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Data for standard curve chord steel roof trusses.

William Hewitt Bush

Department:

DATA FOR STANDARD CURVE CHORD STEEL ROOF TRUSSES

By

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A

T H E S I S

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Approved by ..... Elmo O. Harris
Prof. of Civil Engineering.

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* TRUSS DESIGN *

In the past the Engineering Department of the structural steel company, by which the writer is employed, has been troubled with having to make a large number of preliminary steel truss designs for the purpose of estimating weights for competitive bids on structural steel building contracts. In order to eliminate this expenditure of time, a study was made of the possibility of making a standard design for curved chord steel roof trusses that would give the desired information by observation.

In making this design the necessary factors to be considered are the change of chord members for the varying roof loading and spans. The chord members would change in size for the different spans but the web members, having very little or no stress, would remain of the same section for all span lengths.

A constant for the radius should be determined, in order to take care of the changing of the span lengths, so that all truss dimensions, when reduced, would be proportional. By taking a truss

of a 100'-0" span, center to center of bearing, for the key truss, all dimensions for the shorter spans will then be directly proportional to the dimensions of the key truss.

In determining the radius for the key truss, the approximate bending moment of the truss would be calculated for a total roof load of 45#/sq.ft., trusses spaced for 16'-0" bays, that is, the bending moment is equal to the total truss load times the length of the span, center to center of bearing, divided by the constant 8; then the chord stress is equal to the bending moment divided by the desired depth of the truss at the center. The actual depth of the truss at the center is obtained by trial depths until the resulting compression chord stress requires the use of economical sections which are carried in stock or are obtainable when desired.

The most economical center of span depth, determined from the approximate method, is found to be about 12'-0". The depth of the truss now known, the radius is found by simple trigonometry. The radius for that depth of truss would be approximately 110'-0", or 1.1 the length of the span. The 1.1 of the span

length for the radius is used for all length of truss spans. The most desirable panel spacing for a 100'-0" truss is ten panels. In checking back for the fibre stress in the compression chord angles, on a 10'-0" span, the angles would be subject to an eccentric moment due to the curve of the top chord, a bending moment due to the roof load and the chord stress. For the key truss this fibre stress is about 10700#/sq.in., where the allowable stress is 14800#/sq.in., taken from the A.I.S.C. compression formula.

The truss layout, shown on Drawing Number 1, shows a curved chord steel roof truss design that is worked out as the standard truss design on the basis of a radius of 1.1 the span length. The stress diagram gives negligible stress for all the web members; the smallest size structural shape is used for all spans or 1-L $2\frac{1}{2}$"x $2\frac{1}{2}$"x $\frac{1}{4}$". These angles are crossed in each panel to shorten the unsupported length so as to take care of any compression stress that might be applied, due to eccentric loading of the truss; also this condition is to eliminate the use of vertical web angles at the panel points.

In order to determine the compression chord

angles for the different spans, a plot of the most used roof loadings against the allowable stress for the chord angles is shown on the graphic chart, Drawing Number 3. The compression chord stresses, unsupported length of angles and the maximum span that the chord angles should be used for, as determined from the graphic Drawing Number 3, are compiled in tables, Drawing Numbers 4, 5, 6 & 7.

The chord angles to be used for any truss span can readily be obtained by referring to the column headed "Angles for Span". The stresses in the compression chord angles, for any span, with any loading, can be obtained by proportional reduction from the key truss.

* TRUSS WEIGHTS *

In order to reach a close approximation of the weight for trusses of any span length, the truss members should be separated into constant sizes, proportional sizes and variable sizes of members and fittings. These divisions were made as follows:

Constant members:	web rivets web plates anchor bolts
Proportional members:	web angles splice plates end plates bearing plates stitch rivets wood bolts
Variable members:	com. chord angles ten. chord angles

The size of the detail members and fittings of the truss, such as rivet quantities and plate dimensions, were determined by making a large scale drawing of a 100'-0" truss. The total weight for a 100'-0" truss was computed for each loading. In reducing the span lengths by one foot, the constant would carry on, the proportional would reduce one percent and the variable, or the chord angles, would reduce on account of the reduced length, in all

cases, and for size of members where the span length requires the reduction in size of angles. By following this procedure, satisfactory approximate weights were obtained for all interval span lengths of one foot, from 25'-0" to 100'-0". The weights were figured for the most used roof loadings and building bay spacing. These weights are given in table on Drawing Number 2.

If it is desired to find the weight of a truss, that the condition of loading or bay spacing is different, the approximate weight can be obtained by interpolation.

* STRUCTURAL DETAILING *

It is necessary to determine all panel and diagonal dimensions for curved chord steel roof trusses for making shop details. These dimensions can be obtained for any truss span by taking the percentage of the desired truss span length of the key truss dimensions. For example: with a desired truss span length of 82'-9", the dimensions would be 82.75% of the dimensions for the key truss, since all dimensions reduce directly porportional to the span length. The stresses in all members are reduced by the same procedure. It is obvious that many hours of time can be saved by this method of calculation.

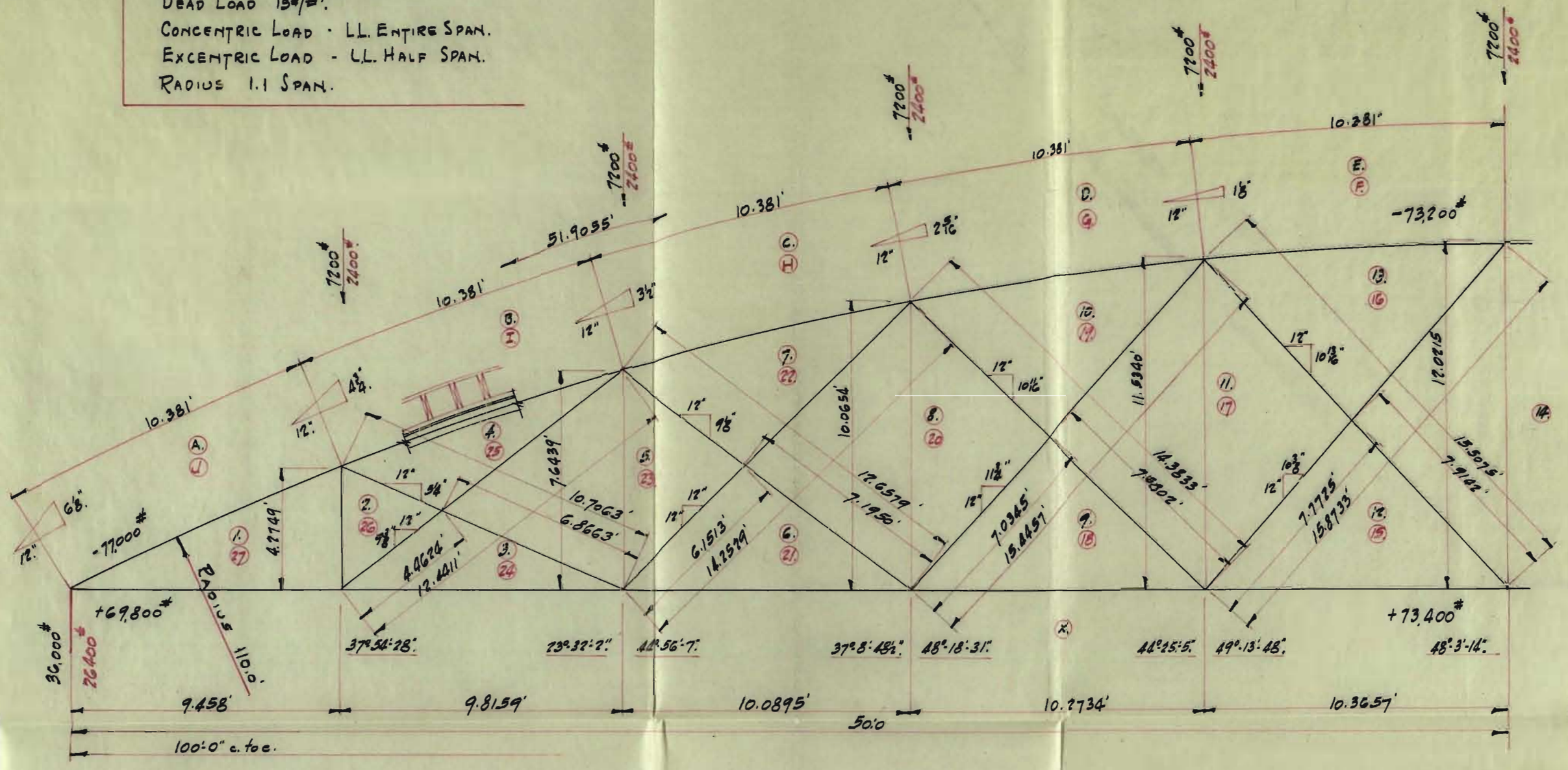
* CONCLUSION *

The standard curved chord steel roof truss design, proportional dimensions and the table of weights for the most frequently used type of truss for garages, small theatre buildings, one story warehouses, airplane hangars and factory buildings; will undoubtedly prove invaluable as a time saver both for the Engineering and Estimating Department.

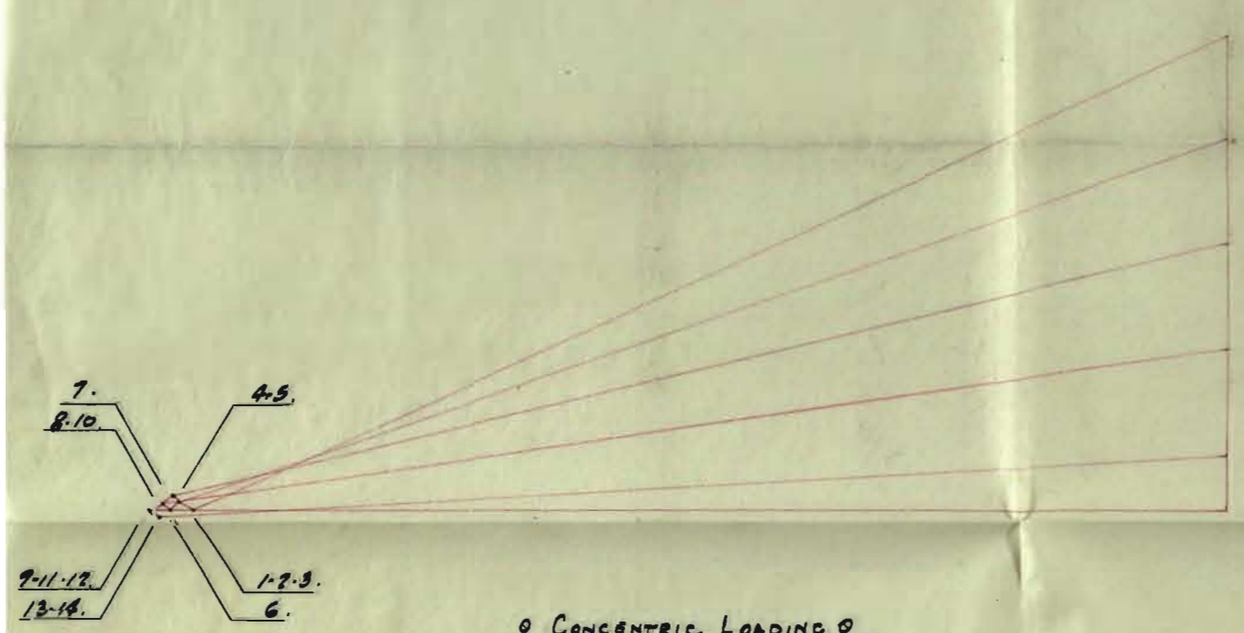
* * *

DATA:

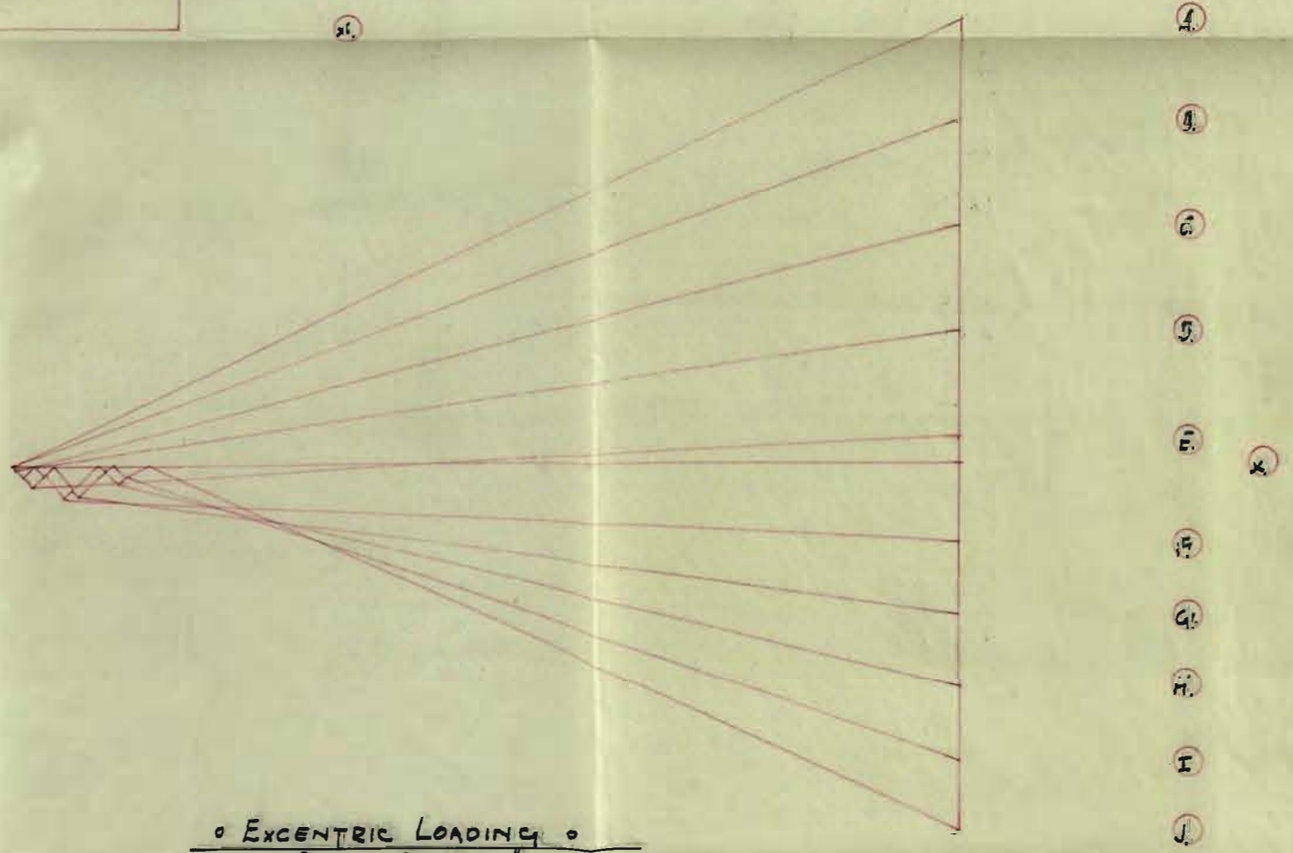
10 Panel Truss 100'-0" Span.
16'-0" Bay As Shown.
20'-0" Bay $\frac{5}{4}$ of Shown.
45#/□' Live Load As Shown.
60#/□' Live Load $\frac{4}{3}$ of Shown.
Dead Load 15#/□'.
Concentric Load - L.L. Entire Span.
Excentric Load - L.L. Half Span.
Radius 1.1 Span.



° Standard Curve Chord Truss °



° Concentric Loading °
Scale 1" = 12,000#



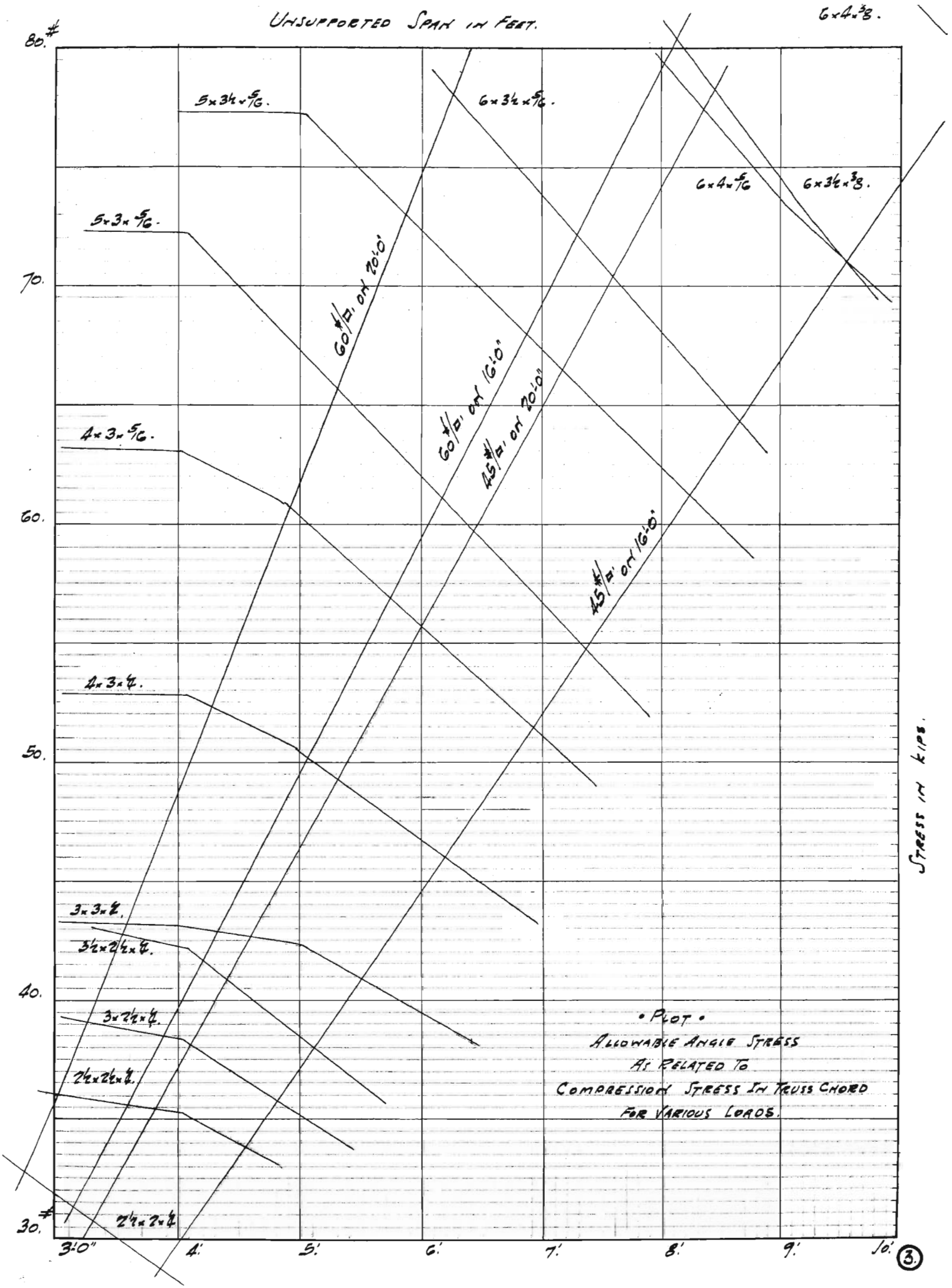
° Excentric Loading °
Scale 1" = 12000#

WEIGHT OF STANDARD CURVE CHORD TRUSSES 25'-0" TO 100'-0" SPANS.

SPAN.	16'-0" BAY. 45#/□'	20'-0" BAY 45#/□'	16'-0" BAY. 60#/□'	20'-0" BAY 60#/□'	APP. MID. TR. HEIGHT.
25'-0"				1034	3'-3"
26'-0"				1037	3'-4"
27'-0"				1117	3'-5"
28'-0"				1147	3'-7"
29'-0"				1201	3'-8"
30'-0"	1005	1038	1110	1255	3'-10"
31'-0"	1029	1091	1195	1286	3'-11"
32'-0"	1052	1117	1224	1344	4'-1"
33'-0"	1076	1142	1253	1404	4'-2"
34'-0"	1100	1201	1282	1499	4'-4"
35'-0"	1123	1228	1338	1534	4'-5"
36'-0"	1146	1254	1400	1569	4'-7"
37'-0"	1206	1312	1429	1672	4'-8"
38'-0"	1231	1340	1489	1708	4'-10"
39'-0"	1255	1423	1520	1745	4'-11"
40'-0"	1280	1452	1551	1781	5'-1"
41'-0"	1304	1481	1691	1938	5'-2"
42'-0"	1370	1518	1725	1977	5'-4"
43'-0"	1395	1547	1758	2016	5'-6"
44'-0"	1456	1690	1792	2128	5'-7"
45'-0"	1482	1722	1909	2169	5'-9"
46'-0"	1508	1754	1944	2210	5'-10"
47'-0"	1611	1786	1980	2349	6'-0"
48'-0"	1639	1907	2015	2398	6'-1"
49'-0"	1667	1940	2191	2435	6'-3"
50'-0"	1695	1974	2229	2478	6'-4"

SPAN.	16'-0" BAY 45#/□'	20'-0" BAY 45#/□'	16'-0" BAY. 60#/□'	20'-0" BAY 60#/□'	APP. MID. TR. HEIGHT.
51'-0"	1723	2154	2768	2521	6'-5"
52'-0"	1751	2191	2307	2659	6'-7"
53'-0"	1779	2227	2345	2714	6'-8"
54'-0"	1950	2264	2447	2769	6'-10"
55'-0"	1980	2300	2487	2931	6'-11"
56'-0"	2011	2337	2540	2978	7'-1"
57'-0"	2041	2373	2580	3152	7'-2"
58'-0"	2072	2620	2620	3207	7'-4"
59'-0"	2102	2660	2659	3252	7'-5"
60'-0"	2416	2700	2895	3540	7'-6"
61'-0"	2451	2740	2938	3594	7'-8"
62'-0"	2486	2855	2981	3648	7'-10"
63'-0"	2522	2896	3059	3707	7'-11"
64'-0"	2557	2938	3102	3818	8'-0"
65'-0"	2592	2979	3146	3873	8'-2"
66'-0"	2627	3020	3190	3928	8'-3"
67'-0"	2800	3132	3567	3983	8'-5"
68'-0"	2838	3174	3616	4038	8'-6"
69'-0"	2875	3371	3664	4098	8'-7"
70'-0"	2912	3416	3713	4356	8'-9"
71'-0"	2949	3460	4035	4414	8'-10"
72'-0"	3176	3932	4087	4472	9'-0"
73'-0"	3216	3982	4140	4530	9'-1"
74'-0"	3256	4033	4192	4588	9'-3"
75'-0"	3296	4088	4245	4646	9'-4"

SPAN.	16'-0" BAY. 45#/□'	20'-0" BAY. 45#/□'	16'-0" BAY 60#/□'	20'-0" BAY 60#/□'	APP. MID TR. HEIGHT.
76'-0"	3336	4134	4297	5048	9'-6"
77'-0"	3376	4184	4350	5110	9'-7"
78'-0"	3416	4235	4402	5168	9'-8"
79'-0"	3456	4285	4632	5230	9'-10"
80'-0"	3687	4336	4687	5292	9'-11"
81'-0"	3729	4386	4741	5354	10'-1"
82'-0"	3761	4537	4796	5416	10'-2"
83'-0"	3803	4589	4850	6234	10'-4"
84'-0"	4287	4786	4905	6305	10'-5"
85'-0"	4334	4779	5159	6376	10'-7"
86'-0"	4381	4832	5204	6447	10'-8"
87'-0"	4429	4884	5613	6518	10'-9"
88'-0"	4476	4937	5674	6589	10'-11"
89'-0"	4523	4990	5735	6427	11'-0"
90'-0"	4743	5613	5796	6496	11'-2"
91'-0"	4792	5672	5857	6565	11'-3"
92'-0"	4964	5731	5918	6634	11'-5"
93'-0"	5013	5790	5979	6703	11'-6"
94'-0"	5063	5849	6040	6772	11'-8"
95'-0"	5112	5908	6481	6841	11'-9"
96'-0"	5162	5967	6639	6910	11'-10"
97'-0"	5211	6026	6705	7348	12'-0"
98'-0"	5261	6466	6771	7420	12'-11"
99'-0"	5310	6529	6837	7493	12'-3"
100'-0"	5360	6592	6903	8026	12'-4"
101'-0"	5410				
102'-0"	5460				


Unsupported Span in Feet.
80.#
70.
60.
50.
40.
30.#
3'0"
4'
5'
6'
7'
8'
9'
10'
5×3½×5/16.
5×3×5/16.
4×3×5/16.
4×3×¼.
3×3×¼.
3½×2½×¼.
3×2½×¼.
2½×2½×¼.
2½×2×¼
60#/□' on 20'0"
60#/□' on 16'0"
45#/□' on 20'0"
45#/□' on 16'0"
6×3½×5/16.
6×4×5/16
6×4×3/8.
6×3½×3/8.
Stress in Kips.
• Plot •
Allowable Angle Stress
As Related To
Compression Stress In Truss Chord
For Various Loads.

CHORD MEMBERS.

16'-0" BAY 45#/Q' ROOF LOADING. MAX STRESS 100'-0" SPAN. T. = 73.4# C. = 77.0#

SPAN.	UNSUPPORTED	ALLOWABLE STRESS	CHORD STRESS	COMPRESSION CHORD	ANGLES FOR SPAN.	TENSION CHORD	ALLOWABLE STRESS	SPAN.
102.0'	10.58'	78.8	78.5	2 Ls - 6 × 4 × 3/8	100	2 Ls - 5 × 3 × 5/16	76.58	104.3'
91.9'	9.52'	70.8	70.8	6 × 3½ × 3/8	90	4 × 3 × 5/16	65.42	89.1'
91.8'	9.51'	70.7	70.6	6 × 4 × 5/16	84	4 × 4 × ¼	61.30	83.5
79.1'	8.20'	61.0	61.0	5 × 3½ × 5/16	80	4 × 3 × ¼	52.30	71.2'
66.6'	6.90'	51.3	51.3	4 × 3 × 5/16	72	3 × 3 × ¼	43.96	59.8'
59.0'	6.11'	45.5	45.5	4 × 3 × ¼	67	3 × 2½ × ¼	39.28	53.5'
52.6'	5.45'	40.6	40.6	3 × 3 × ¼	60	2½ × 2½ × ¼	34.96	46.9'
46.1'	4.77'	35.7	35.7	3 × 2½ × ¼	54	2½ × 2 × ¼	30.76	41.2'
43.2'	4.48'	33.5	33.5	2½ × 2½ × ¼	49			
36.7'	3.80'	28.7	28.7	2½ × 2 × ¼	44			
					37			
					30			

CHORD MEMBERS.

20'-0" BAY. 45#/□' ROOF LOADING

MAX STRESS 100'-0" SPAN T.= 91.7# C.= 92.2#

SPAN.	UNSUP-PORTED	ALLOWABLE STRESS	CHORD STRESS	COMPRESSION CHORD	ANGLES FOR SPAN	TENSION CHORD	ALLOWABLE STRESS	SPAN.
104.3'	10.81'	100.9	100.6	2Ls- 6×4×½	100'	2Ls 6×4×⅝	107.2	98.4'
97.0'	10.06'	94.4	93.5	6×4×⅞	97	6×3½×⅝	101.1	92.8'
89.7'	9.30'	86.2	86.3	6×4×⅜	89 83	5×3½×⅝	89.8	82.3'
81.0'	8.40'	78.2	78.2	6×3½×⅜	81 72	5×3×⅝	83.5	76.5'
72.9'	7.50'	70.2	70.2	6×3½×⅝	71 68	4×3×⅝	71.3	65.4'
68.8'	7.13'	66.3	66.3	5×3½×⅝	66 61	4×4×½	66.9	61.3'
61.7'	6.40'	59.5	59.5	5×3×⅝	57	4×3×½	57.0	52.3'
57.2'	5.93'	55.3	55.3	4×3×⅝	50	3×3×½	47.9	43.9'
50.6'	5.25'	49.0	49.0	4×3×½	43	3×2½×½	42.9	39.3'
43.9'	4.55'	42.5	42.5	3×3×½	41 39	2½×2½×½	38.1	34.9'
41.9'	4.34'	40.6	40.6	3½×2½×½	38 36	2½×2×½	33.0	30.3'
39.0'	4.04'	37.9	37.9	3×2½×½	33 30			
36.1'	3.74'	35.2	35.2	2½×2½×½				
30.6'	3.27'	30.8	30.8	2½×2×½.				

CHORD MEMBERS.

16'-0" BAY 60#/F. ROOF LOADING MAX STRESS 100'-0" SPAN. T. = 97.8# C. = 102.7#

SPAN.	UNSUPPORTED	ALLOWABLE STRESS	CHORD STRESS	COMPRESSION CHORD	ANGLES FOR SPAN.	TENSION CHORD	ANGLE STRESS	SPAN.
100.0'	10.37'	104.0	102.7	2Ls- 6×4×½	98	2Ls.- 6×4×⅝	100.5	98.4'
94.0'	9.75'	96.7	96.5	6×4×⅞	95 94	6×3½×⅝	95.0	92.8'
86.0'	8.92'	88.5	88.2	6×4×⅜	86 84	5×3½×⅝	82.1	82.3'
78.0'	8.10'	80.5	80.5	6×3½×⅜	78	5×3×⅝	78.3	76.6'
70.1'	7.27'	72.0	72.0	6×3½×⅝	70	4×3×⅝	66.8	65.4'
66.0'	6.85'	67.7	67.7	5×3½×⅝	66 67	4×4×½	62.7	61.3'
59.5'	6.18'	61.0	61.0	5×3×⅝	59 55	4×3×½	53.5	52.3'
55.1'	5.72'	56.5	56.5	4×3×⅝	53 48	3×3×½	44.9	43.9'
48.6'	5.05'	49.9	49.9	4×3×½	44	3×2½×½	40.1	39.3'
41.6'	4.32'	42.6	42.6	3×3×½	40 37	2½×2½×½	35.7	34.9'
40.5'	4.20'	41.3	41.3	3½×2½×½	35 34	2½×2×½	30.9	30.2'
37.3'	3.87'	38.0	38.0	3×2½×½	30			
34.7'	3.60'	35.3	35.3	2½×2½×½				
30.8'	3.20'	31.4	31.4	2½×2×½				

CHORD MEMBERS

20'-0" BAY 60#/ft² ROOF LOADING — MAX STRESS, 100'-0" SPAN, T. = 122.3# C. = 128.4#

SPAN.	UNSUPPORTED	ALLOWABLE STRESS	CHORD STRESS	COMPRESSION CHORD	ANGLES FOR SPANS	TENSION CHORD	ANGLE STRESS	SPAN.
100.0'				2Ls - 6 × 6 × 7/16	100'	2Ls - 6 × 4 × 7/16	136.1	111.6'
99.0'	10.25'	126.7	127.0	6 × 6 × 3/8	99 / 88	6 × 4 × 3/8	118.2	96.6'
88.0'	9.14'	113.8	113.0	6 × 4 × 1/2	82	6 × 4 × 5/16	100.5	82.1'
82.0'	8.52'	105.2	105.5	6 × 4 × 7/16	77 / 75	6 × 3½ × 5/16	95.0	77.5'
75.0'	7.78'	96.3	96.3	6 × 4 × 3/8	68	5 × 3½ × 5/16	84.1	68.7'
68.0'	7.07'	87.5	87.3	6 × 3½ × 3/8	63 / 59	5 × 3 × 5/16	78.3	63.9'
59.9'	6.22'	77.9	77.9	6 × 3½ × 5/16	56 / 54	4 × 3 × 5/16	66.8	54.5'
56.1'	5.83'	72.8	72.8	5 × 3½ × 5/16	51	4 × 4 × 4	62.7	51.1'
50.8'	5.28'	65.6	65.6	5 × 3 × 5/16	46 / 43	4 × 3 × 4	53.5	43.7'
46.9'	4.87'	60.3	60.3	4 × 3 × 5/16	40 / 36	3 × 3 × 4	44.9	36.6'
40.7'	4.23'	51.9	51.9	4 × 3 × 4	33 / 32	3 × 2½ × 4	40.1	32.7'
33.7'	3.50'	42.5	42.5	3½ × 2½ × 4	31 / 29	2½ × 2½ × 4	35.7	29.1'
31.0'	3.22'	38.8	38.8	3 × 2½ × 4	28 / 25	2½ × 2 × 4	30.9	25.2'
28.8'	3.00'	36.0	36.0	2½ × 2½ × 4				