C.E. Thesis 1929

INVESTIGATION OF THE STRESSES IN A CONTINUOUS TWO-SPAN HIGHWAY BRIDGE.

BY

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ACKNOWLEDGMENT

May 27, 1929.

Professor A. L. Merrill,
Secretary of the Faculty,
Massachusetts Institute of Technology,
Cambridge, Mass.

Dear Sir:

In accordance with the rules of the Faculty, I hereby submit a thesis entitled "Investigation of the Stresses in a Continuous Two-Span Highway Bridge" in partial fulfillment of the conditions required for the degree of Bachelor of Science.

Respectfully submitted,

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Up to about a quarter of a century ago, structural engineers have looked upon continuous bridges with disfavor. Continuous structures were considered bad practice. But since that time, the prevailing attitude has changed, and continuous bridges are now being quite generally accepted as the full equivalent of other types where field requirements in erection, or where a saving in material, justifies their use.

Several factors are responsible for this changed attitude. In the first place, the uncertainties of analysis and the apprehension concerning the initial adjustment, have been both removed; the former by a more thorough grasp of structural relations, and the latter by increased constructive skill. Then too, practice has served to emphasize the proper economies of constrained types of structures; and this, coupled with the increased recognition given to rigidity in service, has helped greatly to remove the predjudice against continuous bridges.

Further, the popularizing of mechanical stress analysis for use where direct calculation has proven too complicated, has not only removed an obstacle to proper proportioning and practical design, but has also supplied engineers with an eye-picture of deformations, and thus bettered his conception of how movements at the supports or abutments may influence the stresses.

Then again, the change from the use of pin-connections to that of riveted connections for bridge trusses has had its influence. In the old days when pin-connections were the rule, members subject to a reversal of stress had to be made so as to be adjustable, then in erection drawn up to initial tension of an unknown amount. The uncertainties attendant upon such an arrangement opposed its use for main members and so the continuous bridge, with its reversals of stress, was looked upon with disfavor. However, when riveted connections replaced pin connections, this objection was eliminated and so the prejudice could no longer exist.

Accordingly, although steel design still shows a leaning toward the simpler statically determined types of structures, the continuous structure is gradually coming into its own, and with the progressive weakening of what remains of the old influence, we may look forward to a more rapid extension of continuous structures.

It is then with this object in mind that the following thesis is presented: To illustrate the elastic load-deflection method of stress analysis for a continuous bridge.

The bridge selected for investigation is a continuous two-span riveted Warren truss highway bridge now under construction. It is being built over the Missouri River at St. Joseph, Mo., about 1/4 mile south of the combined railway and highway bridge operated by the St. Joseph and Grand Island Railway.

Among the salient features in the design of this structure are the application of continuous trusses to relatively moderate span lengths, and the liberal use of silicon steel. A comparison of the continuous truss with two simple end-supported spans showed a saving of approximately $25,000 or about 7% of the cost of the main bridge. The use of silicon steel wherever the size of the member justified its use resulted in a saving of $37,000. A study of the relative advantages of simple paneling as compared with subdivided paneling was also made. This showed some distinct advantages in favor of the simple paneling, among which were:

(1) Slight saving in cost.
(2) Great simplicity in erection.
(3) Lower secondary stresses.
(4) Better appearance.

The bridge was designed according to the specifications of the American Association of State Highway Officials, 1925, with the modifications noted below.

Live loads:-

Floor - 1 15-ton truck per panel on each of three traffic lanes spaced 9 ft., c. to c.

Trusses - Uniform load of 562# per ft. per truss.
Concentrated load of 26,300# per truss.

Impact :-

Floor - 30% of live loa d for all floor members.

Trusses - $I = \frac{(L\ \ 250)0.8}{10L + 500}$ in which L = loaded length, and I should never exceed 30%

Wind Pressure :-

Transverse wind pressure - 30# per sq. ft. on the area of one floor, two trusses, and two handrails.

Longitudinal wind pressure - 50% of transverse wind pressure per lineal foot of bridge.

Temperature :-

Normal temp. = 60° F.

Maximum temp. = 120° F.

Minimum temp. = -20° F (20° below 0)

Unit Stresses :-

Carbon steel - Tension - 16,000 #/in.^{2}
Compression - $15{,}000 - \frac{50(l)}{r}$
maximum = 13,500

Silicon steel - Tension - 24,000 #/in.^{2}
Compression - $22{,}500 - \frac{75\ l}{r}$
maximum = 18,750

Combinations of loading :-

(1) Dead + live + impact
(2) Dead + 30-lb. wind)
(3) (1) + 15-lb. wind) Allowable unit stresses increased 25%.
(4) (1) + temp.)
(5) (4) + 15-lb. wind) Allowable unit stresses increased 40%
(6) (2) + temp.

The final design adopted shows an arrangement as follows:

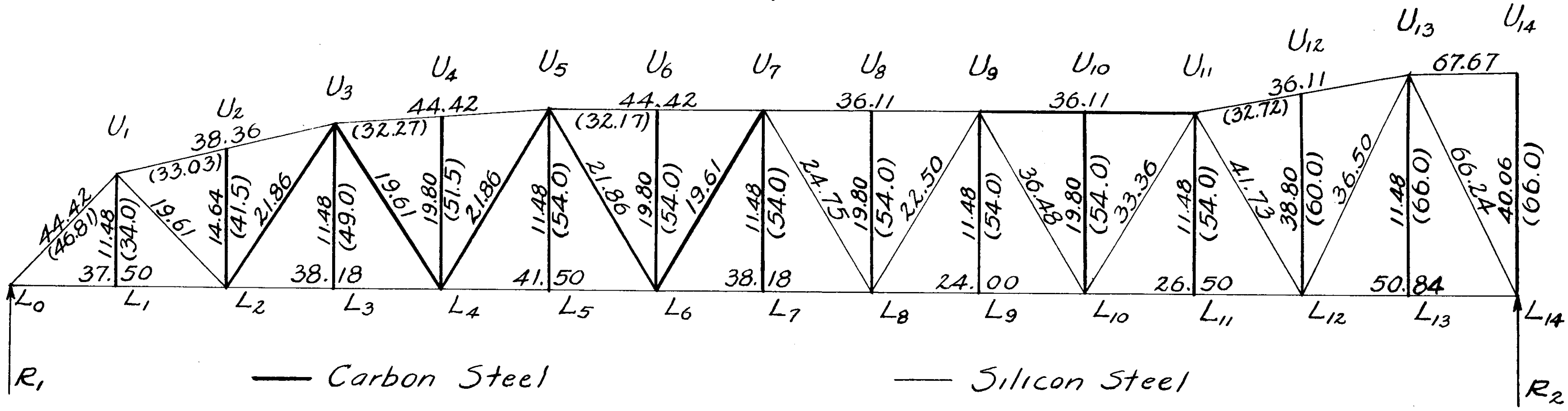
The floor system consists of a 6¼" slab of reinforced concrete carried on transverse members consisting of 8-inch I-beams curved to the desired crown. These beams, spaced three feet c. to c. were carried on two 24-inch and two 27-inch I beam stringers spaced eight feet between centers. The floor beams consisted of a 50" x 3/8" web with four - 6" x 3½" x 5/8" flange angles. A clear roadway of 27 feet with a crown of 2" was provided. 6" x 10" curbs were used, and 2" pipe handrails were installed, but no sidewalks were provided.

The design of the trusses is shown in the accompanying diagram:

see Plate I (next page)

LINE DIAGRAM OF TRUSS

Plain figures show area of members.
Figures in parentheses show length of members.



Note:- Top and bottom lateral systems consist of two tension diagonals (each made up of two angles) in each panel.
Bottom lateral system members are all silicon steel.
Top lateral system — silicon steel, except in panels 9 and 10 and ½ of 8.
For details of design (make-up of members, etc.) and further information, see Eng'g. News-Record Vol. 102, No. 3, Pages 100-102.

PLATE NO. I.

The method used in this investigation is known as the elastic load method. The deflection curve (or the elastic curve) is determined by the use of "elastic" loads, and from this curve the influence lines for the reactions may be obtained. Once the reactions are determined the stress analysis becomes a simple matter.

The method of computing the elastic loa ds used in the following computations is that proposed by H. Muller Breslau. The theory and the derivations of the formulae used are shown in the following quotation from Professor W. M. Fife's (M.I.T.) private translation of Mr. Breslau's work:

THE DEFLECTIONS OF THE JOINTS OF A TRUSS
BY THE METHOD OF ELASTIC
WEIGHTS.

BAR CHAIN METHOD

1. If a series of bars are connected by frictionless joints so as to form a chain, it is possible to find the deflections of the joints due to stresses in the bars by drawing the funicular polygon for a series of imaginary loads placed at the joints whose deflection is desired. In determining the magnitude and direction of these imaginary loads, hereafter called "elastic loads", it is necessary to consider first certain relations between

a series of loads and the corresponding funicular polygon and then demonstrate that the funicular polygon drawn for a particular series of loads will have the same ordinates from some base line as the elastic curve has.

2. To find the loads corresponding to a particular funicular polygon. Fig. 1.

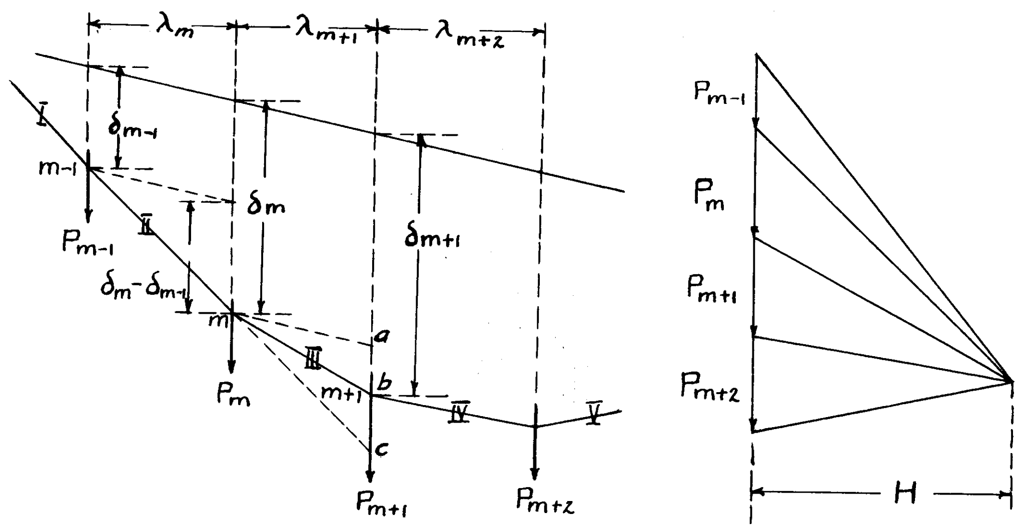


Fig. 1

By similar triangles:

$$\frac{\delta_m - \delta_{m-1}}{\lambda_m} = \frac{ac}{\lambda_{m+1}} = \frac{\delta_{m+1} - \delta_m + bc}{\lambda_{m+1}}$$

also

$$\frac{bc}{\lambda_{m+1}} = \frac{P_m}{H}$$

therefore

$$\frac{\delta_m - \delta_{m-1}}{\lambda_m} = \frac{\delta_{m+1} - \delta_m}{\lambda_{m+1}} + \frac{P_m}{H}$$

and

$$\frac{P_m}{H} = \frac{\delta_m - \delta_{m-1}}{\lambda_m} - \frac{\delta_{m+1} - \delta_m}{\lambda_{m+1}}$$

3.-

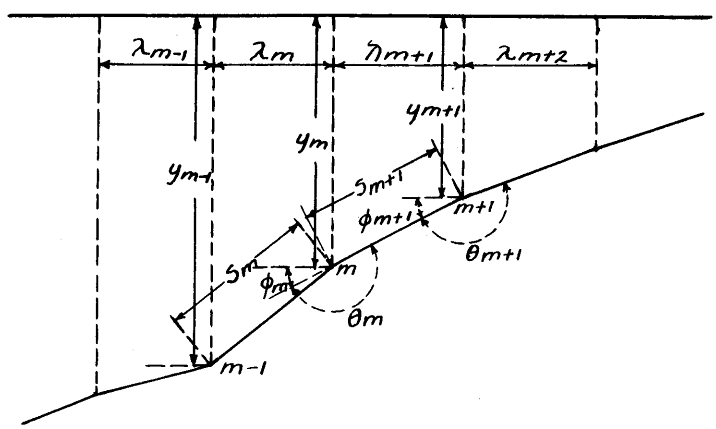


Fig. 2.

Consider any bar chain m-1, m, m 1,..... referred to a pair of co-ordinate axes so that the ordinate for any joint m is y_m. Let the length of the bar immediately to the left of joint m be s_m and let its inclination to the horizontal be ϕ_m the angle being positive when measured contra-clockwise from the horizontal. Let θ_m be the angle between bars (m-1)-(m) and (m)-(m 1) measured on the lower side of the bar chain.

Let the chain undergo stress so that the lengths of the bars change; their inclinations will change also and, consequently the ordinates y will increase or decrease. Let the change in the ordinate y_m be δ_m, which, consequently, is the vertical deflection of joint m.

$$y_{m-1} - y_m = s_m \sin\phi_m$$

differentiating,

$$\delta y_{m-1} - \delta y_m = \delta s_m \sin\phi_m + s_m \cos\phi_m \,\delta\phi_m$$

dividing by $s_m \cos\phi_m = \lambda_m$

$$\frac{\delta y_{m-1} - \delta y_m}{\lambda_m} = \frac{\delta s_m \sin\phi_m}{s_m \cos\phi_m} + \delta\phi_m$$

similarly

$$\frac{\delta y_m - \delta y_{m+1}}{\lambda_{m+1}} = \frac{\delta s_{m+1}}{s_{m+1}} \frac{\sin\phi_{m+1}}{\cos\phi_{m+1}} + \delta\phi_{m+1}$$

Subtracting

$$\frac{\delta_m - \delta_{m+1}}{\lambda_{m+1}} - \frac{\delta_{m-1} - \delta_m}{\lambda_m} = \frac{\delta s_{m+1}}{s_{m+1}} \tan\phi_{m+1} - \frac{\delta s_m}{s_m} \tan\phi_m - \delta\phi_m + \delta\phi_{m+1}$$

or

$$\frac{\delta_m - \delta_{m-1}}{\lambda_m} - \frac{\delta_{m+1} - \delta_m}{\lambda_{m+1}} = -\frac{f_m}{E} \tan\phi_m + \frac{f_{m+1}}{E} \tan\phi_{m+1} - \delta\phi_m + \delta\phi_{m+1}$$

where f_m is the stress intensity in bar (m-1)-(m) and is positive or negative according as the bar is in tension or compression.

Also $180^\circ - (\phi_m - \phi_{m+1}) = \theta_m$

consequently, by differentiating,

$$-\delta\phi_m + \delta\phi_{m+1} = \delta\theta_m$$

therefore,

$$\frac{\delta_m - \delta_{m-1}}{\lambda_m} - \frac{\delta_{m+1} - \delta_m}{\lambda_{m+1}} = \delta\theta_m - \frac{f_m}{E} \tan\phi_m + \frac{f_{m+1}}{E} \tan\phi_{m+1}$$

The left hand side of this equation is the same as the right hand side of the last equation in paragraph 1, consequently, if the elastic loads used are computed by the right hand side of the equation above, and the funicular polygon is drawn, using a unit pole distance, the ordinates of the joints of the funicular polygon from some base line will be the deflections of the joints. This base line is found from the consideration that at the points of support of the structure the deflections are zero.

If we examine the expression

$$\frac{\delta_m - \delta_{m-1}}{\lambda_m} - \frac{\delta_{m+1} - \delta_m}{\lambda_{m+1}} = \delta\theta_m - \frac{f_m}{E}\tan\phi_m + \frac{f_{m+1}}{E}\tan\phi_{m+1}$$

it may be seen that if either ϕ_m or ϕ_{m+1} is 90° the elastic load becomes infinite, consequently, the use of the above expression is limited to examples where none of the bars of the chain are vertical.

The funicular polygon may be drawn by graphic methods or its shape may be determined analytically. In the analytical method use is made of the following property of the funicular polygon: If a number of vertical loads are applied to a simple end-supported beam and the funicular polygon is drawn, the ordinates to the funicular polygon from the line joining the points where the outside strings of the funicular polygon cut the lines of action of the reactions for the simple beam, are the bending moments for the simple beam providing that the funicular polygon was drawn with a unit pole distance. Consequently, it is possible to find the shape of the funicular polygon which will be the deflection curve by imagining that the elastic loads are applied to a simple beam whose span is the length of the structure and drawing the bending moment curve. It is immaterial whether the structure whose deflections are being investigated is simply end-supported or not; the deflection curve may always be obtained in this way. It is to be emphasized, however, that this procedure leads to the shape of the deflection curve only, and that the base line from which the deflections are to be measured is not necessarily the base line from which the bending moment ordinates are laid off; the base line from which the deflections are to be measured must be such as to show zero ordinates to the deflection curve at the points of support. In the case of a structure which is supported at one end only the funicular polygon is obtained by considering the elastic loads to be applied to a cantilever beam of the same length as the structure and supported in the same way, but the deflections are measured from a base line which is tangent to the elastic curve at the end opposite the support.

In the above expression for the elastic loads the first term is the change in the angle between adjacent bars of the chain. If it is desired to find the deflections of the joints of one chord of a truss, the bars of the chord may be considered as forming the bar chain. In such a case the changes of angle may be found from the changes of the angles of the triangles of the truss which meet at the joint in question. This involves the problem of finding the changes in the angles of a triangle due to changes in the lengths of its sides.

4. To find the changes in the angles of a triangle due to changes in the lengths of its sides. Consider the triangle in Fig. 3.

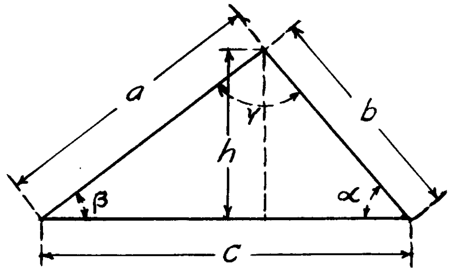


Fig. 3.

$$c = b\cdot\cos\alpha + a\cos\beta$$
$$h = b\cdot\sin\alpha = a\sin\beta$$

Differentiating the expression for c.

$$\delta c = \delta b\cdot\cos\alpha + \delta a\cdot\cos\beta - b\cdot\sin\alpha\,\delta\alpha - a\cdot\sin\beta\,\delta\beta$$
$$= \delta b\cdot\cos\alpha + \delta a\cdot\cos\beta - h(\delta\alpha + \delta\beta)$$

but

$$\alpha + \beta + \gamma = 180^\circ$$

and

$$\delta\alpha + \delta\beta + \delta\gamma = 0$$

therefore

$$\delta c = \delta b\cdot\cos\alpha + \delta a\cdot\cos\beta + h\,\delta\gamma$$

Transposing and dividing by $h = b.\sin\alpha = a.\sin\beta$

$$\delta\gamma = \frac{\delta c}{h} - \frac{\delta b\cdot\cos\alpha}{b\sin\alpha} - \frac{\delta a\cdot\cos\beta}{a\cdot\sin\beta}$$

If the changes in the lengths of the sides of a triangle formed by the bars of a truss are the strains due to stresses f_a, f_b, and f_c (these being stress intensities)

$$\delta a = \frac{f_a}{E}a \qquad \delta b = \frac{f_b}{E}b \qquad \delta c = \frac{f_c}{E}c$$

and

$$\delta\gamma = \frac{f_c}{E}\cdot\frac{c}{h} - \frac{f_b}{E}\cdot\frac{b\cos\alpha}{b\sin\alpha} - \frac{f_a}{E}\cdot\frac{a\cos\beta}{a\sin\beta}$$

$$\delta\gamma = \frac{f_c}{E}\left[\frac{a\cdot\cos\beta + b\cos\alpha}{h}\right] - \frac{f_b}{E}\cdot\frac{b\cdot\cos\alpha}{b\cdot\sin\alpha} - \frac{f_a}{E}\cdot\frac{a\cdot\cos\beta}{a\cdot\sin\beta}$$

$$= \frac{f_c}{E}\left[\frac{a\cdot\cos\beta}{a\cdot\sin\beta} + \frac{b\cdot\cos\alpha}{b\cdot\sin\alpha}\right] - \frac{f_b}{E}\cdot\frac{b\cdot\cos\alpha}{b\cdot\sin\alpha} - \frac{f_a}{E}\cdot\frac{a\cdot\cos\beta}{a\cdot\sin\beta}$$

$$= \frac{f_c - f_a}{E}\cot\beta + \frac{f_c - f_b}{E}\cot\alpha$$

similarly,

$$\delta\alpha = \frac{f_a - f_b}{E}\cot\gamma + \frac{f_a - f_c}{E}\cot\beta$$

$$\delta\beta = \frac{f_b - f_a}{E}\cot\gamma + \frac{f_b - f_c}{E}\cot\alpha$$

In the case under consideration - namely that of a continuous two-span highway bridge - there is one redundant reaction. The specific procedure in the investigation will be as follows:-

(1) Compute areas, weight per foot, and length of all bars of the truss.

(2) Replace the redundant reaction by a unit force acting downward and calculate the stress intensity in each bar caused by the unit load.

(3) Using these stress intensities in the formula above, compute the elastic loads.

(4) Compute the bending moments due to the elastic loads. The curve for the bending moments will be the same as the deflection curve, the latter being referred to a different base line.

(5) In the case of a two-span structure, the application of Maxwell's Theorem will now give the influence line ordinates for the redundant reaction.
(Maxwell's Theorem:- If a force P at point A produces a deflection x at point B, then the same force P at point B will produce the same deflection x at point A).

(6) Having the influence table for the redundant reaction, influence table for all the members of the truss may now be prepared.

(7) Compute panel concentrations for dead load.

(8) Compute dead stresses.

(9) Compute live stresses and impact.

(10) Compute reversals of stress.

The results of the investigation show a close agreement with the results of the designer as given in the Engineering News-Record.

<u>Influence line for end reactions</u>

Pt.	Values found by author	Values given in Eng. News-Record
0	1.000	1.000
1	0.909	0.910
2	0.819	0.819
3	0.730	0.731
4	0.642	0.644
5	0.556	0.559
6	0.472	0.475
7	0.390	0.394
8	0.315	0.318
9	0.244	0.245
10	0.181	0.183
11	0.124	0.125
12	0.078	0.079
13	0.038	0.038
14	0.	0.
15	-0.033	-0.033
16	-0.064	-0.064
17	-0.090	-0.089
18	-0.104	-0.103
19	-0.113	-0.112
20	-0.113	-0.111
21	-0.109	-0.106
22	-0.099	-0.096
23	-0.086	-0.084
24	-0.072	-0.070
25	-0.056	-0.055
26	-0.038	-0.038
27	-0.020	-0.019
28	0.	0.

DEAD STRESS

Bar	Values found by author	Values given in Eng. News-Record.
L_oU_1	-450	-457
L_2U_1	211	212
L_2U_3	-100	-100
L_4U_3	87	87
L_4U_5	-1	2
L_6U_5	-42	-38
L_6U_7	127	129
L_8U_7	-219	-212
L_8U_9	-302	298
$L_{10}U_9$	-393	-384
$L_{10}U_{11}$	479	473
$L_{12}U_{11}$	-468	-463
$L_{12}U_{13}$	534	533
$L_{14}U_{13}$	738	-733
U_1U_2	-466	-472
U_3U_4	-559	-564
U_5U_6	-535	-543
U_7U_8	-358	-369
U_9U_{10}	-11	-14
$U_{11}U_{12}$	490	467
$U_{13}U_{14}$	1040	1014
L_oL_1	309	314
L_2L_3	510	514
L_4L_5	556	562
L_6L_7	470	478
L_8L_9	204	217
$L_{10}L_{11}$	-242	-222
$L_{12}L_{13}$	-715	-694
U_1L_1	56	
U_2L_2	-9	
U_3L_3	56	
U_4L_4	-10	
U_5L_5	57	
U_6L_6	-11	
U_7L_7	56	
U_8L_8	-9	
U_9L_9	54	
$U_{10}L_{10}$	-9	
$U_{11}L_{11}$	55	
$U_{12}-L_{12}$	-10	
$U_{13}L_{13}$	58	
$U_{14}L_{14}$	-23	

Live Stress

Bar	Values found by author	Values given in Eng. News-Record
L_0U_1	-189	-190
L_2U_1	103	104
L_2U_3	- 75	- 75
L_4U_3	78	78
L_4U_5	63	63
L_6U_5	- 69	- 70
L_6U_7	84	84
L_8U_7	-101	-101
L_8U_9	119	119
$L_{10}U_9$	-139	-139
$L_{10}U_{11}$	160	159
$L_{12}U_{11}$	-160	-154
$L_{12}U_{13}$	178	172
$L_{14}U_{13}$	-218	-218
U_1U_2	-198	-199
U_3U_4	-249	-250
U_5U_6	-265	-269
U_7U_8	-235	-238
U_9U_{10}	-151	-153
$U_{11}U_{12}$	174	170
$U_{13}U_{14}$	293	293
L_0L_1	130	131
L_2L_3	219	221
L_4L_5	258	259
L_6L_7	257	560
L_8L_9	200	201
$L_{10}L_{11}$	-153	-151
$L_{12}L_{13}$	-215	-212

No stress in bars U_2L_2, U_4L_4, U_6L_6, U_8L_8, $U_{10}L_{10}$, $U_{12}L_{12}$, and $U_{14}L_{14}$.

Stress in bars U_1L_1, U_3L_3, U_5L_5, U_7L_7, U_9L_9, $U_{11}L_{11}$, and $U_{13}L_{13}$ = 44.

Reversals :-

U_9U_{10} ---	+128	+122
L_6U_5 ---	+ 18	+ 16
L_4U_5 ----	- 62	- 60

As will be noted, the values of the ordinates for the influence line for the end reaction agree closely. The slight differences noted are probably due to a difference in the precision used as the writer made no attempt to carry any of his values beyond the fourth figure, (wherever a fifth figure is given in the computation which follows, it was done to keep the same number of decimal figures).

The dead stresses show the greatest discrepancy, but even here, the maximum error did not exceed 16000#, an error of slightly more than 10%. The stresses found by the writer tended to be smaller than the designer's values near the ends of the truss, ($Lo-L_9$) and greater at the center of the truss (L_9-L_{14}). The difference in the values of the influence line ordinates probably is partly responsible, but the chief source of error here very likely lies in the assumptions made in computing the dead weight. The total dead weight as found by the writer was 30000# greater than that given in the Engineering News Record. There was not sufficient data given to make possible a really accurate calculation of the weight of the top lateral system and the floor system. In the former case, the cross struts had to be calculated approximately whereas in the latter case, the weight of the I beams had to be guessed at since only the nominal size of beams were given.

The writer used the figure 22% for connections and details; the designer's figure was not known. However, on the whole, the differences are not serious and are about as small as can reasonably be expected under the circumstances.

The live stresses agree almost exactly in practically every instance. The maximum difference is $4000^{\#}$ - a variation of less 2-1/2%. After the computations had been made, the writer discovered an error in his results due to the fact that a mistake was made in applying the impact formula. The writer used one panel more than he should have (Loaded L_{14} as well as the other panel points) in computing the loaded length for use in the impact formula. However, as the results were entirely satisfactory, (the difference being practically negligible), no corrections were attempted. A check showed that in the majority of cases, if the correction were applied, the entire difference would be eliminated. This almost exact agreement between the live stresses is possible because no assumptions were necessary in the computations.

The reversals of stress also agree satisfactory. As is to be expected, the variations are not as great as in the case of dead stresses nor as small as in that of the live stresses. The reversals were relatively unimportant in this particular case, there being only three bars subject to a reversal of stress.

As a result of the investigation, the writer comes to the conclusion that the method of elastic loads is as good as any of the other methods of analyzing a statically indeterminate structure of the type considered. Personally, the writer would prefer this method (elastic loads) to any other since it eliminates the necessity for expressions for the stresses due to applied loads and does not involve the solution of simultaneous equations. The one drawback to its use is that greater precision is required in the calculations for the elastic loads.

The computations follow:

TABLE I
Stress with unit load at left reaction

Bar	Length	Area	Weight/ft.	Horiz. Comp.	Vert. Comp.	Stress	Stress Intensity
L_0U_1	46.81	44.42	150.3	+0.946	+1.000	+1.377	+0.03091
L_2U_1	46.81	19.61	67.1	-0.605	-0.639	-0.879	-0.04482
L_2U_3	58.62	21.86	74.7	+0.420	+0.639	+0.764	+0.03495
L_4U_3	58.62	19.61	67.1	-0.529	-0.806	-0.964	-0.04916
L_4U_5	62.86	21.86	74.7	+0.480	+0.806	+0.937	+0.04286
L_6U_5	62.86	21.86	74.7	-0.596	-1.000	-1.164	-0.05325
L_6U_7	62.86	19.61	67.1	+0.596	+1.000	+1.164	+0.05936
L_8U_7	62.86	24.75	84.4	-0.596	-1.000	-1.164	-0.04703
L_8U_9	62.86	22.50	76.7	+0.596	+1.000	+1.164	+0.05173
$L_{10}U_9$	62.86	36.48	124.2	-0.596	-1.000	-1.164	-0.03191
$L_{10}U_{11}$	62.86	33.36	113.8	+0.596	+1.000	+1.164	+0.03489
$L_{12}U_{11}$	62.86	41.73	142.0	+0.119	+0.200	+0.233	+0.00558
$L_{12}U_{13}$	73.42	36.50	124.4	-0.097	-0.200	-0.223	-0.00608
$L_{14}U_{13}$	73.42	66.24	225.2	-0.487	-1.000	-1.112	-0.01679
U_1U_2	33.03	38.36	130.8	+1.548	+0.361	+1.590	+0.04145
U_3U_4	32.27	44.42	150.3	+2.496	+0.194	+2.504	+0.05637
U_5U_6	32.17	44.42	150.3	+3.576	—	+3.576	+0.08050
U_7U_8	32.17	36.11	123.2	+4.767	—	+4.767	+0.13201
U_9U_{10}	32.17	36.11	123.2	+5.960	—	+5.960	+0.16505
$U_{11}U_{12}$	32.72	36.11	123.2	+6.433	+1.200	+6.544	+0.18122
$U_{13}U_{14}$	32.17	67.67	230.4	+6.823	—	+6.823	+0.10083
L_0L_1	32.17	37.50	127.7	-0.946	—	-0.946	-0.02523
L_2L_3	32.17	38.18	130.0	-1.971	—	-1.971	-0.05162
L_4L_5	32.17	41.50	141.4	-2.980	—	-2.980	-0.07181
L_6L_7	32.17	38.18	130.0	-4.171	—	-4.171	-0.10925
L_8L_9	32.17	24.00	81.8	-5.363	—	-5.363	-0.22346
$L_{10}L_{11}$	32.17	26.50	90.3	-6.554	—	-6.554	-0.24732
$L_{12}L_{13}$	32.17	50.84	172.1	-6.337	—	-6.337	-0.12465
U_1L_1	34.00	11.48	39.2	—	—	—	—
U_2L_2	41.50	14.64	50.0	—	—	—	—
U_3L_3	49.00	11.48	39.2	—	—	—	—
U_4L_4	51.50	19.80	67.8	—	—	—	—
U_5L_5	54.00	11.48	39.2	—	—	—	—
U_6L_6	54.00	19.80	67.8	—	—	—	—
U_7L_7	54.00	11.48	39.2	—	—	—	—
U_8L_8	54.00	19.80	67.8	—	—	—	—
U_9L_9	54.00	11.48	39.2	—	—	—	—
$U_{10}L_{10}$	54.00	19.80	67.8	—	—	—	—
$U_{11}L_{11}$	54.00	11.48	39.2	—	—	—	—
$U_{12}L_{12}$	60.00	38.80	62.8	—	—	—	—
$U_{13}L_{13}$	66.00	11.48	39.2	—	—	—	—
$U_{14}L_{14}$	66.00	40.06	67.1	—	—	—	—

TABLE II - Computations for Exchange of Angles (Elastic Loads)

Triangle	[(fc)	− (fa)]	× cot β	+ [(fc)	− (fb)]	× cot α	
$L_0L_1U_1$	[(0.03091)	− 0]	× $\frac{34}{32.2}$	+ [(0.03091)	− (−0.02523)]	× $\frac{32.2}{34}$	= +0.0858
$U_1L_1L_2$	[(−0.04482)	− 0]	× $\frac{34}{32.2}$	+ [(−0.04482)	− (−0.02523)]	× $\frac{32.2}{34}$	= −0.0659
							+0.0199 = $E\delta\theta_1$
$U_1L_2L_1$	[0	− (−0.04482)]	× $\frac{34}{32.2}$	+ [	]	× 0	= +0.0474
$U_2L_2U_1$	[(0.04145)	− (−0.04482)]	× 0.5875	+ [(0.04145)	− 0]	× $\frac{7.5}{32.2}$	= +0.0604
$U_2L_2U_3$	[(0.04145)	− (0.03495)]	× 1.054	+ [(0.04145)	− 0]	× $(-\frac{7.5}{32.2})$	= −0.0028
$U_3L_2L_3$	[0	− (0.03495)]	× $\frac{49}{32.2}$	+ [	]	× 0	= −0.0532
							+0.0518 = $E\delta\theta_2$
$U_3L_3L_2$	[(0.03495)	− 0]	× $\frac{49}{32.2}$	+ [(0.03495)	− (−0.05162)]	× $\frac{32.2}{49}$	= +0.1101
$U_3L_3U_4$	[(−0.04916)	− 0]	× $\frac{49}{32.2}$	+ [(−0.04916)	− (−0.05162)]	× $\frac{32.2}{49}$	= −0.0733
							+0.0368 = $E\delta\theta_3$
$U_3L_4L_3$	[0	− (−0.04916)]	× $\frac{49}{32.2}$	+ [	]	× 0	= +0.0749
$U_4L_4U_3$	[(0.05637)	− (−0.04916)]	× 0.5539	+ [(0.05637)	− 0]	× $\frac{2.5}{32.2}$	= +0.0628
$U_4L_4U_5$	[(0.05637)	− (0.04286)]	× 0.6072	+ [(0.05637)	− 0]	× $(-\frac{2.5}{32.2})$	= +0.0038
$U_5L_4L_5$	[0	− (0.04286)]	× $\frac{54}{32.2}$	+ [	]	× 0	= −0.0720
							+0.0695 = $E\delta\theta_4$
$U_5L_5L_4$	[(0.04286)	− 0]	× $\frac{54}{32.2}$	+ [(0.04286)	− (−0.07181)]	× $\frac{32.2}{54}$	= +0.1403
$U_5L_5L_6$	[(−0.05325)	− 0]	× $\frac{54}{32.2}$	+ [(−0.05325)	− (−0.07181)]	× $\frac{32.2}{54}$	= −0.0784
							+0.0619 = $E\delta\theta_5$

Triangle	[(f_c)	− (f_a)]	× cot β	+ [(f_c)	− (f_b)]	× cot α	=
$U_5L_6L_5$	[0	− (−0.05325)]	× $\frac{54}{32.2}$	+ 0			= +0.0894
$U_6L_6U_5$	[(0.08050)	− (−0.05325)]	× $\frac{32.2}{54}$	+ 0			= +0.0797
$U_6L_6U_7$	[(0.08050)	− (0.05936)]	× $\frac{32.2}{54}$	+ 0			= +0.0126
$U_7L_6L_7$	[0	− (0.05936)]	× $\frac{54}{32.2}$	+ 0			= −0.0997
							+0.0820 = $E\delta\theta_6$
$U_7L_7L_6$	[(0.05936)	− 0]	× $\frac{54}{32.2}$	+ [(0.05936)	− (−0.10925)]	× $\frac{32.2}{54}$	= +0.2001
$U_7L_7L_8$	[(−0.04703)	− 0]	× $\frac{54}{32.2}$	+ [(−0.04703)	− (−0.10925)]	× $\frac{32.2}{54}$	= +0.0141
							+0.2142 = $E\delta\theta_7$
$U_7L_8L_7$	[0	− (−0.04703)]	× $\frac{54}{32.2}$	+ 0			= +0.0790
$U_8L_8U_7$	[(0.13201)	− (−0.04703)]	× $\frac{32.2}{54}$	+ 0			= +0.1066
$U_8L_8U_9$	[(0.13201)	− (0.05173)]	× $\frac{32.2}{54}$	+ 0			= +0.0478
$U_9L_8L_9$	[0	− (0.05173)]	× $\frac{54}{32.2}$	+ 0			= −0.0869
							+0.1465 = $E\delta\theta_8$
$U_9L_9L_8$	[(0.05173)	− 0]	× $\frac{54}{32.2}$	+ [(0.05173)	− (−0.22346)]	× $\frac{32.2}{54}$	= +0.2508
$U_9L_9L_{10}$	[(−0.03191)	− 0]	× $\frac{54}{32.2}$	+ [(−0.03191)	− (−0.22346)]	× $\frac{32.2}{54}$	= +0.0605
							+0.3113 = $E\delta\theta_9$

Triangle

$$U_9L_{10}L_9\ [\ 0 - (-0.03191)] \times \frac{54}{32.2} + 0 = +0.0536$$

$$U_{10}L_{10}U_9\ [(0.16505) - (-0.03191)] \times \frac{32.2}{54} + 0 = +0.1173$$

$$U_{10}L_{10}U_{11}\ [(0.16505) - (0.03489)] \times \frac{32.2}{54} + 0 = +0.0775$$

$$U_{11}L_{10}L_{11}\ [\ 0 - (0.03489)] \times \frac{54}{32.2} + 0 = -0.0586$$

$$+0.1898 = E\delta\theta_{10}$$

$$U_{11}L_{11}L_{10}\ [(0.03489) - 0\ ] \times \frac{54}{32.2} + [(0.03489) - (-0.24732)] \times \frac{32.2}{54} = +0.2267$$

$$U_{11}L_{11}L_{12}\ [(0.00558) - 0\ ] \times \frac{54}{32.2} + [(0.00558) - (-0.24732)] \times \frac{32.2}{54} = +0.1601$$

$$+0.3868 = E\delta\theta_{11}$$

$$U_{11}L_{12}L_{11}\ [\ 0 - (0.00558)] \times \frac{54}{32.2} + [\qquad] \times 0 = -0.0094$$

$$U_{12}L_{12}U_{11}\ [(0.18122) - (0.00558)] \times 0.3699 + [(0.18122) - 0\ ] \times \frac{6}{32.2} = +0.0988$$

$$U_{12}L_{12}U_{13}\ [(0.18122) - (-0.00608)] \times 0.7440 + [(0.18122) - 0\ ] \times \left(-\frac{6}{32.2}\right) = +0.0981$$

$$U_{13}L_{12}L_{13}\ [\ 0 - (-0.00608)] \times \frac{66}{32.2} + [\qquad] \times 0 = +0.0125$$

$$+0.2000 = E\delta\theta_{12}$$

$$U_{13}L_{13}L_{12}\ [(-0.00608) - 0\ ] \times \frac{66}{32.2} + [(-0.00608) - (-0.12465)] \times \frac{32.2}{66} = +0.0453$$

$$U_{13}L_{13}L_{14}\ [(-0.01679) - 0\ ] \times \frac{66}{32.2} + [(-0.01679) - (-0.12465)] \times \frac{32.2}{66} = +0.0181$$

$$+0.0634 = E\delta\theta_{13}$$

$$U_{13}L_{14}L_{13}\ [\ 0 - (-0.01679)] \times \frac{66}{32.2} + 0 = +0.0345$$

$$U_{14}L_{14}U_{13}\ [(0.10083) - (-0.01679)] \times \frac{32.2}{66} + 0 = +0.0573$$

$$U_{14}L_{14}U_{15}\ [(0.10083) - (-0.01679)] \times \frac{32.2}{66} + 0 = +0.0573$$

$$U_{15}L_{14}L_{15}\ [\ 0 - (-0.01679)] \times \frac{66}{32.2} + 0 = +0.0345$$

$$+0.1836 = E\delta\theta_{14}$$

Computations for Bending Moment and Deflection Curve

$E\delta\theta_1 = 0.0199$
$E\delta\theta_2 = 0.0518$
$E\delta\theta_3 = 0.0368$
$E\delta\theta_4 = 0.0695$
$E\delta\theta_5 = 0.0619$
$E\delta\theta_6 = 0.0820$
$E\delta\theta_7 = 0.2142$
$E\delta\theta_8 = 0.1465$
$E\delta\theta_9 = 0.3113$
$E\delta\theta_{10} = 0.1898$
$E\delta\theta_{11} = 0.3868$
$E\delta\theta_{12} = 0.2000$
$E\delta\theta_{13} = 0.0634$
$\frac{1}{2}E\delta\theta_{14} = 0.0918$

$R_1' = 1.9257$

End Reaction under Elastic Loads (Structure considered as end-supported)

1.9257 × 32.2 = 61.95
0.0199
1.9058 × 32.2 = 61.31
0.0518
1.8540 × 32.2 = 59.64
0.0368
1.8172 × 32.2 = 58.46
0.0695
1.7477 × 32.2 = 56.22
0.0619
1.6858 × 32.2 = 54.23
0.0820
1.6038 × 32.2 = 51.60
0.2142
1.3896 × 32.2 = 44.70
0.1465
1.2431 × 32.2 = 39.99
0.3113
0.9318 × 32.2 = 29.98
0.1898
0.7420 × 32.2 = 23.87
0.3868
0.3552 × 32.2 = 11.43
0.2000
0.1552 × 32.2 = 4.99
0.0634
0.0918 × 32.2 = 2.95

61.95
61.31
123.26
59.64
182.90
58.46
241.36
56.22
297.58
54.23
351.81
51.60
403.41
44.70
448.11
39.99
488.10
29.98
518.08
23.87
541.95
11.43
553.38
4.99
558.37
2.95
561.32

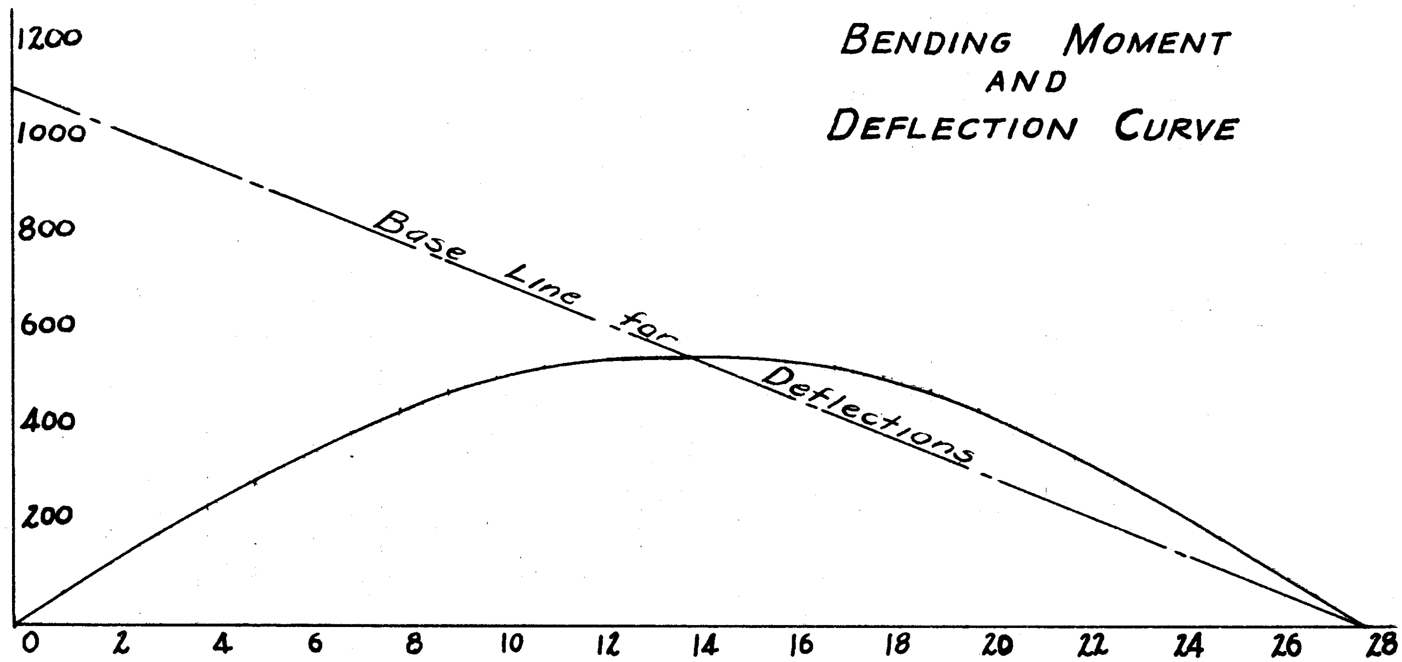

BENDING MOMENT
AND
DEFLECTION CURVE
Base Line for Deflections
1200
1000
800
600
400
200
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28

PLATE II

TABLE III :- INFLUENCE TABLE FOR R_1

Panel Point	(E)x Bending Moment	(E) x Ordinates to Base Line for Deflections	(E) x Deflections	Influence Line Ordinates
L_0	0	+ 1122.6	+1122.6	+1.000
L_1	62.0	+ 1082.5	+ 1020.5	+0.909
L_2	123.3	+ 1042.4	+ 919.1	+0.819
L_3	182.9	+ 1002.3	+ 819.4	+0.730
L_4	241.4	+ 962.2	+ 720.8	+0.642
L_5	297.6	+ 922.1	+624.5	+0.556
L_6	351.8	+882.0	+530.2	+0.472
L_7	403.4	+ 841.9	+438.5	+0.390
L_8	448.1	+ 801.8	+353.7	+0.315
L_9	488.1	+761.7	+273.6	+0.244
L_{10}	518.1	+721.6	+203.5	+0.181
L_{11}	542.0	+681.6	+139.6	+0.124
L_{12}	553.4	+641.5	+88.1	+0.078
L_{13}	558.4	+601.4	+43.0	+0.038
L_{14}	561.3	+561.3	0	0
L_{15}	558.4	+521.2	-37.2	-0.033
L_{16}	553.4	+481.1	-72.3	-0.064
L_{17}	542.0	+441.0	-101.0	-0.090
L_{18}	518.1	+400.9	-117.2	-0.104
L_{19}	488.1	+360.8	-127.3	-0.113
L_{20}	448.1	+320.7	-127.4	-0.113
L_{21}	403.4	+280.6	-122.8	-0.109
L_{22}	351.8	+240.6	-111.2	-0.099
L_{23}	297.6	+200.5	-97.1	-0.086
L_{24}	241.4	+160.4	-81.0	-0.072
L_{25}	182.9	+120.3	-62.6	-0.056
L_{26}	123.3	+80.2	-43.1	-0.038
L_{27}	62.0	+40.1	-21.9	-0.020
L_{28}	0	0	0	0

Note :- Infl. line ordinate at "n" $= \dfrac{\text{Deflection at "n"}}{\text{Deflection at end}}$

R_1 = end reaction.
Downward Deflections considered positive.

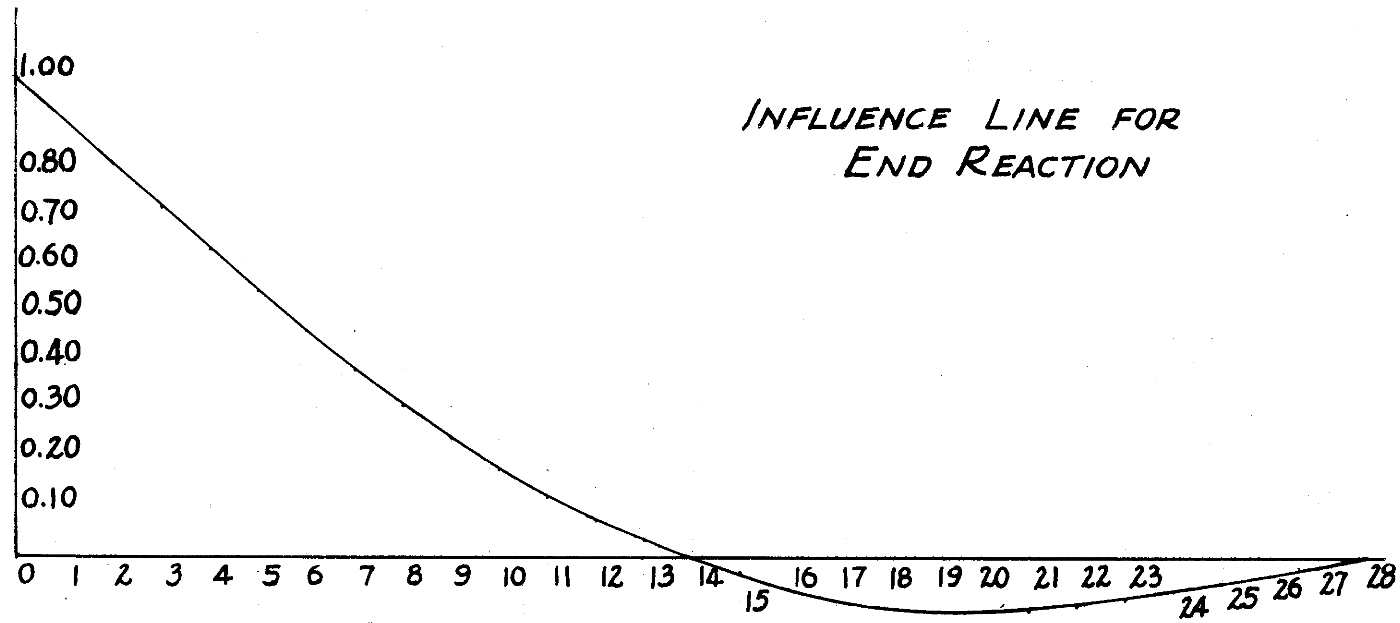

INFLUENCE LINE FOR
END REACTION
1.00
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

PLATE III.

TABLE IV - Influence Tables for Top Chord

Pt.	Vert. Comp. - U_1U_2	Vert. Comp. - U_3U_4	S' - U_5U_6
0	$-\frac{(1.000\times2)-2}{5.53} = -0.$	0	0
1	$-\frac{(0.909\times2)-1}{5.53} = -0.148$	$-\frac{(0.909\times4)-3}{(19.6+1)} = -0.031$	5 $-(0.909\times6) = -0.454$
2	$-\frac{(0.819\times2)}{5.53} = -0.296$	$-\frac{(0.819\times4)-2}{20.6} = -0.062$	4 $-(0.819\times6) = -0.914$
3	$-\frac{(0.730\times2)}{5.53} = -0.264$	$-\frac{(0.730\times4)-1}{20.6} = -0.093$	3 $-(0.730\times6) = -1.380$
4	-0.232	$-\frac{(0.642\times4)}{20.6} = -0.125$	2 $-(0.642\times6) = -1.852$
5	-0.201	$-\frac{(0.556\times4)}{20.6} = -0.108$	1 $-(0.556\times6) = -2.336$
6	-0.171	-0.092	$-(0.472\times6) = -2.832$
7	-0.141	-0.076	$-(0.390\times6) = -2.340$
8	-0.114	-0.061	-1.890
9	-0.088	-0.047	-1.464
10	-0.065	-0.035	-1.086
11	-0.045	-0.024	-0.744
12	-0.028	-0.015	-0.468
13	-0.014	-0.007	-0.228
14	0	0	0
15	+0.012	+0.006	+0.198
16	+0.023	+0.012	+0.384
17	+0.033	+0.017	+0.540
18	+0.038	+0.020	+0.624
19	+0.041	+0.022	+0.678
20	+0.041	+0.022	+0.678
21	+0.039	+0.021	+0.654
22	+0.036	+0.019	+0.594
23	+0.031	+0.017	+0.516
24	+0.026	+0.014	+0.432
25	+0.020	+0.011	+0.336
26	+0.014	+0.007	+0.228
27	+0.007	+0.004	+0.120
28	0	0	0
Totals ---- -	+0.361 -1.807	+0.192 -0.776	+5.982 -17.988

Note :- Stress = $S' \times \frac{p}{h}$; i.e., S' = index stress $\begin{cases} p = 32.2 \\ h = 54.0 \end{cases}$

Pt.	S' - $U_7 U_8$	S' - $U_9 U_{10}$	Vert. Comp. - $U_1 U_{12}$	S'' - $U_{13} U_{14}$
0	0	0	0	0
1	7 - (0.909 x 8) = -0.272	-0.090	$-\frac{(0.909\times12)-11}{9+1}$ = +0.0092	+0.304
2	6 - (0.819 x 8) = -0.552	-0.190	$-\frac{(0.819\times12)-10}{10}$ = +0.0172	+0.534
3	5 - (0.730 x 8) = -0.840	-0.300	$-\frac{(0.730\times12)-9}{10}$ = +0.0240	+0.780
4	4 - (0.642 x 8) = -1.136	-0.420	$-\frac{(0.642\times12)-8}{10}$ = +0.0296	+1.012
5	3 - (0.556 x 8) = -1.448	-0.560	$-\frac{(0.556\times12)-7}{10}$ = +0.0328	+1.216
6	2 - (0.472 x 8) = -1.776	-0.720	$-\frac{(0.472\times12)-6}{10}$ = +0.0336	+1.392
7	1 - (0.390 x 8) = -2.120	-0.900	$-\frac{(0.390\times12)-5}{10}$ = +0.0320	+1.540
8	-(0.315 x 8) = -2.520	-1.150	$-\frac{(0.315\times12)-4}{10}$ = +0.0220	+1.590
9	-(0.244 x 8) = -1.952	-1.440	$-\frac{(0.244\times12)-3}{10}$ = +0.0072	+1.584
10	-1.448	-1.810	$-\frac{(0.181\times12)-2}{10}$ = -0.0172	+1.466
11	-0.992	-1.240	$-\frac{(0.124\times12)-1}{10}$ = -0.0488	+1.264
12	-0.624	-0.780	$-\frac{(0.078\times12)}{10}$ = -0.0936	+0.908
13	-0.304	-0.380	-0.0038 x 12 = -0.0456	+0.468
14	0	0	0	0
15	+0.264	+0.330	+0.0396	+0.462
16	+0.512	+0.640	+0.0768	+0.896
17	+0.720	+0.900	+0.1080	+1.260
18	+0.832	+1.040	+0.1248	+1.456
19	+0.904	+1.130	+0.1356	+1.582
20	+0.904	+1.130	+0.1356	+1.582
21	+0.872	+1.090	+0.1308	+1.526
22	+0.792	+0.990	+0.1188	+1.386
23	+0.688	+0.860	+0.1032	+1.204
24	+0.576	+0.720	+0.0864	+1.008
25	+0.448	+0.560	+0.0672	+0.784
26	+0.304	+0.380	+0.0456	+0.532
27	+0.160	+0.200	+0.0240	+0.280
28	0	0	0	0
Totals ----	+7.976 -15.984	+9.970 -9.980	+1.404 -0.205	+28.016 -0

Note:- Stress = S' x $\frac{32.2}{54}$

Stress = S'' x $\frac{32.2}{66}$

TABLE V

Influence Tables for Vert. Comp. of Diagonals

Pt.	L_2U_1	L_2U_3	L_4U_3	L_4U_5	L_6U_5	L_6U_7	L_8U_7	L_8U_9
0	0	0	0	0	0	0	0	0
1	-0.239	+0.239	-0.122	+0.122	-0.091	+0.091	-0.091	+0.091
2	+0.523	+0.477	-0.243	+0.243	-0.181	+0.181	-0.181	+0.181
3	+0.466	-0.466	-0.363	+0.363	-0.270	+0.270	-0.270	+0.270
4	+0.410	-0.410	+0.517	+0.483	-0.358	+0.358	-0.358	+0.358
5	+0.355	-0.355	+0.448	-0.448	-0.444	+0.444	-0.444	+0.444
6	+0.301	-0.301	+0.380	-0.380	+0.472	+0.528	-0.528	+0.528
7	+0.249	-0.249	+0.314	-0.314	+0.390	-0.390	-0.610	+0.610
8	+0.201	-0.201	+0.254	-0.254	+0.315	-0.315	+0.315	+0.685
9	+0.156	-0.156	+0.197	-0.197	+0.244	-0.244	+0.244	-0.244
10	+0.116	-0.116	+0.146	-0.146	+0.181	-0.181	+0.181	-0.181
11	+0.079	-0.079	+0.100	-0.100	+0.124	-0.124	+0.124	-0.124
12	+0.050	-0.050	+0.063	-0.063	+0.078	-0.078	+0.078	-0.078
13	+0.024	-0.024	+0.031	-0.031	+0.038	-0.038	+0.038	-0.038
14	0	0	0	0	0	0	0	0
15	-0.021	+0.021	-0.027	+0.027	-0.033	+0.033	-0.033	+0.033
16	-0.041	+0.041	-0.052	+0.052	-0.064	+0.064	-0.064	+0.064
17	-0.057	+0.057	-0.073	+0.073	-0.090	+0.090	-0.090	+0.090
18	-0.066	+0.066	-0.084	+0.084	-0.104	+0.104	-0.104	+0.104
19	-0.072	+0.072	-0.091	+0.091	-0.113	+0.113	-0.113	+0.113
20	-0.072	+0.072	-0.091	+0.091	-0.113	+0.113	-0.113	+0.113
21	-0.070	+0.070	-0.088	+0.088	-0.109	+0.109	-0.109	+0.109
22	-0.063	+0.063	-0.080	+0.080	-0.099	+0.099	-0.099	+0.099
23	-0.055	+0.055	-0.069	+0.069	-0.086	+0.086	-0.086	+0.086
24	-0.046	+0.046	-0.058	+0.058	-0.072	+0.072	-0.072	+0.072
25	-0.036	+0.036	-0.045	+0.045	-0.056	+0.056	-0.056	+0.056
26	-0.024	+0.024	-0.031	+0.031	-0.038	+0.038	-0.038	+0.038
27	-0.013	+0.013	-0.016	+0.016	-0.020	+0.020	-0.020	+0.020
28	0	0	0	0	0	0	0	0
Total	+2.930 -0.875	+1.352 -2.407	+2.450 -1.533	+2.016 -1.933	+1.842 -2.341	+2.869 -1.370	+0.980 -3.479	+4.164 -0.665

Note :- Computation is by method of shears.
Influence table for L_0U_1 is same as that for End Reaction with signs reversed.

Pt.	$L_{10}U_9$	$L_{10}U_{11}$	$L_{12}U_{11}$	$L_{12}U_{13}$	$L_{14}U_{13}$
0	0	0	0	0	0
1	-0.091	+0.091	-0.082	+0.082	-0.091
2	-0.181	+0.181	-0.164	+0.164	-0.181
3	-0.270	+0.270	-0.246	+0.246	-0.270
4	-0.358	+0.358	-0.328	+0.328	-0.358
5	-0.444	+0.444	-0.411	+0.411	-0.444
6	-0.528	+0.528	-0.494	+0.494	-0.528
7	-0.610	+0.610	-0.578	+0.578	-0.610
8	-0.685	+0.685	-0.663	+0.663	-0.685
9	-0.756	+0.756	-0.749	+0.749	-0.756
10	+0.181	+0.819	-0.836	+0.836	-0.819
11	+0.124	-0.124	-0.925	+0.925	-0.876
12	+0.078	-0.078	-0.016	+1.016	-0.922
13	+0.038	-0.038	-0.008	+0.008	-0.962
14	0	0	0	0	0
15	-0.033	+0.033	+0.007	-0.007	-0.033
16	-0.064	+0.064	+0.013	-0.013	-0.064
17	-0.090	+0.090	+0.018	-0.018	-0.090
18	-0.104	+0.104	+0.021	-0.021	-0.104
19	-0.113	+0.113	+0.023	-0.023	-0.113
20	-0.113	+0.113	+0.023	-0.023	-0.113
21	-0.109	+0.109	+0.022	-0.022	-0.109
22	-0.099	+0.099	+0.020	-0.020	-0.099
23	-0.086	+0.086	+0.017	-0.017	-0.086
24	-0.072	+0.072	+0.014	-0.014	-0.072
25	-0.056	+0.056	+0.011	-0.011	-0.056
26	-0.038	+0.038	+0.008	-0.008	-0.038
27	-0.020	+0.020	+0.004	-0.004	-0.020
28	0	0	0	0	0
Total	+0.421 -4.920	+5.739 -0.240	+0.201 -5.500	+6.500 -0.201	+0 -8.508

TABLE VI

Influence Tables for Bottom Chord

Pt.	$S_1' - L_2L_3$		$S_2'-L_4L_5$	$S_2'-L_6L_7$	$S_2'-L_8L_9$	$S_2'-L_{10}L_{11}$	$S_3'-L_{12}L_{13}$
0	0		0	0	0	0	0
1	+(0.909 × 3) − 2	= +0.727	+0.545	+0.363	+0.181	0	−0.183
2	+(0.819 × 3) − 1	= +1.457	+1.095	+0.733	+0.371	+0.009	−0.353
3	+(0.730 × 3)	= +2.190	+1.650	+1.110	+0.570	+0.030	−0.510
4	+(0.642 × 3)	= +1.926	+2.210	+1.494	+0.778	+0.062	−0.654
5	+(0.556 × 3)	= +1.668	+2.780	+1.892	+1.004	+0.116	−0.772
6	+(0.472 × 3)	= +1.416	+2.360	+2.304	+1.248	+0.192	−0.864
7	+(0.390 × 3)	= +1.170	+1.950	+2.730	+1.510	+0.290	−0.930
8	+(0.315 × 3)	= +0.945	+1.575	+2.205	+1.835	+0.465	−0.905
9	+(0.244 × 3)	= +0.732	+1.220	+1.708	+2.196	+0.684	−0.828
10	+(0.181 × 3)	= +0.543	+0.905	+1.267	+1.629	+0.991	−0.647
11	+(0.124 × 3)	= +0.372	+0.620	+0.868	+1.116	+1.364	−0.388
12	+(0.078 × 3)	= +0.234	+0.390	+0.546	+0.702	+0.858	+0.014
13	+(0.038 × 3)	= +0.114	+0.190	+0.266	+0.342	+0.418	+0.494
14	0		0	0	0	0	0
15		−0.099	−0.165	−0.231	−0.297	−0.363	−0.429
16		−0.192	−0.320	−0.448	−0.576	−0.704	−0.832
17		−0.270	−0.450	−0.630	−0.810	−0.990	−1.170
18		−0.312	−0.520	−0.728	−0.936	−1.144	−1.352
19		−0.339	−0.565	−0.791	−1.017	−1.243	−1.469
20		−0.339	−0.565	−0.791	−1.017	−1.243	−1.469
21		−0.327	−0.545	−0.763	−0.981	−1.199	−1.417
22		−0.297	−0.495	−0.693	−0891	−1.089	−1.287
23		−0.258	−0.430	−0.602	−0.774	−0.946	−1.118
24		−0.216	−0.360	−0.504	−0.648	−0.792	−0.936
25		−0.168	−0.280	−0.392	−0.504	−0.616	−0.728
26		−0.114	−0.190	−0.266	−0.342	−0.418	−0.494
27		−0.60	−0.100	−0.140	−0.180	−0.220	−0.260
28	0		0	0	0	0	0
Total		+13.494 −2.991	+17.490 −4.985	+17.486 −6.979	+13.482 −8.973	+5.479 −10.967	+0.508 −19.995

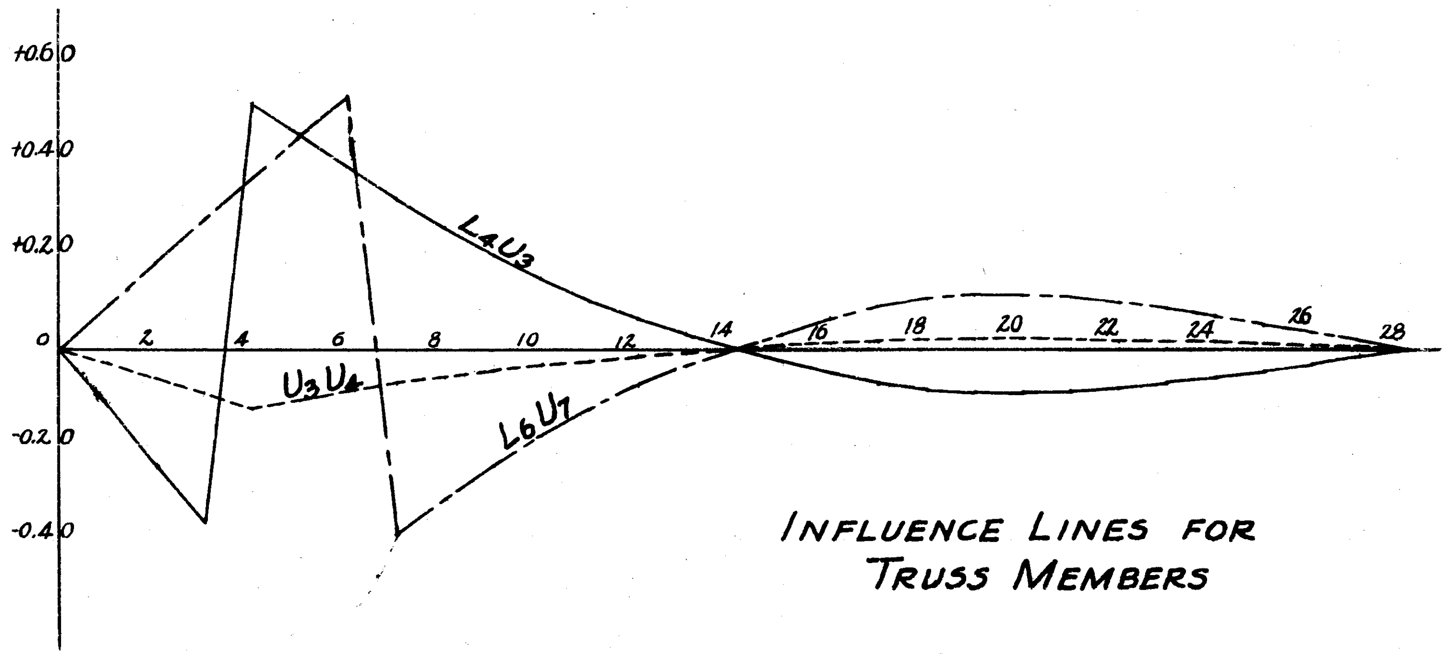
Note :- Influence table for L_0L_1 is same as that for the end reaction. ($h = 34.0$)

$$\text{stress} = S' \times \frac{P}{h} \; ; \; P = 32.2 \text{ in every case}$$

$h_1 = 49.0$

$h_2 = 54.0$

$h_3 = 66.0$



+0.60
+0.40
+0.20
0
-0.20
-0.40
2
4
6
8
10
12
14
16
18
20
22
24
26
28
L4U3
U3U4
L6U7
INFLUENCE LINES FOR
TRUSS MEMBERS

PLATE IV

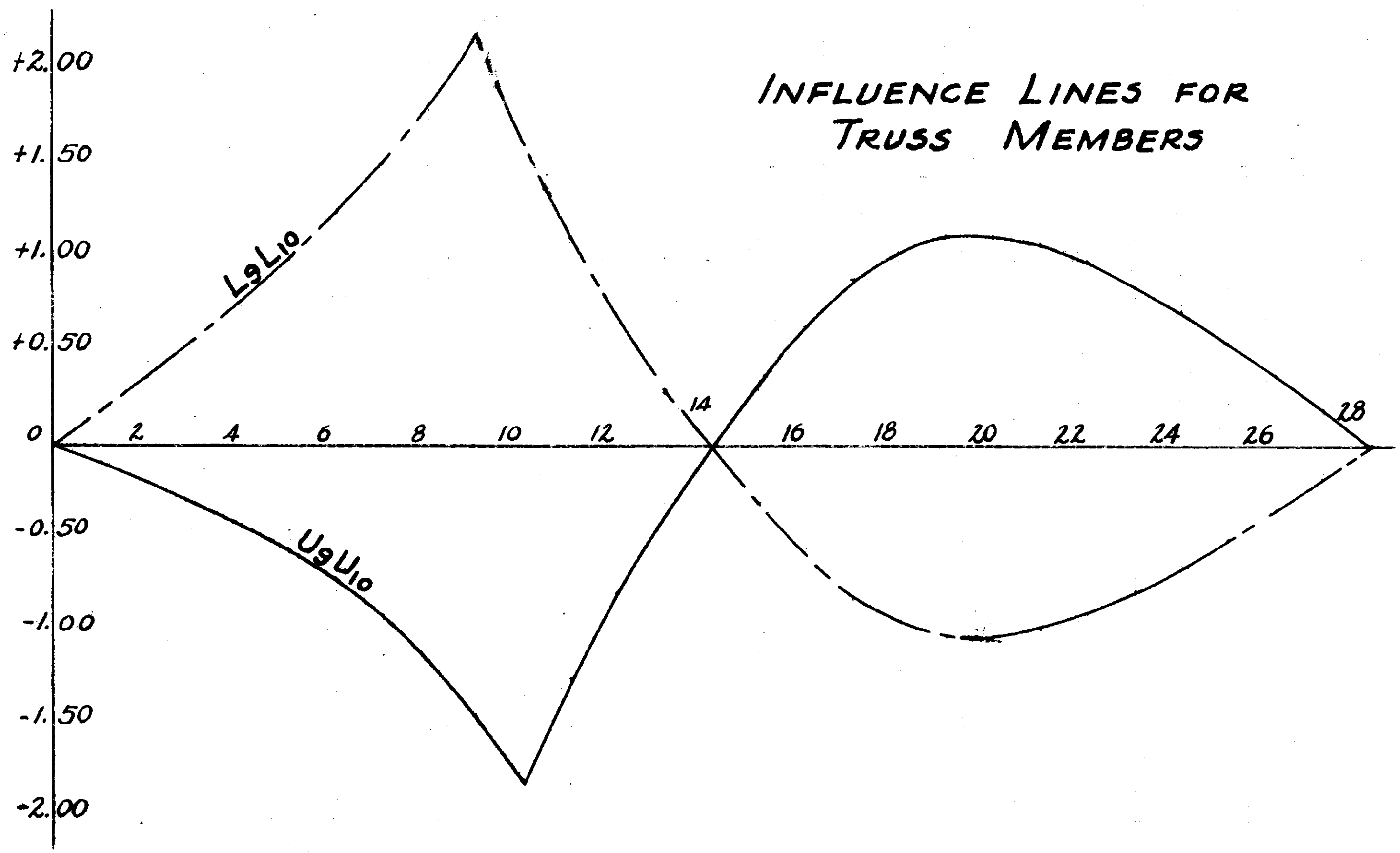

INFLUENCE LINES FOR
TRUSS MEMBERS
+2.00
+1.50
+1.00
+0.50
0
-0.50
-1.00
-1.50
-2.00
2
4
6
8
10
12
14
16
18
20
22
24
26
28
L9L10
U9U10

PLATE V

Dead Load Concentrations at Panel Points:

Top Chord Panel Points

Panel Point	U_1	U_2	U_3	U_4	U_5	U_6	U_7
Chord member	2.16	2.16	2.16	2.42	2.42	2.42	2.42
Chord member	-	2.16	2.42	2.42	2.42	2.42	1.98
Vertical	0.67	1.04	0.96	1.74	1.06	1.84	1.06
Diagonal	3.52	-	2.19	-	2.35	-	2.11
Diagonal	1.57	-	1.96	-	2.34	-	2.65
Lateral System	2.40	2.09	4.32	2.09	8.28	2.09	8.28
Total for Truss	10.32	7.45	14.04	8.67	18.87	8.77	18.50
22% details	2.27	1.52	3.09	1.72	4.15	1.73	4.07
Total	12.59	8.97	17.13	10.39	23.02	10.50	22.57

Panel Point	U_8	U_9	U_{10}	U_{11}	U_{12}	U_{13}	U_{14}
Chord member	1.98	1.98	1.98	1.98	2.00	2.00	3.71
Chord member	1.98	1.98	1.98	2.00	2.00	3.71	3.71
Vertical	1.84	1.06	1.84	1.06	1.88	1.29	2.21
Diagonal	-	2.41	-	3.58	-	4.57	-
Diagonal	-	3.90	-	4.46	-	8.26	-
Lateral System	2.09	8.28	2.09	8.28	2.09	9.45	9.45
Total for Truss	7.89	19.61	7.89	21.36	7.97	29.28	19.08
22% details	1.53	4.31	1.53	4.70	1.75	6.44	4.20
Total	9.42	23.92	9.42	26.06	9.72	35.72	23.28

Note: Dead Loads at Lo and L_{29} neglected since they do not affect the stresses in the truss members.

Dead Load Concentrations at Panel Points:

Bottom Chord Panel Points

Panel Point	L_1	L_2	L_3	L_4	L_5	L_6	L_7
Chord member	2.06	2.06	2.09	2.09	2.27	2.27	2.09
Chord member	2.05	2.09	2.09	2.27	2.28	2.09	2.09
Vertical	0.67	1.04	0.96	1.74	1.06	1.84	1.06
Diagonal	-	1.57	-	1.96	-	2.34	-
Diagonal	-	2.19	-	2.35	-	2.11	-
Lateral System	0.77	0.70	0.64	0.64	0.64	0.64	0.64
Total for Truss	5.55	9.65	5.78	12.05	6.25	11.39	5.88
22% details	1.22	2.01	1.27	2.24	1.38	2.28	1.29
Flooring, etc.	48.96	48.96	48.96	48.96	48.96	48.96	48.96
Total	55.73	60.62	56.01	63.25	56.59	62.53	56.13

Panel Point	L_8	L_9	L_{10}	L_{11}	L_{12}	L_{13}	L_{14}
Chord member	2.09	1.32	1.32	1.45	1.45	2.77	2.77
Chord member	1.32	1.31	1.45	1.45	2.77	2.77	2.77
Vertical	1.84	1.06	1.84	1.06	1.89	1.29	2.21
Diagonal	2.65	-	3.90	-	4.46	-	8.26
Diagonal	2.41	-	3.58	-	4.57	-	8.26
Lateral System	0.64	0.70	0.77	0.77	0.85	0.92	0.92
Total for Truss	10.95	4.39	12.86	4.73	15.99	7.75	25.19
22% details	2.21	0.97	2.63	1.04	3.52	1.71	5.54
Flooring, etc.	48.96	48.96	48.96	48.96	48.96	48.96	48.96
Total	62.12	54.32	64.45	54.73	68.47	58.42	79.69

Note: Dead Loads at Lo and L_{29} neglected since they do not affect the stresses in the truss members.

Dead Load Concentrations at Panel Points:

Total Concentration at each Panel Point

Panel Point	1	2	3	4	5	6	7
Top load	12.59	8.97	17.13	10.39	23.02	10.50	22.57
Bottom load	55.73	60.62	56.01	62.25	56.59	62.53	56.13
Total	68.32	69.59	73.14	72.64	79.61	73.03	78.70

Panel Point	8	9	10	11	12	13	14
Top load	9.42	23.92	9.42	26.06	9.72	35.72	23.28
Bottom load	62.12	54.32	64.45	54.73	68.47	58.42	79.69
Total	71.54	78.24	73.87	80.79	78.19	94.14	102.97

Note: Dead Loads at Lo and L_{29} neglected since they do not affect the stresses in the truss members.

Computations for Dead Stresses

Panel Points	Dead Load	Bar L_0U_1 Influence Line Ordinates	Vert. Comp.	Bar L_2U_1 Influence Line Ordinates	Vert. Comp.	Bar L_2U_3 Influence Line Ordinates	Vert. Comp.	Bar L_4U_3 Influence Line Ordinates	Vert. Comp.
1 & 27	68.3	(-0.909) + (0.020)	-60.7	(-0.239) + (-0.013)	-17.2	(0.239) + (0.013)	+17.2	(-0.122) + (-0.016)	-9.4
2 & 26	69.6	(-0.819) + (0.038)	-54.3	(+0.523) + (-0.024)	+34.8	(0.477) + (0.024)	+34.9	(-0.243) + (-0.031)	-19.2
3 & 25	73.1	(-0.730) + (0.056)	-49.3	(0.466) + (-0.036)	+31.4	(-0.466) + (0.036)	-31.4	(-0.363) + (-0.045)	-29.8
4 & 24	72.6	(-0.642) + (0.072)	-41.4	(0.410) + (-0.046)	+26.4	(-0.410) + (0.046)	-26.4	(0.517) + (-0.058)	+33.3
5 & 23	79.6	(-0.556) + (0.086)	-37.4	(0.355) + (-0.055)	+23.9	(-0.355) + (0.055)	-23.9	(0.448) + (-0.069)	+30.2
6 & 22	73.0	(-0.472) + (0.099)	-27.2	(0.301) + (-0.063)	+17.4	(-0.301) + (0.063)	-17.4	(0.380) + (-0.080)	+21.9
7 & 21	78.7	(-0.390) + (0.109)	-22.1	(0.249) + (-0.070)	+14.1	(-0.249) + (0.070)	-14.1	(0.314) + (-0.088)	+17.8
8 & 20	71.5	(-0.315) + (0.113)	-14.4	(0.201) + (-0.072)	+9.2	(-0.201) + (0.072)	-9.2	(0.254) + (-0.091)	+11.6
9 & 19	78.2	(-0.244) + (0.113)	-10.3	(0.156) + (-0.072)	+6.6	(-0.156) + (0.072)	-6.6	(0.197) + (-0.091)	+8.3
10 & 18	73.9	(-0.181) + (0.104)	-5.7	(0.116) + (-0.066)	+3.7	(-0.116) + (0.066)	-3.7	(0.146) + (-0.084)	+4.6
11 & 17	80.8	(-0.124) + (0.090)	-2.8	(0.079) + (-0.057)	+1.8	(-0.079) + (0.057)	-1.8	(0.100) + (-0.073)	+2.2
12 & 16	78.2	(-0.078) + (0.064)	-1.1	(0.050) + (-0.041)	+0.7	(-0.050) + (0.041)	-0.7	(0.063) + (-0.052)	+0.9
13 & 15	94.1	(-0.038) + (0.033)	-0.5	(0.024) + (-0.021)	+0.3	(-0.024) + (0.021)	-0.3	(0.031) + (-0.027)	+0.4
Total	991.8		-327.2		+153.1		-83.4		+72.8

Dead Reactions :—

$R_1 = R_3 = 327.3$

$R_2 = 2(991.8 - 327.3) + 103.0 = 1432.0$

COMPUTATIONS FOR DEAD STRESSES (CONT.)

Panel Point	Dead Load	L_4U_5 Sum of Infl. Line Ord.	L_4U_5 Vert. Comp.	L_6U_5 Sum of Infl. Line Ord.	L_6U_5 Vert. Comp.	L_6U_7 Sum of Infl. Line Ord.	L_6U_7 Vert. Comp.	L_8U_7 Sum of Infl. Line Ord.	L_8U_7 Vert. Comp.	L_8U_9 Sum of Infl. Line Ord.	L_8U_9 Vert. Comp.	$L_{10}U_9$ Sum of Infl. Line Ord.	$L_{10}U_9$ Vert. Comp.	$L_{10}U_{11}$ Sum of Infl. Line Ord.	$L_{10}U_{11}$ Vert. Comp.
1 & 27	68.3	+0.138	+9.4	-0.111	-7.6	+0.111	+7.6	-0.111	-7.6	+0.111	+7.6	-0.111	-7.6	+0.111	+7.6
2 & 26	69.6	+0.274	+19.1	-0.219	-15.3	+0.219	+15.3	-0.219	-15.3	+0.219	+15.3	-0.219	-15.3	+0.219	+15.3
3 & 25	73.1	+0.408	+29.8	-0.326	-23.8	+0.326	+23.8	-0.326	-23.8	+0.326	+23.8	-0.326	-23.8	+0.326	+23.8
4 & 24	72.6	+0.541	+39.2	-0.430	-31.2	+0.430	+31.2	-0.430	-31.2	+0.430	+31.2	-0.430	-31.2	+0.430	+31.2
5 & 23	79.6	-0.379	-30.2	-0.530	-42.2	+0.530	+42.2	-0.530	-42.2	+0.530	+42.2	-0.530	-42.2	+0.530	+42.2
6 & 22	73.0	-0.300	-21.9	+0.373	+27.2	+0.627	+45.8	-0.627	-45.8	+0.627	+45.8	-0.627	-45.8	+0.627	+45.8
7 & 21	78.7	-0.226	-17.8	+0.281	+22.1	-0.281	-22.1	-0.719	-56.6	+0.719	+56.6	-0.719	-56.6	+0.719	+56.6
8 & 20	71.5	-0.163	-11.7	+0.202	+14.4	-0.202	-14.4	+0.202	+14.4	+0.798	+57.0	-0.798	-57.0	+0.798	+57.0
9 & 19	78.2	-0.106	-8.3	+0.131	+10.2	-0.131	-10.2	+0.131	+10.2	-0.131	-10.2	-0.869	-67.9	+0.869	+67.9
10 & 18	73.9	-0.062	-4.6	+0.077	+5.7	-0.077	-5.7	+0.077	+5.7	-0.077	-5.7	+0.077	+5.7	+0.923	+68.3
11 & 17	80.8	-0.027	-2.2	+0.034	+2.7	-0.034	-2.7	+0.034	+2.7	-0.034	-2.7	+0.034	+2.7	-0.034	-2.7
12 & 16	78.2	-0.011	-0.9	+0.014	+1.1	-0.014	-1.1	+0.014	+1.1	-0.014	-1.1	+0.014	+1.1	-0.014	-1.1
13 & 15	94.1	-0.004	-0.4	+0.005	+0.5	-0.005	-0.5	+0.005	+0.5	-0.005	-0.5	+0.005	+0.5	-0.005	-0.5
Total	991.8		-0.5		-36.2		+109.2		-187.9		+259.3		-337.4		+411.4

COMPUTATIONS FOR DEAD STRESSES (CONT.)

Panel Point	Dead Load	$L_{12}U_{11}$ Sum of Intl. Line Ord.	$L_{12}U_{11}$ Vert. Comp.	$L_{12}U_{13}$ Sum of Intl. Line Ord.	$L_{12}U_{13}$ Vert. Comp.	$L_{14}U_{13}$ Sum of Intl. Line Ord.	$L_{14}U_{13}$ Vert. Comp.	U_1U_2 Sum of Intl. Line Ord.	U_1U_2 S' (V.C.)	U_3U_4 Sum of Intl. Line Ord.	U_3U_4 S' (V.C.)	U_5U_6 Sum of Intl. Line Ord.	U_5U_6 S'	U_7U_8 Sum of Intl. Line Ord.	U_7U_8 S'
1 & 27	68.3	-0.078	-5.4	+0.078	+5.4	-0.111	-7.6	-0.141	-9.6	-0.027	-1.8	-0.334	-22.8	-0.112	-7.6
2 & 26	69.6	-0.156	-10.8	+0.156	+10.8	-0.219	-15.3	-0.282	-19.6	-0.055	-3.8	-0.686	-47.7	-0.248	-17.3
3 & 25	73.1	-0.235	-17.2	+0.235	+17.2	-0.326	-23.8	-0.244	-17.8	-0.082	-6.0	-1.024	-74.9	-0.392	-28.6
4 & 24	72.6	-0.314	-22.8	+0.314	+22.8	-0.430	-31.2	-0.206	-15.0	-0.111	-8.1	-1.420	-103.1	-0.560	-40.7
5 & 23	79.6	-0.394	-31.3	+0.394	+31.3	-0.530	-42.2	-0.170	-13.5	-0.091	-7.2	-1.820	-144.8	-0.760	-60.4
6 & 22	73.0	-0.474	-34.6	+0.474	+34.6	-0.627	-45.8	-0.135	-10.0	-0.073	-5.3	-2.238	-163.4	-0.984	-71.8
7 & 21	78.7	-0.556	-43.7	+0.556	+43.7	-0.719	-56.6	-0.102	-8.0	-0.055	-4.3	-1.686	-132.5	-1.248	-98.2
8 & 20	71.5	-0.640	-45.8	+0.640	+45.8	-0.798	-57.0	-0.073	-5.2	-0.039	-2.8	-1.212	-86.7	-1.616	-115.6
9 & 19	78.2	-0.726	-56.7	+0.726	+56.7	-0.869	-67.9	-0.047	-3.7	-0.025	-2.0	-0.786	-61.9	-1.048	-82.0
10 & 18	73.9	-0.815	-60.3	+0.815	+60.3	-0.923	-68.3	-0.027	-2.0	-0.015	-1.1	-0.462	-34.2	-0.616	-45.5
11 & 17	80.8	-0.907	-73.3	+0.907	+73.3	-0.966	-78.0	-0.012	-1.0	-0.007	-0.6	-0.204	-16.5	-0.272	-22.0
12 & 16	78.2	-0.003	-0.2	+1.003	+78.2	-0.986	-77.0	-0.005	-0.4	-0.003	-0.2	-0.084	-6.6	-0.112	-8.8
13 & 15	94.1	-0.001	-0.1	+0.001	+0.1	-0.995	-93.6	-0.002	-0.2	-0.001	-0.1	-0.030	-2.8	-0.040	-3.8
Total	991.8		-402.2		+480.2		-664.3		-106.0		-43.3		-897.9		-602.3

COMPUTATIONS FOR DEAD STRESSES (CONT.)

Panel Point	Dead Load	U_9U_{10} Sum of Infl. Line Ord.	U_9U_{10} S'	$U_{11}U_{12}$ Sum of Infl. Line Ord.	$U_{11}U_{12}$ S' (V.C.)	$U_{13}U_{14}$ Sum of Infl. Line Ord.	$U_{13}U_{14}$ S'	L_0L_1 Sum of Infl. Line Ord.	L_0L_1 S'	L_2L_3 Sum of Infl. Line Ord.	L_2L_3 S'	L_4L_5 Sum of Infl. Line Ord.	L_4L_5 S'	L_6L_7 Sum of Infl. Line Ord.	L_6L_7 S'
1 & 27	68.3	+0.110	+7.5	+0.033	+2.3	+0.584	+39.9	+0.889	+60.7	+0.667	+45.6	+0.445	+30.4	+0.223	+15.2
2 & 26	69.6	+0.190	+13.2	+0.063	+4.4	+1.066	+74.1	+0.781	+54.3	+1.343	+93.5	+0.905	+63.0	+0.467	+32.2
3 & 25	73.1	+0.260	+19.0	+0.09[illegible]	+6.6	+1.564	+114.2	+0.674	+49.3	+2.022	+147.7	+1.370	+100.0	+0.718	+52.4
4 & 24	72.6	+0.300	+21.8	+0.116	+8.5	+2.020	+146.8	+0.570	+41.4	+1.710	+124.1	+1.850	+134.3	+0.990	+71.8
5 & 23	79.6	+0.300	+23.8	+0.136	+10.8	+2.420	+192.6	+0.470	+37.4	+1.410	+112.1	+2.350	+186.9	+1.290	+102.7
6 & 22	73.0	+0.270	+19.7	+0.152	+11.1	+2.778	+202.5	+0.373	+27.2	+1.119	+82.8	+1.865	+136.1	+1.611	+117.8
7 & 21	78.7	+0.190	+15.0	+0.163	+12.8	+3.066	+241.0	+0.281	+22.1	+0.843	+66.3	+1.405	+110.5	+1.967	+154.7
8 & 20	71.5	-0.020	-14.3	+0.158	+11.3	+3.172	+227.0	+0.202	+14.4	+0.606	+43.8	+1.010	+72.2	+1.414	+101.2
9 & 19	78.2	-0.310	-24.2	+0.143	+11.2	+3.166	+247.5	+0.131	+10.3	+0.393	+30.7	+0.655	+51.2	+0.917	+71.7
10 & 18	73.9	-0.770	-56.0	+0.108	+8.0	+2.922	+216.0	+0.077	+5.7	+0.231	+17.1	+0.385	+28.5	+0.539	+39.9
11 & 17	80.8	-0.340	-27.5	+0.059	+4.8	+2.524	+204.0	+0.034	+2.8	+0.102	+8.2	+0.170	+13.7	+0.238	+19.2
12 & 16	78.2	-0.140	-10.9	-0.017	-1.3	+1.804	+141.1	+0.014	+1.1	+0.042	+3.3	+0.070	+5.5	+0.098	+7.7
13 & 15	94.1	-0.050	-4.7	-0.006	-0.6	+0.930	+87.4	+0.005	+0.5	+0.015	+1.4	+0.025	+2.4	+0.035	+3.3
Total	991.8		-17.6		+89.9		+2134.1		+327.2		+776.6		+934.7		+789.8

COMP. FOR DEAD STRESS (CONT.)

		L_8L_9		$L_{10}L_{11}$		$L_{12}L_{13}$	
Panel Points	Dead Load	Sum of Infl. Line Ordinates	S′	Sum of Infl. Line Ordinates	S′	Sum of Infl. Line Ordinates	S′
1 & 27	68.3	+0.001	+0.1	-0.220	-15.0	-0.443	-30.2
2 & 26	69.6	+0.029	+2.0	-0.409	-28.5	-0.847	-58.9
3 & 25	73.1	+0.066	+4.8	-0.586	-42.8	-1.238	-90.5
4 & 24	72.6	+0.130	+9.4	-0.730	-53.0	-1.590	-115.4
5 & 23	79.6	+0.230	+18.3	-0.830	-66.0	-1.890	-150.2
6 & 22	73.0	+0.357	+26.1	-0.897	-65.5	-2.151	-157.0
7 & 21	78.7	+0.529	+41.6	-0.909	-71.6	-2.347	-184.9
8 & 20	71.5	+0.818	+58.5	-0.778	-55.6	-2.374	-169.9
9 & 19	78.2	+1.179	+92.3	-0.559	-43.7	-2.297	-179.2
10 & 18	73.9	+0.693	+51.2	-0.153	-11.3	-1.999	-148.0
11 & 17	80.8	+0.306	+24.7	+0.374	+30.2	-1.558	-125.9
12 & 16	78.2	+0.126	+9.9	+0.154	+12.0	-0.818	-63.9
13 & 15	94.1	+0.045	+4.2	+0.055	+5.2	+0.065	+6.1
~~Total~~	991.8		+343.1		-405.6		-1467.9

COMP. FOR DEAD STRESS

Bar	S'	Ratio	Stress
L_0U_1	-327.2	$\frac{46.8}{34}$	-450
L_2U_1	+153.1	$\frac{46.8}{34}$	+211
L_2U_3	-83.4	$\frac{58.6}{49}$	-100
L_4U_3	+72.8	$\frac{58.6}{49}$	+87
L_4U_5	-0.5	$\frac{62.86}{54}$	-1
L_6U_5	-36.2	$\frac{62.86}{54}$	-42
L_6U_7	+109.2	$\frac{62.86}{54}$	+127
L_8U_7	-187.9	$\frac{62.86}{54}$	-219
L_8U_9	+259.3	$\frac{62.86}{54}$	+302
$L_{10}U_9$	-337.4	$\frac{62.86}{54}$	-393
$L_{10}U_{11}$	+411.4	$\frac{62.86}{54}$	+479
$L_{12}U_{11}$	-402.2	$\frac{62.86}{54}$	-468
$L_{12}U_{13}$	+480.2	$\frac{73.4}{66}$	+534
$L_{14}U_{13}$	-664.3	$\frac{73.4}{66}$	-738
U_1U_2	-106.0	$\frac{33.03}{7.5}$	-466
U_3U_4	-43.3	$\frac{32.27}{2.5}$	-559
U_5U_6	-897.9	$\frac{32.2}{54}$	-535
U_7U_8	-602.3	$\frac{32.2}{54}$	-358
U_9U_{10}	-17.6	$\frac{32.2}{54}$	-11
$U_{11}U_{12}$	+89.9	$\frac{32.72}{6}$	+490
$U_{13}U_{14}$	+2134.1	$\frac{32.2}{66}$	+1040
L_0L_1	+327.2	$\frac{32.2}{34}$	+309
L_2L_3	+776.6	$\frac{32.2}{49}$	+510
L_4L_5	+934.7	$\frac{32.2}{54}$	+556
L_6L_7	+789.8	$\frac{32.2}{54}$	+470
L_8L_9	+343.1	$\frac{32.2}{54}$	+204
$L_{10}L_{11}$	-405.6	$\frac{32.2}{54}$	-242
$L_{12}L_{13}$	-1467.9	$\frac{32.2}{66}$	-715

Computations for Live Stresses:

Un.Ld. = .562x32.2 = 18.08 per panel Conc.Ld. = 26.3 $I = \frac{0.8(L\ 250)}{10L\ \ 500}$ where L - loaded length

Bar	L_oU_1		U_1U_2 & U_2U_3	
Uniform Load over	Lo - L_{14} inclusive		Lo - L_{14} inclusive	
Concentrated load at	L_1		L_2	
Un. Ld.	-5.498 x 18.08	= -99.44	-1.807 x 18.08	= -32.67
Conc.Ld.	-0.909 x 26.3	= -23.91	-0.296 x 26.3	= - 7.78
Vertical Comp.or S'		-123.35		-40.45
Stress	$-123.35 \times \frac{46.8}{34}$	= -170.22	$-40.45 \times \frac{33.03}{7.5}$	= -178.14
Impact	$-170.22 \times \frac{0.8(450\ 250)}{(10 \times 450)\ 500}$	= 19.06	$-178. \times \frac{0.8 \times 700}{5000}$	= -19.95
Total Live Stress		- 189.28		-198.09

Bar	U_3U_4 & U_4U_5		U_5U_6 & U_6U_7	
Uniform Load over	Lo - L_{14} inclusive		Lo - L_{14} inclusive	
Concentrated load at	L_1		L_6	
Un.Ld.	-0.776 x 18.08	=- 14.03	-17.988 x 18.08	= -325.26
Conc.Ld.	-0.125 x 26.3	=- 3.29	- 2.832 x 26.3	= - 74.48
Vertical Comp.or S'		- 17.32		-399.74
Stress	$-17.32 \times \frac{32.27}{2.5}$	= -223.63	$-397.74 \times \frac{32.2}{54}$	= -238.13
Impact	$-223.63 \times \frac{0.56}{5}$	= - 25.06	$-238.13 \times \frac{0.56}{5}$	= - 26.67
Total Live Stress		-248.69		-264.80

Computations for Live Stresses:

Un.Ld. = .562 x 32.2 = 18.08 per panel Conc.Ld. = 26.3 $I = \frac{0.8(L\ 250)}{10L\ \ 500}$ where L = loaded length

Bar	U_7U_8 & U_8U_9		U_9U_{10} & $U_{10}U_{11}$	
Un.Load over	Lo - L_{14} incl.		LO - L_{14} incl.	
Conc.Ld. at	L_8		L_{10}	
Un. Ld.	-15.984 x 18.08	= - 288.99	-9.980 x 18.08	= - 180.44
Conc.Ld.	- 2.52 x 26.3	= - 66.28	-1.810 x 26.3	= - 47.60
Vertical Comp. orS'		- 355.27		- 228.04
Stress	$-355.27 \times \frac{32.2}{54}$	= - 211.74	$-228.04 \times \frac{32.2}{54}$	= - 135.91
Impact	$-211.74 \times \frac{0.56}{5}$	= - 23.71	$-135.91 \times \frac{0.56}{5}$	= - 15.22
Total Live Stress		- 235.45		- 151.13

Bar	$U_{11}U_{12}$ & $U_{12}U_{13}$		$U_{13}U_{14}$	
Un.Load over	Lo - L_9 & L_{14} - L_{28}		Lo - L_{28}	
Conc.Ld. at	L_{20}		L_8	
Un.Ld.	1.404 x 18.08	= 25.38	28.06 x 18.08	= 506.53
Conc.Ld.	0.1356x 26.3	= 3.57	1.59 x 3.57	= 41.82
Vertical Comp.orS'		28.95		548.35
Stress	$28.95 \times \frac{32.72}{6}$	= 157.87	$548.35 \times \frac{32.2}{66}$	= 267.05
Impact	$157.87 \times \frac{0.8(740\ 250)}{7400\ \ 500}$ =	15.79	$267.05 \times \frac{0.8(900\ \ 250)}{9000\ \ 500}$	= 25.86
Total Live Stress		173.66		292.91

Computations for Live Stresses:

Un.Ld. = .562 x 32.2 = 18.08 per panel   Conc.Ld. = 26.3 $I = \frac{0.8(1 \quad 250)}{10 \quad 500}$ where L = loaded length

Bar	$L_2 U_1$		$L_2 U_3$	
Uniform Ld. over	$L_2 - L_{14}$		$L_3 - L_{14}$	
Conc.Ld. at	L_2		L_3	
Un. Ld.	2.93 x 18.08	= 52.97	-2.407 x 18.08	= -43.52
Conc. Ld.	0.523 x 26.3	= 13.75	-0.466 x 26.3	-12.26
Vertical Comp.		66.72		-55.78
Stress	$66.72 \times \frac{46.81}{34}$	= 92.07	$-55.78 \times \frac{58.62}{49}$	= -66.94
Impact	$92.07 \times \frac{0.8(386 \quad 250)}{3860 \quad 500}$	= 10.77	$66.94 \times \frac{0.8(354 \quad 250)}{3540 \quad 500}$	= - 8.01
Total Live Stress		102.84		-74.95

Bar	$L_4 U_3$		$L_4 U_5$	
Un. Ld. over	$L_4 - L_{14}$		$L_0 - L_4$ & $L_{14} - L_{28}$	
Conc.Ld. at	L_4		L_4	
Un. Ld.	2.450 x 18.08	= 44.30	2.016 x 18.08	= 36.45
Conc. Ld.	0.517 x 26.3	= 13.60	0.483 x 2.63	= 12.70
Vertical Comp.		57.90		49.15
Stress	$57.9 \times \frac{52.62}{49}$	= 69.48	$49.15 \times \frac{62.86}{54}$	= 57.21
Impact	$69.48 \times \frac{0.8(322 \quad 250)}{3220 \quad 500}$	= 8.28	$57.21 \times \frac{0.8(580 \quad 250)}{5800 \quad 500}$	= 6.00
Total Live Stress		77.76		63.21

Computations for Live Stresses:

Bar	$L_6\ U_5$		$L_6\ L_7$	
Un. Ld. over	$Lo\text{-}L_5\ \&\ L_{14}\text{-}L_{28}$		$Lo - L_6\ \&\ L_{14} - L_{28}$	
Conc.Ld. at	L_5			
Un.Ld.	-2.341 x 18.08	= - 42.33	2.869 x 18.08	= 51.87
Conc.Ld.	-0.444 x 26.3	= - 11.68	0.528 x 26.3	= 13.92
Vert. Comp.		54.01		65.79
Stress	$-54.01 \times \frac{62.86}{54}$	= - 62.86	$65.79 \times \frac{62.86}{54}$	= 76.58
Impact	$-62.86 \times \frac{0.8(610\quad 250)}{6100\quad 500}$	= - 6.55	$76.58 \times \frac{0.8(640\quad 250)}{6400\quad 500}$	= 7.90
Total		-69.41		84.48

Bar	$L_8\ U_7$		$L_8\ U_9$	
Un.Ld.over	$Lo\text{-}L_7\ \&\ L_{14} - L_{28}$		$Lo\ \text{-}L_8\ \&\ L_{14}\text{-}\ L_{28}$	
Conc.Ld. at	L_7		L_8	
Un. Ld.	-3.479 x 18.08	= - 62.90	4.164 x 18.08	= 75.29
Conc.Ld.	-0.610 x 26.3	= - 16.04	0.685 x 26.3	= 18.02
Vert. Comp.		- 78.94		93.31
Stress	$-78.94 \times \frac{62.86}{54}$	= - 91.89	$93.31 \times \frac{62.86}{54}$	= 108.51
Impact	$-91.89 \times \frac{(675\quad 250)0.8}{6750\quad 500}$	= 9.37	$108.51 \times \frac{0.8(710\quad 250)}{7100\quad 500}$	= 10.95
Total		-101.16		119.46

Computations for Live Stresses:

BAR	$L_{10}\ U_9$		$L_{10}\ U_{11}$	
Un. Ld. over	$LO-L_9$ & $L_{14}-L_{28}$		$Lo-L_{10}$ & $L_{14}-L_{28}$	
Conc.Ld. at	L_9		L_{10}	
Un. Ld.	-4.920 x 18.08	= -88.85	5.739 x 18.08	= 103.76
Conc. Ld.	-0.756 x 26.3	= -19.88	0.819 x 26.3	= 21.54
Vert. Comp.		-108.83		125.30
Stress	-108.83 x $\frac{62.86}{54}$	= -126.68	125.3 x $\frac{62.86}{54}$	= 145.85
Impact	-126.68 x $\frac{0.8(740\quad 250)}{7400\quad 500}$	= - 12.67	145.85x $\frac{0.8(770\quad 250)}{7700\quad 500}$	= 14.59
Total		-139.35		160.44

BAR	$L_{12}\ U_{11}$		$L_{12}\ U_{13}$	
Un. Ld. over	$Lo-L_{14}$		$Lo-L_{14}$	
Conc.Ld. at	L_{11}		L_{12}	
Un. Ld.	-5.50 x 18.08	= - 99.44	6.50 x 18.08	= 117.52
Conc. Ld.	-0.925x 26.3	= - 24.33	1.016x 2.63	= 26.72
Vert. Comp.		-123.77		144.24
Stress	-123.77 x $\frac{62.86}{54}$	= -144.07	144.24 x $\frac{73.42}{66}$	= 160.39
Impact	-144.07 x $\frac{0.8(450\quad 250)}{4500\quad 500}$	= - 16.14	160.39 x .112	= 17.96
Total		-160.21		178.35

Computations for Live Stresses:

Bar	$L_{14}\ U_{13}$		$Lo\ L_1\ \&\ L_1\ L_2$	
Un. Ld. over	$Lo - L_{28}$		$Lo-L_{14}$	
Conc. Ld. at	L_{14}		L_1	
Un. Ld.	-8.508 x 18.08	=-153.82	5.498 x 18.08	= 99.44
Conc.Ld.	-0.962 x 26.3	=- 25.30	0.909 x 26.3	= 23.91
S'	Vert. Comp	=-179.12		123.35
Stress	$-179.12 \times \frac{73.42}{66}$	=-199.18	$123.35 \times \frac{32.2}{34}$	= 116.69
Impact	$-199.18 \times \frac{.08(900\quad 250)}{9000\quad 500}$	=- 19.30	$116.7 \times \frac{0.8(450 \times 250)}{4500\quad 500}$	= 13.07
Total		-218.48		129.76

Bar	$L_2\ L_3\ \&\ L_3\ L_4$		$L_4\ L_5\ \&\ L_5\ L_6$	
Un. Ld. over	$Lo - L_{14}$		$Lo - L_{14}$	
Conc. Ld. at	L_3		L_5	
Un. Ld.	13.494 x 19.08	= 243.79	17.490 x 18.08	= 316.22
Conc. Ld. at	2.19 x 26.3	= 57.60	2.78 x 26.3	= 73.11
S'	Vert. Comp	= 300.57		= 389.33
Stress	$300.6 \times \frac{32.2}{49}$	= 197.34	$389.33 \times \frac{32.2}{54}$	= 232.04
Impact	197.34x .112	= 22.10	232.04 x .112	= 25.99
Total		219.44		258.03

Computations for Live Stresses

Bar	L_6L_7 & L_7L_8		L_8L_9 & L_9L_{10}	
Un.Ld.over Conc.Ld.at	$Lo-L_{14}$ L_7		$Lo-L_{14}$ L_9	
Un. Ld.	$+17.486 \times 18.08$ =	+ 316.15	$+13.48^{2} \times 18.08$ =	+243.75
Conc. Ld.	$+ 2.73 \times 26.3$ =	+ 71.80	$+ 2.196 \times 26.3$ =	57.75
S'		+ 387.95		+301.50
Stress	$+388 \times \frac{32.2}{54}$ =	+ 231.25	$+301.5 \times \frac{32.2}{54}$ =	+179.69
Impact	$+231.25 \times 0.112$ =	+ 25.90	$+179.7 \times .112$ =	+ 20.13
Total		+ 257.15		+199.82

Bar	$L_{10}L_{11}$ & $L_{11}L_{12}$		$L_{12}L_{13}$ & $L_{13}L_{14}$	
Un.Ld.over Conc.Ld. at	$L_{14}-L_{28}$ L_{20}		$Lo-L_{11}$ & $L_{14} - L_{28}$ L_{20}	
Un. Ld.	-10.967×18.08 =	-198.28	-19.995×18.08 =	-361.60
Conc.Ld.	$- 1.243 \times 26.3$ =	- 32.69	$- 1.469 \times 26.3$ =	38.63
S'		-230.97		-400.23
Stress	$-230.97 \times \frac{32.2}{54}$ =	-137.68	$-400.2 \times \frac{32.2}{66}$ =	-195.26
Impact	$-137.7 \times .112$ =	- 15.42	$-195.3 \times \frac{0.8(805+250)}{8050+500}$ =	-19.25
Total		-153.10		-214.51

Computations for Live Stresses

Reversals:

	U_9 U_{10}		L_6 U_5		L_4 U_5	
Un.Ld.Over	$L_{14}-L_{28}$		$L_6 - L_{14}$		$L_5 - L_{14}$	
Conc.Ld.at	L_{19}		L_6		L_5	
Un.Ld.	+9.97x18.08	= 180.26	+1.842x18.08	= +33.30	-1.933x18.08	= -34.95
Conc.Ld.	+1.13x26.3	= 29.72	0.472x26.3	= +12.41	-0.448x26.3	= -11.78
S'		+209.98		+45.71		-46.73
Stress	$+209.98\times\frac{32.2}{54}$	= +125.10	$+45.71\times\frac{62.86}{54}$	= +53.21	$-46.73\times\frac{62.86}{54}$	= 54.39
Impact	$+125.10\times\frac{0.56}{5}$	= + 14.01	$+53.21\times\frac{(260+250)0.8}{2600+500}$	= 7.00	$-54.39\times\frac{0.8(290+500)}{2900+500}$	= -6.96
Total		+139.01		+60.21		-61.35
Dead Stress		- 11.00		-42.00		1.00
Reversal		+128.00		+18.21		-62.35