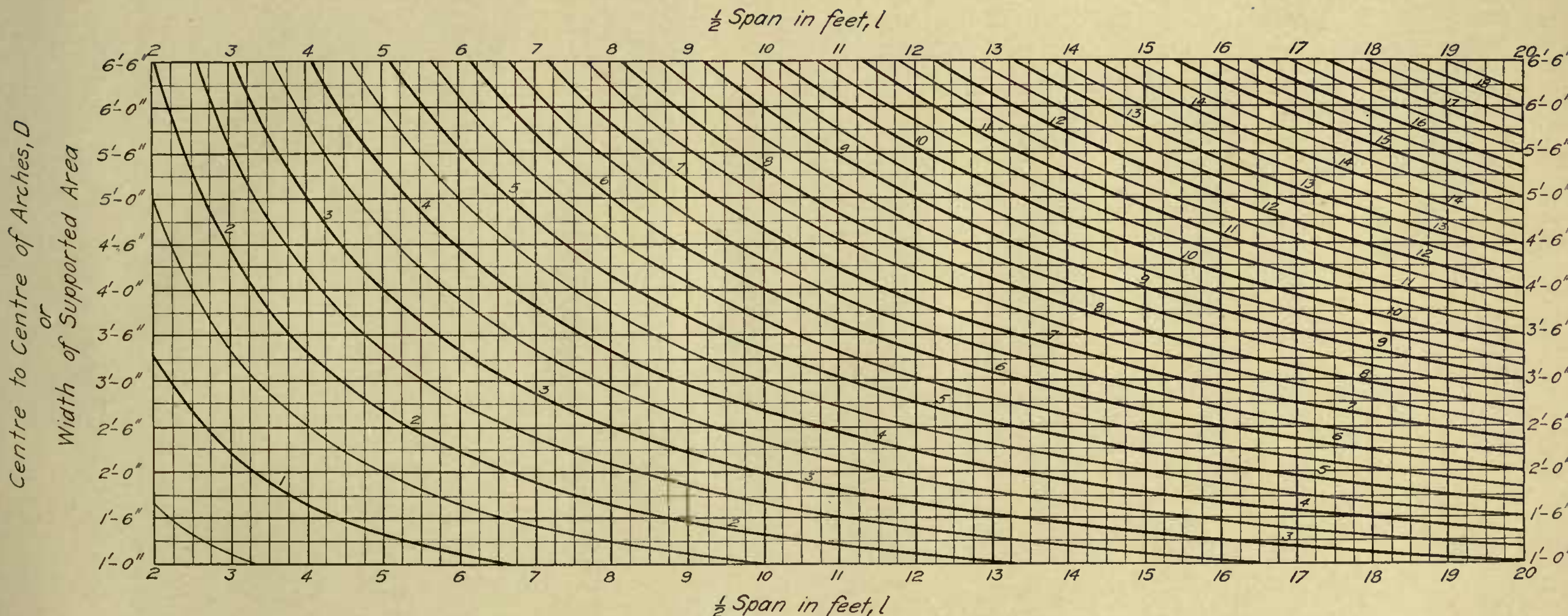


PLATE 19.—150 Pounds per Square Foot.

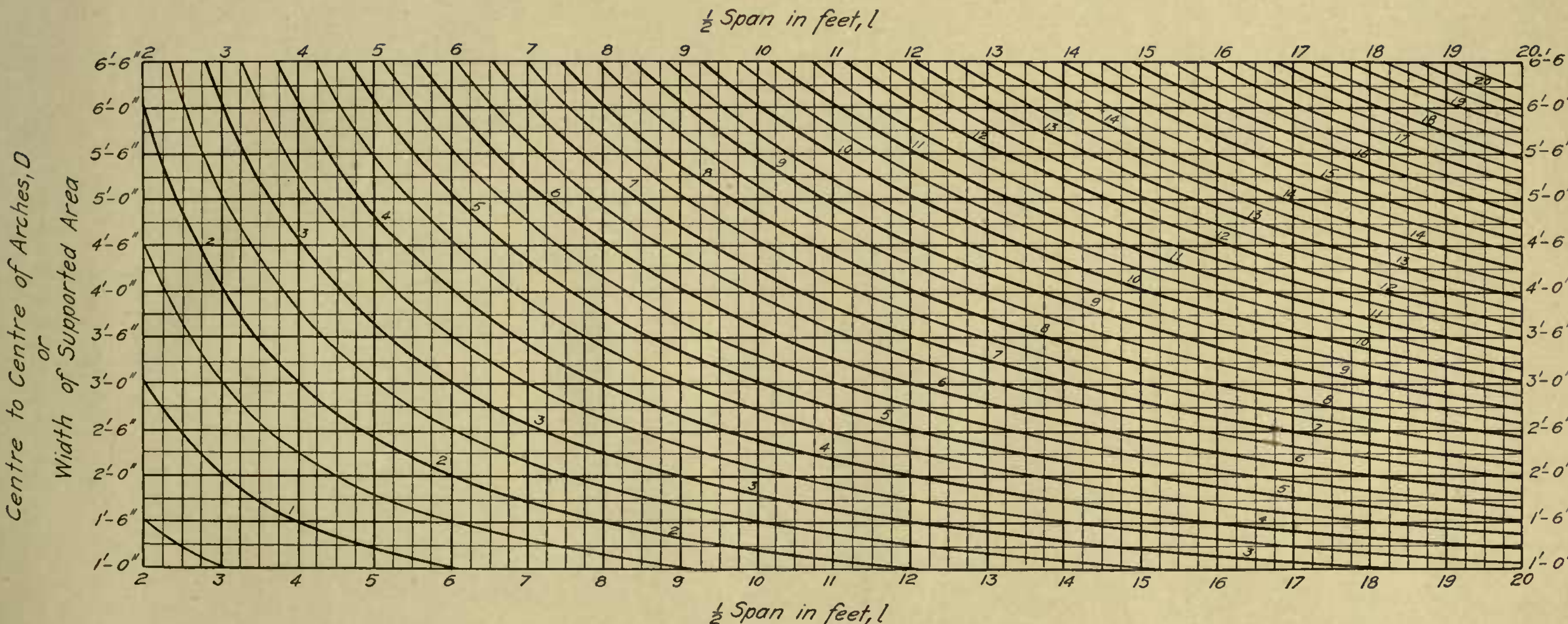


PLATE 20.—165 Pounds per Square Foot.

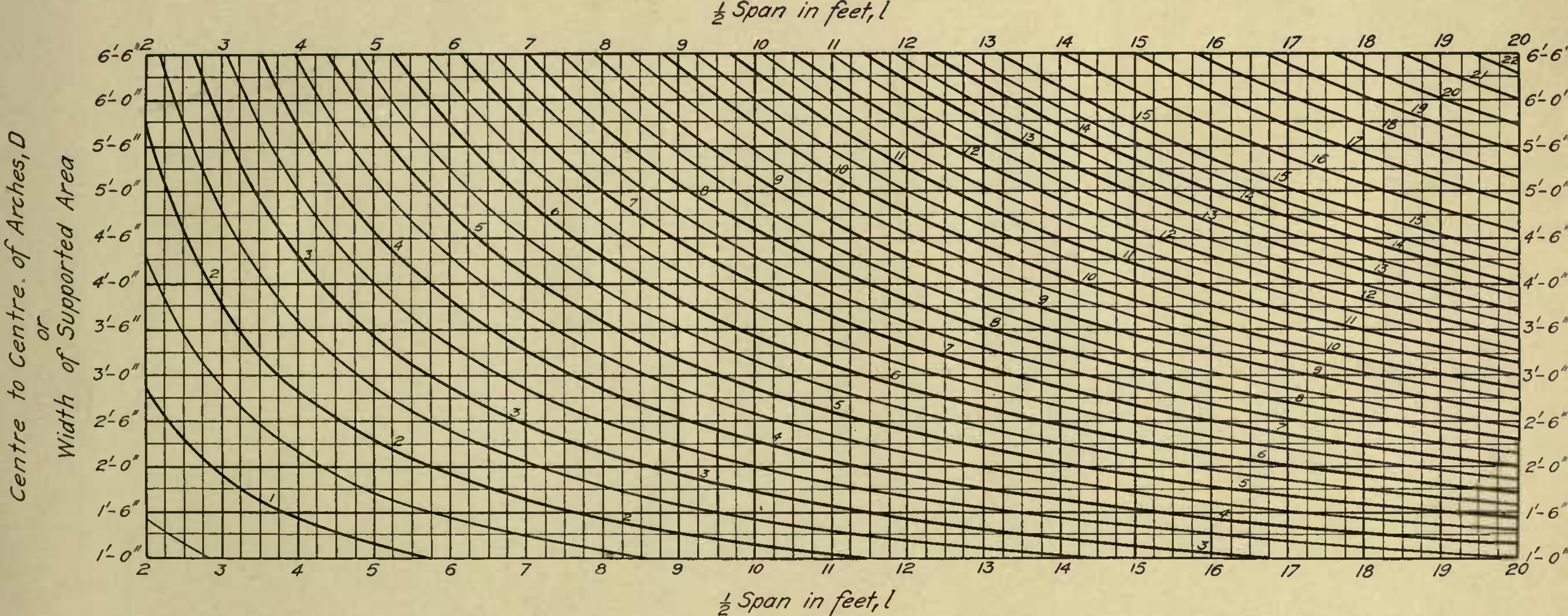


PLATE 21.—175 Pounds per Square Foot.

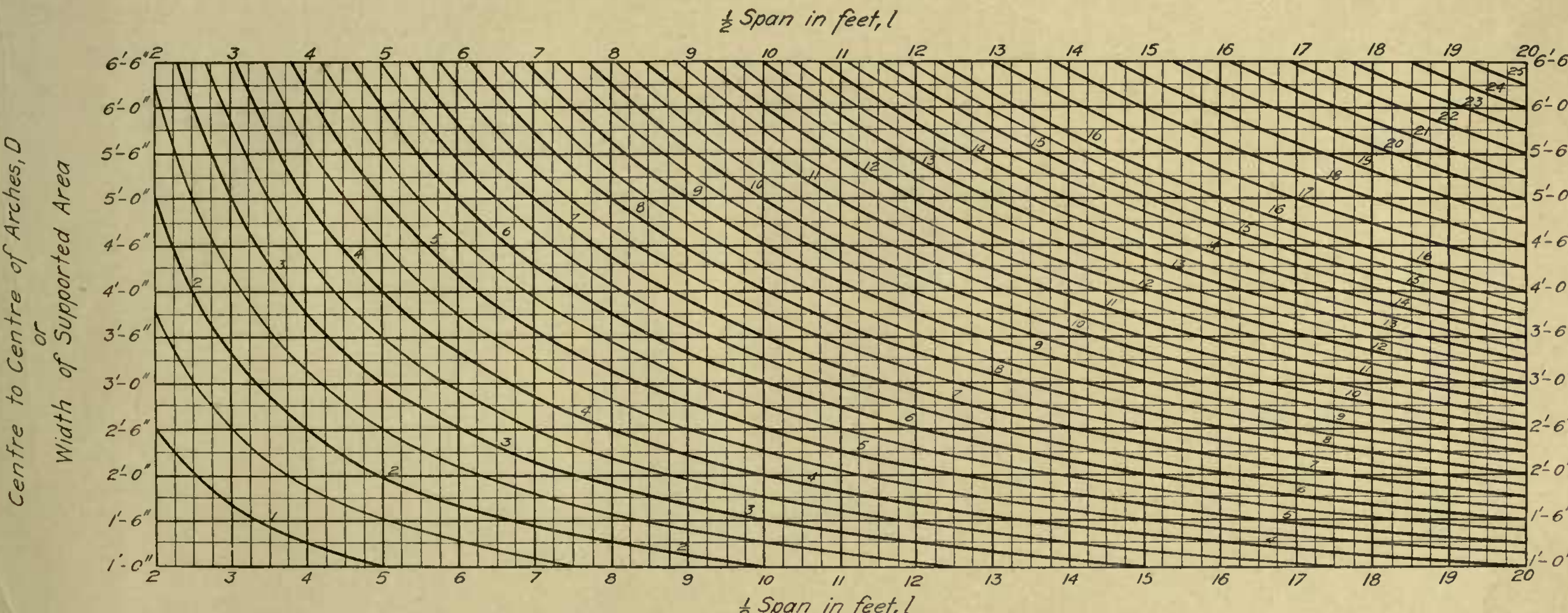


PLATE 22.—200 Pounds per Square Foot.

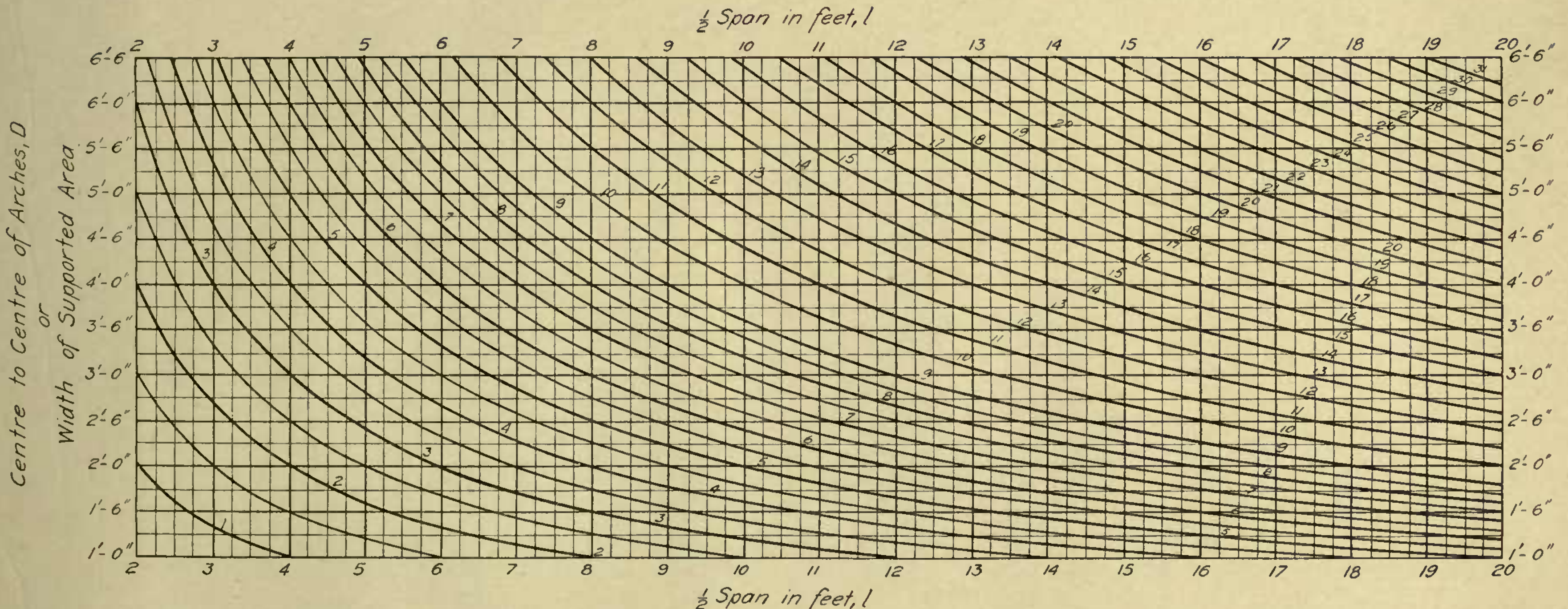


PLATE 23.—250 Pounds per Square Foot.

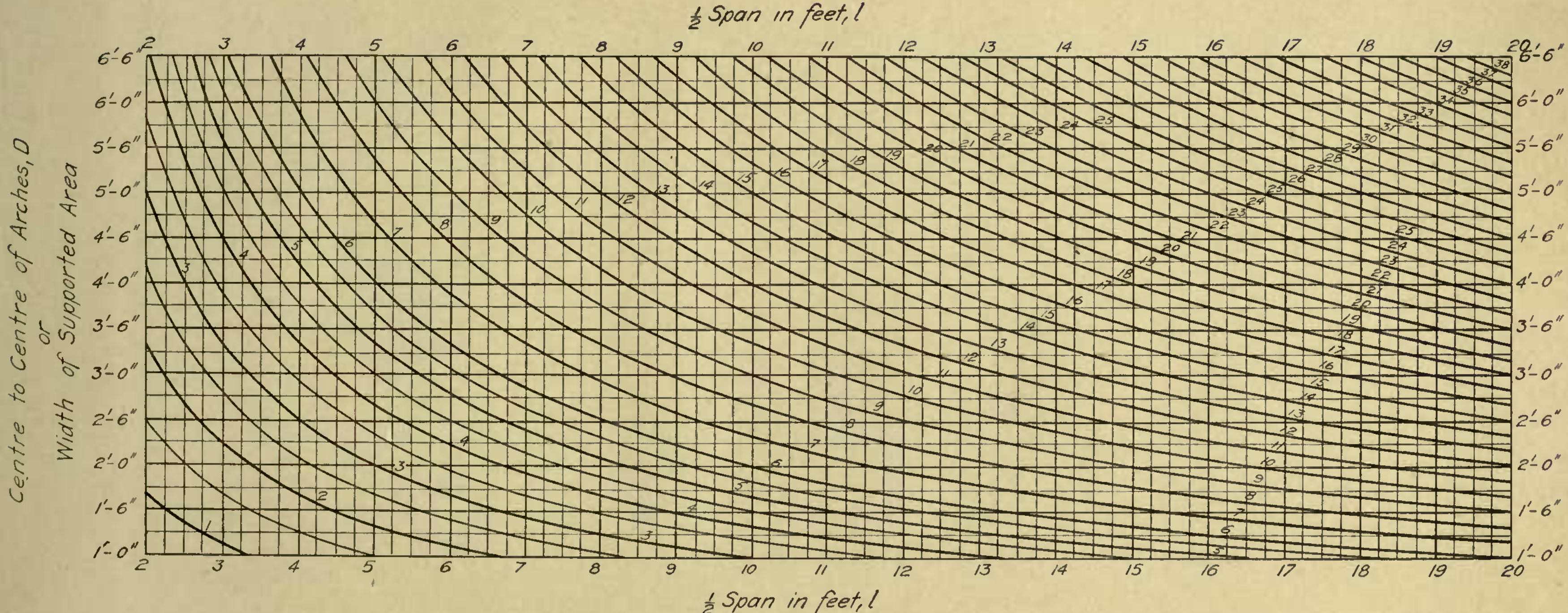


PLATE 24.—300 Pounds per Square Foot.

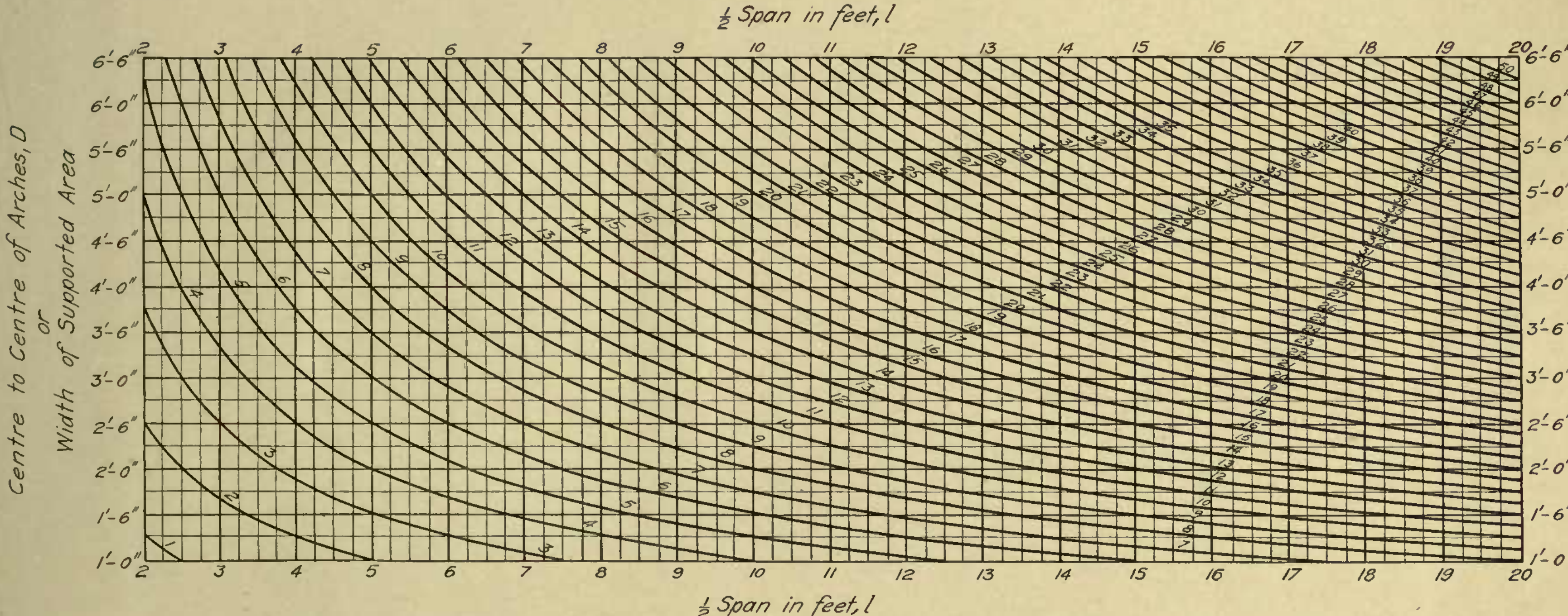


PLATE 25.—400 Pounds per Square Foot.