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A STUDY OF INFLUENCE LINE ANALYSIS OF STRESSES IN A CANTILEVER STEEL HIGHWAY BRIDGE

BY

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A

THESIS

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1932 .

Approved by E. W. Carlton
Associate Professor of Civil Engineering

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PREFACE

As its name implies, this thesis introduces to the reader the basic conceptions and principles of the use of influence line analysis of the structural theory relating to calculation of stresses in a steel cantilever bridge truss.

It is the common practice in all text books dealing with structural theory to confine their discussions on stress analysis to the purely time honored analytical methods, with the mere mention of the possibilities of graphic or semi-graphic methods of influence line analysis of structures beyond simple trusses. During the study of my course in advanced structures, the possibilities of the influence line method of stress analysis for the more complicated structures, such as the cantilever types, became apparent and since there was little or no information to be had in this field it was decided to make an exhaustive study of influence line analysis of stresses in a typical cantilever truss bridge as my thesis work.

In practically all design offices the current practice in designing advanced structures is to use analytical methods of stress analysis, but this has always proven laborious, difficult, and conductive of errors, resulting in the necessity of extreme care with all calculations and frequent checking. The reason that very little advance or change in methods of design have occurred in past years is probably due to the fact that designers of the old school are rather hesitant to adopt new and unproven methods and the natural inertia against changing their accustomed practices. But in recent years it has been felt the graphic or semi-graphic methods are faster and less liable to error than the analytical methods. Therefore, if the above methods can be found to give results within the required limits of accuracy, they have everything in their favor.

The influence line method of stress analysis simplifies many problems of design, and especially reduces the space, and time required for a complete treatment of bridge trusses and concentrated load systems.

Therefore, an attempt has been made in this thesis to prove the practicability of the influence line method of stress analysis in the design of advanced bridge structures.

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A STUDY OF INFLUENCE LINE ANALYSIS OF THE STRESSES IN A CANTILEVER STEEL HIGHWAY BRIDGE

This thesis consists of a detailed study, together with the necessary calculations, of the various stresses in a cantilever steel highway bridge by the use of influence lines.

The following data for the truss used in this study is typical for the present day trend in cantilever highway bridge construction.

Data:

Inclined Chord Pratt-type Truss:

Anchor Arm:

10 panels at 25'0" = 250'0"
Height at hip = 30'0"
Height at peak = 50'0"

Cantilever Arm:

5 panels at 25'0" = 125'0"
Height at peak = 50'0"
Height at end of suspended span = 30'0"

Suspended Span:

8 panels at 25'0" = 200'0"
Height at hip = 30'0"
Height at peak = 37'6"

The loading used in the study is the standard recommended practice of the Missouri State Highway Department and is as follows: A uniform load of 510 pounds per foot of truss, with concentrated loads of 15000 pounds for moment and 7500 pounds for shear. The usual signs for indicating the type of stress were used, that is, the plus means tension and the minus means compression. Only live load strusses have been calculated. Three methods have been used in determining these stresses: first, the method of determining the ordinate of the influence lines by purely graphical methods; second, the method of determining the ordinates by the semi-graphical method, and third, the check method of simple moments.

The aim of this study is to compare the methods from the standpoint of accuracy of results, amount of labor required, and the practicability of using these methods in the actual designing of this type of structure. Any point of special difficulty in the calculations of the stresses in any specific member will be discussed. The final conclusion will be the writer's recommendation as to what method, or combination of methods, can be best used for a cantilever bridge.

In the study of large and complicated trusses, curves called influence lines are drawn to show the variations of various functions such as shear, moment, or deflection at a given section; or the stress in a given bar, due to the passage of a single unit load across the span. Such curves are important in the study of the effect of concentrated loads, and also in the development of certain theorems of structural action. They were first used by Professor Winkler of Berlin Germany in 1867.

An influence line may be defined as a curve any ordinate of which gives the value of the function (shear, moment, bar stress, etc) for which the curve is drawn when a load of unity is at the ordinate. It is constructed by plotting directly under the point where the unit load is placed, an ordinate the height of which represents to some scale the value of the particular function being studied when the load is in that position. Contrast carefully shear and moment curves with influence lines for shear and moment. A shear or moment curve records graphically the value of the function at all sections of a beam under a <u>fixed</u> loading; an influence line for shear or moment records graphically the value of the function at a <u>single</u> section for a load at <u>all</u> sections.

The following examples illustrate the construction of a few simple influence lines. If the definition of an influence line given above and the constructions below are clearly understood, there should be no difficulty in extending these methods to the construction of any influence line for any statically determinate structure.

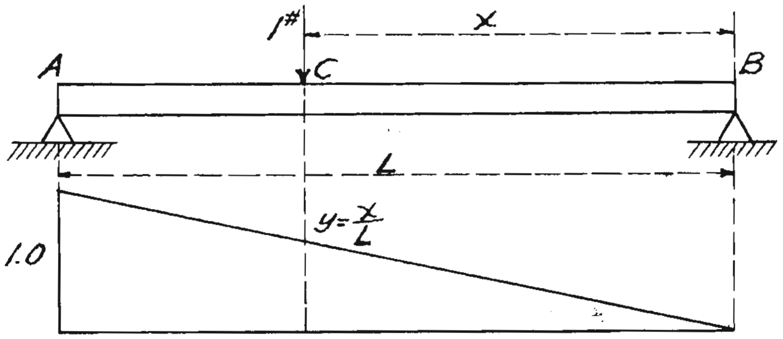


FIG. 1.

In Fig. 1 is shown a simple beam and the influence line for its left reaction. Keeping in mind that this influence line should show the variation in the left reaction as a unit load moves across the span, the student should reason as follows. When the load is at B the reaction at A is zero and the ordinate to the influence line at B is zero. As the load moves from B towards A the reaction at A increases, and as this reaction is

$$R_A = \frac{x}{L}$$

when the unit load is at any point, C, x feet to the left of B, it must be increasing at a uniform rate and the influence line must be a straight line as shown, the ordinate at A being 1, since that will be the reaction at A when the load is at that point.

In drawing influence lines, positive values of the function being considered are generally plotted above the reference line. Reactions which act upward are considered as positive, and the signs for shear and moment are as previously defined.

In Fig. 2 is shown a simple structure and the influence line for the reaction at D as a unit load moves from A to B.

When the unit load is at A the reaction at D is 3/10, and since it acts downward the ordinate to the influence line at A must be -3/10 as shown. As the load moves to the right the reaction at D decreases numerically, evidently at a uniform rate, and when it is directly over the support at C the reaction at D is zero. As the unit load moves to the right toward B the reaction at D increases at a uniform rate until the load reaches B. When the unit load is at B the reaction at D is $1\frac{1}{2}$ and the influence line must be as shown.

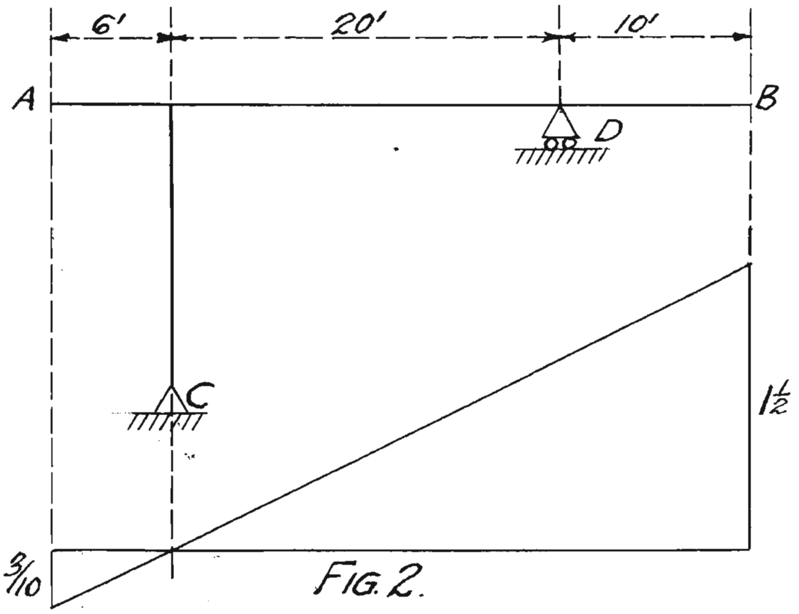


FIG. 2.

In Fig. 3 is shown a simple beam with the influence lines for shear and for bending moment at C. In studying the influence line for shear at C, as the unit load moves from B towards A, pass a section at C and consider the part of the beam on the left of the section. As long as the unit load is between B and C the only force acting on the part of the beam to the left is the reaction at A, and evidently between B and C the influence

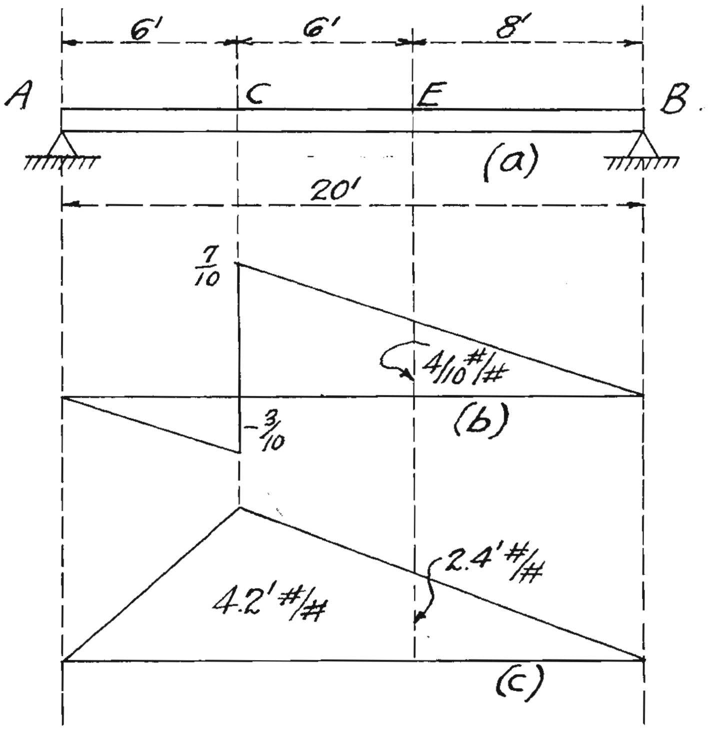


FIG. 3.

line for shear at C must be the same as the influence line for reaction at A. After the load passes C it is more convenient to consider the part of the beam on the right of the section at C since the only force acting on this part is the reaction at B. The shear at C varies as the reaction at B when the unit load is between C and A, and this variation is as shown. Although the reaction at B acts upward the shear at C is negative in accordance with the definition previously given,and is so shown in the figure.

In drawing the influence line for bending moment at C the same method of attack is used. When the unit load is between B and C the bending moment at C is the left reaction multiplied by the distance from this reaction to C. This is the product of a reaction which is changing at a uniform rate and a constant distance, and the bending moment, therefore, is changing at a uniform rate. When the unit load is between A and C the bending moment at C is the right reaction multiplied by the distance from B to C, and obviously changes at a uniform rate as shown in the figure.

In Fig. 4(a) is shown diagrammatically a bridge girder loaded through a floor system. In a drawing influence lines for such girders it is usual to deal with a unit reaction from the floor system; that is, the load applied to the floor system is assumed to be of such magnitude and so loacted that when it is over a floorbeam the reaction of that floorbeam on the girder will be one unit.

The influence line for bending moment at panel point 3, shown in Fig. 4(c), needs no explanation; the method of attack is the same as that used in drawing the influence line for bending moment in Fig. 3(c). The influence line for shear shown in Fig. 4(b), however, differs from that shown in Fig. 3(b) in that the former is an influence line for shear at any section within a panel whereas the latter is an influence line for shear at a specific section. Since the load can be applied to the girder in Fig. 4(a) only at the panel points, the shear between panel points must be constant, and an influence line for shear at at any section within a panel is an influence line for shear at all section in that panel. In studying the influence line for shear in panel 2-3, which is shown in Fig. 4(b), the same method may be used as before except that it is only when the unit load is between 3 and B or between 2 and A that the reaction is the only force acting on the part of the structure being considered. The portion of the influence line drawn for the unit load between the

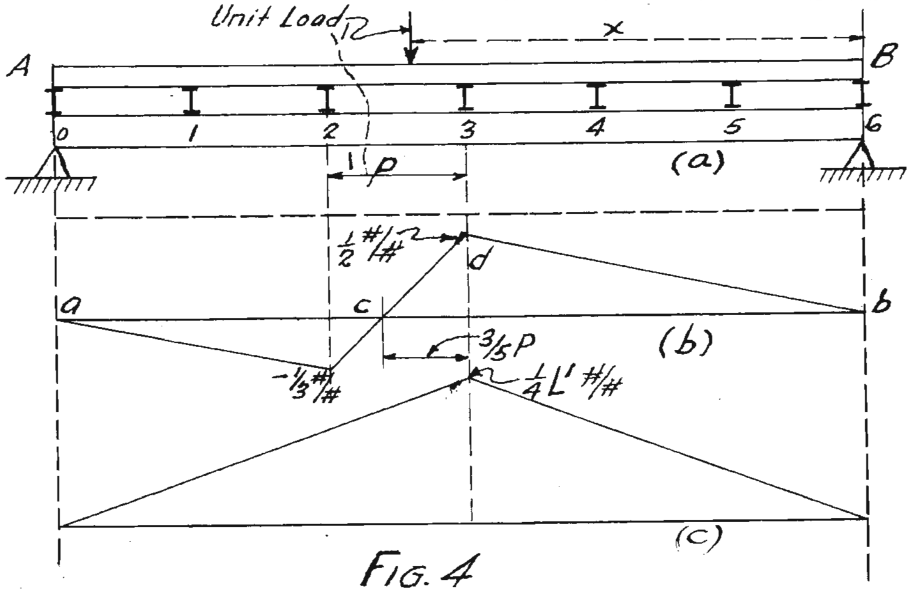


FIG. 4

points just mentioned is of course similar to that drawn for shear at C in Fig. 3, but when the unit load is between points 2 and 3, an additional force acts on the part of the beam under consideration.

For example, pass the section 1-1 shown in Fig. 4(a) and consider the part on the left of this section. As long as the unit load is between 3 and B the reaction at A is the only force acting on the part of the structure under consideration, and the construction of this portion of the influence line for shear in the panel is very simple. As soon as the unit load passes point 3 moving towards A there begins to be a downard force at point 2 on the part of the beam on the left of the section.

This downard force at point 2 increases uniformly as the unit load moves from 3 to 2, and at the same time the reaction at A is increasing at a uniform rate. Since the shear in panel 2-3 is the reaction at A minus the downward force, or floorbeam reaction, at point 2, it is evident that it also is changing at a uniform rate and the influence line for shear in the panel may be completed by connecting the ordinates at points 2 and 3 by a straight line as shown. If this statement does not seem clear it is easy to write an equation for this portion of the influence line in terms of x, the length of span L, and the panel length p.

It may seem that unnecessarily detailed attention has been given to the construction of these very simple influence lines. The writer believes, however, that much of the confusion regarding influence lines often existing in the student's mind is the result of attempting to remember the shape of the simple forms first encourtered in studying the subject instead of carefully building them up, step by step, from the fundamental definition.

Attention should be called to the units of measure for the ordinates of influence lines. In the influence line shown in Fig.1, the ordinate at A is given as 1, which means that the reaction at A will be 1 lb.per lb. of load at A. Similarly at a section E, 8 ft. to the left of B in Fig. 3 the ordinate at A is given as 1, which means that the reaction at A will be 1 lb. per lb. of load at A.

Similarly at a section E, 8 ft. to the left of B in Fig. 3, the ordinate to the influence line for shear at C is 4/10 lb. per lb.; i.e., for each pound of load placed at E there will be a shear at C of 4/10 lb. The influence line for bending moment at C has at E an ordinate of 2.4 ft.-lb. per lb., or there will be a bending moment at C of 2.4 ft.-lb for each pound of load placed at E. Evidently the unit load instead of being 1 lb. may be 1 kip, 1 ton, 1 kilogram, or one unit of weight in any system we wish to use, without affecting in any way the construction of the influence line.

Since an influence line is constructed to show the effect of a unit load, it is clear that we may determine from it the effect of a load of any magnitude in any position by multiplying the ordinate at the load by the magnitude of the load. Thus in Fig. 3 at point E the ordinate to the influence line for shear at C is 4/10 lb. per lb. of load at E, the ordinate to the influence line for bending moment at C is 2.4 ft.-lb. per lb. of load at E. Consequently, if a load of 10,000 lb. is placed at E, we have due to this load:

Shear at C = 4/10 lb. per lb. x 10,000 lb = 4000 lb.

Bending moment at C = 2.4 ft.-lb per lb. x 10,000 lb = 24,000 ft.-lb.

Also it should be clear that if we place a uniformly distributed load of w lb. per ft. anywhere on the beam, the effect of this load on any function may be found from the influence line for that function. Considering a short length dx, the load on it is wdx, and if the ordinate to the influence line at the point where dx is taken is y, the effect of this load is wydx and the total effect is

$w\int ydx$ = w x area under influence line between limits of distributed load.

For example, if a uniformly distributed load of 4000 lb. per ft. is placed on the beam in Fig. 3 extending from E to C, we have:

Shear at C = (7/10 lb.per lb + 4/10 lb.per lb.)½ x 6 ft. x 4000 lb. per ft. = 13,200 lb.

Bending moment at C = (4.2 ft.-lb.perlb. + 2.4 ft.-lb. per lb)½ x 6 ft. x 4000 lb.per ft. = 79,200 ft.lb.

The cantilever type of bridge trusses have long been used where long spans were necessary and especially where the use of falsework during erection would be exceedingly costly or even virtually impossible. The present trend in bridge construction has been away from the types formerly used; the sub-divided K-type trusses and the designer today is leaning more and more to the use of the curved, or inclined cord, Pratt type trusses, and the flat cord Warren type. In any cantilever truss where the erection of the cantilever arm and suspended span is done with a traveler, the calculation of erection stresses is a large part of the entire stress analysis. For the Pratt and Warren type trusses the influence lines for any member can be easily and quickly drawn. Then, when the weight of the traveler, and also any load that might be applied incidental to erection, is known, the erection stresses can be quickly calculated. In case stresses in the anchor arm become too large during erection, a false bent may be placed and the truss cantilevered on out. Many highway bridges of any considerable length, are calculated for an equivalent loading consisting on a uniform live load and a special roving concentrated load. This type of loading is especially adapted to the use of influence lines, due to the fact that the stress in any member is found by multiplying the area under the influence line for this member by the uniform load in pounds per linear foot of truss. The calculations become slightly longer for a large member of concentrated loads but these are also very simple once the position for maximum stress has been determined, and this position of loads must be determined no matter what method is used.

Influence lines are not widely used at present in the calculation of stresses in small bridges, due largely to the mistaken idea as to their complexity. Once the fundamental idea as to the meaning of influence lines is clearly grasped by anyone who can calculate moment or shear in a beam or member can build any influence line step by step by calculating the controlling ordinates. Also many men, serving in executive capacities in design offices, are not in sympathy with any method of graphics for calculating stresses. This is due to their own unfamiliarity with the study of graphic calculations. Any stress within two per cent of the actual stress is sufficient for design, purposes due to the factor of safety used in all steel design. Any draftsman can easily come within these limits.

Two general statements may be made concerning the purely graphical method before going into detail of the actual construction of the various influence lines by this method. First, the influence lines by this method are larger and occupy considerable space on the sheet, thus necessitating the drawing of the stress itself several times as they cannot conveniently be kept on one sheet. Second, since they are larger, any error in drafting will likely be multiplied several times.

A cantilever truss is a structure made determinate by the introduction of a hinge. The effect of the hinge is to reduce the bending moment at that point to zero. In trusses the chord members connecting this point are made with a sliding joint and consequently can carry no stress. The supports divide the truss into several parts. In Fig 5 AB is the anchor arm

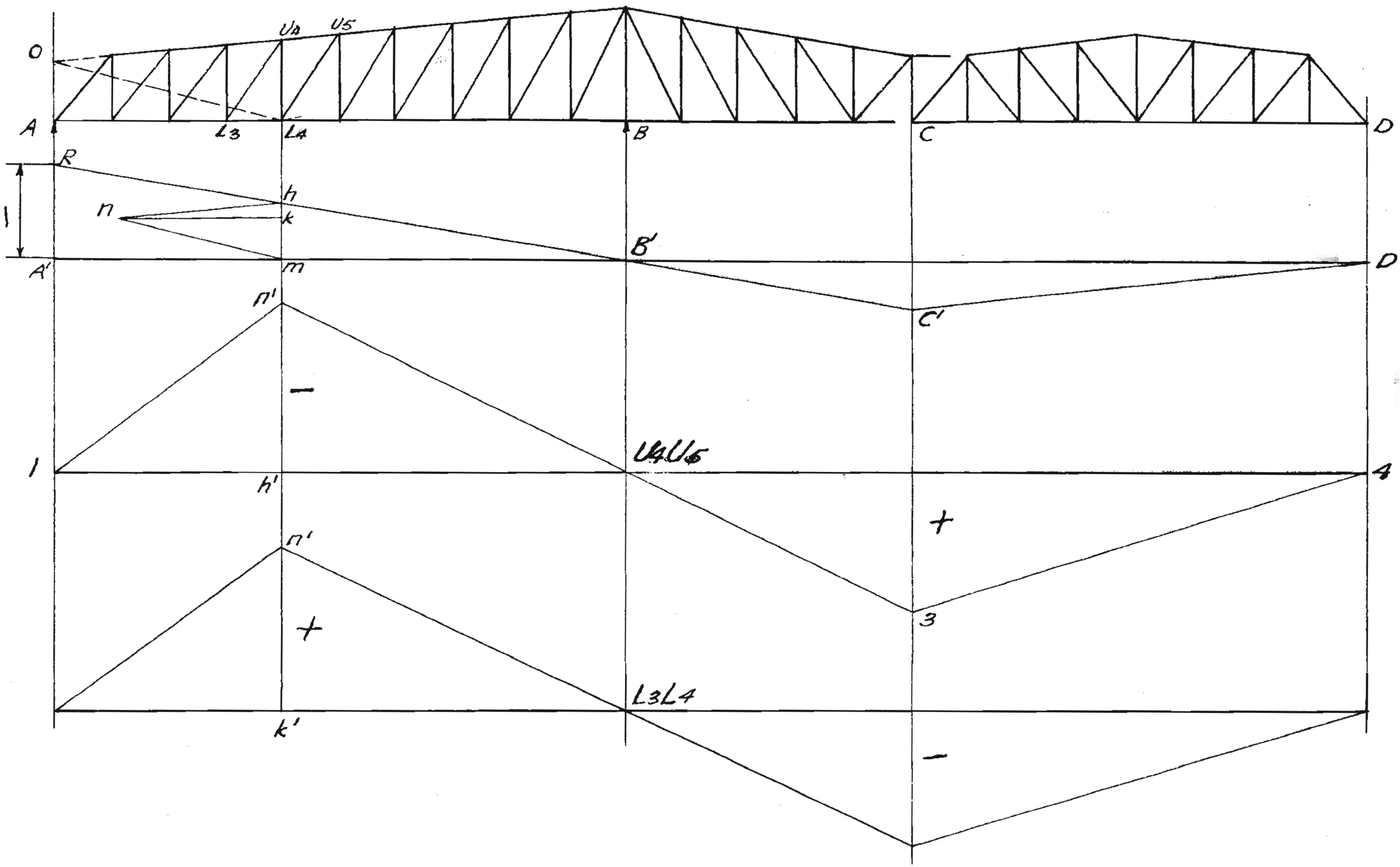


Fig. 5

BC is the cantilever arm and CD is the suspended span. The suspended span is calculated merely as a simple truss. Any load to the right of D has no effect on any member to the left of D. The influence line for the reaction at A is the line A', R, B', C', D', drawn for a unit load. It is easily seen that as a load moves to the left from D the reaction at A will be negative until the load reaches B, becoming a maximum when the load is at C. As the load moves from B to A, the anchor arm acts as a simple span. Therefore, any load to the right of B causes tension in the top chord of the anchor arm and compression in the lower chord and vice versa for loads to the left of B. The influence lines for any member of the anchor arm can be divided from this influence line for the reaction at A. Let us consider the influence line for the top chord U_4U_5. Extend the chord U_4U_5 until it intersects the line of R_A produced at a point O. Draw a line from O to L_4. Then from h, directly below L_4, draw a line parallel to the chord U_3U_4 until it is intersected by a line from m drawn parallel to the line O-L_4. Then nh becomes the controlling ordinate for the influence line and is plotted directly below the point m, and the line showing the effect of a moving unit load on U_4U_5 is drawn. Then since the stress in the lower chord varies as that in the top chord, a line parallel to L_3L_4 drawn from n to hm is the ordinate for the influence line for the lower chord L_3L_4. When these ordinates are found a line drawn from these points thru the reaction line B cuts the line under the end of suspended span at C and gives the necessary point to complete the lines. By scaling the ordinate at any point the effect of any load at any point on these members may be determined. If the top chord has a constant slope, as in the structure used in this thesis, the point O will be constant for all members of both upper and lower chords. However, in case of a curved upper chord, the procedure is exactly the same. Each upper chord is extended to locate the point O and the same lines drawn as in the example given here. The influence lines for all members of the upper and lower chords are shown on Sheet I. They have been drawn on a common base line so they can be placed on one sheet and easily seen. It will be noted that a special construction was necessary to draw the influence line for the lower chord L_9L_{10}; due to the fact that no ordinate could be obtained from the influence line for the reaction at A. By inspection of the truss at this point is is clearly seen that this member cannot receive any tension from live load since the load is transfered by the floor system to the truss only at a panel points, panel concentration at L_9 is entirely taken by the diagonal $U_{10}L_9$ and the post U_9L_9 Considering the anchor arm as a simple span the line for reaction at B is drawn, marked A"', B"',M. Then, using the above method the ordinate 11-12 is found and plotted below the point L_9. A line drawn from that point thru B" gives the influence line for the compression in the member. The portion of this line to the left of B" is shown as a broken line and it is not used. From an inspection of these lines it is clearly evident why accurate drafting is very essential. For example, any small variations in the ordinate 9't' for the lower chord L_8L_9 is multiplied several times when it reaches the line under the point C".

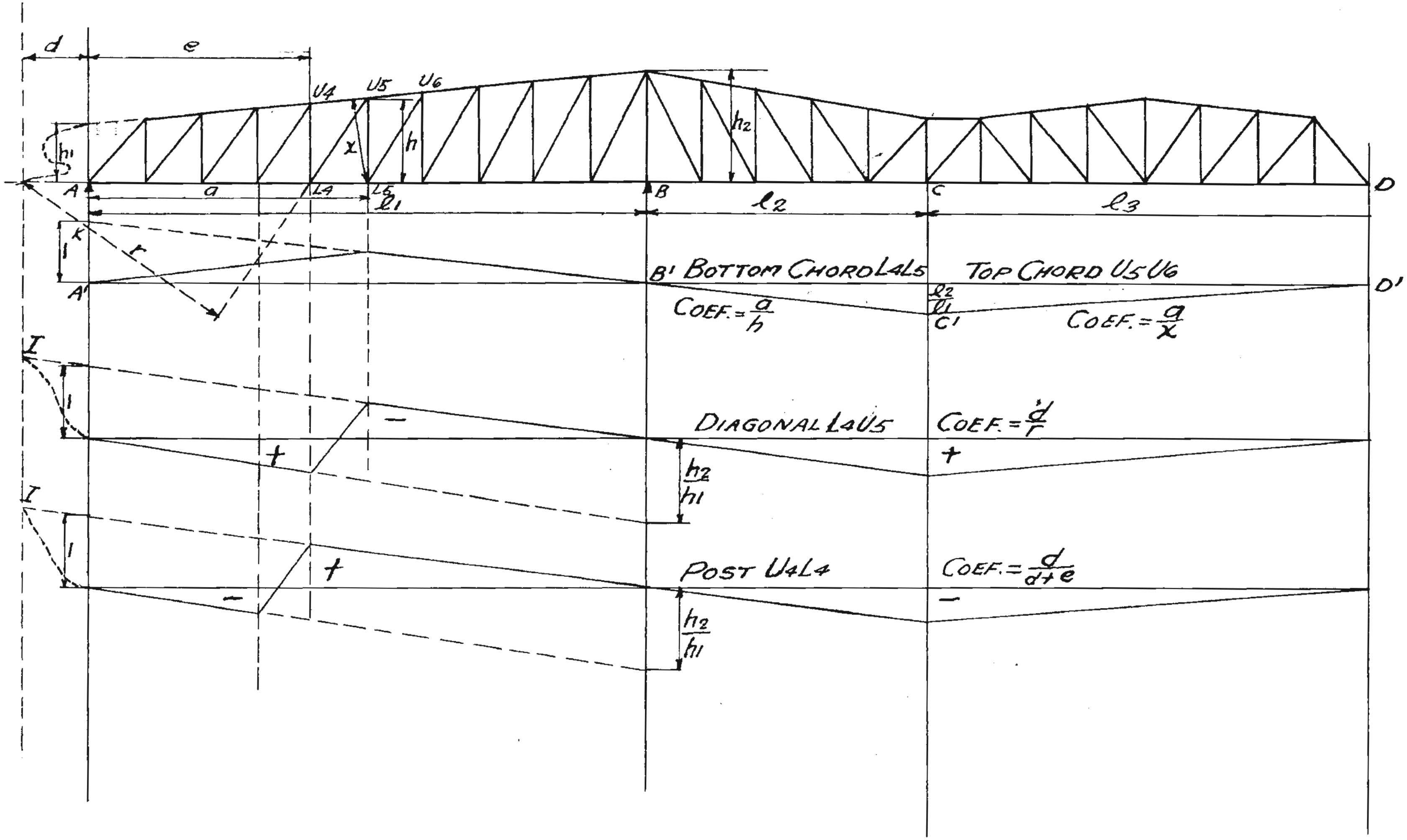
As the diagonals and posts cannot be handled in the usual manner in the anchor arm let us consider Sheet VII, the stresses in the suspended span. This span is handled exactly as any ordinary simple span. A'B'D is the influence line for the reaction at A. By extending the top chord to the point O and drawing the line O L_3 the ordinates for the top chord U_2U_3 and L_3L_4, namely, o_2g_2 and o_2r_2 may be found and the lines drawn for these members. Then by drawing from o_2 parallel to the diagonal U_1L_2, the ordinate o_2k_2 is found. This is one of the controlling ordinates for the influence line for U_2L_3. As a load at L_3 produces positive shear in the diagonal and a load at L_2 produces negative shear in the diagonal it is evident that at some point in the panel the shear must pass thru zero. Knowing one ordinate if this point of zero shear can be found the influence line for the member can be constructed. One method is by drawing the influence line for the reactions at B, just as was done for the reaction at A. The same method of obtaining the ordinate is used for obtaining the ordinate o_2K_2. This when plotted below the panel point L_2 fixes the final ordinate for the drawing of the line for the diagonal. However, an easier method is the one followed on this sheet. Draw a line from point O to B. Where this line cuts the diagonal is the point of maximum shear in the panel. When this point is projected downward and a line drawn from the ordinate o_2k_2 thru this point until it intersects the line below L_2 then all the controlling points for the diagonal have been found. The method for drawing the influence lines for the posts is the same. Draw a vertical line from o_2 to the point m_2 and one ordinate for the post U_2L_2 is found. As this post gets its maximum compression when L_2L_3 gets its maximum tension the same point of negative shear holds and so the line is drawn. It will be noted that on this sheet the ordinates for the diagonals are found from the reaction that is "behind" the diagonal, that is, from the reaction nearest to the upper end of the member. Now to return to the stresses in the anchor arm, Sheet II. The ordinate for the diagonals and posts could not be satisfactorily drawn from the influence line for the reaction at A, so considering the anchor arm as a simple span these points were found from the reaction at B, which is marked PEF. It will be noted on this sheet that unity is taken as four inches, whereas on other sheets it was taken as two inches. This was necessary due to to the difficulty of separating the various lines. If each line is drawn on a separate base line it would require a great deal of space. The same applies to the influence line for the posts m Sheet II A. Sheets II and IIA clearly show the difficulty of the graphical method for calculating the stresses in diagonals and verticals. When calculating the stress in chord members, where there is no point of zero stress, the area under the influence line times the uniform load gives the stress in the member. However, since the truss receives its load from the floor system only at panel points, the ordinate of the influence line at each panel point must be known for posts and diagonals. Also where the influence line crosses the base line the distance from the panel point in question is multiplied by the uniform load if it is equal to, but does not exceed a half panel length. If less than half a panal length, the actual scaled distance is used.

On an influence line for any member in a simple span the concentrated load is placed where the ordinates is greatest to obtain the maximum stress. This does not hold true for the tension in diagonals in the anchor arm of a cantilever. The concentrated load is placed on the end of the cantilever arm until the distance to the lower end of the diagonal from B is equal to or less than the length of the cantilever arm. This fact is proved by moments.

For example in calculating the tension stress in U_5L_4 Sheet 2, full panel loads would be applied due to uniform load, from L_0 out to panel L_4, since the point of zero stress is 14.76' from L_4, this being above 12.5 or a full half panel length. A uniform load would also be applied from B' to D'. Now by inspecting the ordinates of the line for this member, that on the right of B' is 0.44 while the maximum on the left of B' is 0.63. It would seem that the concentrated load would be placed on the left at the 0.63 ordinate but since this point is farther from B' than the end of the cantilever arm is from B' the concentrated load must be placed at the 0.44 ordinate under the end of the cantilever arm. The reason is this: For every diagonal and post a uniform load is placed on the span from B to D to produce tension in the member. This load causes a negative reaction at A, that is acting downward. For the first four diagonals not enough load can be placed on the anchor arm to seriously counteract the loads placed between B and D. In calculating the stress in diagonal U_5L_4 a section, would be passed thru the panel cutting members U_4U_5, L_4L_5 and U_5L_4 itself. To find the stress in U_5L_4 the position of the structure to the left is considered a free body with only one force, the reaction at A. Then by taking moments at the point of intersection of U_4U_5 and L_4L_5 (a point somewhere out side the truss) the stress in diagonal U_5L_4 is found. The greater the reaction at A is, the greater is the stress in the diagonal. In other words, the reaction at A must be a maximum for a maximum stress to be produced in the diagonal and so long as the position of the load is farther to the left of B than the end of the

the cantilever arm is from B, a maximum reaction at A will not be produced. The method of placing the influence lines for all the diagonals or all the posts on a common base line is difficult and unsatisfactory. The influence line for each member could be drawn on a separate base line but this would require a large amount of space and would involve drawing the truss itself several times.

In drawing the influence line for the post U_1L_1 the influence line for the reactions at A must be used. On sheet IIA this is marked PGE. Then from a point on the influence line PGE directly below the post L_1U_1 a line is drawn parallel to the top chord. When this line is intersected by a line drawn from a point on PE parallel to the line $O\ L_1$ the ordinate for this post would be fixed and the influence line for the stress may be drawn.



d
e
U4
U5
U6
h'
x
h
h2
A
a
L4
L5
l1
B
l2
C
l3
D
k
1
r
A'
B' BOTTOM CHORD L4L5
TOP CHORD U5U6
D'
COEF. = a/h
l2/l1
C'
COEF. = a/x
I
1
−
+
DIAGONAL L4U5
COEF. = d/r
+
h2/h1
I
1
+
−
POST U4L4
COEF. = d/(d+e)
−
h2/h1

Fig. 6

The semi-graphic method of calculating the stresses in the anchor is much simpler than the graphic method, once the fundamental idea of the method is clearly understood. The influence lines for this method may well be called "reduced" influence lines since a coefficient is used to determine the true stress in a member. The influence line for any member can easily be derived from the influence line for the reaction at A (Fig. 6), considering the part between A and B is identical with the influence line for that member if the anchor arm is assumed a simple span. The part of the influence line between B and D is for all members of the anchor arm, a triangle with the height 1 $2/l_1$ below C, that is identical with the influence line for the reaction at A. The influence coefficient for any member is equal to the stress produced in that member by an upward force unity applied at A, the truss being assumed fixed at B. In Fig. 6 A'KB'C'D'A' is the influence line for the reaction at A, where A'K is unity. By drawing a line from A' to the intersection of a vertical from its center of moments and the line B'K the influence line is drawn for the bottom chord L_4L_5. By passing a section thru panel 4-5 with a load unity acting upward at A, and taking moments about U_5, the stress in L_4L_5 is equal to a/h which is the influence coefficient for this member. This is also the influence line for the top chord U_5U_6, the influence coefficient for which is a/r. The construction of the influence line for the diagonal L_4U_5 can be clearly seen in the figure. It could be drawn by finding its center of moments I or by its influence ordinate h_2/h_1 If the top chord should not be of constant slope the ordinate would change each time the slope of the chord changed. However, this would cause no difficulty. The influence line for the post U_4L_4 is also shown in the Figure.

The influence coefficients can be easily and quickly found by the use of a Maxwell diagram, starting resolution of forces at A and ending at B.

Sheet III shows the influence lines for all members of the anchor arm. The small number of lines and the small amount of space required affords a striking contrast with the same lines by the graphic method. This type of construction is particularly adapted to this type of truss or any truss having a straight or fairly straight top chord. The same influence line serves for two members, each having a different influence coefficient, however. These coefficients were found by a Maxwell diagram, shown m on the sheet. Some of the coefficients obtained in this way were checked by the other method and were entirely satisfactory. The same method of loading for maximum stresses in the posts and diagonals was used as was discussed under the graphic method preceeding this. The distances of the points of zero stress from the panel points were calculated by similar triangles after the ordinates were drawn as a check on the distances as scaled.

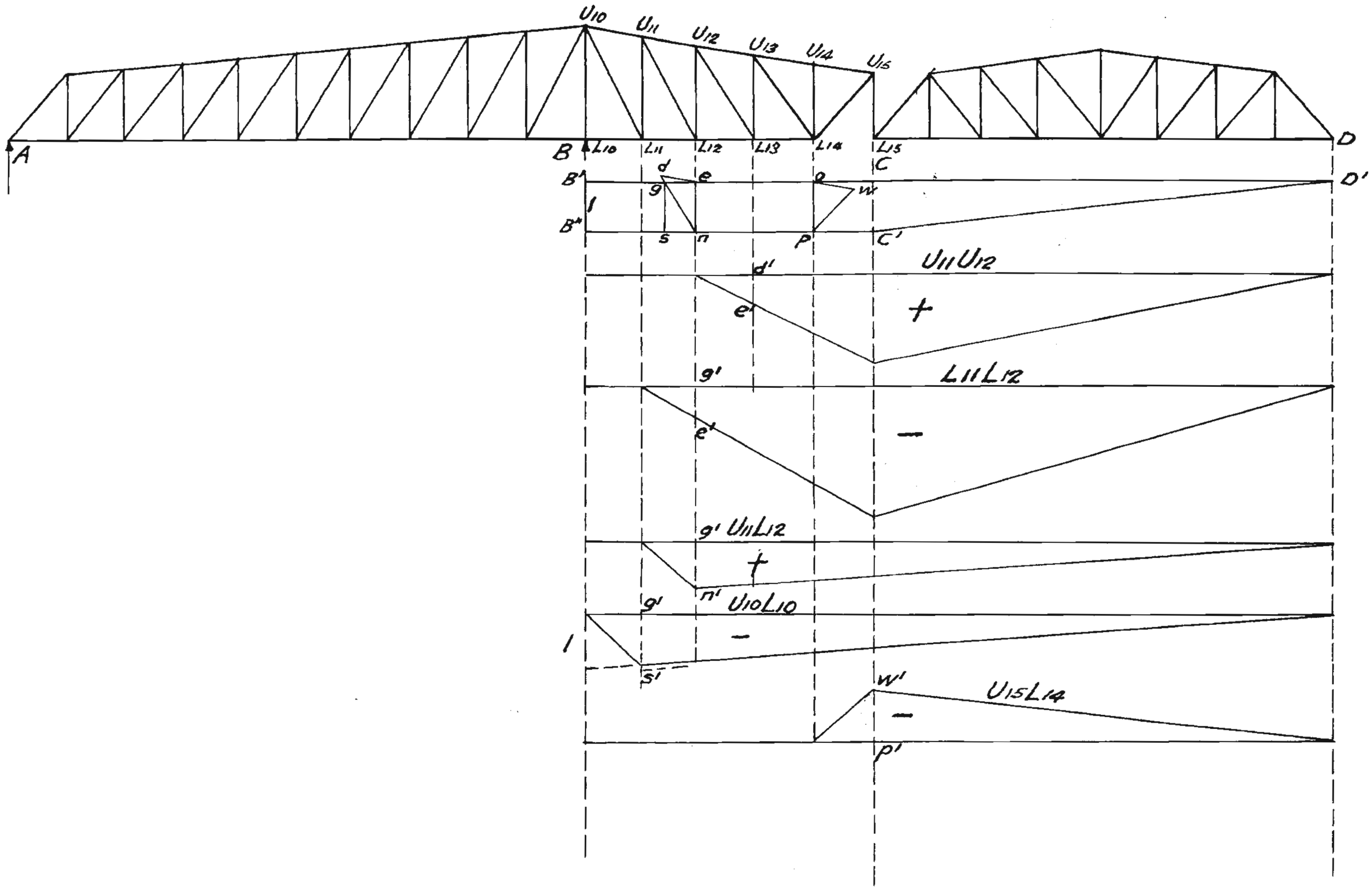

U10
U11
U12
U13
U14
U15
A
B
L10
L11
L12
L13
L14
L15
C
D
B'
B''
l
d
e
g
o
w
s
n
p
C'
D'
d'
e'
U11U12
+
g'
e'
L11L12
−
g' U11L12
+
n'
g'
U10L10
−
l
s'
w'
U15L14
−
p'

Fig. 7

The stresses in all members of the cantilever arm are independent of the reactions and are influenced only by loads on the suspended span and on the cantilever arm itself.

In Fig. 7 the influence lines are shown for various members of the cantilever arm. The reaction at B is the line B'B"D' and from this all the ordinates may be derived. As a unit load moves from D to B the reaction at B increases until it becomes unity at C and is the same across the cantilever arm. All top chord members will be in tension and all bottom chord members in compression In constructing the influence line for top chord $U_{11}U_{12}$ a line is drawn from e, a point under the center of moments for this member, parallel to the top chord. Then from point n a line is drawn parallel to the diagonal $U_{11}L_{12}$ until it intersects the line from point e. This gives the point d. Then d e is the controlling ordinate for the influence line for this member. Any load to the left of L_12 will have no effect on the member $U_{11}L_{12}$. For the bottom chord $L_{11}L_{12}$ the distance ge is the ordinate. g is the point where the line d n cuts the base of the reaction line. In drawing the lines for these members since a load to the left of a certain point has no effect on the member the reaction B is really being moved to the right for each successive member and then that panel becomes the end panel in the truss, etc. To draw the influence line for the bottom chord $L_{11}L_{12}$, the usual procedure would be to draw a line horizontally from d until it intersected the line me instead of using the ordinate ge. However, when a load is applied at L_{15}, the bottom chord carries the same compression with the top chord sloped that it would if the top and bottom chords are parallel. The same is true of the posts and diagonals. The ordiante gs is equal to unity and is notcorrect if used as this. It must be plotted back one panel to the left and where it intercepts the ordinate for the next post fixes the true ordinate for that post. Where a line drawn from a point a unit distance below the base line to D, intersects gs gives the true length of the ordinate for the diagonal $U_{10}L_{10}$.

The diagonal $U_{15}L_{14}$ carries only compression stress and when a line drawn from O parallel to the top chord intersects a line drawn from p parallel to $U_{15}L_{14}$, the ordinate is fixed. The post $U_{14}L_{14}$ does not carry any live load stress. The complete influence lines in the cantilever arm are on Sheets IV and V.

The graphic method is fairly satisfactory for short cantilever arms. The question of space required comes up again, due to the large ordinates to the influence lines. The lines are all much more simple than those for the anchor arm due to the fact that there can be no reversal of stress in the members.

Fig. 8 shows the influence lines for members of the cantilever arm by the semi-graphical method. The truss is assumed fixed at B and a load unity placed at H. This method of drawing the influence lines is simple, rapid and accurate. Sheet VI shows these lines, with the caluulations for stresses and the maxwell diagrams for the influence coefficients.

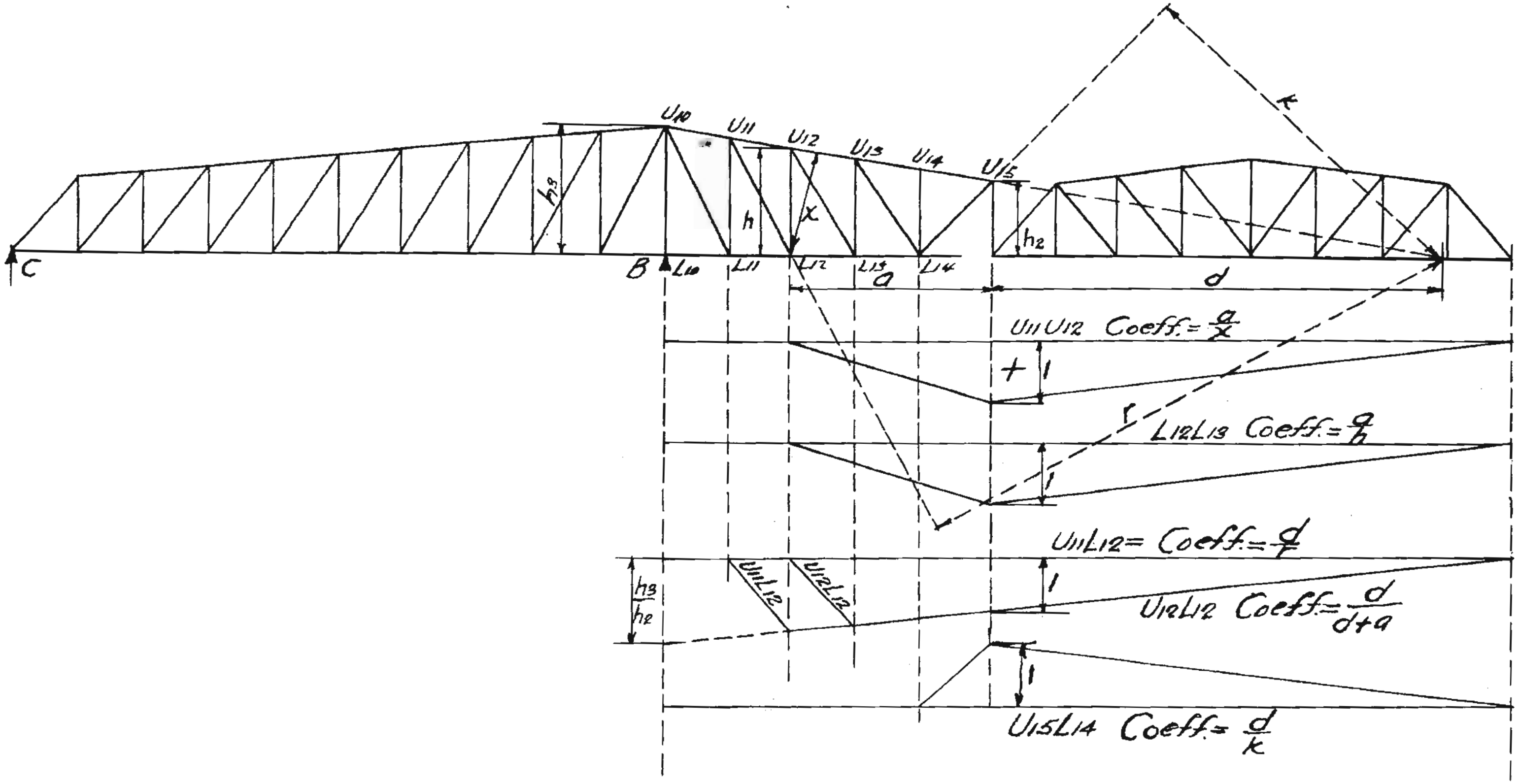

U10
U11
U12
U13
U14
U15
k
h9
h
X
h2
C
B
L10
L11
L12
L13
L14
a
d
U11 U12 Coeff. = a/X
+
1
L12L13 Coeff. = a/h
1
U11L12 = Coeff. = d/f
1
h3/h2
U11L12
U12L12
U12L12 Coeff. = d/(d+a)
1
U15L14 Coeff. = d/k

Fig. 8

Sheets VII and VIII show the influence lines for the simple span. Sheet VII has previously been discussed. Sheet VIII, the semi graphic solution, again clearly illustrates the superiority of this method over the purely graphical method. The lines more condensed and can be drawn in much less time. The calculations of stresses in various members is easier and more simple than the graphic method. In drawing the influence line for the post U_4L_4 by the graphic method it is necessary to assume that this post is not the center of the truss and that the diagonal shown with a broken line is in place. Then proceed exactly as for the other posts.

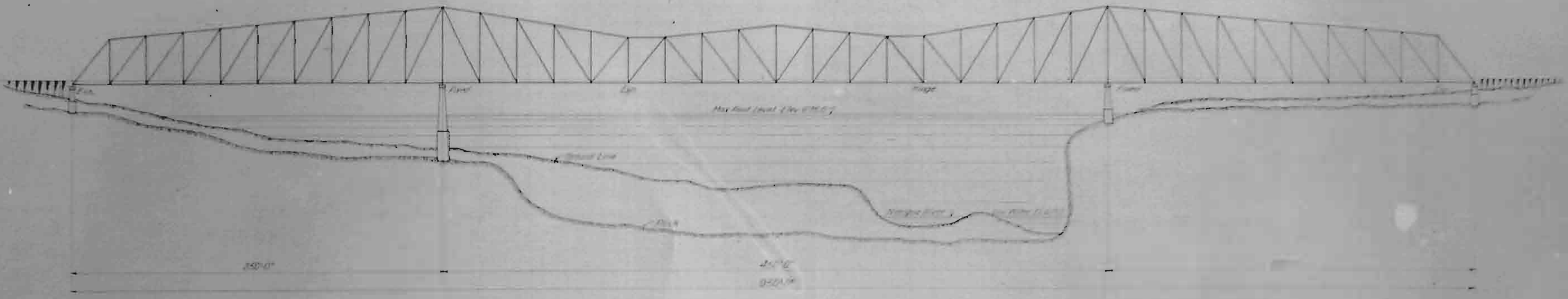
In Conclusion:

The results of this study show conclusively that the semi-graphical method of calculating stresses in a cantilever truss to be faster and more reliable than purely graphical method and is faster and equally as reliable as the analytical method of moments.

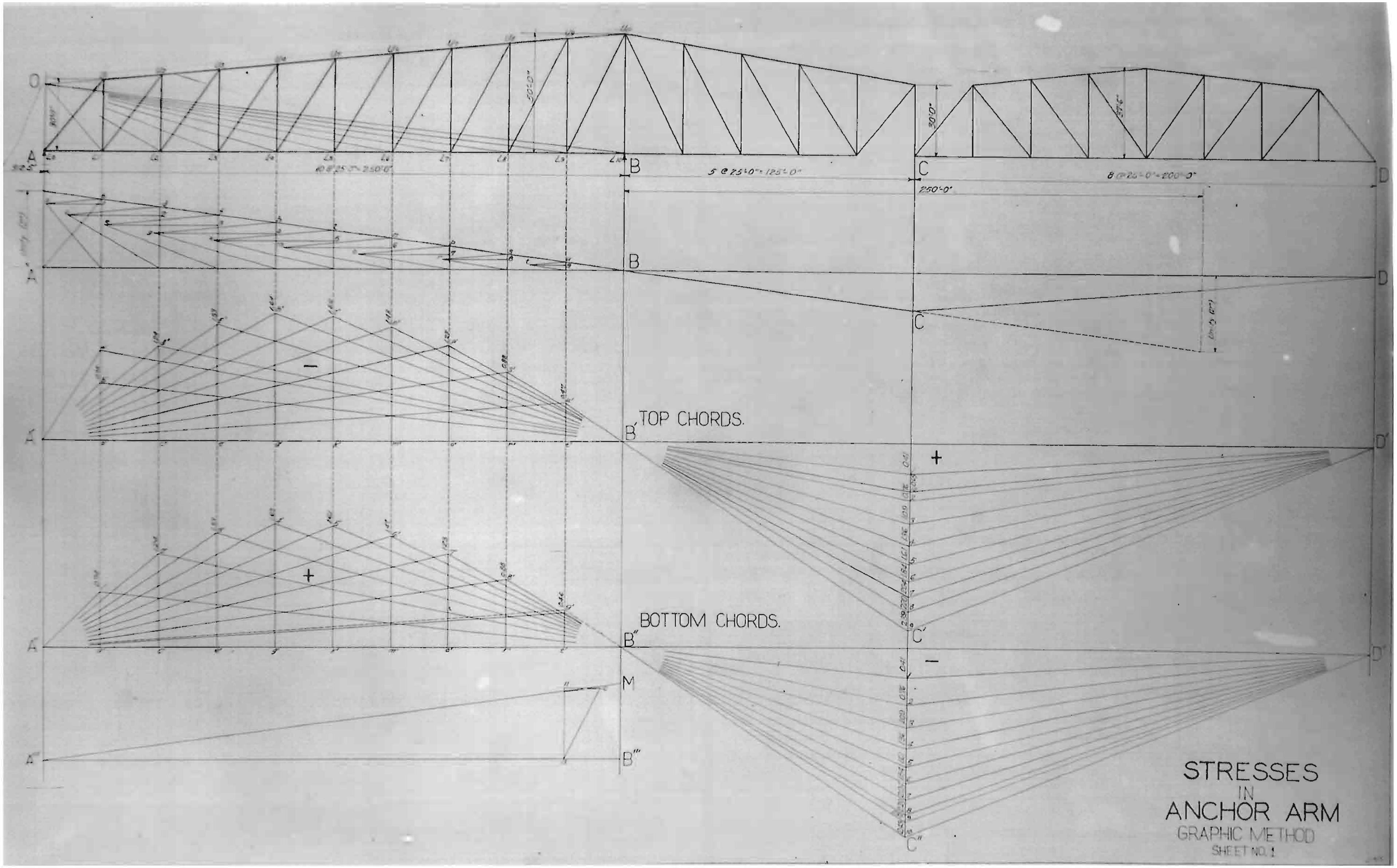
The graphical method requires an excessive amount of drawing space, this amount increasing as the span length increases. There is also a large chance for serious inaccuracies when calculating the stresses in the anchor arm due to loads in the cantilever arm and the suspended span. The influence lines for the posts and diagonals are extremely dificult to draw accurately, and can hardly be placed on a common base line, due to the fact that the ordinates of the lines under each panel point must be known. The change in these ordinates for different members is so small that accurate scaling of their lengths is almost impossible. The influence line for all members can not be drawn from the same reaction influence line. This method is better for the stresses in the cantilever arm than it is for the anchor arm, as these members do not have a reversal of stress. This method is more applicable to the posts and diagonals in the cantilever arm for the same reason. For simple spans, such as the suspended span in this case, the graphical method is better suited particularly to the top and bottom chords. The diagonals and posts carry the same difficulties as stated above.

The semi graphic method is an ideal method for a cantilever bridge for several reasons. It is especially well adapted to the calculation of the stresses in the anchor arm where the members have a reversal of stress, since the portion of the influence line for any member of the anchor arm is under the cantilever arm and suspended span is a triangle of a constant height the variation in stresses being taken care of by the coefficient. This method is fast and accurate. It requires only a small amount of drawing space. Once the principle is understood it is a simple matter of drawing straight lines, yet for all its simplicity it shows very plainly the position of the loads for a maximum stress and enables this stress to be easily and quickly calculated. There are no critical points to project down from the truss and every ordinate on every line can be easily checked. The calculations by this method can be made with all the accuracy desired as the slope of every line is known. This method is rapid, even when coefficients are calculated and even more rapid when the Maxwell diagram is used. This diagram can be drawn with sufficient accuracy for all design stresses. The stresses in top and bottom chord members are especially easy to find by this method. Anyone who can select the center of moments for these members can draw the influence lines. Stresses in diagonals and posts are also easily found. It would be difficult to imagine or to find a faster more accurate method for checking stresses in any framed structure than this. It is excellent for rating existing structures for different loadings, since the same line may be used for any load. Simple spans are rapidly and accurately worked by this method.

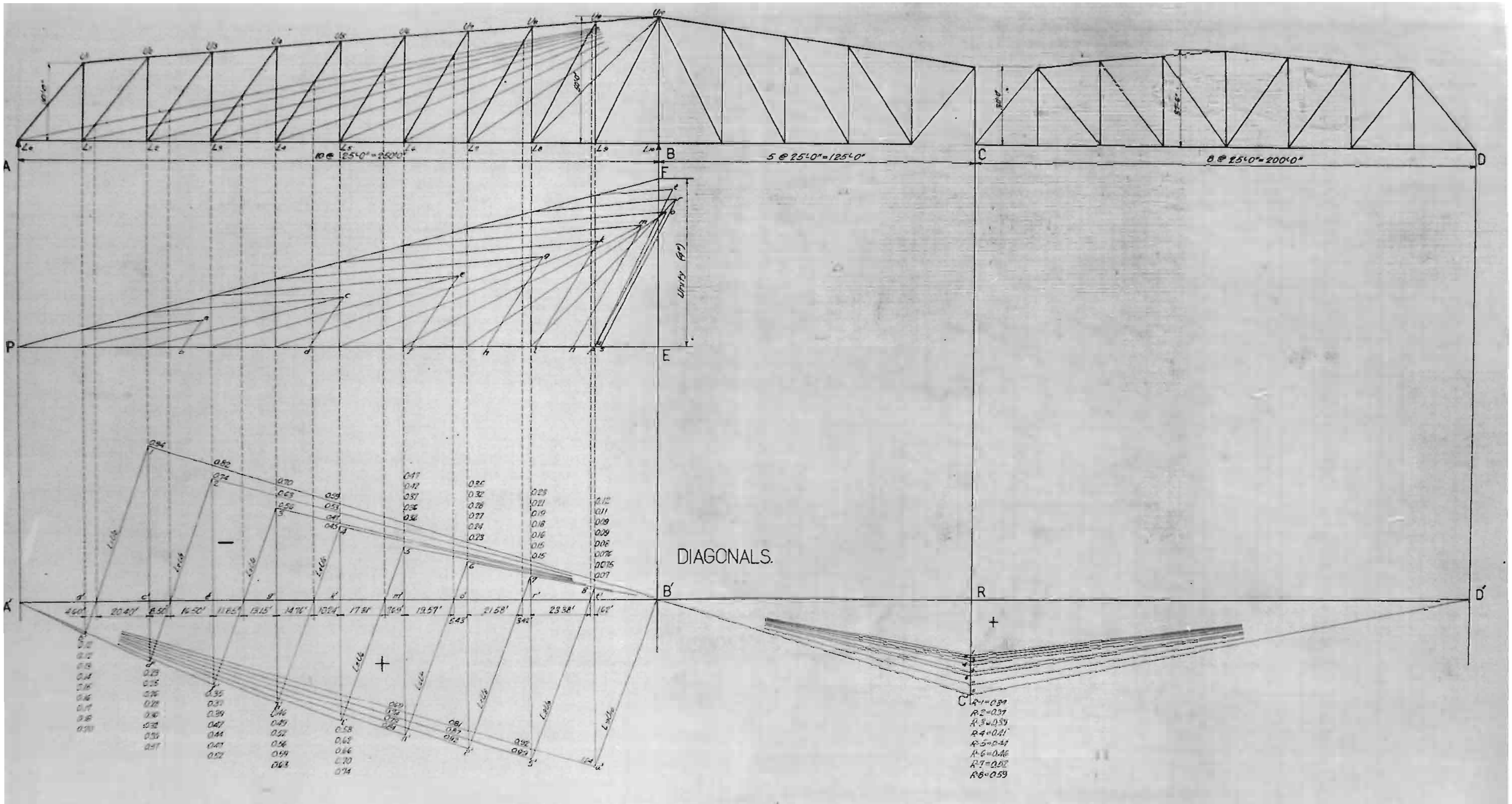
The graphical method can be used successfully for the stresses in the members of the cantilever arm of a cantilever truss. It is also fairly well suited to simple spans. The chief difficulty in any span is the question of stresses in posts and diagonals. The semi-graphical method is good for any type of span. It is especially good for the cantilever type of bridge.



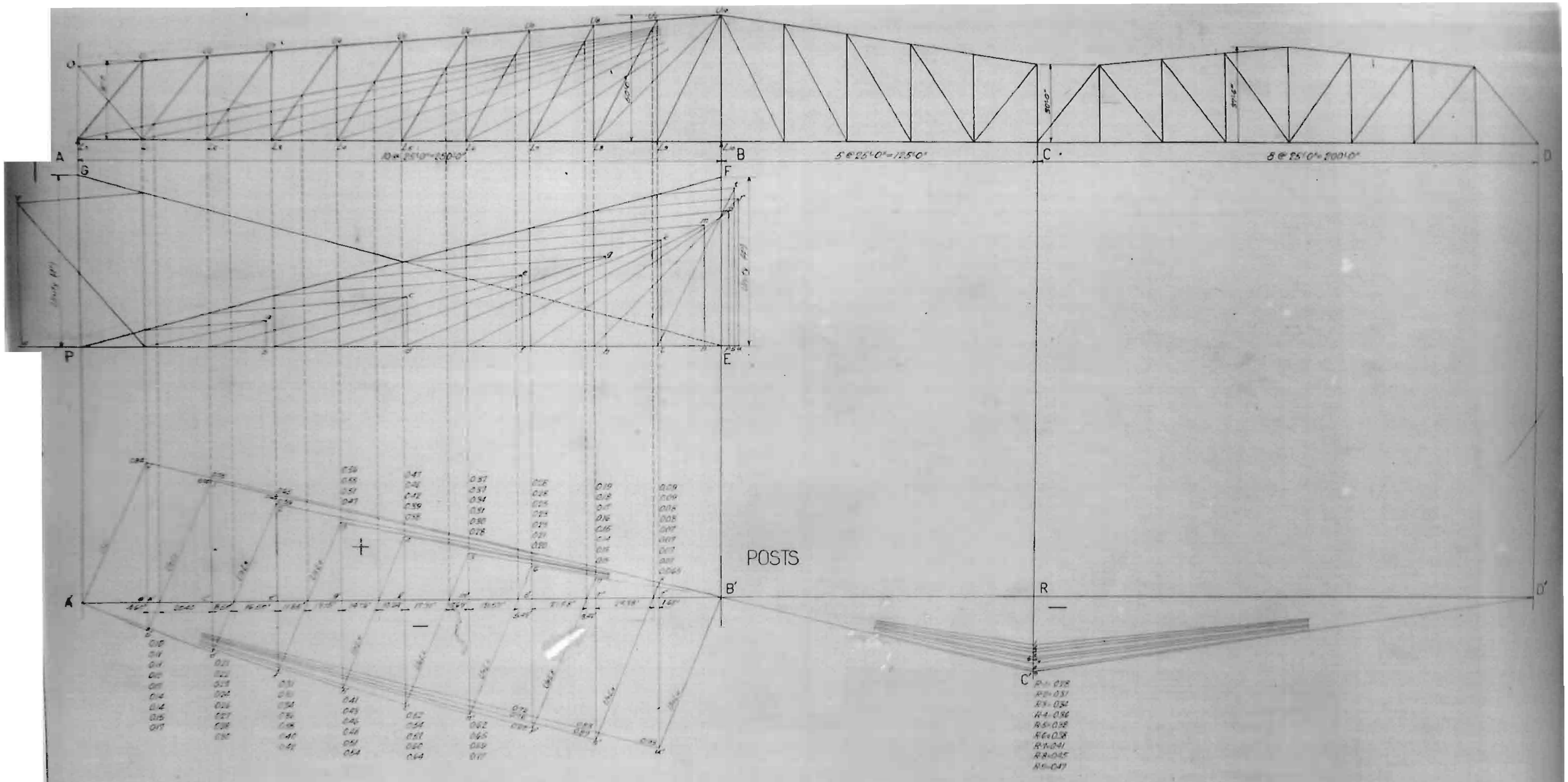
GENERAL PLAN



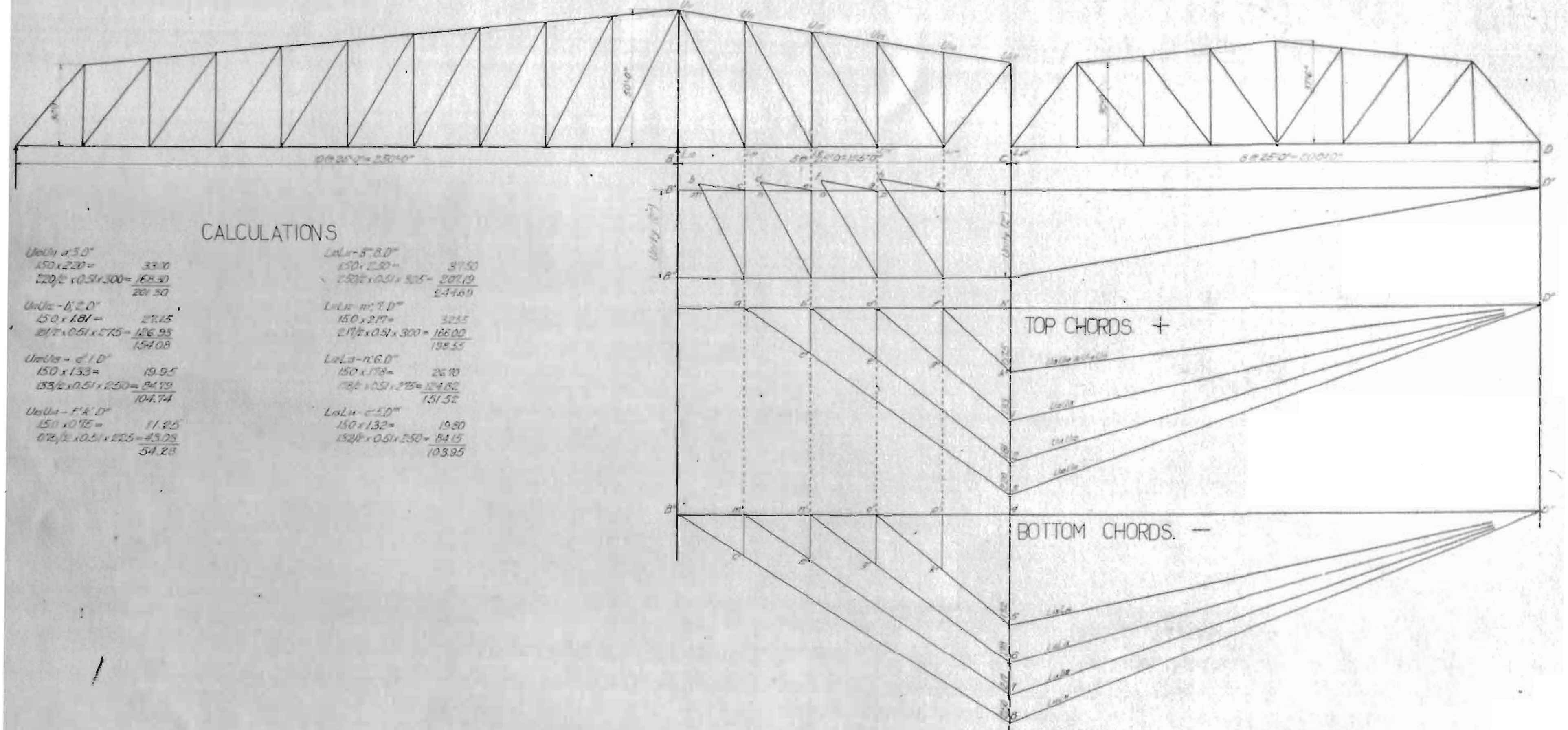
STRESSES
IN
ANCHOR ARM
GRAPHIC METHOD
SHEET NO. 1



STRESSES
IN
ANCHOR ARM
GRAPHIC METHOD
SHEET NO. 2



STRESSES
IN
ANCHOR ARM
GRAPHIC METHOD
SHEET NO.2A



CALCULATIONS

U_0U_1 a'3.0"
1.50 x 2.20 = 33.00
2.20/2 x 0.51 x 300 = 168.30
201.30

U_1U_2 - b'2.0"
1.50 x 1.81 = 27.15
1.81/2 x 0.51 x 275 = 126.93
154.08

U_2U_3 - c'1.0"
1.50 x 1.33 = 19.95
1.33/2 x 0.51 x 250 = 84.79
104.74

U_3U_4 - F'K'.0"
1.50 x 0.75 = 11.25
0.75/2 x 0.51 x 225 = 43.03
54.28

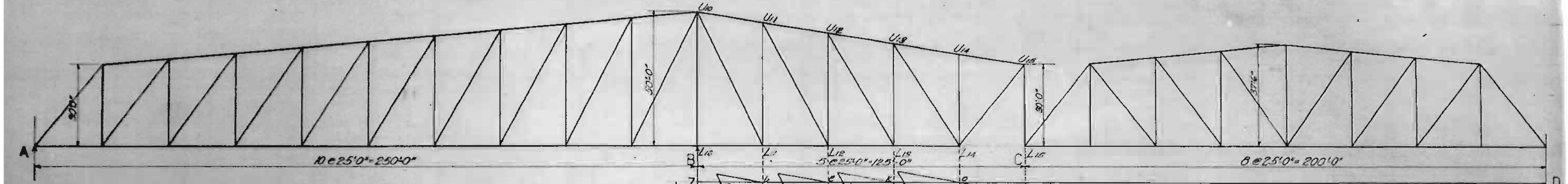
L_0L_1 - 5'8.0"
1.50 x 2.50 = 37.50
2.50/2 x 0.51 x 325 = 207.19
244.69

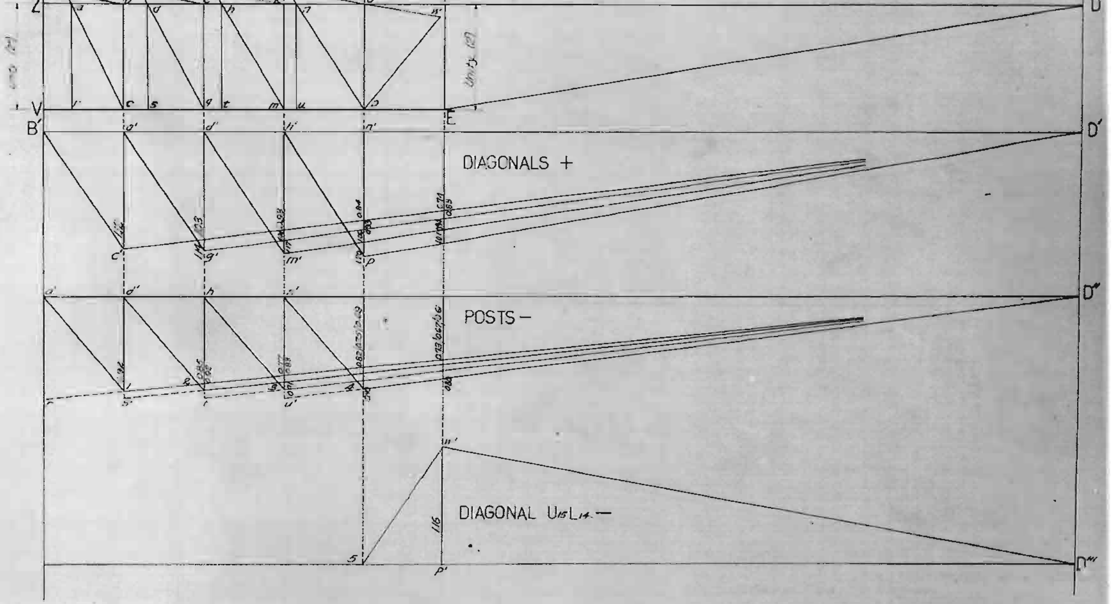
L_1L_2 - m'7.0"
1.50 x 2.17 = 32.55
2.17/2 x 0.51 x 300 = 166.00
198.55

L_2L_3 - n'6.0"
1.50 x 1.78 = 26.70
1.78/2 x 0.51 x 275 = 124.82
151.52

L_3L_4 - o'5.0"
1.50 x 1.32 = 19.80
1.32/2 x 0.51 x 250 = 84.15
103.95

STRESSES
IN
CANTILEVER ARM
GRAPHIC METHOD
SHEET NO 4.





CALCULATIONS

$U_{10}L_{11}$ - B'c'D'
7.5 x 1.12 = 8.40
57.37 x 0.74 = 42.45
12.75(1.12+1.03+0.93+0.84) = 49.98
100.83

$U_{11}L_{12}$ - a'g'D'
7.5 x 1.14 = 8.55
57.37 x 0.83 = 47.62
12.75(1.14+1.04+0.93) = 39.65
95.82

$U_{12}L_{13}$ - d'm'D'
7.5 x 1.17 = 8.77
57.37 x 0.94 = 53.93
12.75(1.17+1.06) = 28.43
91.13

$U_{13}L_{14}$ - h'p'D'
7.5 x 1.20 = 9.00
57.37 x 1.07 = 61.38
12.75 x 1.20 = 15.30
85.68

$U_{15}L_{14}$ - 5 w' D'''
7.5 x 1.16 = 8.70
57.37 x 1.16 = 66.55
75.25

$U_{10}L_{10}$ - a' 1 D''
7.5 x 0.92 = 6.90
57.37 x 0.61 = 34.99
12.75(0.92+0.85+0.77+0.69) = 41.18
83.07

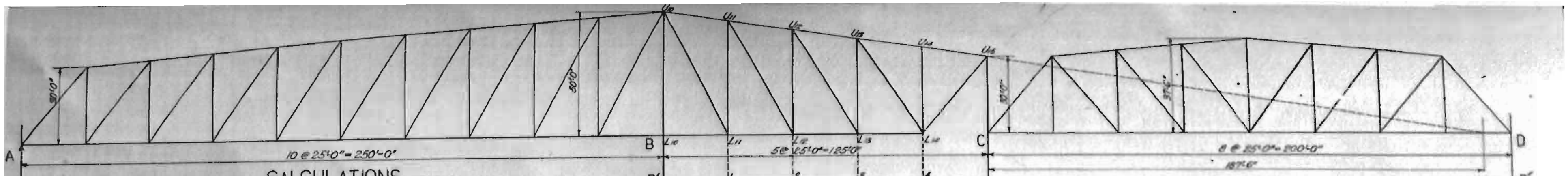
$U_{11}L_{11}$ - d' 2 D''
7.5 x 0.92 = 6.90
57.37 x 0.67 = 38.44
12.75(0.92+0.83+0.75) = 31.87
77.21

$U_{12}L_{12}$ - h' 3 D''
7.5 x 0.91 = 6.82
57.37 x 0.73 = 41.88
12.75(0.91+0.81) = 22.06
70.76

$U_{13}L_{13}$ - n' 4 D
7.5 x 0.90 = 6.75
57.37 x 0.80 = 45.89
12.75 x 0.90 = 11.47
64.11

STRESSES
IN
CANTILEVER ARM
GRAPHIC METHOD
SHEET NO. 5

LKS



CALCULATIONS.

$U_{10}U_{11}$-1, C'D'
150 x 1.0 = 15.00
300/2 x 0.51 = 76.50
91.50 x 2.20 = 201.30

$U_{11}U_{12}$-2, C'D'
15.0 x 1.0 = 15.00
275/2 x 0.51 = 70.12
85.12 x 1.81 = 154.06

$U_{12}U_{13}$-3, C'D'
15.0 x 1.0 = 15.00
250/2 x 0.51 = 63.75
78.75 x 1.33 = 104.74

$U_{13}U_{14}$-4 C'D'
15.0 x 1.0 = 15.00
225/2 x 0.51 = 57.37
72.37 x 0.75 = 54.27

$L_{10}L_{11}$-B', C'D'
15.0 x 1.0 = 15.00
325/2 x 0.51 = 82.87
97.87 x 2.50 = 244.67

$L_{11}L_{12}$-1, C'D'
15.0 x 1.0 = 15.00
300/2 x 0.51 = 76.50
91.50 x 2.17 = 198.55

$L_{12}L_{13}$-2, C'D'
15.0 x 1.0 = 15.00
275/2 x 0.51 = 70.12
85.12 x 1.78 = 151.51

$L_{13}L_{14}$-3 C'D'
15.0 x 1.0 = 15.00
250/2 x 0.51 = 63.75
78.75 x 1.32 = 103.95

$U_{10}L_{10}$-B"8, C"D"
7.5 x 1.53 = 11.47
12.75(1.53 + 1.40 + 1.26 + 1.13) = 67.83
57.37 x 1.0 = 57.37
136.67 x 0.60 = 82.00

$U_{11}L_{11}$-5, 9, C"D"
7.5 x 1.40 = 10.50
12.75(1.40 + 1.26 + 1.13) = 48.32
57.37 x 1.0 = 57.37
116.19 x 0.65 = 75.52

$U_{12}L_{12}$-6, 10, C"D"
7.5 x 1.26 = 9.45
12.75(1.26 + 1.13) = 30.47
57.37 x 1.0 = 57.37
97.29 x 0.72 = 70.04

$U_{13}L_{13}$-7, 11, C"D"
7.5 x 1.0 = 8.47
12.75 x 1.13 = 14.41
57.37 x 1.0 = 57.37
80.25 x 0.79 = 63.39

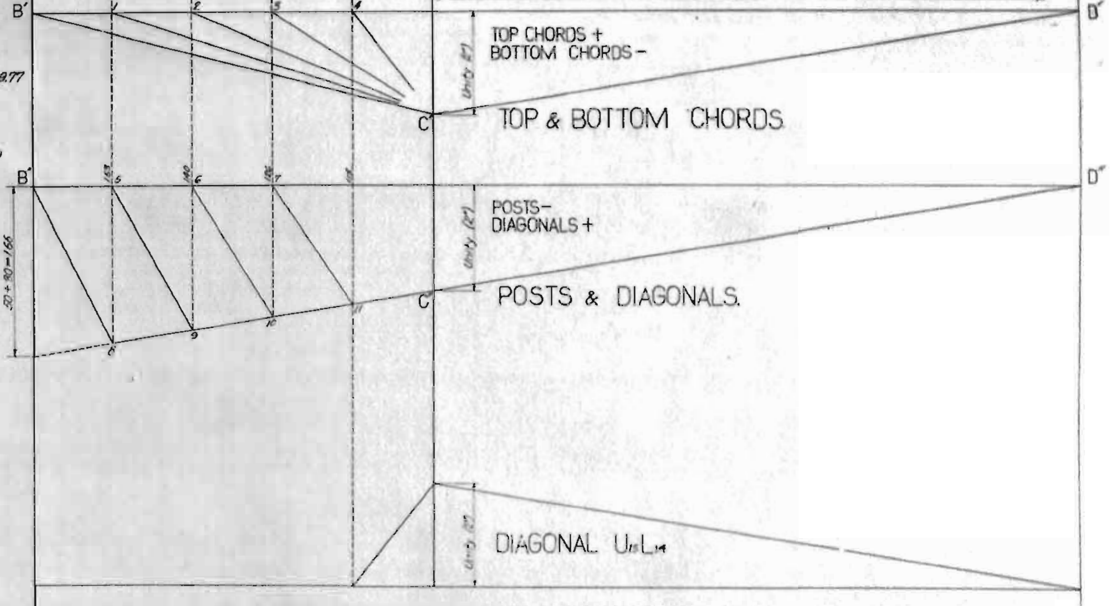
$U_{10}L_{11}$-B", C", 1
7.5 x 1.53 = 11.47
12.75(1.53 + 1.40 + 1.26 + 1.13) = 67.83
57.37 x 1.0 = 57.37
136.67 x 0.73 = 99.77

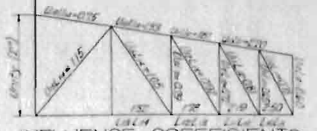
$U_{11}L_{12}$-5, 9, C", D"
7.5 x 1.40 = 10.50
12.75(1.40 + 1.26 + 1.13) = 48.32
57.37 x 1.0 = 57.37
116.19 x 0.81 = 94.10

$U_{12}L_{13}$-6, 10, C", D"
7.5 x 1.26 = 9.45
12.75(1.26 + 1.13) = 30.47
57.37 x 1.0 = 57.37
97.29 x 0.92 = 89.50

$U_{13}L_{14}$-7, 11, C", D"
7.5 x 1.13 = 8.47
12.75 x 1.13 = 14.41
57.37 x 1.0 = 57.37
80.25 x 1.05 = 84.25

$U_{15}L_{14}$-
7.5 x 1.0 = 7.50
57.37 x 1.0 = 57.37
64.87 x 1.15 = 74.60



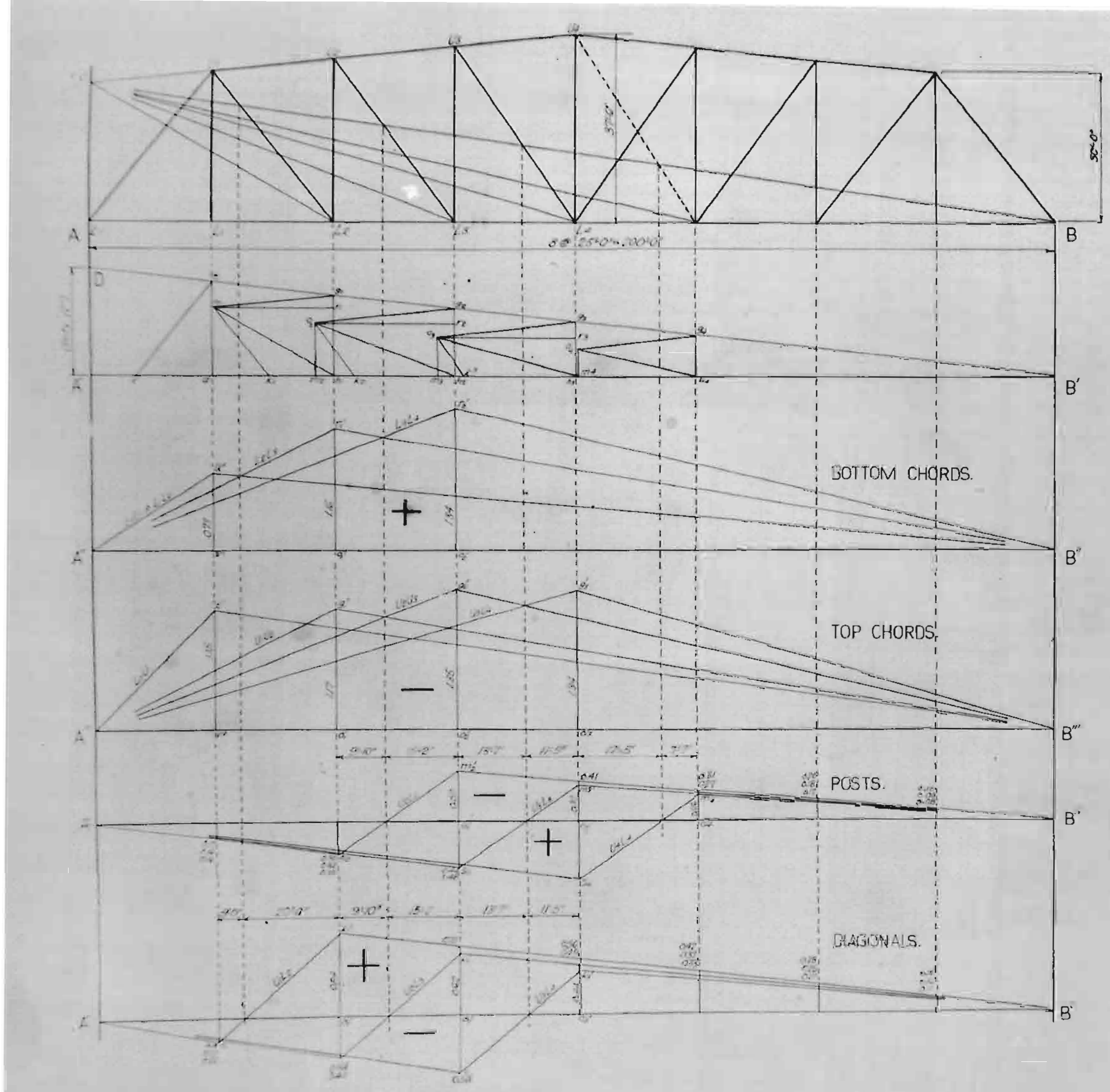


INFLUENCE COEFFICIENTS.

STRESSES
IN
CANTILEVER ARM.

SEMI-GRAPHIC METHOD

SHEET NO. 6



CALCULATIONS.

BOTTOM CHORDS.

L0L1 & L1L2 – A″u′B″A″
15.0 × 0.73 = 10.95
0.73/2 × 200 × 0.51 = 37.23
48.18

L2L3 – A″r1′B″A″
15.0 × 1.16 = 17.40
1.16/2 × 200 × 0.51 = 59.16
76.56

L3L4 – A″r3′B″A″
15.0 × 1.34 = 20.10
1.34/2 × 200 × 0.51 = 68.34
88.44

TOP CHORDS.

L0U1 – A‴c′B‴A‴
15.0 × 1.15 = 17.25
1.15/2 × 200 × 0.51 = 58.65
75.90

U1U2 – A‴g1′B‴A‴
15.0 × 1.17 = 17.55
1.17/2 × 200 × 0.51 = 59.67
77.22

U2U3 – A‴g2′B‴A‴
15.0 × 1.35 = 20.25
1.35/2 × 200 × 0.51 = 68.85
89.10

U3U4 – A‴g3′B‴A‴
15.0 × 1.34 = 20.10
1.34/2 × 200 × 0.51 = 68.85
88.95

POSTS.

U1L1 – A^IV S1 m1′ B^IV
+ 12.75 × 0.16 = 2.04
0.51(12.5 + 9.83)0.33 = 3.76
7.5 × 0.33 = 2.47
+ 8.27

− 7.5 × 0.50 = 3.75
12.75(0.10 + 0.20 + 0.31 + 0.41 + 0.50) = 19.51
− 23.26

U2L2 – A^IV S2 m2′ B^IV
+ 7.5 × 0.49 = 3.67
12.75(0.16 + 0.32 + 0.49) = 12.37
+ 16.04

− 7.5 × 0.37 = 2.77
12.75(0.09 + 0.18 + 0.27) = 6.88
0.51(12.5 + 11.4)0.37 = 4.51
− 14.16

U3L3 – A^IV S3 m3′ B^IV
+ 7.5 × 0.59 = 4.42
12.75(0.15 + 0.30 + 0.44 + 0.59) = 18.87
+ 23.29

− 7.5 × 0.26 = 1.95
12.75(0.10 + 0.20) = 3.82
0.51(12.5 + 25.8)0.26 = 2.66
− 8.43

DIAGONALS.

U1L2 – A^V S1 k1′ B^V
+ 7.5 × 0.84 = 6.30
12.75(0.14 + 0.28 + 0.42 + 0.56 + 0.70 + 0.84) = 37.48
+ 43.78

− 7.5 × 0.22 = 1.65
0.51(12.5 + 5.0)0.22 = 1.96
− 3.61

U2L3 – A^V S2 k2′ B^V
+ 7.5 × 0.62 = 4.65
12.75(0.12 + 0.25 + 0.37 + 0.49 + 0.62) = 23.59
+ 28.24

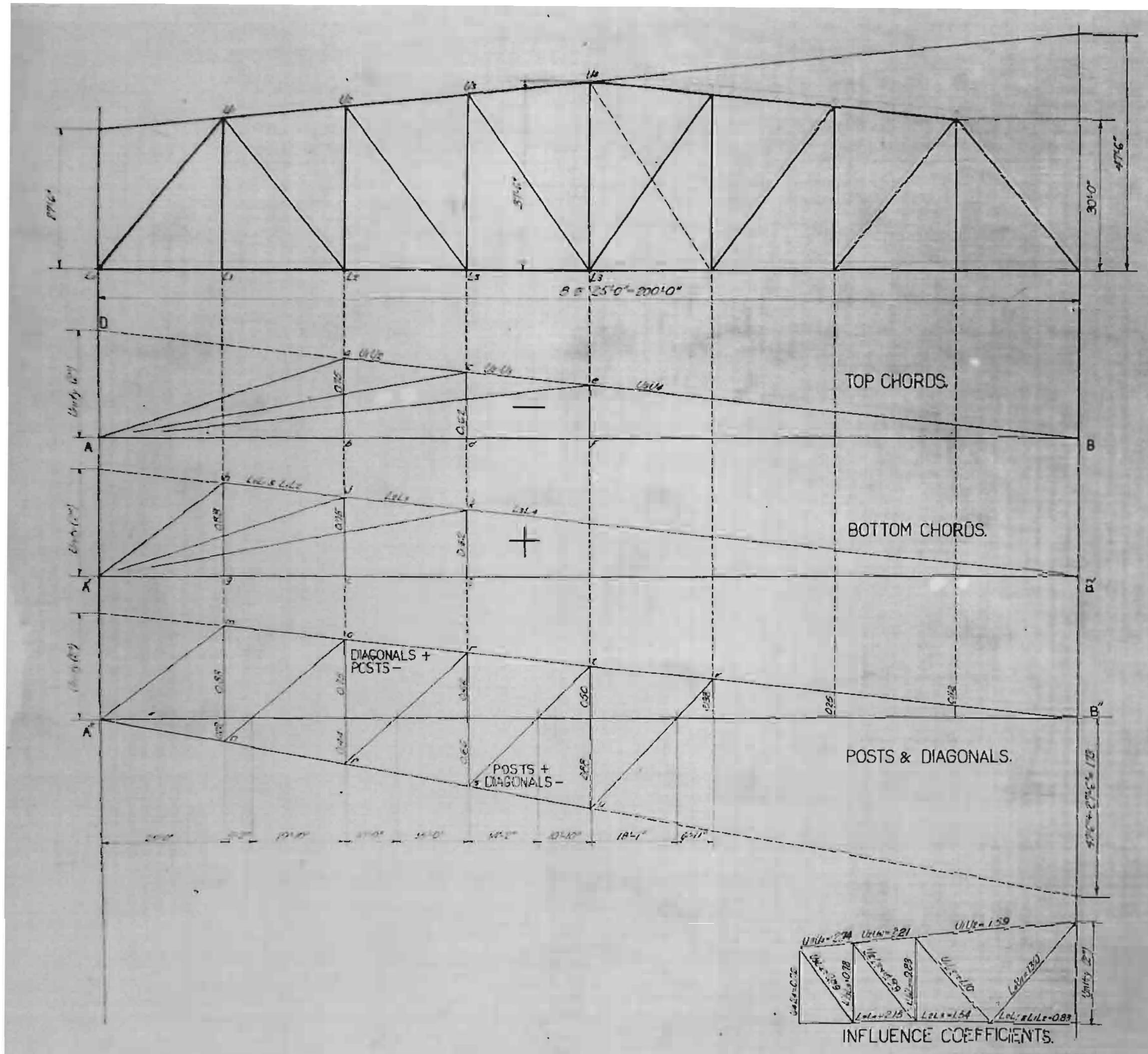
− 7.5 × 0.40 = 3.00
12.75 × 0.20 = 2.55
0.51(12.5 + 9.85)0.40 = 4.55
− 10.10

U3L4 – A^V S3 k3′ B^V
+ 7.5 × 0.44 = 3.30
12.75(0.11 + 0.22 + 0.33) = 8.41
0.51(12.5 + 11.42)0.44 = 5.37
+ 17.08

− 7.5 × 0.58 = 4.35
12.75(0.19 + 0.38 + 0.58) = 14.66
− 19.01

STRESSES
IN
SUSPENDED SPAN

GRAPHIC METHOD
SHEET NO 7



CALCULATIONS.

TOP CHORDS.

U1U2 - A, a, B, A
150 x 0.75 = 11.25
0.75/2 x 0.51 x 200 = 38.25
49.50 x 1.59 = 78.70

U2U3 - A, c, B, A
150 x 0.62 = 9.30
0.62/2 x 0.51 x 200 = 31.62
40.92 x 2.21 = 90.43

U3U4 - A, e, B, A
15.0 x 0.50 = 7.50
0.50/2 x 0.51 x 200 = 25.50
33.00 x 2.74 = 90.42

L0U1 - A", m, B", A"
15.0 x 0.88 = 13.20
0.88/2 x 0.51 x 200 = 44.88
58.08 x 1.30 = 75.50

DIAGONALS.

U1L2 - A", n, o, B", A"
+ 7.5 x 0.75 = 5.62
12.75(0.12+0.25+0.38+0.50+0.62+0.75) = 33.40
+39.02 x 1.10 = 42.92

− 7.5 x 0.22 = 1.65
0.51(12.5+5.16)0.22 = 1.98
−3.63 x 1.10 = 3.99

U2L3 - A", r, B", A"
+ 7.5 x 0.62 = 4.65
12.75(0.12+0.25+0.38+0.50+0.62) = 23.84
+28.49 x 0.99 = 28.20

− 7.5 x 0.44 = 3.30
12.75 x 0.22 = 2.80
0.51(12.5+10.0)0.44 = 5.05
−11.15 x 0.99 = 11.04

U3L4 - A", s, t, B", A"
+ 7.5 x 0.50 = 3.75
12.75(0.12+0.25+0.38) = 9.56
0.51(12.5+10.66)0.50 = 5.90
+19.21 x 0.89 = 17.10

− 7.5 x 0.66 = 4.95
12.75(0.22+0.44+0.66) = 16.83
−21.78 x 0.89 = 19.38

BOTTOM CHORDS.

L0L1 & L1L2 - A', f, B', A'
150 x 0.88 = 13.20
0.88/2 x 0.51 x 200 = 44.88
58.08 x 0.83 = 48.21

L2L3 - A', j, B, A'
150 x 0.75 = 11.25
0.75/2 x 0.51 x 200 = 38.25
49.50 x 1.54 = 76.23

L3L4 - A', k, B, A'
150 x 0.62 = 9.30
0.62/2 x 0.51 x 200 = 31.62
40.92 x 2.15 = 87.98

POSTS.

U2L2 - A", p, B", A"
− 7.5 x 0.62 = 4.65
12.75(0.62+0.50+0.38+0.25+0.12) = 23.84
−28.49 x 0.83 = 23.65

+ 7.5 x 0.44 = 3.30
12.75 x 0.22 = 2.80
0.51(12.5+10.0)0.44 = 5.05
+11.15 x 0.83 = 9.25

U3L3 - A", s, t, B", A"
− 7.5 x 0.50 = 3.75
12.75(0.38+0.25+0.12) = 9.56
0.51(12.5+10.66)0.50 = 5.90
−19.21 x 0.73 = 14.02

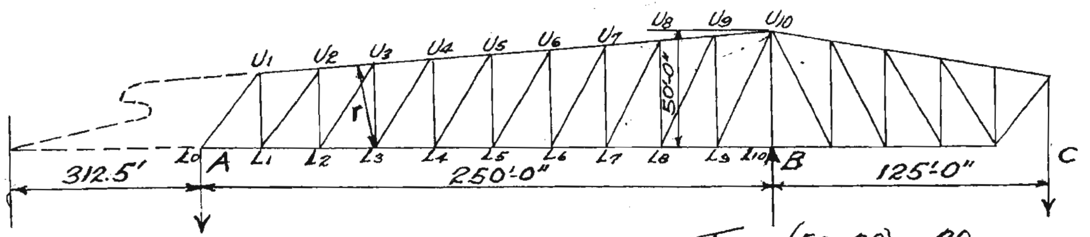
+ 7.5 x 0.66 = 4.95
12.75(0.22+0.44+0.66) = 16.83
+21.78 x 0.78 = 16.99

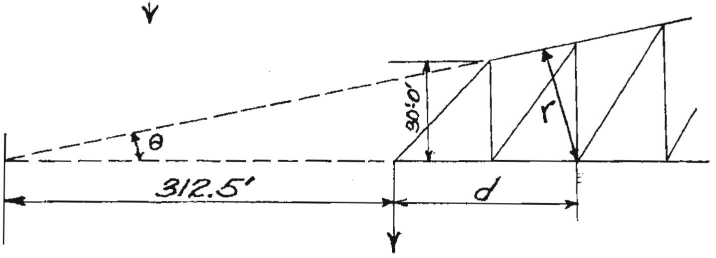
U4L4 - A", u, v, B", A"
− 7.5 x 0.38 = 2.85
12.75(0.12+0.25) = 4.72
0.51(12.5+6.92)0.38 = 3.76
−11.33 x 0.72 = 8.16

+ 7.5 x 0.88 = 6.60
12.75(0.22+0.44+0.66+0.88) = 28.05
+34.65 x 0.72 = 24.95

STRESSES
IN
SUSPENDED SPAN
SEMI-GRAPHIC METHOD
SHEET NO. 8

CALCULATION OF STRESSES BY MOMENTS





$$\frac{(50-30)}{225} = \frac{30}{X} \quad X=337.5$$

$$337.5-25=312.5$$

$$\tan.\theta = \frac{30}{337.5} = 0.08888$$

$$\theta = 5^\circ 05'$$

$$r=(312.5+d)\sin\theta$$

$$\Sigma M_B = 15.0 \times 125 + 125 \times 0.51 \times 100 + 125 \times 0.51 \times 62.5 - 250 R_A$$

$$R_A = 48.94$$

STRESSES IN ANCHOR ARM

Top Chord Members-----Tension

U_1U_2

$r = (312.5 + 25)0.0886 = 29.90$

$S = \frac{25 \times 28.94}{29.90} = 40.91$

U_2U_3

$r = (312.5 + 50)0.0886 = 32.12$

$S = \frac{50 \times 48.94}{32.10} = 76.23$

U_3U_4

$r = (312.5 + 75)0.0886 = 34.33$

$S = \frac{75 \times 48.94}{34.33} = 106.92$

U_4U_5

$$r = (312.5 + 100)0.0886 = 36.55$$

$$S = \frac{100 \times 48.94}{36.55} = 133.90$$

U_5U_6

$$r = (312.5 + 125)0.0886 = 38.76$$

$$S = \frac{125 \times 48.94}{38.76} = 157.83$$

U_6U_7

$$r = (312.5 + 150)0.0886 = 40.98$$

$$S = \frac{150 \times 48.94}{40.98} = 179.14$$

U_7U_8

$$r = (312.5 + 175)0.0886 = 43.19$$

$$S = \frac{175 \times 48.94}{43.19} = 198.30$$

U_8U_9

$$r = (312.5 + 200)0.0886 = 45.41$$

$$S = \frac{200 \times 48.94}{45.41} = 215.55$$

U_9U_{10}

$$r = (312.5 + 225)0.0886 = 47.62$$

$$S = \frac{225 \times 48.94}{47.62} = 231.24$$

Bottom Chord Members-----Compression

Increase in length of posts per panel = 2.22'

$L_0L_1 \quad S = \frac{25 \times 48.94}{30} = 40.78$

$L_1L_2 \quad S = \frac{50 \times 48.94}{32.22} = 75.95$

$L_2L_3 \quad S = \frac{75 \times 48.94}{34.44} = 106.58$

$L_3L_4 \quad S = \frac{100 \times 48.94}{36.66} = 133.50$

$L_4L_5 \quad S = \frac{125 \times 48.94}{38.88} = 157.34$

$L_5L_6 \quad S = \frac{150 \times 48.94}{41.10} = 178.61$

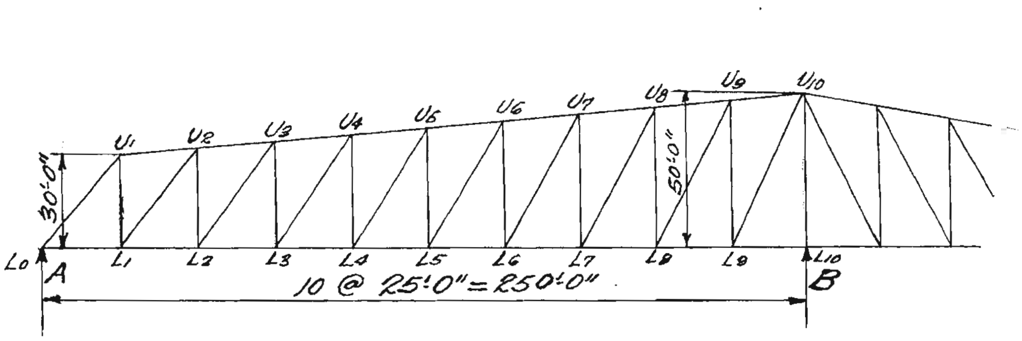
$L_6L_7 \quad S = \frac{175 \times 48.94}{43.32} = 197.70$

$L_7L_8 \quad S = \frac{200 \times 48.94}{45.54} = 214.93$

$L_8L_9 \quad S = \frac{225 \times 48.94}{47.76} = 230.56$

$L_9L_{10} \quad S = \frac{250 \times 48.94}{50} = 244.70$

Top Chord Members -------Compression



Conc.load
at

L1 $$R_A = \frac{\overbrace{250 \times 0.51 \times 250/2}^{15937.5} + 15.0 \times 225}{250} = 77.25$$

L2 $$R_A = \frac{15937.5 + 15.0 \times 200}{250} = 75.75$$

L3 $$R_A = \frac{15937.5 + 15.0 \times 175}{250} = 74.25$$

L4 $$R_A = \frac{15937.5 + 15.0 \times 150}{250} = 72.75$$

L5 $$R_A = \frac{15937.5 + 15.0 \times 125}{250} = 71.25$$

L6 $$R_A = \frac{15937.5 + 15.0 \times 100}{250} = 69.75$$

L7 $$R_A = \frac{15937.5 + 15.0 \times 75}{250} = 68.25$$

L8 $$R_A = \frac{15937.5 + 15.0 \times 50}{250} = 66.75$$

L9 $$R_A = \frac{15937.5 + 15.0 \times 25}{250} = 65.25$$

Top Chord Members-----Compression (Cont.)

U_1U_2

$r = 29.90$

$$S = \frac{25 \times 77.25 - 25 \times 0.51 \times 12.5}{29.90} = 59.26$$

U_2U_3

$r = 32.12$

$$S = \frac{50 \times 75.75 - 50 \times 0.51 \times 25}{32.12} = 98.07$$

U_3U_4

$r = 34.33$

$$S = \frac{75 \times 74.25 - 75 \times 0.51 \times 37.5}{34.33} = 120.43$$

U_4U_5

$r = 36.55$

$$S = \frac{100 \times 72.75 - 100 \times 0.51 \times 50}{36.55} = 129.27$$

U_5U_6

$r = 38.76$

$$S = \frac{125 \times 71.25 - 125 \times 0.51 \times 62.5}{38.76} = 126.98$$

U_6U_7

$r = 40.98$

$$S = \frac{150 \times 69.75 - 150 \times 0.51 \times 75}{40.98} = 115.30$$

U_7U_8

$r = 43.19$

$$S = \frac{175 \times 68.25 - 175 \times 0.51 \times 87.5}{43.19} = 95.72$$

U_8U_9

$r = 45.41$

$$S = \frac{200 \times 66.75 - 200 \times 0.51 \times 100}{45.41} = 69.37$$

U_9U_{10}

$r = 47.62$

$$S = \frac{225 \times 65.25 - 225 \times 0.51 \times 112.5}{47.62} = 37.21$$

Bottom Chord Members-----Tension

L_0L_1

$$S = \frac{77.25 \times 25 - 25 \times 0.51 \times 12.5}{30} = 59.06$$

L_1L_2

$$S = \frac{75.75 \times 50 - 50 \times 0.51 \times 25}{32.22} = 97.76$$

L_2L_3

$$S = \frac{74.25 \times 75 - 75 \times 0.51 \times 37.5}{34.44} = 120.04$$

L_3L_4

$$S = \frac{72.75 \times 100 - 100 \times 0.51 \times 50}{36.66} = 128.89$$

L_4L_5

$$S = \frac{71.25 \times 125 - 125 \times 0.51 \times 62.5}{38.88} = 126.60$$

L_5L_6

$$S = \frac{69.75 \times 150 - 150 \times 9.51 \times 75}{41.10} = 114.96$$

L_6L_7

$$S = \frac{68.25 \times 175 - 175 \times 0.51 \times 87.5}{43.32} = 95.44$$

L_7L_8

$$S = \frac{66.75 \times 200 - 200 \times 0.51 \times 100}{45.54} = 69.17$$

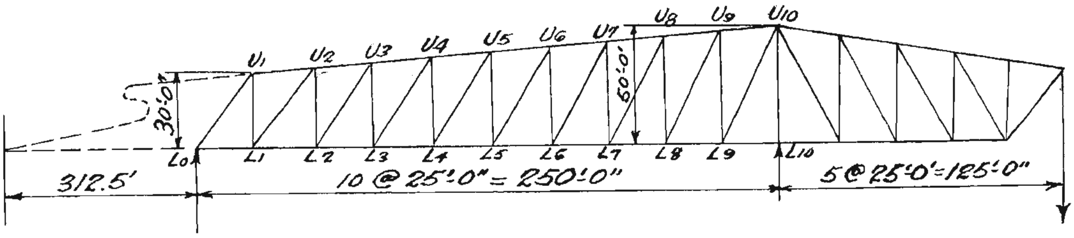
L_8L_9

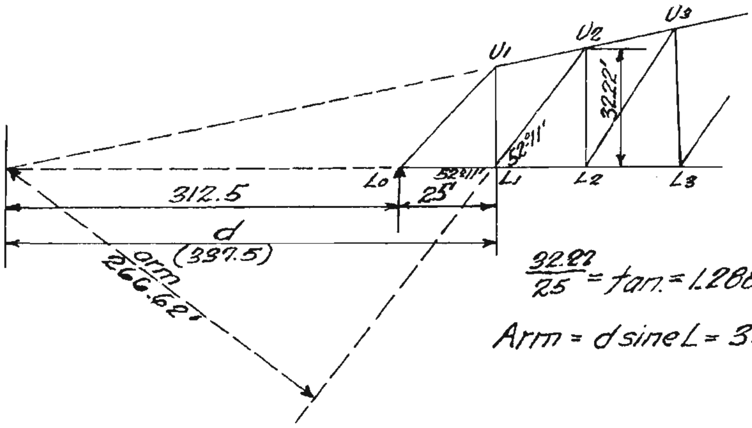
$$S = \frac{65.25 \times 225 - 225 \times 0.51 \times 112.5}{47.76} = 37.10$$

L_9L_{10}

$$S = \frac{65.25 \times 250 - 250 \times 0.51 \times 125 - 15.0 \times 25}{50} = 0.00$$

DIAGONALS------ ANCHOR ARM





$\frac{32.22}{25}$ = tan = 1.2888 ∠ = 52°11'

Arm = d sine ∠ = 337.5' x 0.7900 = 266.62'

Member	Divided by 25		Tang.	Angle	Sine	d	Arm
L_1U_2	32.22	=	1.2888	52°11'	0.7900	337.5	266.62
L_2U_3	34.44	=	1.3776	54°01'	0.8092	362.5	293.33
L_3U_4	36.66	=	1.4664	55°42'	0.8261	387.5	320.11
L_4U_5	38.88	=	1.5552	57°16'	0.8412	412.5	346.99
L_5U_6	41.10	=	1.6440	58°41'	0.8543	437.5	373.76
L_6U_7	43.32	=	1.7328	60°01'	0.8662	462.5	400.62
L_7U_8	45.54	=	1.8216	61°14'	0.8766	487.5	427.34
L_8U_9	47.76	=	1.9104	62°22'	0.8859	512.5	454.02
L_9U_{10}	50.00	=	2.0000	63°26'	0.8944	537.5	480.74

DIAGONALS ---------COMPRESSION

L_1U_2

$$R_A = \frac{200\text{x}7.5+12.75(25+50+75+100+125+150+175+200)}{250} = 51.90$$

$$S = \frac{312.5\text{x}51.90}{266.62} = 60.83$$

L_2U_3

$$R_A = \frac{7.5\text{x}175+12.75(25+50+75+100+125+150+175)}{250} = 40.95$$

$$S = \frac{40.95\text{x}312.5}{293.33} = 43.62$$

L_3U_4

$$R_A = \frac{12.75(25+50+75+100+125+150)+150\text{x}7.5}{250} = 31.27$$

$$S = \frac{312.5\text{x}31.27}{320.11} = 30.52$$

L_4U_5

$$R_A = \frac{12.75(25+50+75+100)+125(12.5+10.24)0.51}{250} = 22.30$$

$$S = \frac{22.30\text{x}312.5}{346.99} = 20.08$$

L_5U_6

$$R_A = \frac{12.75(25+50+75)+100.0(12.50+7.69)0.51+100\text{x}7.5}{250} = 14.77$$

$$S = \frac{312.5\text{x}14.77}{373.76} = 12.34$$

DIAGONALS------COMPRESSION (CONTINUED)

L_6U_7

$$R_A = \frac{12.75(25+50)+75(12.50+5.43)0.51+7.5\times75}{250} = 8.82$$

$$S = \frac{312.5\times8.82}{400.62} = 6.87$$

L_7U_8

$$R_A = \frac{12.75\times25+50(12.50+3.42)0.51+50\times7.5}{250} = 4.40$$

$$S = \frac{312.5\times4.40}{427.34} = 3.21$$

L_8U_9

$$R_A = \frac{25(12.50+1.62)0.51+7.5\times25}{250} = 1.47$$

$$S = \frac{312.5\times1.47}{454.02} = 1.01$$

L_9U_{10}

$$S = 0.00$$

DIAGONALS-------TENSION

L_1U_2

$$R_A = \frac{58.5x125+125x0.51x62.5-(12.50+4.60)0.51x225}{250} = 37.33$$

$$S = \frac{37.33x312.5+337.5x(12.50+4.60)0.51}{266.62} = 54.80$$

L_2U_3

$$R_A = \frac{58.5x125+125x0.51x62.5-(8.5x12.5)0.51x200-12.75x225}{250} =$$

$$= 25.14$$

$$S = \frac{25.14x312.5+12.75x337.5+(12.5+8.5)0.51x341.25}{293.33} = 53.91$$

L_3U_4

$$R_A = \frac{51.0\ x125+125x0.51x62.5-12.75(225+200)-}{250}$$

$$\frac{-175(12.50+11.85)0.51+7.5x125}{250} = 14.81$$

$$S = \frac{312.5x14.81+12.75(337.5+362.5)+387.5(12.5+11.85)0.51}{320.11} =$$

$$= 57.37$$

L_4U_5

$$R_A = \frac{51x125+125x0.51x62.5+7.5x125-12.75(225+200+175+150}{250} = 6.94$$

$$S = \frac{6.94x312.5+12.75(337.5+362.5+387.5+412.5}{346.99} = 61.37$$

DIAGONALS --------TENSION

L_5U_6

$$R_A = \frac{51.0\times125+125\times0.51\times62.5-12.75(225+200+175+150+125)-}{250}$$

$$\frac{-7.5\times125}{250} = -6.94$$

$$S = \frac{-6.94\times312.5+12.75(337.5+362.5+387.5+412.5+437.5)+}{373.76}$$

$$\frac{+7.5\times437.5}{373.76} = 69.07$$

L_6U_7

$$R_A = \frac{51.0\times125+125\times0.51\times62.5-12.75(225+}{250}$$

$$\frac{+200+175+150+125+100)-7.5\times100}{250} = -11.69$$

$$S = \frac{-11.69\times312.5+12.75(337.5+362.5+387.5+412.5+437.5+}{400.62}$$

$$\frac{+462.5)+7.5\times462.5}{400.62} = 75.92$$

L_7U_8

$$R_A = \frac{51\times125+125\times0.51\times62.5-12.75(225+200+175+150+}{250}$$

$$\frac{+125+100+75)\ -7.5\times75}{250} = -14.36$$

$$S = \frac{-14.36\times312.5+12.75(337.5+362.5+387.5+412.5+}{427.34}$$

$$\frac{-+437.5+462.5+487.5+7.5\times487.5}{427.34} = 84.20$$

DIAGONALS -------TENSION

L_8U_9

$$R_A = \frac{125\times51+125\times0.51\times62.5-12.75(225+200+175+}{250}$$

$$\frac{+150+125+100+75+50)-7.5\times50}{250} = -16.16$$

$$S = \frac{-16.16\times312.5+12.75(337.5+362.5+387.5+}{454.02}$$

$$\frac{+412.5+437.5+462.5+487.5+512.5)+7.5\times512.5}{454.02} = 92.82$$

L_9U_{10}

$$R_A = \frac{51\times125+125\times0.51\times62.5-12.75(225+200+175+150+}{250}$$

$$\frac{+125+100+75+50+25)-7.5\times25}{250} = -16.68$$

$$S = \frac{-16.68\times312.5+12.75(337.5+362.5+387.5+412.5+}{480.74}$$

$$\frac{+437.5+462.5+487.5+512.5+537.5)+7.5\times537.5}{480.74} = 101.97$$

ANCHOR ARM---------COMPRESSION

POSTS

L_1U_1

$$R_A = \frac{58.5\times125+125\times0.51\times62.5}{250} = 45.42$$

$$S = \frac{312.5\times45.42}{337.5} = 42.05$$

L_2U_2

$$R_A = \frac{58.5\times125+125\times0.51\times62.5-225(125+4.60)0.51}{250} = 37.57$$

$$S = \frac{312.5\times37.57+0.51(12.5+4.6)\times337.5}{362.5} = 40.51$$

L_3U_3

$$R_A = \frac{58.5\times125+125\times0.51\times62.5-12.75\times225-(12.50+8.50)0.51\times}{250}$$

$$\frac{\times200}{250} = 25.38$$

$$S = \frac{312.5\times25.38+12.75\times337.5+362.5(12.5+8.50)0.51}{287.5} = 41.59$$

L_4U_4

$$R_A = \frac{58.5\times125+125\times0.51\times62.5-12.75(225+200)-0.51}{250}$$

$$\frac{(12.5+1185)175}{250} = 15.05$$

$$S = \frac{312.5\times15.05+12.75(337.5+362.5)+0.51(12.5+11.85)387.5}{412.5} = 44.70$$

L_5U_5

$$R_A = \frac{58.5\times12.5+125\times0.51\times62.5-12.75(225+200+175+150}{250} = 7.17$$

$$S = \frac{312.5\times7.17+12.75(337.5+362.5+387.5+412.5)}{437.5} = 48.83$$

L_6U_6

$$R_A = \frac{58.5\times125+125\times0.51\times62.5-12.75(225+200+175+}{250}$$

$$\frac{+150+125)}{250} = 0.80$$

$$S = \frac{312.5\times0.8+12.75(337.5+362.5+387.5+412.5+437.5)}{462.5} = 53.95$$

L_7U_7

$$R_A = \frac{51.0\times125+125\times0.51\times62.5-12.75(225+200+175+}{250}$$

$$\frac{+150+125+100)-7.5\times100}{250} = -11.28$$

$$S = \frac{-11.28\times312.5+12.75(337.5+362.5+387.5+412.5+}{487.5}$$

$$\frac{+437.5+462.5)+7.5\times462.5}{487.5} = 62.65$$

L_8U_8

$$R_A = \frac{51.0\times125+125\times0.51\times62.5-12.75(225+200+175+}{250}$$

$$\frac{150+125+100+75)-7.5\times75}{250} = -14.36$$

$$S = \frac{-14.36\times312.5+12.75(337.5+362.5+387.5+412.5+}{512.5}$$

$$\frac{+437.5+462.5+487.5)+7.5\times487.5}{512.5} = 70.21$$

L_9U_9

$$R_A = \frac{51.0x125+0.51x125x62.5-12.75(225+200+175+150+}{250}$$

$$\frac{+125+100+75+50)-7.5x50}{250} = -16.16$$

$$S = \frac{-16.16x312.5+12.75(337.5+362.5+387.5+412.5+437.5+}{537.5}$$

$$\frac{+462.5+487.5+512.5)+7.5x512.5}{537.5} = 78.40$$

$L_{10}U_{10}$

$$R_A = \frac{125x51.0+125x0.51x62.5-12.75(225+200+175+150+}{250}$$

$$\frac{+125+100+75+50+25)-7.5x25}{250} = -16.68$$

$$S = \frac{-16.68x31.25+12.75(337.5+362.5+287.5+412.5+437.5+}{562.5}$$

$$\frac{+462.5+487.5+512.5+537.5)+7.5x537.5}{562.5} = 87.14$$

<u>POSTS</u>------TENSION

L_1U_1

$$R_A = \frac{12.75(25+50+75+100+125+150+175+200+225)+}{250}$$

$$\frac{225x7.5}{250} = 64.12$$

$$S = \frac{-312.5x64.12+}{337.5} = 59.37$$

L_2U_2

$$R_A = \frac{12.75(25+50+75+100+125+150+175+200)+7.5+200}{250} = 51.90$$

$$S = \frac{-51.9 \times 312.5}{362.5} = 44.74$$

L_3U_3

$$R_A = \frac{12.75(25+50+75+100+125+150+175)+7.5 \times 175}{250} = 40.95$$

$$S = \frac{312.5 \times 40.95}{387.5} = 33.02$$

L_4U_4

$$R_A = \frac{12.75(25+50+75+100+125+150)+150 \times 7.5}{250} = 31.27$$

$$S = \frac{312.5 \times 31.27}{412.5} = 23.69$$

L_5U_5

$$R_A = \frac{12.75(25+50+75+100)+125(12.5 \times 10.24)0.51+7.5 \times 125}{250} =$$

$$15.92$$

$$S = \frac{312.5 \times 22.29}{437.5} = 15.92$$

L_6U_6

$$R_A = \frac{12.75(25+50+75)+0.5(12.50+7.69)100+100 \times 7.5}{250} = 14.76$$

$$S = \frac{312.5 \times 14.76}{462.5} = 9.97$$

L_7U_7

$$R_A = \frac{12.75(25+50)+0.51(12.50+5.43)75+7.5 \times 75}{250} = 8.81$$

$$S = \frac{312.5 \times 8.81}{487.5} = 5.647$$

L_8U_8

$$R_A = \frac{12.75(25)+0.51(12.50+3.42)50+7.5x50}{250} = 4.39$$

$$S = \frac{312.5x4.39}{512.5} = 2.67$$

L_9U_9

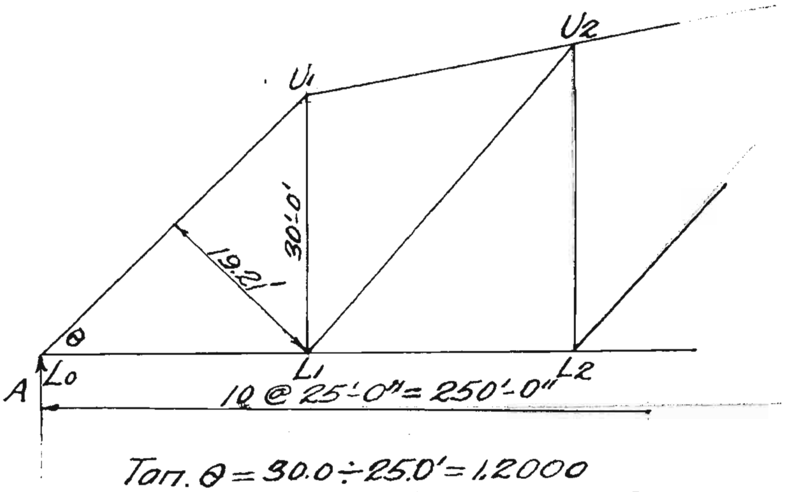
$$R_A = \frac{7.5x25+0.51(12.5x1.62)25}{250} = 1.47$$

$$S = \frac{312.5x1.47}{537.5} = 0.854$$

$L_{10}U_{10}$

$S = 0.00$

END POST



$\text{Tan. } \theta = 30.0 \div 25.0' = 1.2000$

$\theta = 50^\circ 12' \quad \text{sine } \theta = 0.7683$

$\text{Arm} = 25.0 \times 0.7628 = 19.21'$

U_1L_0

COMPRESSION

$$R_A = \frac{250 \times 125 \times 0.51 + 15.0 \times 225}{250} = 77.25$$

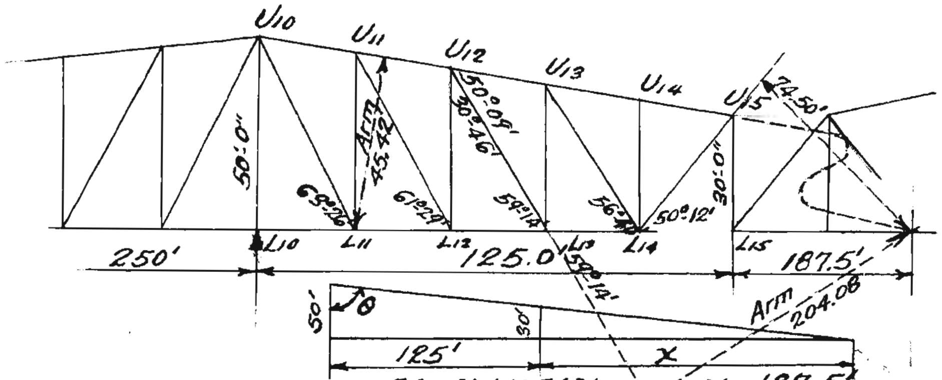
$$S = \frac{77.25 \times 25 - 25 \times 0.51 \times 12.50}{19.21} = 92.23$$

TENSION

$$R_A = \frac{15.0 \times 125 + 51.0 \times 125 + 125 \times 0.51 \times 62.5}{250} = 48.94$$

$$S = \frac{25 \times 48.94}{19.21} = 63.69$$

STRESSES IN CANTILEVER ARM



50 : 30 = x + 125 : x   x = 187.5

(125 + 187.5) ÷ 50 = tan. θ = 6.2500

θ = 80°55'

LENGTH OF DIAGONALS

Member	Divided by 25	=	Tang.	Angle	Cosine	Length
$U_{10}L_{11}$	50		2.000	63°26'	0.4472	55.90
$U_{11}L_{12}$	46		1.840	61°29'	0.4774	52.37
$U_{12}L_{13}$	42		1.680	59°14'	0.5115	48.87
$U_{13}L_{14}$	38		1.520	56°40'	0.5495	45.49

TOP CHORD ARMS

Member	Angle	Sine	Diagonal	Arm
$U_{10}L_{11}$	54°21'	0.8126	55.90	45.42
$U_{11}L_{12}$	52°24'	0.7923	52.37	41.49
$U_{12}L_{13}$	50°09'	0.7677	48.87	37.52
$U_{13}L_{14}$	47°35'	0.7383	45.49	33.58

90°00' 63°26' 26°34'	90°00 61°29 28°31'	90°00' 59°14' 30°46'	90°00' 56°40' 33°20'
80°55' 26°34' 54°21'	80°55' 28°31 52°24'	80°55 30°46 50°09'	80°55 33°20' 47°-35'

Top Chord----Tension

Concentration at end of cantilever arm =

$$15.0 + 200/2 \times 0.51 = 66.0$$

$U_{10}U_{11}$

$$S = \frac{66.0\times100+0.51\times100\times50}{45.42} = 201.45$$

$U_{11}U_{12}$

$$S = \frac{66.0\times75+0.51\times75\times75/2}{41.49} = 153.87$$

$U_{12}U_{13}$

$$S = \frac{66.0\times50+0.51\times50\times25}{37.52} = 104.94$$

$U_{13}U_{14}$

$$S = \frac{66.0\times25+25\times0.51\times12.5}{33.58} = 53.87$$

Bottom Chords----Compression

$L_{10}L_{11}$

$$S = \frac{66.0\times125+125\times0.51\times62.5}{50} = 244.68$$

$L_{11}L_{12}$

$$S = \frac{66.0\times100+100\times0.51\times50}{46} = 198.91$$

$L_{12}L_{13}$

$$S = \frac{66.0x75+75x0.51x75/2}{42} = 152.00$$

$L_{13}L_{14}$

$$S = \frac{66.0x50+50x0.51x25}{38} = 103.62$$

DIAGONALS------TENSION

See Figure______

Member	Divide by 25		Tang.	Angle	Sine	d	Arm
$U_{10}L_{11}$	50	=	2.000	63°26'	0.8944	287.5	257.14
$U_{11}L_{12}$	46	=	1.840	61°29'	0.8787	262.5	230.66
$U_{12}L_{13}$	42	=	1.680	59°14'	0.8593	237.5	204.08
$U_{13}L_{14}$	38	=	1.520	56°40'	0.8355	212.5	177.54

$U_{10}L_{11}$

$$S = \frac{7.5x287.5+57.36x187.5+12.75(212.5+}{257.14}$$

$$\frac{237+262.5+287}{257.14} = 99.79$$

$U_{11}L_{12}$

$$S = \frac{7.5x62.5+57.36x187.5+12.75(212.5+237.5+262.5)}{230.66} = 94.54$$

$U_{12}L_{13}$

$$S = \frac{7.5x237.5+57.36x187.5+12.75(212.5+237.5)}{204.08} = 89.54$$

$U_{13}L_{14}$

$$S = \frac{7.5x212.5+57.36x187.5+12.75x212.5}{177.54} = 84.81$$

Posts-------Compression

$U_{10}L_{10}$

$$S = \frac{7.5x287.5+57.36x187.5+12.75(212.5+237.5+262.5+287.5}{312.5} = 82.11$$

$U_{11}L_{11}$

$$S = \frac{7.5x262.5+57.36x187.5+12.75(212.5+237.5+62.5)}{287.5} = 75.85$$

$U_{12}L_{12}$

$$S = \frac{7.5x237.5+57.36x187.5+12.75(212.5+237.5)}{262.5} = 69.61$$

$U_{13}L_{13}$

$$S = \frac{7.5x212.5+57.36x187.5+12.75x212.5}{237.5} = 63.40$$

Diagonal See Figure________

$U_{15}L_{14}$

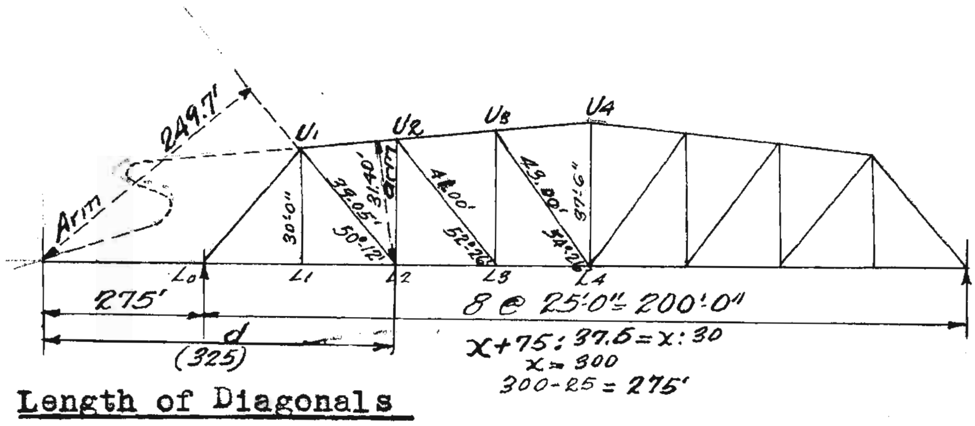
$\mathrm{Tan} = 30 \div 25 = 1.200 = 50^{\circ}12'$

$\mathrm{Sine}\ 50^{\circ}12' = .7652$

$212.5x.7683 = 163.26$

$$S = \frac{7.5x187.5+57.37x187.5}{163.26} = 74.501$$

STRESSES IN SUSPENDED SPAN



Length of Diagonals

Member	Divided by 25	= Tang.	Angle	Sine	Length
U_1L_2	30.0	1.200	50°12'	0.7683	39.05
U_2L_3	32.5	1.300	52°26'	0.7926	41.00
U_3L_4	35.0	1.400	54°28'	0.8138	43.00

Top Chord-----Arms

Member	Angle	Sine	Diagonal	Arm
U_1U_2	53°31'	0.8040	39.05	31.40
U_2U_3	55°48'	0.8271	41.00	33.91
U_3U_4	57°51	0.8467	43.00	36.41

180°0' −[(90°50°12) + 84°17] = 53°31'

180°0' −[(90°52°26) + 84°17] = 55°48'

180°0' −[(90°54°28) + 84°17] = 57°51'

Top Chord ------ Compression

U_1U_2

$$R_A = \frac{200\times0.51\times100+150\times15.0}{200} = 62.25$$

$$S = \frac{50\times62.25-50\times0.51\times25}{31.40} = 78.82$$

U_2U_3

$$R_A = \frac{200\times0.51\times100+125\times15.0}{200} = 60.375$$

$$S = \frac{75\times60.37-75\times0.51\times37.5}{33.91} = 91.22$$

U_3U_4

$$R_A = \frac{200\times0.51\times100+100\times15.0}{200} = 58.5$$

$$S = \frac{100\times58.5-100\times0.51\times50}{36.41} = 90.63$$

Bottom Chord ----- Tension

L_0L_2

$$R_A = \frac{15.0\times175+100\times0.51\times200}{200} = 64.12$$

$$S = \frac{25\times64.12-12.5\times0.51\times18.75}{30} = 49.44$$

L_2L_3

$$R_A = \frac{150\times15.0+100\times0.51\times200}{200} = 62.25$$

$$S = \frac{50\times62.25-50\times0.51\times25}{32.5} = 76.15$$

L_3L_4

$$R_A = \frac{125 \times 15.0 + 100 \times 0.51 \times 200}{200} = 60.375$$

$$S = \frac{60.37 \times 75 - 75 \times 0.51 \times 37.5}{35.0} = 88.38$$

END POSTS See Figure______

L_0U_1

$$\text{Tan.} = 30/25 = 1.2000 = 50^\circ 12'$$
$$r/25 = \sin 50^\circ 12'$$
$$r = 0.7683 \times 25 = 19.21$$

$$R_A = \frac{175 \times 15.0 + 175 \times 0.51 \times 100}{200} = 57.75$$

$$S = \frac{25 \times 57.75}{19.21} = -75.16$$

DIAGONAL ARMS See Figure_______

Member	Divided by 25		Tang.	Angle	Sine	d	Arm
U_1L_2	30	=	1.200	$50^\circ 12'$	0.7683	325	249.7'
U_2L_3	32.5	=	1.300	$52^\circ 26'$	0.7926	350	277.41'
U_3L_4	35.0	=	1.400	$54^\circ 28'$	0.8138	375	305.17'

Diagonals-------Tension

U_1L_2

$$R_A = \frac{1.75(25+50+75+100+125+150)+15.0\times7.5}{200} = 39.09$$

$$S = \frac{275\times39.09}{24.97} = 43.05$$

U_2L_3

$$R_A = \frac{125\times7.5+12.75(25+50+75+100+125)}{200} = 28.59$$

$$S = \frac{275\times28.59}{277.41} = 28.34$$

U_3L_4

$$R_A = \frac{7.5\times100+0.51(12.50+10.66)100+12.75(25+50+75)}{200} = 19.21$$

$$S = \frac{275\times19.22}{305.17} = 17.31$$

Diagonals-----Compression

U_1L_2

$$R_A = \frac{7.5\times175+0.51(12.5+5.16)175}{200} = 14.44$$

$$S = \frac{275\times14.44-0.51(12.5+5.16)300-300\times25}{249.7} = 3.92$$

U_2L_3

$$R_A = \frac{7.5\times150+0.51(12.5+100)150+12.75\times175}{200} = 25.38$$

$$S = \frac{275\times25.38-12.75\times300-0.51(12.5+10)325-7.5\times325}{277.41} = 10.85$$

U_3L_4

$$R_A = \frac{7.5\times125+12.75(175+150+125)}{200} = 33.37$$

$$S = \frac{275\times33.37-12.75(300+325+350)-7.5\times350}{305.17} = 19.27$$

<u>Posts</u>-------<u>Compression</u>

U_2L_2

$$R_A = \frac{7.5\times125+12.75(125+100+75+50+25)}{200} = 28.59$$

$$S = \frac{275\times28.59}{325} = 24.19$$

U_3L_3

$$R_A = \frac{7.5\times100+12.75(25+50+75)+0.51(12.50+10.66)100}{200} = 19.22$$

$$S = \frac{275\times19.22}{350} = 15.10$$

U_4L_4

$$R_A = \frac{7.5\times75+12.75(25+50)+0.51(12.50+6.92)750}{200} = 11.31$$

$$S = \frac{275\times11.31}{375} = 8.29$$

<u>Post</u>------<u>Tension</u>

U_2L_2

$$R_A = \frac{150\times7.5+150(12.5+10.0)0.51+175\times12.75}{200} = 25.38$$

$$S = \frac{275\times25.38-12.75\times300-0.51(12.50+10.0)325-7.5\times325}{325} = 9.26$$

U_3L_3

$$R_A = \frac{7.5 \times 125 + 12.75(125 + 150 + 175)}{200} = 33.37$$

$$S = \frac{275 \times 33.37 - 12.75(300 + 325 + 350) - 7.5 \times 350}{350} = 16.79$$

U_4L_4

$$R_A = \frac{100 \times 7.5 \times 12.75(100 \times 125 + 150 + 175)}{200} = 38.81$$

$$S = \frac{275 \times 38.81 - 12.75(300 + 325 + 350 + 375) - 375 \times 7.5}{375} = 24.93$$

CALCULATIONS FOR DRAWING NO. 1

Stresses in Top and Bottom Chords of Anchor Arm

Graphic Method

Top Chords

L_0U_1 --- A',w,B',10,D'
1.18 x 15.0 = 17.70
1.18/2 x 0.51 x 250 = 75.22
-92.92
0.65 x 15.0 = 9.75
0.65/2 x 0.51 x 325 = 53.87
+63.62

U_1U_2 --- A',b',1,D'
15.0 x 0.75 = 11.25
0.75/2 x 0.51 x 250 = 47.81
-59.06
15.0 x 0.41 = 6.15
0.41/2 x 0.51 x 325 = 33.98
+40.13

U_2U_3 --- A',d',2,D'
1.24 x 15.0 = 18.60
1.24/2 x 0.51 x 250 = 79.05
-97.65
0.76 x 15.0 = 11.40
0.76/2 x 0.51 x 325 = 62.98
+74.38

U_3U_4 ---A',f',3,D'
1.52 x 15.0= 22.95
1.52/2 x 0.51 x 250 = 97.54
-120.49

1.09 x 15.0 = 16.35
1.09/2 x 0.51 x 325 = 90.33
+106.68

U_4U_5---A',h',4,D'

$$\begin{array}{lr}
15.0 \text{ x } 1.64 = & 24.60 \\
1.64/2 \text{ x } 0.51 \text{ x } 250 = & \underline{104.55} \\
 & -129.15 \\
15.0 \text{ x } 1.36 = & 20.40 \\
1.36/2 \text{ x } 0.51 \text{ x } 325 = & \underline{112.71} \\
 & +133.11
\end{array}$$

U_5U_6---A',l',5,D'

$$\begin{array}{lr}
15.0 \text{ x } 1.62 = & 24.30 \\
1.62/2 \text{ x } 0.51 \text{ x } 250 = & \underline{103.27} \\
 & -127.57 \\
15.0 \text{ x } 1.61 = & 24.15 \\
1.61/2 \text{ x } 0.51 \text{ x } 325 = & \underline{133.43} \\
 & -+157.58
\end{array}$$

U_6U_7---A',n',6,D'

$$\begin{array}{lr}
1.48 \text{ x } 15 = & 22.20 \\
1.48/2 \text{ x } 0.51 \text{ x } 250 = & \underline{94.35} \\
 & -116.55 \\
15.0 \text{ x } 1.84 = & 27.60 \\
1.84/2 \text{ x } 0.51 \text{ x } 325 = & \underline{152.49} \\
 & +180.09
\end{array}$$

U_7U_8---A',p',7,D'

$$\begin{array}{lr}
15.0 \text{ x } 1.23 = & 18.45 \\
1.23/2 \text{ x } 0.51 \text{ x } 250 = & \underline{78.41} \\
 & -96.86 \\
15.0 \text{ x } 2.04 = & 30.60 \\
2.04/2 \text{ x } 0.51 \text{ x } 325 = & \underline{169.06} \\
 & +199.66
\end{array}$$

U_8U_9---A'-,S',8,D'

$$\begin{array}{lr}
15.0 \text{ x } 0.88 = & 13.20 \\
0.88/2 \text{ x } 0.51 \text{ x } 250 = & \underline{56.10} \\
 & -69.30 \\
15.0 \text{ x } 2.20 = & 33.00 \\
2.20/2 \text{ x } 0.51 \text{ x } 325 = & \underline{182.32} \\
 & +215.32
\end{array}$$

U_9U_{10}---A',u',9,D'

$$\begin{array}{lr}
15.0 \text{ x } 0.47 = & 7.05 \\
0.47/2 \text{ x } 0.51 \text{ x } 250 = & \underline{29.96} \\
 & -37.01 \\
15.0 \text{ x } 2.39 = & 35.85 \\
2.39/2 \text{ x } 0.51 \text{ x } 325 = & \underline{198.07} \\
 & +233.92
\end{array}$$

Bottom Chords

L_0L_1---A",1',1,D"
15.0 x 0.74 = 11.10
0.74/2 x 0.51 x 250 = 47.17
+58.27

15.0 x 0.41 = 6.15
0.41/2 x 0.51 x 325 = 33.98
-40.13

L_1L_2---A",2',2,D"
15.0 x 1.24 = 81.60
1.24/2 x 0.51 x 250 = 79.05
+97.65
0.76 x 15.0 = 11.40
0.76/2 x 0.51 x 325 = 62.98
-74.38

L_2L_3---A",3'3,D"
15.0 x 1.52 = 22.95
1.53/2 x 0.51 x 250 = 97.54
+120.49
1.09 x 15.0 = 16.35
1.09/2 x 0.51 x 325 = 90.33
-106.68

L_3L_4---A",4',4,D"
15.0 x 1.63 = 24.45
1.63/2 x 0.51 x 250 = 103.91
+128.36
15.0 x 1.36 = 20.40
1.36/2 x 0.51 x 325 = 112.71
-133.11

L_4L_5---A",5',5,D"
15.0 x 1.61 = 24.15
1.61/2 x 0.51 x 250 = 102.64
+126.79
15.0 x 1.61 = 24.15
1.61/2 x 0.51 x 325 = 133.43
-157.58

L_5L_6---A",6',6,D"
15.0 x 1.47 = 22.05 22.05
1.47/2 x 0.51 x 250 = 93.71
+115.76
15.0 x 1.84 = 27.60
1.84/2 x 0.51 x 325 = 152.49
-180.09

L_6L_7---A",7',7,D"	
15.0 x 1.23 =	18.45
1.23/2 x 0.51 x 250 =	78.41
	+96.86
15.0 x 2.04	30.60
2.04/2 x 0.51 x 325 =	169.06
	-199.66
L_7L_8---A",8',8,D"	
15.0 x 0.88=	13.20
0.88/2 x 0.51 x 250 =	56.10
	+69.30
15.0 x 2.20 =	33.00
2.20/2 x 0.51 x 325 =	182.32
	-215.32
L_8L_9---A",9',9,D"	
15.0 x 0.46 =	6.90
0.46/2 x0.51 x 250 =	29.32
	+36.22
15 x 2.33 =	34.95
233/2 x 325 x 0.51 =	193.10
	-228.05
$L9L_{10}$----A",B",10,D"	
15.0 x 2.49 =	37.35
2.49/2 x 325 x 0.51 =	206.36
	-243.71

CALCULATIONS FOR DRAWINGS NO. 2 & 2A

Stresses in Diagonals & Posts

Graphic Method

Diagonals

L_1U_2 --- A',b',1,8,D'

7.5 x 0.94 = 7.05
12.75(0.94+0.82+0.70+0.59+0.47+0.35
+0.23+0.12) = 53.80
-60.85

0.51(12.5 + 4.6)0.20 = 1.74
7.5 x .59 = 4.42
325 x 0.51 x 59/2 = 48.90
+55.06

L_2U_3--- A',d',2,7,D'

7.5 x 0.74 = 5.55
12.75(0.74+0.63+0.53+0.42+0.32+0.21+0.11) = 37.74
-43.29

7.5 x 0.52 = 3.90
325 x 0.51 x 0.52/2 = 43.09
12.75 x 0.18 = 2.29
0.51(12.5 + 8.50)0.37 = 3.96
+53.24

L_3U_4---A',f',3,6,D'

7.5 x 0.56 = 4.20
12.75(0.56+0.47+0.37+0.28+0.19+0.09) = 24.99
-29.19

7.5 x 0.46 = 3.45
325 x 0.51 x 0.46/2 = 38.12
12.75(0.17 + 0.35) = 6.63
0.51(12.5 +11.85)0.52 = 6.46
+54.66

L_4U_5(A',h',4,5,D')

7.5 x 0.45 = 3.37
12.75(0.09 +0.18 + 0.27 +0.36) 11.48
0.51(12.5 + 10.24)0.45 = 5.22
-20.07

7.5 x 0.44 = 3.30
325 x 0.51 x 0.44/2 = 36.46
12.75(0.16+0.32+0.47+0.63) = 20.14
+ 59.90

L_5U_6---A',1',5,4,D'

7.5 x 0.32 = 2.40
12.75(0.08 ≠ 0.16 ≠0.24) = 6.12
0.51(12.50 ≠ 7.69)0.32 = 3.29
-11.81

7.5 x 0.74 = 5.50
325 x 0.51 x 0.41/2 = 33.98
12.75(0.15≠0.30≠0.44≠0.59≠0.74) = 28.30
≠67.78

L_6U_7---A',n',6,3,D'

7.5 x .23 = 1.72
12.75(0.076 ≠ 0.15) = 2.88
0.51(12.5 ≠ 5.43)0.23 = 2.10
-6.70

7.5 x 0.84 = 6.30
12.75(0.14≠0.28≠0.42≠0.56≠0.70≠0.84)= 37.48
325 x 0.51 x 0.39/2 = 32.32
≠76.10

L_7U_8---A',p',7,3,D'

7.5 x 0.15 = 1.12
12.75 x 0.075 = .96
0.51(12.5 ≠ 3.42)0.15 = 1.22
-3.30

7.5 x 0.92 = 6.90
12.75(0.13≠0.26≠0.39≠0.52≠0.66≠0.79≠0.92 = 46.79
325 x 0.51 x 0.37/2 = 30.66
≠84.35

L_8U_9---A',s',8,2,D'

7.5 x 0.07 = 0.52
0.51(12.5 ≠ 1.62)0.07 = 0.50
-1.02

7.5 x 0.99 = 7.42
12.75(0.12≠0.25≠0.37≠0.49≠0.62≠0.74≠0.87≠0.99)= 56.74
325 x 0.51 x 0.33/2 = 27.34
≠91.50

L_9U_{10}---A',u',B',1,D'

7.5 x 1.04 = 7.80

12.75(0.12+0.23+0.35+0.46+0.58+ 66.30
+0.69+0.81+0.92+1.04) = 27.34

325 x 0.51 x 0.33/2 = +101.44

Posts

L_1U_1---A',y',9,D'

7.5 x 0.84 = 6.30

12.75(0.9+0.19+0.28+0.37+0.47+
0.56+0.65+0.75+0.84) = 53.55
+59.85

7.5 x 0.47 = 3.52
325 x 0.51 x 0.47/2 = 38.95
-42.47

L_2U_2---A',b',1,8,D'

7.5 x .74 = 5.50

12.75(0.9+0.18+0.28+0.37+0.46+0.55+0.65+0.74)=42.33
+46.83

7.5 x 0.45 = 3.37
325 x 0.51 x 0.45/2 = 37.29
0.51(12.5 +4.6)0.17 = 1.48
-42.14

L_3U_3---A',d',2,7,D'

0.65 x 7.5 = 4.87

12.75(.08+0.17+0.25+0.34+0.42+0.51+0.59) = 30.09
+34.96

7.5 x 0.41 = 3.07
325 x 0.51 x 0.41/2 = 33.98
12.75 x 0.15 = 1.91
0.51(12.5 + 8.5)0.30 = 3.21
-42.19

L_4U_4---A',f',3,6,D'

7.5 x 0.47 = 3.52
12.75(0.08+0.16+0.23+0.31+0.39+0.47) = 20.91
+24.43

12.75(0.14+0.28) = 5.35
0.51(12.5+11.85)0.42 = 5.21
7.5 x 0.38 = 2.85
325 x 0.51 x 0.38/2 = 31.49
-44.90

L_5U_5---A',h'4,5,D'

7.5 x 0.38 = 2.85
12.75(0.07+0.15+0.23+0.30) = 9.56
0.51(125 +10.24)0.38 = 4.40
+16.81

12.75(0.14+0.27+0.40+0.54) = 17.21
7.5 x 0.38 = 2.85
325 x 0.51 x 0.38/2 = 31.49
-51.55

L_6U_6---A',l',5,4,D'

7.5 x 0.28 = 2.10
0.28(12.5 + 7.69) = 2.88
12.75(0.07+0.14+0.21) = 5.35
+10.33

7.5 x 0.36 = 2.70
0.51 x 325 x 0.36/2 = 29.83
12.75(0.13+0.23+0.38+0.51+0.64) = 24.48
-57.01

L_7U_7---A',n',6,3,D'

7.5 x 0.20 = 1.50
12.75(0.07+0.13) = 2.55
0.51(12.5+5.43)0.20 = 1.83
+5.88

7.5 x 0.72 = 5.40
12.75(0.12+0.24+0.36+0.48+0.60+0.72) = 32.13
325 x 0.51 x 0.34/2 = 28.18
-65.71

L_8U_8---A',p,7,2,D'

7.5 x 0.13 = 0.97
12.75 x 0.07 = 0.89
0.51(12.50+3.42)0.13 = 1.05
+ 2.91

7.5 7.5 x 0.80 = 6.00
12.75(0.11+0.23+0.34+0.46+0.57+0.69+0.80)= 40.80
325 x 0.51 x 0.31/2 = 25.69
-72.49

L_9U_9---A',s',8,1,D'

7.5 x 0.065 = 0.49
0.51(12.5 +1.62)0.065 = 0.47
+0.96

7.5 x 0.87 = 6.52
12.75(0.11+0.22+0.33+0.43+0.54
+0.65+0.74+0.87) = 49.85
325 x 0.51 x 28/2 = 23.20
-79.57

$L_{10}U_{10}$---A',5',B',1,D'

7.5 x 0.93 = 6.97
12.75(0.10+0.21+0.31+0.41+0.52
+0.62+0.72+0.83+0.93) = 59.29
325 x 0.51 x 0.28/2 = 23.20
- 89.46

CALCULATIONS FOR DRAWING NO. 3

Stresses in Anchor Arm

Semi-Graphic Method

Top Chords

L_0U_1 ---- A',b,B',C',D'
0.90 x 15.0 = 13.50
0.90/2 x 250 x 0.51 = 57.37
70.87 x 1.31 = -92.84
15 x 0.50 = 7.5
0.50/2 x 0.51 x 325 = 41.44
48.94 x 1.31 = +64.11

U_1U_2----A',b,C',D'
0.90 x 15.0 = 13.50
0.90/2 x 0.51 x 250 = 57.37
70.87 x 0.83 = -58.82

48.94 x 0.83 = +40.62
(See L_0U_1)

U_2U_3----A'd,C',D'
15.0 x 0.80 = 12.00
0.80/2 x 250 x 0.51 = 51.00
63.00 x 1.56 = -98.28
48.94 x 1.56 = +74.79

U_3U_4---A',f,C',D'
0.70 x 15.0 = 10.50
0.70/2 x 250 x 0.51 = 44.62
55.12 x 2.19 = 120.71
48.94 x 2.19 = +107.18

U_4U_5---A',h,C',D'
15.0 x 0.60 - 9.00
0.60/2 x 0.51 x 250 = 38.25
47.25 x 274 = -129.46
48.94 x 2.74 = +134.09

U_5U_6---A',l,C',D'
0.50 x 15.0 = 7.50 7.50
0.50/2 x 0.51 x 250 = 31.87
39.37 x 3.23 = -127.16
48.94 x 3.23 = +158.07

U_6U_7----A',n,C',D',
15.0 x 0.4 = 6.00
0.40/2 x 0.51 x 250 = 25.50
31.50 x 3.66 = -115.29
48.94 x 3.66 = +179.12

U_7U_8----A',p,C',D'
15.0 x 0.30 = 4.50
0.30/2 x 0.51 x 250 = 19.12
23.62 x 4.05 = -95.33
48.94 x 4.05 = +198.21

U_8U_9----A',s,C',D'
15.0 x 0.20 = 3.00
0.20/2 x 0.51 x 250 = 12.75
15.75 x 4.41 =-69.46
48.94 x 4.41 = 215.82

U_9U_{10}----A',t,C',D'
15.0 x 0.10 = 1.50
0.10/2 x 0.51 x 250 = 6.47
7.87 x 4.73 = -37.22

48.94 x 4.73 = 231.486

Bottom Chords

L_0L_1----A'b,C',D'
70.87 x 0.83 = +58.82
48.94 x 0.83 = -40.62

L_1L_2----A',d,C',D
63.0 x 1.55 = +97.65
48.94 x 1.55 = -75.86

L_2L_3----A', ,C',D'
55.12 x 2.18 = +120.16
48.94 x 2.18 = -106.69

L_3L_4----A'h,C',D'
47.25 x 2.73 = +128.99
48.94 x 2.73 = -133.61

L_4L_5----A',l,C',D'
39.37 x 3.21 = +126.38
48.94 x 3.21 = -157.10

L_5L_6----A',n,C',D'
31.50 x 3.64 = +114.66
48.94 x 3.64 = -178.14

L_6L_7----A',p,C',D'
23.62 x 4.03 = +95.19
48.94 x 4.03 = -197.23

L_7L_8----A',s,C',D'
15.75 x 4.38 +68 .98
48.94 x 4.38 = -214.36

L_8L_9----A',u,C'D'
7.87 x 4.70 = 36.99
48.94 x 4.70 = $\underline{-230.02}$

L_9L_{10}----A',B',C',D'
00.00 x 4.99 = 000.00
48.94 x 4.99 = -244.21

Diagonals

L_1U_2

0.51 x 25 = 12.75 panel concentration
12.75(0.10+0.20+0.30+0.40+0.50+0.60+0.70+0.80)
12.75 x 3.60 = 45.90
7.5 x 0.80 = 6.00
51.90 x 1.18 = -61.24

7.5 x 0.50 = 3.75
325 x 0.51 x 0.50/2 = 41.44
0.51(12.50+4.60)0.18 = 1.56
46.75 x 1.18 = +55.16

L_2U_3

12.75x(0.10+0.20+0.30+0.40
+0.50+0.60+0.80) = 35.70
7.5 x 0.70 = 5.25
40.95 x 1.07 = -43.81

12.75 x 0.18 = 2.29
(8.5+12.5)0.51x0.36 = 3.85
7.5 x 0.50 = 3.75
0.50/2 x 0.51 x 325 = 41.44
51.33 x 1.07 = +54.92

L_3U_4

12.74(0.10+0.20+0.30+0.40+0.50+0.60)
12.75x2.10 = 26.77
7.5x0.60 = 4.50
31.27 x 0.97 = -30.33

325x0.51x0.50/2 = 41.44
7.5x0.50 = 3.75
12.75(0.18+0.36) = 6.88
(12.50+11.85)0.51x0.54 = 6.71
58.78 x 0.97 = +57.02

L_4U_5

12.75(0.10+0.20+0.30+0.40+0.50)
12.75x1.50 = 19.12
7.5 x 0.50 = 3.75
22.87 x 0.89 = -20.35

12.75(0.18+0.36+0.54+0.72) = 22.95
325x0.51x0.50/2 = 41.44
7.5x0.50 = 3.75
68.14 x0.89 =+60.64

L_5U_6

12.75(0.10+0.20+0.30) = 7.65
0.40(12.50+7.69)0.51 = 4.12
7.5 x 0.40 = 3.00
14.77 x 0.83 = -12.26

7.5x0.90 = 6.75
325x0.51x0.50/2 = 41.44
12.75(0.18+0.36+0.54+0.72+0.90) =34.42
82.61 x 0.83 = +68.56

L_6U_7

12.75(0.10+0.20) = 3.82
0.30(12.50+5.43)0.51 = 2.74
7.5x0.30 = 2.25
8.81 x 0.77 = -6.78

7.5x1.08 = 8.10
12.75(0.18+0.36+0.54+0.72+0.90+1.08) =48.19
325x0.51x0.50/2 = 41.44
97.73x0.77 = +75.25

L_7U_8

7.5 x0.20 = 1.50
12.75(0.10) = 1.27
0.20(12.50+3.42)0.51 = 1.62
4.39 x 0.73 = 3.20

7.5 x 1.26 = 9.45
0.51x325x0.50/2 = 41.44
12.75(0.18+36+0.54+0.72+0.90+1.08+1.26) = 64.26
115.15 x 0.73 =
+84.06

L_8U_9

0.10 x 7.5 = 0.75

0.10(12.50+1.62)0.51 = 0.72

1.47 x 0.68 = 0.999

1.44 x 7.5 = 10.80

12.75(0.18+0.36+0.54+0.72+0.90

+1.08+1.26+1.44) = 82.62

325 x 0.51 x 0.50/2 = 41.44

134.86 x 0.68 = +91.70

L_9U_{10}

1.62 x 7.5 = 12.15

12.75(0.18+0.36+0.54+0.72+0.90

+1.08+1.26+1.44+1.62), = 103.27

325 x 0.51 x 0.50/2 = 41.44

156.86 x 0.64 = +100.39

Posts

L_1U_1

7.5 x 0.90 = 6.75

12.75(0.10+0.20+0.30+0.40+0.50+

0.60+0.70+0.80+0.90) = 57.37

64.12x0.93 = +59.63

0.51 x 325 x 0.50/2 = 41.44

7.5 x0.50 = 3.75

45.19 x 0.93 = -42.03

L_2U_2 x 0.80 = 6.00

12.75(0.1+0.2+0.3+0.4+0.5

+0.6+0.7+0.8) = 45.90

51.90 x 0.86 =+44.63

7.5 x 0.5 = 3.75

325 + 0.51 x 0.50/2 = 41.44

(12.50+4.60)0.51x0.18 = 1.57

46.76 c 0.86 = 40.21

L_3U_3

7.5 x 0.70 = 5.25
12.75(0.10+0.20+0.30+0.40+0.50 +0.60+0.70) = 35.70
40.95 x 0.80 = +32.76

7.5 x 0.50 = 3.75
325 x 0.51 x 0.50/2 = 41.44
12.75 x 0.18 = 2.29
(12.50+8.50)0.51x0.36 = 3.86
51.34 x 0.80 = -41.07

L_4U_4

7.5 x 0.60 = 4.50
12.75(0.10+0.20+0.30+0.40+0.50+0.60) = 26.77
+31.27 x 0.76 = +23.76

7.5 x 0.50 = 3.75
0.51 x 325 x 0.50/2 = 41.44
12.75(0.18+0.36) = 6.88
0.51(12.50+11.85)0.54 = 6.70
58.77 x 0.76 = -44.66

L_5U_5

7.5 x0.50 = 3.75
12.75(0.10+0.20+0.30+0.40) = 12.75
0.51(12.50+12.24)0.50 = 5.80
22.30 x 0.71 = +15.83

7.5 x 0.50 = 3.75
0.51 x 325 x 0.50/2 = 41.44
12.75(0.18+0.36+0.54+0.72) = 22.95
68.14 x 0.71 = -48.38

L_6U_6

7.5 x 0.40 = 3.00
12.75(0.10+0.20+0.30) = 7.65
(12.50+7.69)0.40 = 4.12
14.77 x 0.67 = +9.89

7.5 x 0.50 = 3.75
325x0.51x0.50/2 = 41.44
12.75(0.18+0.36+0.54+0.72+0.92) = 34.42
79.61x0.67= -53.34

L_7U_7

7.5 x 0.30 = 2.25
12.75(0.10+0.20) = 3.82
0.51(12.50+5.43)0.30 = 2.74
8.81 x 0.63 = +5.55

7.5 x 1.08 8.10
12.75(0.18+0.36+0.54+0.72+0.90+1.08) = 48.19
41.44
97.73x0.63=-61.57

L_8U_8

12.75 x 0.10 = 1.27
0.51(12.5+3.42)0.20 = 1.62
7.5 x0.20 = 1.50
4.39 x 0.60 =+2.63

12.75(0.18+0.36+0.54+0.72+0.90+1.08+1.26)=64.26
7.5 x 1.26 = 9.45
325 x 0.51 x 0.50/2 = 41.44
115.15x0.60 =
-69.09

L_9U_9

7.5 x 0.10 = 00.75
0.51(12.5+1.62)0.10,= 00.72
1.47 x 0.57 =+0.837

7.5 x 1.44 = 10.80
325 x 0.51 x 0.50/2 = 41.44
12.75(0.18+0.36+0.54+0.72+0.90
+1.08+1.26+1.44 = 82.62
134.86 x 0.57 = -76.87

$L_{10}U_{10}$

7.5 x 1.62 = 12.15
325 x 0.51 x 0.50/2 = 41.44
12.75(0.18+0.36+0.54+0.72+0.90
+1.08+1.26+1.44+1.62) = 103.27
156.86 x 0.55 = -86.27

SUMMATION AND COMPARISON OF STRESSES

STRESSES IN ANCHOR ARM

<u>Top Chords</u>

		Method		
Member	Stress	Graphic	Semi-Graphic	Moments
L_0U_1	+	63.62	64.11	63.69
	-	92.14	92.84	92.26
U_1U_2	+	40.13	40.62	40.91
	-	59.06	58.82	59.26
U_2U_3	+	74.38	74.79	76.23
	-	97.65	98.28	98.07
U_3U_4	+	106.68	107.18	106.92
	-	120.49	120.71	120.43
U_4U_5	+	133.11	134.09	133.90
	-	129.15	129.46	129.27
U_5U_6	+	157.58	158.07	157.83
	-	127.57	127.16	126.98
U_6U_7	+	180.09	179.12	179.14
	-	116.55	115.29	115.30
U_7U_8	+	199.66	198.21	198.30
	-	96.86	95.66	95.72
U_8U_9	+	215.32	215.82	215.55
	-	69.30	69.46	69.37
U_9U_{10}	+	233.92	231.49	231.24
	-	37.01	37.22	37.21

STRESSES IN ANCHOR ARM CONTINUED

<u>Bottom Chords</u>		Method		
Member	Stress	Graphic	Semi-Graphic	Moments
L_0L_1	+	58.27	58.82	59.06
	-	40.13	40.62	40.78
L_1L_2	+	97.65	97.65	97.76
	-	74.38	75.86	75.95
L_2L_3	+	120.49	120.16	120.04
	-	106.68	106.69	106.58
L_3L_4	+	128.36	128.99	128.89
	-	133.11	133.61	133.50
L_4L_5	+	126.79	126.38	126.60
	-	157.58	157.10	157.34
L_5L_6	+	115.76	114.66	114.96
	-	180.09	178.14	178.61
L_6L_7	+	96.86	95.19	95.44
	-	199.66	197.23	197.70
L_7L_8	+	69.30	69.98	69.17
	-	215.32	214.32	214.93
L_8L_9	+	36.22	36.99	37.10
	-	228.05	230.02	230.56
L_9L_{10}	+	000.00	000.00	000.00
	-	243.71	244.26	244.70

STRESSES IN ANCHOR ARM CONTINUED

Diagonals

		Method		
Member	Stress	Graphic	Semi-Graphic	Moments
L_1U_2	+	55.06	55.16	54.80
	-	60.85	61.24	60.83
L_2U_3	+	53.24	54.92	53.91
	-	43.29	43.81	43.62
L_3U_4	+	54.66	57.02	57.37
	-	29.19	30.33	30.52
L_4U_5	+	59.90	60.64	61.37
	-	20.07	20.35	20.08
L_5U_6	+	67.78	68.56	69.07
	-	11.81	12.26	12.34
L_6U_7	+	76.10	75.25	75.92
	-	6.70	6.78	6.87
L_7U_8	+	84.35	84.06	84.20
	-	3.30	3.20	3.21
L_8U_9	+	91.50	91.70	92.82
	-	1.02	0.99	1.01
L_9U_{10}	+	101.44	100.39	101.97
	-	00.00	00.00	00.00

STRESSES IN ANCHOR ARM CONTINUED

Posts

		Method		
Member	Stress	Graphic	Semi Graphic	Moments
L_1U_1	+	59.85	59.63	59.37
	-	42.47	42.03	42.05
L_2U_2	+	46.83	44.63	44.74
	-	42.14	40.21	40.51
L_3U_3	+	34.96	32.76	33.02
	-	42.17	41.07	41.59
L_4U_4	+	24.43	23.76	23.69
	-	44.90	44.66	44.70
L_5U_5	+	16.81	15.83	15.92
	-	51.55	48.38	48.83
L_6U_6	+	10.33	9.89	9.97
	-	57.01	53.34	53.95
L_7U_7	+	5.88	5.55	5.64
	-	65.71	61.57	62.65
L_8U_8	+	2.91	2.63	2.67
	-	72.49	69.09	70.21
L_9U_9	+	0.96	0.84	0.85
	-	79.57	76.87	78.40
$L_{10}U_{10}$	+	0.00	0.00	0.00
	-	89.46	86.27	87.14

STRESSES IN CANTILEVER ARM

		Method		
Member	Stress	Graphic	Semi-Graphic	Moments
$U_{10}U_{11}$	+	201.30	201.30	201.45
$U_{11}U_{12}$	+	154.08	154.06	153.87
$U_{12}U_{13}$	+	104.74	104.74	104.94
$U_{13}U_{15}$	+	54.28	54.27	53.87
$L_{10}L_{11}$	-	244.69	244.67	244.68
$L_{11}L_{12}$	-	198.55	198.55	198.91
$L_{12}L_{13}$	-	151.52	151.51	152.00
$L_{13}L_{14}$	-	103.95	103.95	103.62
$U_{10}L_{10}$	-	83.07	82.00	82.11
$U_{11}L_{11}$	-	77.21	75.52	75.85
$U_{12}L_{12}$	-	70.76	70.04	69.61
$U_{13}L_{13}$	-	64.11	63.39	63.40
$U_{14}L_{14}$	-	00.00	000.00	00.00
$U_{10}L_{11}$	+	100.83	99.77	99.79
$U_{11}L_{12}$	+	95.82	94.10	94.54
$U_{12}L_{13}$	+	91.13	89.50	89.54
$U_{13}L_{14}$	+	85.68	84.25	84.81
$U_{15}L_{14}$	+	74.25	74.60	74.50

STRESSES IN SUSPENDED SPAN

		Method		
Member	Stress	Graphic	Semi-Graphic	Moments
L_0U_1	-	75.90	75.50	75.16
U_1U_2	-	77.22	78.10	78.82
U_2U_3	-	89.10	90.43	91.22
U_3U_4	-	89.10	90.42	90.63
L_0L_1	+	48.18	48.21	49.44
L_1L_2	+	48.18	48.21	49.44
L_2L_3	+	76.56	76.23	76.15
L_3L_4	+	88.44	87.98	88.38
U_2L_2	+ -	9.27 23.26	9.25 23.64	9.26 24.19
U_3L_3	+ -	16.04 14.16	16.99 14.98	16.79 15.10
U_4L_4	+ -	23.29 8.43	24.95 8.16	24.93 8.29
U_1L_2	+ -	43.78 3.62	42.92 3.99	43.05 3.92
U_2L_3	+ -	28.24 10.10	28.30 11.04	28.34 10.85
U_3L_4	+ -	17.08 19.01	17.10 19.38	17.31 19.27

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