The Wisconsin engineer. Vol. 24, No. 5 February 1920

Madison, Wisconsin: Wisconsin Engineering Journal Association, [s.d.]

https://digital.library.wisc.edu/1711.dl/7P3DBZ6M5SIJV8I

Office Copy.

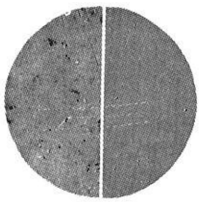
Out Nov 2/19/20
1000 copies

The Wisconsin Engineer

VOL. XXIV. FEBRUARY, 1920 NO. 5

Making Tractor Motors Save Oil

Used oil as seen through the microscope. Note the grit and punctures in the film.



Fresh oil as seen through the microscope. Note the smooth unpunctured film.

By replacing the systems of motor lubrication that use oil over and over, with the Madison-Kipp Fresh Oil System, oil consumption can be reduced more than three-fourths.

The comparative tests that established this fact were made with a typical, standard, four cylinder motor.

First it was equipped with a regulation crankcase system, using its oil over and over.

With this system, .128 pints of oil were required for each brake horse-power hour.

Then it was equipped with a Madison-Kipp Fresh Oil System.

Its oil consumption dropped to .018 pints per brake horse-power hour. The oil saving effected by the Madison-Kipp system was 83%.

These and many other tests are available for inspection to any one interested.

Similar results have for years been demonstrated in the field by tens of thousands of two cylinder tractors.

The natural consequence is a decided preference for Kipp-Equipt motors among experienced tractor users.

Madison-Kipp Corporation
Madison, Wisconsin

Madison-Kipp Lubricators

Fresh Oil System

Volume 24 **Founded 1896** **Number 5**

The Wisconsin Engineer

$1.00 a Year **15c a Copy**

Subscriptions, payable before February 1, $1.00 a year in United States, Porto Rico, Hawaii, the Philippines, Cuba, or Mexico; $1.25 in Canada; and $1.50 in other countries. Copyright 1919 by the Wisconsin Engineering Journal Association. Any article printed herein may be reprinted provided due credit is given. Entered as second class matter Sept. 26, 1910, at the post office at Madison, Wis., under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized October 21, 1918.

Published monthly from October to May, inclusive by
THE WISCONSIN ENGINEERING JOURNAL ASSOCIATION,
306a Engineering Building, Madison, Wisconsin
Telephone University 177

HOW COME?—A "sweet young thing" who happened to get into a Junior Engineer's English section wrote a story, as per schedule. The stories were exchanged in class, for criticism, and here is what one of the Engineers got in exchange for his good A-plus story. She was writing about a railroad wreck, and, while describing the excitement among the passengers, said, "Pandemonium reigned, the women screamed, a fire broke out, my breath came in short pants." P. Z.

CONTENTS

The Wisconsin Engineer

VOL. XXIV. FEBRUARY, 1920 NO. 5

DEFLECTION OF STRUCTURES BY THE METHOD OF ELASTIC WEIGHTS.

By William S. Kinne,
Associate Professor of Structural Engineering, Wisconsin.

The method of elastic weights offers an effective and easily applied analytical method for the calculation of the displacement of the joints of a framed structure due to the distortion of its members. Compared with other methods of calculation, this method has the great advantage that the displacement of all joints can be determined from the same set of calculations. A similar result is obtained by means of the Williot Diagram, a graphical solution, which in common with most graphical work, is not so precise as analytical methods.

In all of the text books with which the writer is familiar, the method of elastic weights has been applied only to the determination of the vertical displacement of the joints of the structure. In this article the method of elastic weights has been extended to include also the horizontal displacement of the joints. The method is thus made perfectly general.

The determination of vertical displacements by the method of elastic weights is based on the observed similarity between the deflection diagram of a framed structure due to the distortion of any of its members and the moment diagram due to an "elastic weight" applied at the moment center for the distorted member. This elastic weight is a function of the distortion of the member and the form of the truss. As shown by the analysis given in this article, the horizontal displacement of any joint is a function of the shear produced by the same elastic weight used for the vertical displacements.

In determining the distortion of a truss in terms of its form for comparison with moment and shear diagrams due to elastic weights, use is made of two of the principles of kinematics. The first of these principles defines the direction of motion of a point during a small angular rotation about a given point, which is known as an instantaneous rotation. This principle is as follows: During an instantaneous rotation, the direction of motion of a given particle is along the tangent to its path at any given instant, that is, the direction of motion is perpendicular to the radius joining the particle and its center of rotation, which is known as an instantaneous center. As the motion of the joints of a truss due to the distortion of any member is very small compared to the dimensions of the structure, the rotation of a given joint about any fixed point can be classed as an instantaneous rotation.

The second law of kinematics defines the position of the center of rotation for two portions of a truss due to the distortion of a connecting member. This law is as follows: When a member connecting two parts of a structure is distorted, the center of relative rotation of the two parts of the structure is located at the moment center for the distorted member, and the angular rotation is equal to the distortion of the member divided by its moment lever arm.

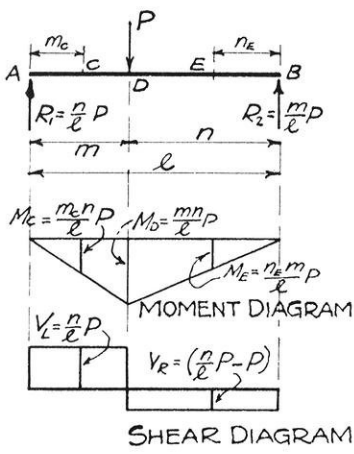


FIG. 1

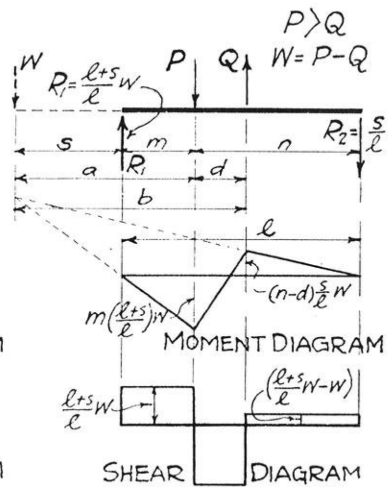


FIG. 2

It will be convenient to have for reference the moment and shear diagrams for a few cases of typical elastic weight loading. Fig. 1 shows the case of a simple beam carrying a single load P. The moment and shear diagrams are shown with values indicated at certain points. In Fig. 2 is shown a simple beam carrying a downward load P and an upward load Q. The dotted arrow W at a distance s to the left of the beam shows the position of the resultant of P and Q. Moments and shears are given in terms of W and the distances as indicated on Fig. 2.

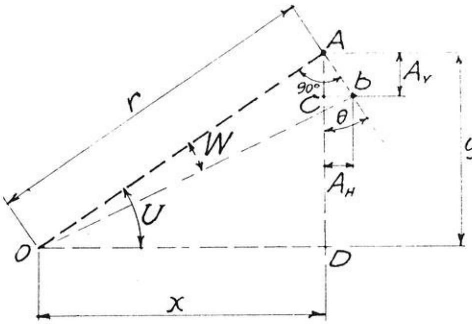


FIG. 3

As all of the displacements calculated in the work to follow are given in terms of the vertical and horizontal components of the motion of the joints, it will be advisable to discuss the method of determining these components. Fig. 3 shows a point A which is rotated through a small angle W about O as a center. Since this can be classed as an instantaneous rotation, the direction of motion is along line AB, at right angles to AO. Point B shows the revolved position of A. Then, AB = r W. Let A_v and A_h represent, respectively, the vertical and horizontal displacements of A due to the rotation. From the triangle ABC,

$$A_h = AB \sin U = r\ W \sin U$$
$$A_v = AB \cos U = r\ W \cos U$$

Also from triangle OAD, sin U = y/r, and cos U = x/r. Substituting these values in the equations above,

$$A_v = x\ W \quad - \quad - \quad - \quad (1)$$
$$A_h = y\ W \quad - \quad - \quad - \quad (2)$$

that is, the vertical and horizontal components of the rotation of a point are equal respectively to the horizontal and vertical distances from the point to the center of rotation multiplied by the angular rotation.

The detail work of determining the displacement diagrams for vertical and horizontal deflections, and comparing these diagrams with the moment and shear diagrams for elastic weights, can best be carried out by dividing the truss members into groups for which the work is identical. Thus the chord mem-

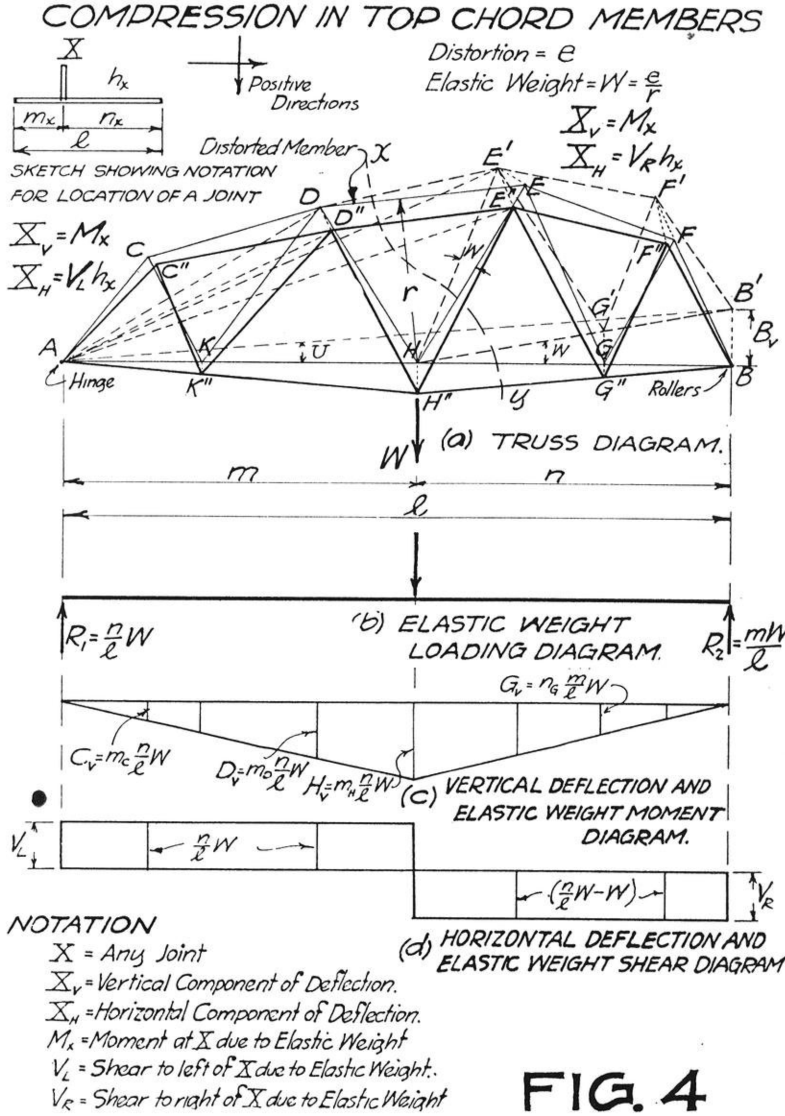


FIG. 4

bers, both upper and lower, will form one general group, and the web members, inclined and vertical, will form another. Chord members will be discussed first.

Fig. 4 shows a typical simple truss supported at points A and B. Any upper chord member, as DE, is assumed to be shortened an amount e due to a compressive stress. All other members are assumed to be unstressed, so that the displacement is due entirely to the member indicated. As stated by the second principle of kinematics given above, the center of relative rotation of the two parts ACDHK and HEFBG into which the structure is divided by the distorted member, is located at H, the moment center for that member. It is also stated that the relative rotation of the two parts mentioned above is measured by an angle, which will be called W, whose value is equal to the distortion of the member divided by its moment lever arm, which will be called r; that is,

$$W = e/r \qquad - \qquad - \qquad (3)$$

In calculating the effect of this angular rotation on the position of the joints, it will be assumed that the portion of the truss to the left of H remains fixed in position, and that the portion to the right rotates about H as a center. This will be known as a rotation of the First Stage. When the member DE is shortened, the angle DHE is decreased, thereby causing all points to the left of H to move upward and to the left, that is, the angular rotation is counterclockwise, or negative.

An examination of Fig. 4 shows that this rotation has caused point B to rise from its supports a distance B_v. From eq. (1), $B_v = n\ W$, where W is the change in angle DHE due to the shortening of the upper chord member DE, as given by eq. (3), and n is the horizontal distance from H, the center of rotation, to B, the point whose motion is desired.

In reality, point B does not leave its supports, which shows that the left hand portion of the structure is not fixed in position as assumed. To correct this error, the deformed truss must be rotated about A as a center through an angle such that B is brought back to a horizontal line joining A and B. This is known as a rotation of the Second Stage. The angle of this rotation, which will be denoted by U, is given by the expression,

$$U = B_v/l = n\ W/l \qquad - \qquad - \qquad (4)$$

where l is the span length. The resulting angular rotation is clockwise, or positive.

In Fig. 4, the heavy lines indicate the final deflected position of the distorted structure. For any given point, the displacement is shown by the relative positions of the corresponding points in the undeformed truss, shown by the light lines, and the deformed truss, shown by the heavy lines.

From the preceding discussion it can be seen that there are certain points located to the left of the moment center for the distorted member which are subjected to a rotation of the second stage only. All other points are subjected to rotations of both the first and second stages. In calculating the actual displacements of the joints, these two groups will be discussed separately.

Consider first the displacement of joint D. This point is located on that portion of the structure which was assumed as fixed during the rotation of the first stage, and is subjected only to a second stage rotation. From eqs. (1) and (2), the displacement of D due to an angular rotation U, as given by eq. (4) is

$$D_v = m_d\, U = +\, m_d\, n\, W/l \qquad - \qquad (5)$$
$$D_h = h_d\, U = +\, h_d\, n\, W/l \qquad - \qquad (6)$$

where m_d is the horizontal distance from D to A, and h_d is the height of the truss at D. This notation is as shown on the sketch given in Fig. 4. The sign notation used above is shown by the arrows on Fig. 4; positive directions are downward and to the right.

It can be shown that the vertical displacements of joints C, K, and H are given by values similar to eq. (5), and that the displacements are proportional to the distances from A to the point in question. These values are plotted on the vertical displacement diagram of Fig. 4(c).

The horizontal deflection of K and H is zero, for, since the height of these points above the horizontal is zero, eq. (2) shows that they have no horizontal motion. For joint C, we have $C_h = +\, h_c n\ W/l$. This differs from eq. (6) only in that h_c is substituted for h_d; each value has a common term n W/l. In plotting the horizontal displacement diagram, only this common term will be used, as shown in Fig. 4(d).

Next consider a point, such as E, Fig. 4(a), which is subjected to rotations of both stages. The components of displacement due to rotation of the first stage, which will be denoted by E'_v and E'_h, are, $E'_v = -(n - n_e)\ W$, and $E'_h = -h_e\ W$, where $(n - n_e)$ and h_e are respectively the horizontal and vertical distances from H, the center of rotation, to E, the point in question.

For rotation of the second stage, center at A and angular rotation U, as given by eq. (4), the components of motion will be denoted by E''_v and E''_h. These components are, $E''_v = + (l - n_e)\ U = + (l - n_e)\ n\ W/l$, and $E''_h = + h_e\ U = + h_e\ n\ W/l$, where $(l - n_e)$ and h_e are respectively the horizontal and vertical distances from A to E.

The components of the resultant displacement of joint E, which will be denoted by E_v and E_h, are

$$E_v = E'_v + E''_v = -(n - n_e)\ W + (l - n_e)\ n\ W/l,$$

from which,

$$E_v = + n_e\ m\ W/l \qquad - \qquad - \qquad (7)$$

Also, $E_h = E'_h + E''_h = -h_e\ W + h_e\ n\ W/l$
from which,

$$E_h = + (n\ W/l - W)\ h_e \qquad - \qquad (8)$$

In eqs. (7) and (8), the sign and distance notation is as shown on Fig. 4.

The displacement of joint F is given by expressions similar to eqs. (7) and (8), except that h_f, m_f, and n_f are substituted for h_e, m_e, and n_e.

For points of the lower chord, such as G, it will be found by a similar process that,

$$G_v = -n_g\ m\ W/l \qquad - \qquad - \qquad (9)$$

and

$$G_h = O \qquad - \qquad - \qquad - \qquad (10)$$

It will be noted that eq. (9) is similar to eq. (7). From a study of Fig. 4(a) it is quite evident that G can have no horizontal motion, for its height above both centers of rotation is zero. This can also be shown from eq. (8) by supposing that point E is located on the lower chord. The value of h_c is therefore zero. and $E_h = 0$.

Referring now to the diagram of Fig. 1, and comparing the vertical deflection diagram of Fig. 4(c) and the moment diagram of Fig 1, it will be noted that they are identical in form. On comparing the values of the ordinates at corresponding points they will be found to be identical, if $P = W$. From this similarity of diagrams for equal loading conditions, the following rule can be formulated: To determine the vertical deflection of the joints of a truss due to the deformation of a top chord member, place at the moment center for the distorted member an elastic weight which is equal to the deformation of the given chord member divided by its moment lever arm. For compression in the distorted member, this elastic weight acts downward; for tension it acts upward. The vertical component of the deflection of any joint is equal to the moment at the joint in question due to the elastic weight placed as noted above. Positive (clockwise) moments indicate downward deflections.

On comparing the diagram of Fig. 4 (d), as plotted for horizontal deflections, and the shear diagram of Fig. 1, it can be seen that if $P = W$, these diagrams are identical. Therefore, the horizontal deflection of any joint of the truss due to the distortion of a top chord member can be expressed as a function of the shear at that point due to the same elastic weight as used for vertical deflections. The following rule can then be formulated: To determine the horizontal deflection of any joint in a truss due to the distortion of a top chord member, apply the same elastic weight as defined above for vertical deflections. The horizontal deflection of any joint of the truss is equal to the shear at that joint multiplied by the vertical distance from the joint in question to the horizontal line joining the points of support. Positive values indicate deflection to the right.

On Fig. 4 (a) the rules stated for the determination of vertical and horizontal deflections are stated in symbolic form. These symbols are explained under "Notation" on Fig. 4. The value $X_h = V_l\ h_x$ applies to all joints to the left of the dotted section x—y, while $X_h = V_r\ h_x$ holds for all joints to the right. Since $h_x = 0$ for all lower chord joints, $X_h = 0$ is a special value for these joints.

The displacement of the joints of a truss due to the distortion of a lower chord member is shown on Fig. 5. It is assumed that member KH is elongated an amount e by a tensile stress. The method of procedure is exactly the same as for the upper chord members, and the results are identical in form, except for the horizontal deflection of the joints to the right of the dotted section x—y of Fig. 5. It will therefore be necessary to discuss in detail only those joints which differ from the preceding work.

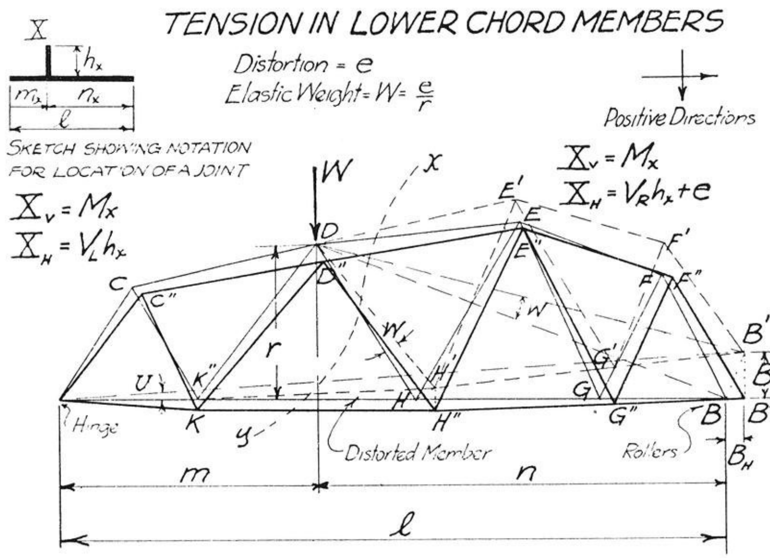


FIG. 5

For example, consider the horizontal motion of joint E, which is subjected to rotations of both stages. The rotation angles are given by eqs. (3) and (4), as the quantities involved are the same as used for the preceding case. Using the same notation as before, $E'_h = -(h_e - h_d)\ W$, and $E''_h = +h_e\ n\ W/l$, from which,

$$E_h = E'_h + E''_h = +(n\ W/l - W)\ h_e + h_d\ W.$$

In Fig. 5 it can be seen that $h_d = r$, and from eq. (3), $W = e/r$. Hence $h_d\ W = e$, and the above equation becomes,

$$E_h = +(n\ W/l - W)\ h_e + e \qquad (11)$$

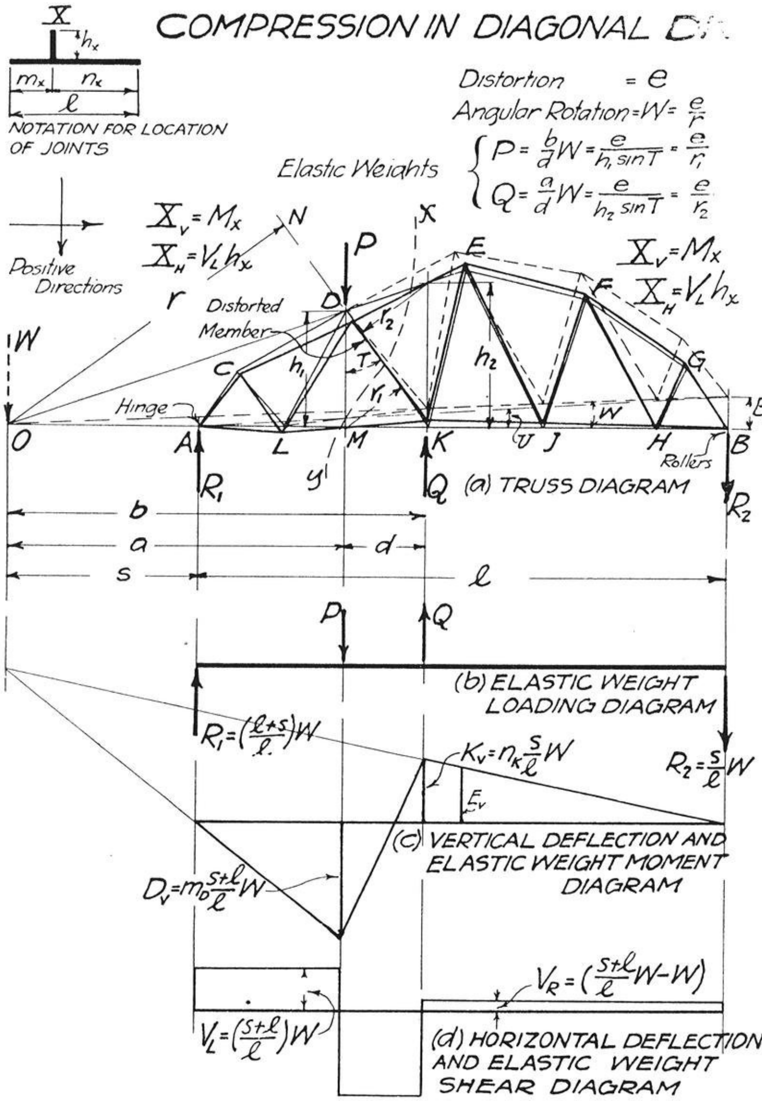

COMPRESSION IN DIAGONAL D...
NOTATION FOR LOCATION OF JOINTS
Distortion = e
Angular Rotation = W = e/r
Elastic Weights
P = b/d W = e/(h₁ sin T) = e/r₁
Q = a/d W = e/(h₂ sin T) = e/r₂
Positive Directions
Distorted Member
Hinge
Rollers
(a) TRUSS DIAGRAM
(b) ELASTIC WEIGHT LOADING DIAGRAM
(c) VERTICAL DEFLECTION AND ELASTIC WEIGHT MOMENT DIAGRAM
(d) HORIZONTAL DEFLECTION AND ELASTIC WEIGHT SHEAR DIAGRAM

FIG. 6

On referring to Fig. 4 (d), it will be found that (n W/l — W) is the shear to the right of the elastic weight, and hence eq. (11) can be written,

$$E_h = V_r h_e + e \quad - \quad - \quad (12)$$

As shown by comparing eq. (8) and (11) or (12), the horizontal deflection of joint E for lower chord distortions differs from that for top chord distortions by the term e. This term represents the elongation of the distorted member. A similar expression results for joint F.

The horizontal deflection of a lower chord joint, as G, Fig. 5, can be derived from eq. (12) by assuming that E is a lower chord joint, and that $h_e = 0$. Changing subscripts to denote joint G,

$$G_h = + e \quad - \quad - \quad - \quad (13)$$

General values for the deflections of joints are indicated on Fig. 5, using the notation outlined on Fig. 4.

The deflection of joints will now be determined for distortion of web members. Fig. 6 shows a typical truss in which it is assumed that inclined web member DK is shortened an amount e due to a compressive stress. According to the second principle of kinematics given below, the center of rotation for the first stage is located at the moment center for the distorted member. This center is located at the intersection of the chord members cut by the section x—y, that is, at point O, a distance s to the left of joint A, Fig. 6(a). The angular rotation is given as the distortion of the member divided by its moment lever arm. This arm is the perpendicular distance from O to member DK produced. It is indicated by r of Fig. 6(a). Then,

$$W = e/r \quad - \quad - \quad - \quad (14)$$

For compression in DK, this is a negative rotation.

As before, the portion of the truss to the left of section x—y is assumed to stand fast during the rotation of the first stage, which causes joint B to rise from its supports a distance $B_v = (s + l)$ W. To correct for the error in this assumption, the distorted truss is revolved about A through a positive rotation given by

$$U = B_v / l = \frac{s + l}{l} W \quad - \quad (15)$$

This is the rotation of the second stage for the case under consideration.

By the same general methods and with the notation previously adopted, it will be found for joints to the left of x—y, as for example joint D, that,

$$D_v = + m_d U = + m_d \frac{s+1}{l} W \qquad (16)$$

and

$$D_h = + h_d U = + h_d \frac{s+1}{l} W \qquad (17)$$

For joint L, the vertical deflection is similar to eq. (16), and the horizontal deflection is zero. Values given by eqs. (16) and (17) are plotted on Figs. 6 (c) and (d).

Joints to the right of section x—y are subjected to rotations of both stages. For joint E,

$$E'_v = -(s + m_e) W; \quad E''_v = + n_e U = + m_e \left(\frac{s+1}{l}\right) W.$$

and

$$E'_h = - h_e W; \quad E''_h = + h_e U = + h_e \left(\frac{s+1}{l}\right) W.$$

The total deflections are,

$$E_v = E'_v + E''_v = - m_e s W/l \qquad (18)$$

$$E_h = E'_h + E''_h = \left(\frac{s+1}{l} W - W\right) h_e \qquad (19)$$

In eq. (18) the minus sign indicates that this joint deflects upward, as shown by the fact that it is plotted above the horizontal axis in Fig. 6 (c).

Corresponding values for lower chord joint K can be derived from eqs. (18) and (19) by substituting $m_k = m_e$ and $h_k = h_e = 0$, noting that joint K lies on the horizontal line AB. We then have,

$$K_v = - m_k s W/l \qquad (20)$$

$$K_h = 0 \qquad (21)$$

These values, together with similar values for other joints, are plotted in Figs. 6 (c) and (d) to form the vertical and horizontal deflection diagrams.

On comparing these diagrams with those of Fig. 2, it will be noted that they are identical in form and in the values of the ordinates. The required elastic loading for deformations due to web members is then of the form shown on Fig. 2 and repeated on Fig. 6(b).

In the cases already considered, the angular rotation W was applied as a load at the moment center for the distorted member. If this procedure is to be followed in the case under consideration, a load W must be applied at point O, as shown by the dotted arrow in Fig. 6 (a). However, it is more convenient to deal with loads applied at points on the span, as for example P and Q of Fig. 6 (a). In order that this substitution may be made, P and Q must answer the following condition: (a) $P - Q = W$, and (b) the reactions R_1 and R_2 must be the same for P and Q as for W.

From condition (b), moments about A gives,

$$-R_2 l = P(a - s) - Q(b - s)$$

The above equation and that given under condition (a), when solved, give,

$$P = b\,W/d \qquad (22)$$

$$Q = a\,W/d \qquad (23)$$

It is to be noted here that P will always be greater than Q, and that P is to be applied at the end of the distorted member which is nearer the amount center O.

When the stresses in the distorted diagonal are compressive, the elastic loads are to be directed as shown in Fig. 6 (a). It will be noted that they are so placed that, if acting on member DK as a fre body, the resulting stress would be compressive, giving a stress of the same character as that causing the distortion. If DK was in tension, the direction of P and Q would have to be reversed.

The values of P and Q given in eqs. (22) and (23) can be written in a form somewhat more convenient for calculatoin due to certain relations existing between the similar triangles ONK and DMK of Fig. 6(a). We then have,

$$P = e/h_1 \sin T = e/r_1 \qquad (24)$$

$$Q = e/h_2 \sin T = e/r_2 \qquad (25)$$

All values involved are shown on Fig. 6(a).

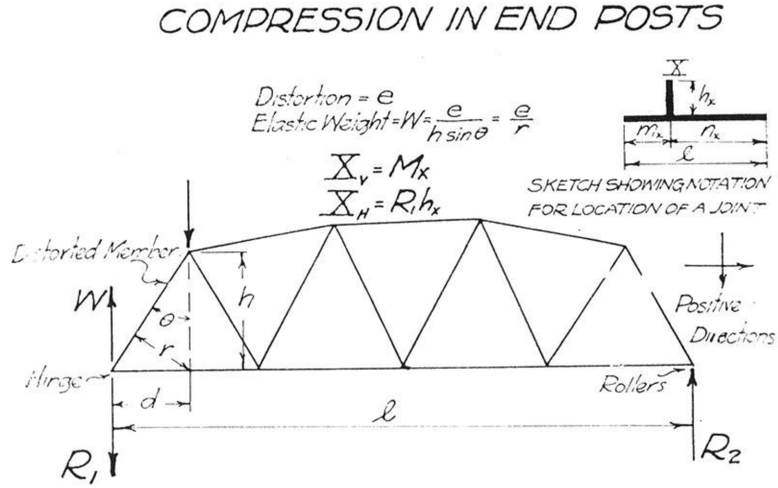


FIG. 7

The results of the above analysis for inclined web members can be summarized as follows: To determine the deflection of the joints of a truss due to the distortion of an inclined web member, apply at the ends of the distorted member elastic weights P and Q for which values are given in eqs. (22) to (25). These loads are to be applied so that their stress effect is the same as the stress which causes the distortion in the member under consideration.

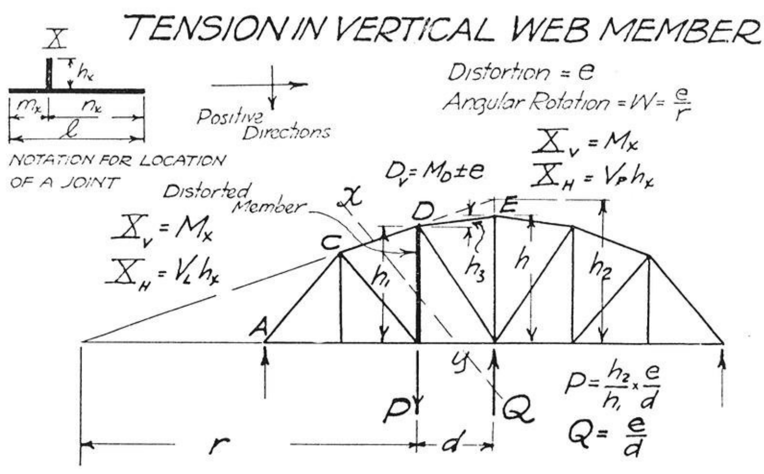


FIG. 8

The vertical deflection of any joint is equal to the moment at the joint in question due to the above described elastic weights. Positive moments indicate downward deflection.

The horizontal deflection of any joint is equal to the shear at that joint due to the above elastic weights, multiplied by the height of the joint in question above a line connecting the points of support at the ends of the truss. These values are shown in symbolic form on Fig. 6 (a).

The end post member is a special case of an inclined web member. Fig. 7 shows a typical truss with the elastic weights in position. In this case the two loads are equal, and have the values indicated in the figure. General values in terms of the notation already used are given for vertical and horizontal deflection of joints. Positive moments indicate downward deflection, and positive shears indicate deflection to the right.

In Fig. 8 is shown a truss with vertical web members. Consider the deflection of the truss due to the deformation of a vertical member. As the distorted member is vertical, it is impossible to apply the elastic weights as for a diagonal, as shown in Fig. 6. By a process exactly the same as that used for the case of Fig. 6 it can be shown that the elastic weights are to be arranged as shown in Fig. 8. General values for vertical and horizontal deflection are indicated in the figure. It will be noted that the vertical deflection of the upper end of the distorted vertical is given by $D_v = M_x + e$, and that the corresponding value for the lower end of the member is $H_v = M_x$. In general, for members whose stress is determined by conditions on a section such as x—y of Fig. 8, it will be found best to determine the deflection of the joint at the lower end of the distorted member, as given by the equation $H_v = M_x$. The deflection of the joint at the upper end of the distorted member can be determined from that at the lower end by adding or subtracting the distortion of the vertical member, depending upon whether it is compression or tension. For a joint such as K at the foot of the vertical CK, it is best to determine the vertical deflection of joint C and then add e, the distortion of CK, in order to determine the vertical deflection of joint K. Horizontal deflections for these joints are determined by the methods given for the truss of Fig. 6.

In a truss with a curved top chord, such as shown in Fig. 8, distortion of the center vertical EF causes deflection of all of the joints. For a truss which is symmetrical about the center line, the deflection of the joints can be determined by applying at joint F a downward elastic weight $W = \frac{2h_3}{hd} e$. All terms are as shown on Fig. 8. The deflection of the two halves of the truss are equal for the conditions shown in Fig. 8. For vertical deflections, $X_v = M_x$ for all joints except E, for which $E_v = M_x - e$. Horizontal deflections are given by $X_h = V_1 h_x$, except for joint E, where $E_h = 0$.

The general methods given above apply also to trusses with horizontal chords. Elastic weights due to the deformation of chord members are determined by dividing the deformation by the height of the truss, which is a constant quantity. For inclined web members, the elastic weights P and Q, as given by

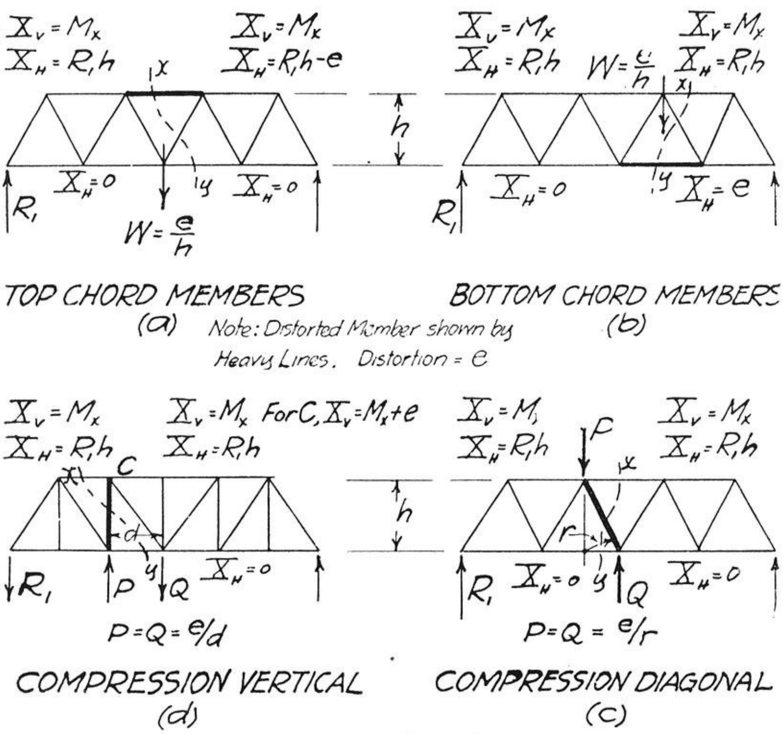


FIG. 9

eq. (24) and (25), are equal, for it is evident from Fig. 6(a) that $r_1 = r_2$ for parallel chord trusses. Similar conditions hold for the truss of Fig. 8.

Horizontal deflection formulas and methods of calculation are somewhat simplier than those for curved chord trusses, due to the fact that the height of the truss is uniform. These values are shown on Fig. 9. The values shown on Fig. 9 (a) can be obtained directly from those given on Fig. 4 (a). Thus from Fig. 4 (a), the horizontal deflection of joints to the left of section x—y is given by the general term $X_h = V_l h_x$. In Fig. 9 (a), $h_x = h$, the height of the truss, and $V_l = R_1$, the left reaction due to the elastic weights. Hence for upper chord points, $X_h = R_1 h$. Since $h_x = 0$ for lower chord joints, the horizontal deflection for these points is zero, which is expressed by the general formula $X_h = 0$. To the right of section x—y of Fig. 4 (a), horizontal deflections are given by the general formula $X_h = V_r h_x$. For the conditions shown on Fig. 9 (a), $V_r = R_1 h - W h$. But $W = e/h$. Therefore $X_h = V_r h_x = R_1 h - e$. For lower chord joints, $h_x = 0$, and $X_h = 0$. These values are shown on Fig. 9 (a).

By similar methods, the values shown on Fig. 9 (c) are obtained from Fig. 6; and those on Fig. 9 (d) are obtained from Fig. 8. End post values for horizontal chord trusses are the same as shown on Fig. 7 for the curved chord truss.

The solution of problems of the deflection of trusses by the method of elastic weights is greatly facilitated by means of a tabulated form for the calculations. A carefully selected scheme of tabulating the calculations will make the work almost automatic. To illustrate such schemes of tabulation, several problems will be worked out in detail. Before proceeding to the detailed work involved in the solution of problems, a brief discussion will be given of the points to be considered in making the tabulations.

Figs. A. C. and E show diagrams on which are given the dimensions of the trusses and the deformations of the members due to the applied loads. The deformations of the members are calculated from the formula $e = Sl/AE$, where e = deformation of member; S = stress due to the applied loads; l = length of member; A = its area; and E = the modulus of elasticity of the material composing the truss members. Plus values indicate deformations due to tension, and minus values indicate deformations due to compression. In general, the deformation should be expressed in the same units in which the deflection is desired. For example; if the deflection is desired in inches, express the deformation of all members in inches. On Figs. A, C, and D, all deformations are expressed in inches.

The calculations for the values of the elastic weights for chord and web members have been arranged in separate tables as a matter of convenience. These tables contain the deformations of the several members, as determined from the above formula, and the moment lever arms of the members. These lever arms can be determined by direct calculation from the truss diagrams, or they can be scaled from a large size drawing of the truss. In making the tables, the members are arranged in order, beginning at the fixed end of the truss. For the examples given, all trusses are assumed as fixed at the left end and supported on rollers at the right end.

Tables A, E and I give the calculations for the elastic weights for top and bottom chord members. Values of the elastic weight W are given and also the joint is designated at which the load is to be applied. Plus values indicate that the load is applied downward.

Tables B, F, and J give the calculations for the elastic weights, P and Q, for the web members. The directions in which these loads act are determined by means of the rules stated in connection with the derivation of eqs. (22) to (25). In determining the position and direction of P and Q, it must be remembered that the moment centers for all members on the left of the truss center lie to the left of the left end of the span, and that moment centers for members to the right of the truss lie to the right of the right end of the span. Hence for members to the left of the truss center, P is located at the left end of the member, and Q is located at the right end. For members to the right of the truss center, P is located at the right end of the member, and Q is located at the left end. A little study of the tables for web members will clear up this point.

The elastic weights are to be considered as applied at the joints of the truss. At each joint, the total elastic weight is the sum of the values due to the chord and web members. Since the loads are all vertical, the resulting reactions, shears, and moments due to the elastic weights can be calculated by assuming that the loads are applied on a simple beam of the same span as the truss. Figs. B, D, and F show the elastic weights in position for the several examples. The reactions R_1 and R_2 are calculated by the usual methods.

The vertical deflection at any joint has been shown to be equal to the bending moment due to the elastic weights. Hence, to determine the vertical deflection of any joint, the moment is to be calculated at the joint in question for the loading shown in Figs. B, D, or F. Calculations for the moments at all joints are given in Tables C, G, and K. Since the distances between the loads are all equal in the cases under consideration, the required moments can be calculated by means of the well known principle that the moment at any point is equal to the summation of the shears in front of that point times the common distance between the moment centers. Thus in Table C, the moment at joint D is the summation of shears, 0.09026, times 12.5, the common distance between points, or $M = 0.09026 \times 12.5 = 1.128$. It is to be noted that the distance between points is to be expressed in the same units as the moment lever arms of the members. In this case the foot unit has been used. All calculations are arranged in convenient form in the tables.

The horizontal deflection of the joints of the truss have been shown to be equal to a function of the shear due to the elastic weights, multiplied by the height of the truss at the joint in question. For trusses with horizontal chords, the discussion given above shows that the deflection of the lower chord joints can be determined by considering that the lower chord is a connected chain of members. The horizontal deflection of any joint is the sum of the elongations of all members between the joint in question and the fixed point. Deflections of top chord joints are determined in a similar manner after the deflection of the top chord joint nearest the fixed point is known. This deflection is given by a term of the form R_1 h, where R_1 is the left reaction, as given by Figs. D and F, and h is the common height of the truss. Since the top chord deformations are a shortening of the members, the successive summations of these deformations must be subtracted from the term R_1 h. The tabulations of

Tables H and L are conveniently arranged for the calculation of the desired reflections.

Vertical deflections are equal to the moments due to the elastic weights described above. The general methods are the same as for the curved chord truss.

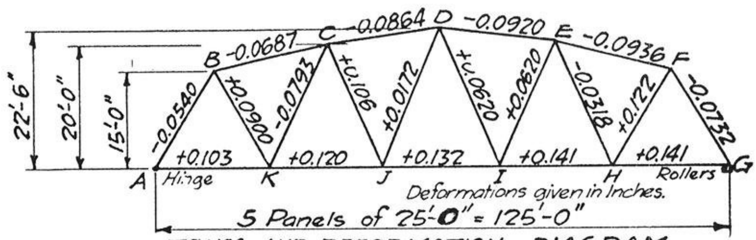
Table D shows a convenient tabulation for the calculation of the horizontal deflection of the joints of a curved chord truss. For lower chord members, the procedure is exactly the same as given above for the horizontal chord truss. The necessary values are given in the first three columns in Table D, and column 10 gives the desired deflections for the lower chord joints indicated in column 11.

The discussion given above shows that the deflection of any top chord joint of a curved chord truss can be expressed in the form $X_h = V_r h_x$. In this expression V_r is the shear to the right of the panel containing the distorted member. This shear can not be obtained directly from the loads given on Fig. B, or from the shear values given in Table C. A study of Fig. 6 and the general formulas derived therefrom will show that the desired value of V_r for any panel can be obtained from the shear in that panel by subtratcing the value of Q or P for the right end of the web member in the panel in question. For members to the left of the truss center, use values of Q, and for members to the right use values of P.

The form of tabulation adopted for Table D greatly simplifies the selection of values of P and Q, and the determination of the value of V_r. It will be noted that in column 4 of Table D, the panel of Fig. B and the corresponding web member of Fig. A are designated by the same letters. This aids in selecting the proper shear for any member. Again, in selecting values of Q or P for any member, take the elastic weight which is located at the joint designated by the last letter in the member notation. For example, member IE is to the right of the truss center, and hence select the value of P at joint E for member IE. To reduce the amount of work required in making the tabulations, values of P and Q for lower chord joints have been omitted, for it is evident that $h_x = 0$, and hence $V_r h_x = 0$ for lower chord joints.

CALCULATION OF VERTICAL AND HORIZONTAL DEFLECTIONS BY THE METHOD OF ELASTIC WEIGHTS

EXAMPLE I. CURVED CHORD WARREN TRUSS.



TRUSS AND DEFORMATION DIAGRAM.

FIG. A

TABLE A

ELASTIC WEIGHTS
CHORD MEMBERS

VALUES OF W

Member	e	r	$W=\frac{e}{r}$	Joint
			0	A
AK	+0.103	15.0	+0.00687	B
BC	-0.0687	17.16	+0.00401	K
KJ	+0.120	20.0	+0.00600	C
CD	-0.0864	21.14	+0.00408	J
JI	+0.132	22.5	+0.00587	D
DE	-0.0920	21.14	+0.00435	I
IH	+0.141	20.0	+0.00705	E
EF	-0.0936	17.16	+0.00546	H
HG	+0.141	15.0	+0.00940	F
			0	G

TABLE B

ELASTIC WEIGHTS
WEB MEMBERS

VALUES OF P AND

Member	e	P			Q		
		r_1	$P=\frac{e}{r_1}$	Joint	r_2	$Q=\frac{e}{r_2}$	Joint
AB	-0.0540	9.601	-0.00562	A	9.601	+0.00562	B
BK	+0.0900	9.601	-0.00937	B	11.20	+0.00803	K
KC	-0.0793	9.273	-0.00855	K	10.60	+0.00748	C
CJ	+0.106	10.60	-0.01000	C	11.26	+0.00942	J
JD	+0.0172	10.32	+0.00168	J	10.93	-0.00157	D
ID	+0.0620	10.32	+0.00600	I	10.93	-0.00568	D
EI	+0.0620	10.60	-0.00585	E	11.26	+0.00550	I
HE	-0.0318	9.273	-0.00343	H	10.60	+0.00300	E
FH	+0.122	9.601	-0.01270	F	11.20	+0.01089	H
GF	-0.0732	9.601	-0.00762	G	9.601	+0.00762	F

NOTATION:- For values of e; + = extension, - = compression.
For values of W, P, and Q; + = downward loads, - = upward loads

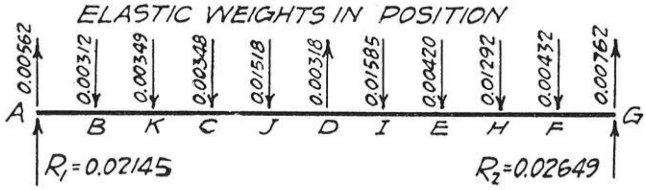


FIG. B

TABLE C

CALCULATION OF VERTICAL DEFLECTION

Panel	Shear	Σ Shear	Moment = Vertical Deflection	Joint
		0	0	A
AB	+0.02707			
		+0.02707	+0.339 inches	B
BK	+0.02395			
		+0.05102	+0.639 "	K
KC	+0.02046			
		+0.07148	+0.893 "	C
CJ	+0.01698			
		+0.08846	+1.106 "	J
JD	+0.00180			
		+0.09026	+1.128 "	D
DI	+0.00318			
		+0.09344	+1.168 "	I
IE	−0.01267			
		+0.08077	+1.009 "	E
EH	−0.01687			
		+0.06390	+0.799 "	H
HF	−0.02979			
		+0.03411	+0.427	F
FG	−0.03411			
		0	0	G

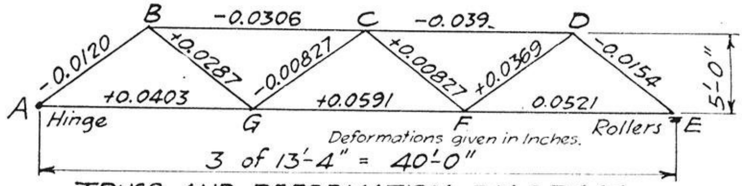
TABLE D

CALCULATION OF HORIZONTAL DEFLECTION

Member (1)	e (2)	Σe (3)	Panel and Web Member (4)	Shear (5)	P or Q (6)	V_R (7)	h_x (8)	$V_R h_x$ (9)	Horizontal Deflection = $V_R h_x + \Sigma e$ (10)	Joint (11)
		0							0	A
AK	+0.103	0	AB	+0.02707	+0.00562	+0.02145	15	+0.322	+0.322 ins.	B
		+0.103	BK	+0.02395			0	0	+0.103 "	K
KJ	+0.120	+0.103	KC	+0.02046	+0.00748	+0.01298	20	+0.260	+0.363 "	C
		+0.223	CJ	+0.01698			0	0	+0.223 "	J
JI	+0.132	+0.223	JD	+0.00180	-0.00157	+0.00337	22.5	+0.0758	+0.299 "	D
		+0.355	DI	+0.00318			0	0	+0.355 "	I
IH	+0.141	+0.355	IE	-0.01267	-0.00585	-0.00682	20	-0.1364	+0.219 "	E
		+0.496	EH	-0.01687			0	0	+0.496 "	H
HG	+0.141	+0.496	HF	-0.02979	-0.01270	-0.01709	15	-0.256	+0.240 "	F
		+0.637	FG	-0.03411					+0.637 "	G

NOTATION: For Shears; + = Positive Shear, − = Negative Shear
For Deflections; + = Deflections Downward and to the Right.

EXAMPLE 2. HORIZONTAL CHORD WARREN TRUSS



TRUSS AND DEFORMATION DIAGRAM

FIG. C

TABLE E

ELASTIC WEIGHTS
CHORD MEMBERS
VALUES OF W

Member	e	r	$W = \frac{e}{r}$	Joint
BC	-0.0306	5.0	+0.00612	G
CD	-0.0395	5.0	+0.00790	F
AG	+0.0403	5.0	+0.00806	B
GF	+0.0591	5.0	+0.01182	C
FE	+0.0521	5.0	+0.01042	D

TABLE F

ELASTIC WEIGHTS
WEB MEMBERS
VALUES OF P AND Q

Member	e	P			Q		
		r_1	$P = \frac{e}{r_1}$	Joint	r_2	$Q = \frac{e}{r_2}$	Joint
AB	-0.0120	4.0	-0.00300	A	4.0	+0.00300	B
BG	+0.0287	4.0	-0.00718	B	4.0	+0.00718	G
GC	-0.00827	4.0	-0.00207	G	4.0	+0.00207	C
CF	+0.00827	4.0	+0.00207	F	4.0	-0.00207	C
FD	+0.0369	4.0	-0.00923	D	4.0	+0.00923	F
DE	-0.0154	4.0	-0.00385	E	4.0	+0.00385	D

ELASTIC WEIGHTS IN POSITION

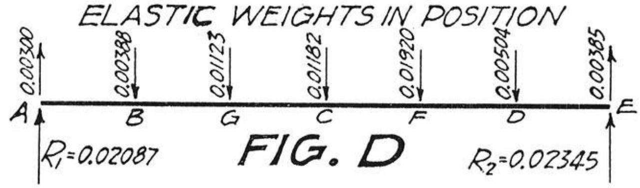


FIG. D

TABLE G

CALCULATION OF VERTICAL DEFLECTION

Panel	Shear	Σ Shear	Deflection	Joint
		0	0	A
AB	+0.02387			
		+0.02387	+0.1592 inches	B
BG	+0.01999			
		+0.04386	+0.2920 "	G
GC	+0.00876			
		+0.05262	+0.3510 "	C
CF	-0.00306			
		+0.04956	+0.3305 "	F
FD	-0.02226			
		+0.02730	+0.1820 "	D
DE	-0.02730			
		0	0	E

Notation for Tables E, F, G, and H same as for Tables A, B, C, and D of Ex. 1.

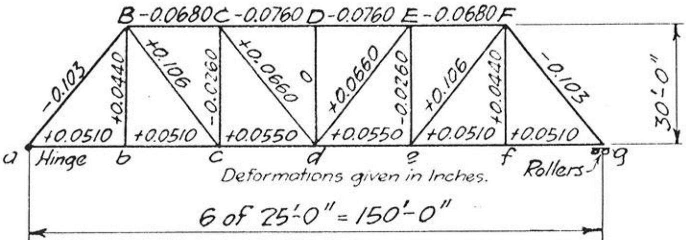
TABLE H

CALCULATION OF HORIZONTAL DEFLECTION

$(R_1 h_x = 0.02087 \times 5.0 = 0.10435)$

Member	e	Value of Σe Top Chord	Value of Σe Bottom Chord	$R_1 h_x - \Sigma e$	Deflection	Joint
					0	A
		0	0	+0.1044	+0.1044 ins.	B
AG	+0.0403		+0.0403		+0.0403 "	G
BC	-0.0306	-0.0306		+0.0738	+0.0738 "	C
GF	+0.0591		+0.0994		+0.0994 "	F
CD	-0.0395	-0.0701		+0.0343	+0.0343 "	D
FE	+0.0521		+0.1515		+0.1515 "	E

EXAMPLE 3. HORIZONTAL CHORD PRATT TRUSS



TRUSS AND DEFORMATION DIAGRAM

FIG. E

TABLE I

ELASTIC WEIGHTS CHORD MEMBERS

VALUES OF W

Member	e	r	$W = \frac{e}{r}$	Joint
ab	+0.0510	30	+0.00170	B
bc	+0.0510	30	+0.00170	B
cd	+0.0550	30	+0.00183	C
BC	-0.0680	30	+0.00227	c
CD	-0.0760	30	+0.00254	d

TABLE J

ELASTIC WEIGHTS WEB MEMBERS

VALUES OF P AND Q

Member	e	P: r_1	P: $P = \frac{e}{r_1}$	P: Joint	Q: r_2	Q: $Q = \frac{e}{r_2}$	Q: Joint
aB	-0.103	19.2	-0.00536	a	19.2	+0.00536	B
Bb	+0.440	∞			∞		
Bc	+0.106	19.2	-0.00552	B	19.2	+0.00552	c
Cc	+0.0260	25	-0.00104	c	25	+0.00104	d
Cd	+0.0660	19.2	-0.00344	C	19.2	+0.00344	d
Dd	0						

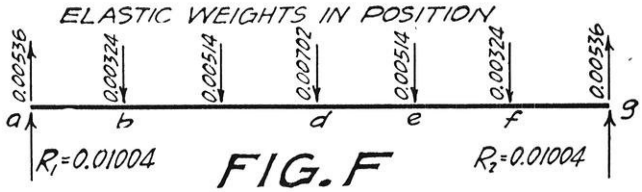


FIG. F

TABLE K

CALCULATION OF VERTICAL DEFLECTION

Panel	Shear	Σ Shear	Deflection	Joint	Member	e	Deflection	Joint
		0	0	a				
ab	+0.01540							
		+0.01540	+0.385	B	Bb	+0.0440	+0.429 ins	b
bc	+0.01216							
		+0.02756	+0.689	c	Cc	-0.0260	+0.715 "	C
cd	+0.00702							
		+0.03458	+0.865	d	Dd	0	+0.865 "	D
de	-0.00702							
		+0.02756	+0.689	e	Ee	-0.0260	+0.715 "	E
ef	-0.01216							
		+0.01540	+0.385	F	Ff	+0.0440	+0.429 "	f
fg	-0.01540							
		0	0	g				

TABLE L

CALCULATION OF HORIZONTAL DEFLECTION

$(R_1h_x = 0.01004 \times 30 = 0.3012)$

Member	e	Value of Σ e		$R_1h_x - \Sigma e$	Deflection	Joint
		Bottom Chord	Top Chord			
		0			0	a
ab	+0.0510					
		+0.0510			+0.0510 ins.	b
bc	+0.0510					
		+0.1020			+0.1020 "	c
cd	+0.0550					
		+0.1570			+0.1570 "	d
de	+0.0550					
		+0.2120			+0.2120 "	e
ef	+0.0510					
		+0.2630			+0.2630 "	F
fg	+0.0510					
		+0.3140			+0.3140 "	g
			0	+0.3012	+0.3012 "	B
BC	-0.0680					
			-0.0680	+0.2332	+0.2332 "	C
CD	-0.0760					
			-0.1440	+0.1572	+0.1572 "	D
DE	-0.0760					
			-0.2200	+0.0812	+0.0812 "	E
EF	-0.0680					
			-0.2880	+0.0132	+0.0132 "	F

Notation for Tables I, J, K, and L same as for Tables A, B, C, and D of Ex. 1.

HOW SAND AND GRAVEL ARE PUT ON THE MARKET

By Henry Ford,

Junior Civil.

Concrete has assumed great importance as a building material and is destined to assume even greater importance. Many uses are being made of it, some of which were formerly thought impracticable. Concrete has proved itself to be an excellent material for country highways and it is used even to make freight cars and boats.

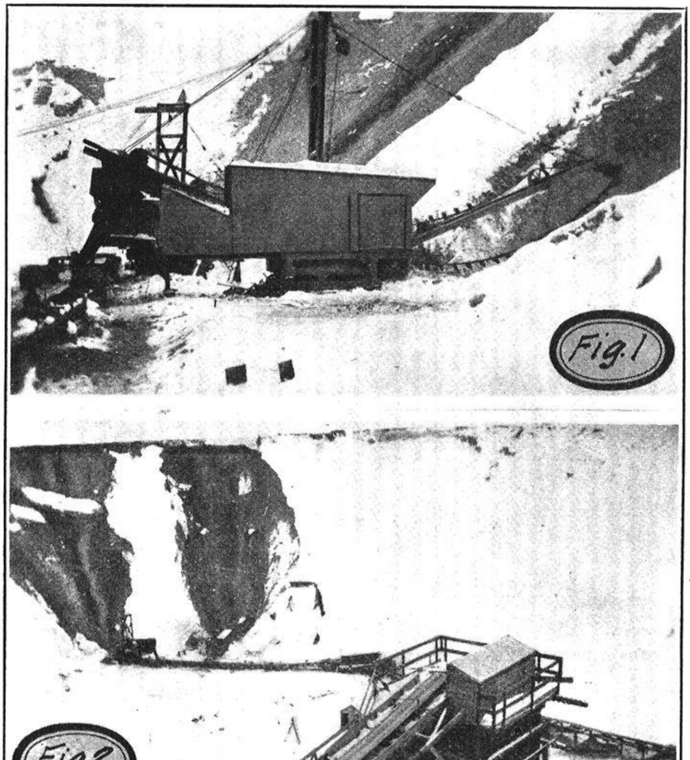


Fig. 1.—*Digging machine.*
Fig. 2.—*View of Pit showing digging machine and Conveyor.*

It is popular, not because it is so much better than steel or brick, but, principally, for the reason that the aggregate, which forms the larger part, is found widely distributed. There is hardly a state that has not some material that will make good concrete aggregate.

The glacial deposits of sand and gravel are a valuable source of supply. Southern Wisconsin is particularly well supplied with a large amount of such material. Nearly every hill in the terminal zone of the glaciers is a gravel bank. Some deposits are more valuable than others because they are more accessible. They are near a railroad or a town where the demand is great. Some banks are valuable because the material is clean and not covered deeply with dirt and clay.

An important condition that will make a deposit valuable is the grading of the fine and coarse material. Some pits are found where there is little coarse stone and the sand is as fine as flour. Obviously such a pit could not be worked profitably, since the demand is for coarse aggregate for concrete. Material of that kind would be alright for mortar, but the demand for mortar sand is not large.

One of the largest companies that is putting this glacial sand and gravel on the market is the Janesville Sand and Gravel Co. This company operates three loading plants near Janesville, Wis. It is interesting to go into the details of how such a bulky material is put on the market.

There are many acres of available deposit but there are only a few pits that are worked on a large scale. Any one of these large pits is typical of all of them. The gravel is covered with clay and loam to a depth varying from almost nothing in some places to ten and sometimes fifteen feet in others. This has to be removed before anything else can be done. The stripping. as it is called, is done with a steam shovel, and the dirt is hauled away in small dump cars. If the haul is short, wheel-scrapers are often used.

The actual digging for market can now commence. Digging is continued downward until water is struck, which is at a depth of about ninety feet. Records of wells driven in the vicinity show that the deposit is over two hundred feet thick. Of course, it is impracticable if not impossible to go deeper than the water level. When this level is reached the digging machines work their way into the bank from the bottom, allowing the sand to

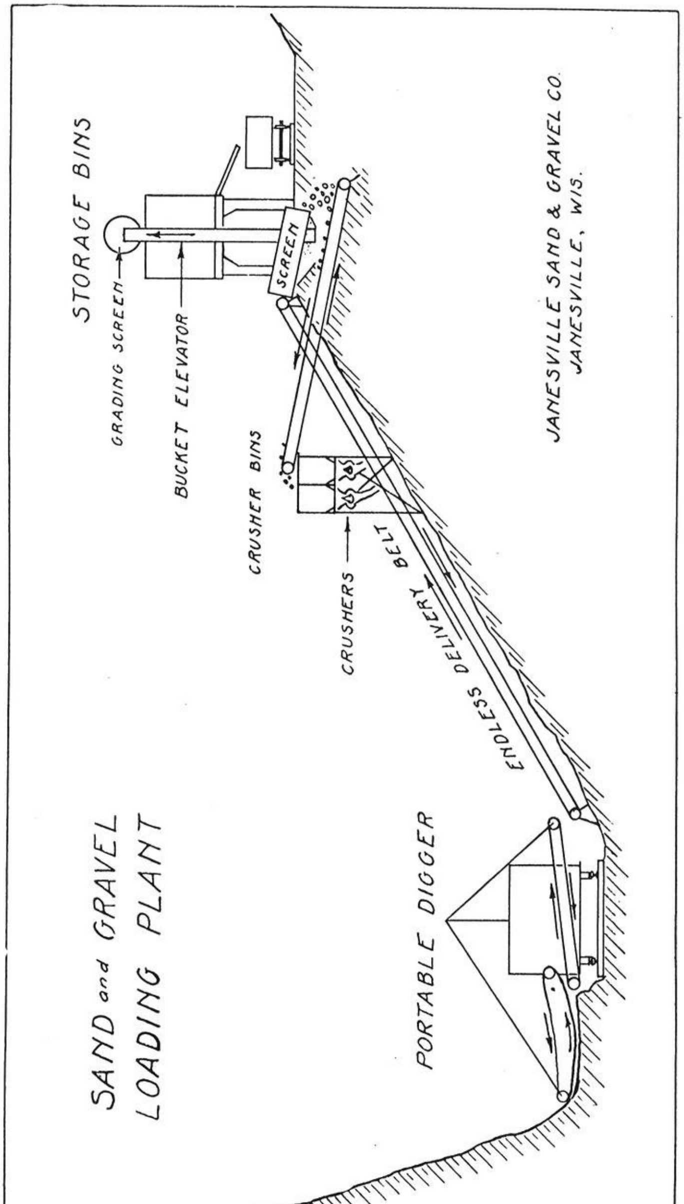


Diagram of Layout for handling material at the Janesville Sand and Gravel Company's plant.

cave down. Great care must be taken in caving, so that men and machinery are not buried.

The sand and gravel is taken from the deposit by digging machines or automatic shovelers. These machines load the material on to endless belt conveyors that carry it to the screens and storage bins. Such a digger is a novel machine. It consists of an endless chain to which are attached shovel-like blades. The chain is arranged so that the sand or gravel is dragged along the ground and on to a short belt, which in turn carries the sand to the large stationary conveyor belts. The whole machine is mounted on wheels and can be moved about on rails, and is operated electrically.

The large conveyor belts are made in sections, because the distance from the digging machine to the loader is always changing. Also, if the belt is longer than about three hundred feet (six hundred feet measuring return) the tension in the upper part would be greater than the allowable stress. The loader bins are, of course, permanent, and as the sand and gravel is dug away it is necessary to use more belting. The conveyor belts are made of 24-inch rubber covered canvas about one-half inch thick. Each conveyor unit is operated by its own electric motor.

The conveyor belt delivers its load to a coarse rotary screen. Here all boulders of over 1½ inch diameter are removed. The remainder is elevated to the grading screen. The boulders are carried back, by another belt, to the crusher bins. Two small gyratory crushers break up these boulders. The crushed material drops down onto the delivery belt to go again through the coarse screen, this time to pass on to the grading screen. The crusher bins take care of any variation in the grading of the material as it comes from the pit. If much coarse material is coming up from the pit, the crushers are shut down or only one is used, but if the pit run is too fine, both crushers are used, so as to maintain an average grading of the material leaving the loader.

The coarse screen is at the foot of the loader. All material that passes it is elevated to the top by means of an endless chain-bucket elevator and is dropped into a large rotary grading screen. This screen separates it into fine, medium, and coarse aggregates, or, as they are called, mason's sand, torpedo sand,

and broken stone or gravel. These fall into their respective bins. It is often desirable to use the sand and gravel as it comes from the pit; it is then dumped into another bin and is called pit or bank run.

The bins are about fifteen feet above the ground, so that the sand or gravel can be spouted into gondola cars or trucks. The railroad cars are loaded from the side and the trucks from directly beneath the bins. With this arrangement both can be loaded at the same time and with any grade of material.

Several of these pits are located on both the C. M. & St. Paul Ry. and the C. & N. W. Ry. so that orders from almost anywhere can be handled promptly. Local trade is supplied by means of motor trucks. The company maintains ten seven-ton trucks; they are continually busy delivering to the various building jobs in Janesville.

Much of the Janesville sand and gravel is shipped to Chicago and Milwaukee, as well as to other cities within a radius of two hundred miles. The pits are worked during the winter as long as there is a demand for material. There is little danger of using up the supply, for the deposit is over two hundred feet thick, and it extends over many acres of area.

THE HANDSHAKE.

With the opening of this new semester many strangers come into our midst. From our own experiences we know that the stranger coming into our surroundings invariably has a feeling of recklessness. In an effort to fraternize the engineering students, it is our first duty to relieve that strain of uneasiness.

Some people just naturally make friends with everyone they meet; others make friends with only a few, but their friendships are lasting. In order to establish fellowship among the engineers, amiability toward the stranger is absolutely essential. The best and most unassuming method to accomplish this is by means of the handhake. A handshake is like oil to the creaking wheels of constraint.

Does your handshake speak for you: "I'm pleased to meet you" and "I surely would like to have you come again", or is it like a wet mitten? Did you ever stop to think that the grasp of your hand displays to the stranger in one minute, more of your true character than a conversation does in half an hour? By this means you are measured, weighed, and stamped. If you are aware of the presence of a stranger among us today, don't shift the responsibility of reception to George; use your own engineering initiative. Shake hands with that stranger in such a way that he can hear a little bird say, "Gee, you surely are welcome among the Engineers." W. E. E.

EDITORIALS

NECROLOGY.

With sorrow we record below the names of those who have been taken from our midst within the past few weeks. Madison has not escaped the dread Influenza which has returned to ravage the country for the second winter in succession. Shortly after the school opened in January, Flu made its re-appearance, and the infirmary and hospitals were rapidly filled with those who fell before it. In spite of splendid facilities furnished by the new Bradley Memorial Hospital, and the tireless efforts of doctors and nurses, a number of the patients died. The sympathy of the students and faculty of this college goes out to the friends and relatives of those who passed away.

Miss Jean Howell, instructor in English for several sections of engineers, died, January 28, of pneumonia.

Paul P. Stokes, a sophomore electrical from Elkhorn, died at the infirmary, on January 21, of inflammatory rheumatism.

C. W. Blackstone, a freshman from Shullsburg, died of pneumoni.a

George Burton Beach, a freshman from Muscatine, Iowa, died of pneumonia.

ARE YOU LEANING ON SOMEONE?

Using a muscle strengthens it; lack of use weakens it; so it is with the various mental faculties. Your power of observation is good or poor depending upon the use you have made of it. If you know the result that a fellow student has obtained for a certain problem, do you try to obtain the same result by the same method, or do you attack the problem in your own way, working accurately and with foresight for an individual result? The first process weakens your initiative, your accuracy, and your power of reason, while the other gives these characteristics strength. Individual work gives you faith in the accuracy of your results, and, more important, confidence in your ability.

Another question: Do you depend upon your text or note book for formulae or constants or facts that occur in your daily work, or do you carry such material in your mind? Your memory can be strengthened greatly if it is trained to carry essential data.

A college education is an opportunity for mental training. The college graduate must not lean on anyone. Me must be self-supporting, and if necessary be able to uphold others weaker than himself. Make the most of your opportunity, by developing your initiative, your memory, your power of reason, your capacity for hard work. Learn to do your own thinking, so that you may be ready to take a place as a leader,—not as a follower.

F. A. B.

THE ANNUAL DANCE.

A new date for the annual Engineers' Dance has finally been set; the big party will be held on Saturday evening, March 27, at nine o'clock, in the gymnasium and concert room of Lathrop Hall. The party had been planned for December 19, but had to be postponed on account of the lengthening of the Christmas recess. The original design for the feature programs is completed and other arrangements are under way. Coming shortly after St. Patrick's Day and before the middle of the semester, the dance should be a great success.

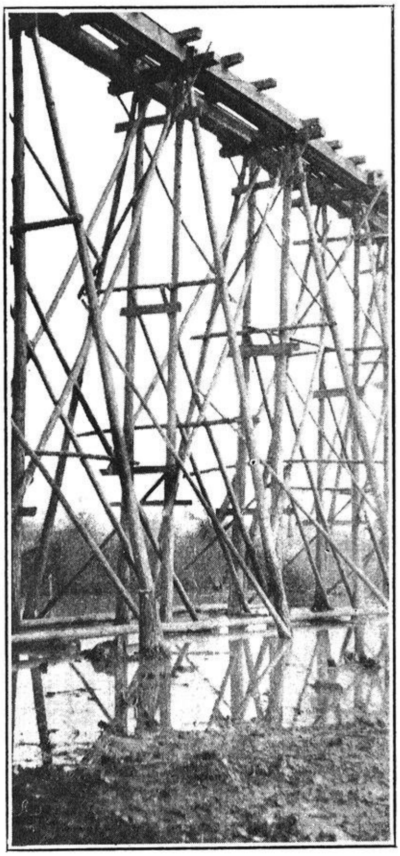
ENGINEERS' SONGS.

Soon there will be a day with sunshine warm enough to make the old stone steps feel cozy, and then a crowd of lusty roughnecks will be seen struggling for "standing room only," and the time-honored pep songs and yells will cheer us between dismal class periods. Wouldn't it be fine, just about then, to have a copy of the "Engineers' Song Book", so that the whole crowd would know the rarest and best "numbers"? A list of songs has been compiled, and within a short time the plan of publication will be definite; the book ought to be ready at about St. Pat's Day. If you know any good lively or humorous songs that are not as yet generally known, add them to the collection by putting a copy of the songs and the name of the melody in the Wisconsin Engineer mail-box in the lobby.

ALUMNI NOTES

By WILLARD A. KATES

The alumni association is planning to inaugurate a system whereby members of the university faculty and prominent alumni in Madison will be able to tour the largest centers where Wisconsin alumni are organized, to speak and keep the grads in touch with the university. No definite plan has been agreed upon, but some system for working out the details is planned in the near future.



CONATY'S TRESTLE

FRED L. ALTER, c '14, City Engineer of Manitowoc, will oversee construction of $500,000 paving, bridge, and sewer work this coming year.

BERNARD M. CONATY, c '18, has been having some interesting work with the Aluminum Company of America down in the North Carolina mountains. As he puts it, "Last summer I was chief of party, instrument man, and sometimes the party on a triangulation survey in the mountains of North Carolina. Since September I have been on construction work. I have had a try at nearly everything from railroad work to industrial building construction." He sends the accompanying photo of a temporary trestle 46ft. high that was used in building a railway fill.

H. V. TENNANT, C. T., graduate student in 1910-11-12, is doing consulting work with headquarters at Portage, Wis. He is City Engineer of Portage, is on State Engineer Mack's staff as engineer in charge of the Portage levee system, besides doing general engineering work in surrounding towns and county.

LIEUT. EDWARD H. CONNOR, ex-c '19, who is in the regular army, was married on November 12, to Anna Thayer of Leavenworth, Kans.

R. L. DODD, e '13, distribution engineer for the T. M. E. R. & L. Co., visited the campus looking for men for summer employment work.

"BOB" FOLGE, formerly at Nela Park on illumination work is now with the Goodyear Tire and Rubber Company.

A. F. FREDERICKSEN, m '18, who is at the head of the Tool Service Department of the Waukesha Motor Co., is looking for graduates who would like to get into tool designing work. He writes, "There is a wonderful opportunity in that line these days."

FRED GERHARDT, c '18, writes that he is on a 10,000-ton oil tanker of the Standard Oil Company, working for a Chief Engineers' License. He is married and expects to leave the sea soon to study for advanced degrees.

R. H. GRAMBSCH, e '15, gives his new address as 628 24th Ave., Milwaukee, Wisconsin.

E. GRANT, c '17, has been appointed instructor in Civil Engineering in the Nolte State College of Agriculture and Mechanic Arts at Bozeman, Montana. He assumed his new duties January 1.

A. E. HENRY, e '17, who is in the traffic office of the A. T. & T. Company at Detroit, spent several days in Madison during January for the purpose of interviewing men who desire to go into telephone engineering.

CEILAN A. HENDEE, e '14, visited the College during January. Since graduation he spent two and a half years with a Milwaukee firm that was engaged in electrical contracting work, eight months in mining work in Colorado, and the remainder of the time in the Navy. He enlisted at the beginning of the war as a Landsman for Electrician, and at the close was Ensign—Engineering duty. He spent 32 months on the battleship Delaware and during that time passed through the Panama Canal and visited Manila and Honolula.

SAM L. HOUGHTON, min '14, is Mine Supt. of the Homestead Iron Dike Mines Co., copper and gold property, at Homestead, Oregon.

PROFESSOR F. A. KARTAK, e '09, formerly of the electrical engineering department, has been appointed chairman of the executive council of the Milwaukee School of Engineering.

CARL F. KOTTLER, e '18, is a sales engineer for the Mechanical Appliance Co., of Milwaukee. He is now with their New York agents, the Dudley-Curry Electric Co., 39 Cortland St. His address is 462 3rd St., Brooklyn, N. Y.

CARROLL H. LUCKEY, c '14, who has been working with the Highway Commission of North Dakota, is now production engineer with a company engaged in concrete work. His address is 813 3rd Ave. N., Fargo, N. D.

ISADOR W. MENDELSOHN, c '17, who is with the North Dakota Public Health Laboratory, at Grand Forks, visited the College early in January.

The marriage of R. C. MUIR, e '05, to Marian Page Bedford, occurred January 24, at Grand Rapids, Mich. Mr. and Mrs. Muir will be at home after Feb. 15 at 506 Rugby Road, Schenectady, N. Y.

G. H. NICKELL, c '11, formerly Division Engineer with the Highway Commission at Eau Claire is selling Lakewood equipment in California.

ARTHUR A. PORATH, c-ex '18, is engaged to marry Miss Gladys L. Johnson. Porath is Assistant Highway Commissioner of Brown County.

RAYMOND E. PORTER, m '17, is in the engineering department of the Falls Motors Corporation, at Sheboygan Falls, Wis.

J. R. SHEA, e '09, writes that his address is 508 So. Austin Blvd., Oak Park, Illinois. Mr. Shea recently returned after two years in Tokio, Japan, as representative of the Western Electric Company.

F. D. SHUFFELBARGER, c '11 discharged from the army April 7th, has a contract for eight miles of mountain road near Albuquerque, New Mexico. Work is closed for the winter, but he expects to start about March 15th. He is doing engineering work also for the City Electric Railway and reports the probabilities of much drainage work in the locality in the next few years.

E. RAIMON STIVERS, C. E. '15, is with the Interstate Commerce Commission at 46 Municipal Bldg., Chattanooga, Tenn. He writes, "I am using some of my time in studying law and accounting . . . preparing myself for a broader outlook should the opportunity present itself. After having spent several years on the go, I have spent this whole year in one city, namely Chattanooga, and am having a touch of settled life. My activities include gym work, two lodges, church, A. A. E., and even fussing."

NELSON B. TAN, ch '18, has returned to China, where he will form a chemical import and export company. Since graduation Tan has been with the C. F. Burgess Co., of Madison.

J. TRANTIN, JR., ch '15, writes that he has wished upon himself "that citation for bravery termed 'Wife' ", and has settled down. He is Foundry Superintendent of The Piston Ring Company located at Muskegon, Michigan.

E. H. VAN PATTEN, m '17, is now with the Marlin Refining Co., Ponca City, Okla.

HARRY W. VROMAN, c '12, was recently made Division Engineer of the Highway Commission at Eau Claire.

JOHN H. WASSON, c '12, who has been with the appraisal department of the Interstate Commerce Commission for a number of years, on Jan. 12, began work with the Cooley & Marvin Co., accountants and appraisal engineers of Boston. At present he is making an appraisal of the Menasha Woodenware Plant. He states that the field work of appraising the railroads is about complete and that the field forces are being disbanded.

J. B. WILKINSON, m '16, M. E. '17, chief engineer for the Union Dye and Chemical Corp., at Kingsport, Tenn., visited the College Jan. 30.

CAMPUS NOTES

By Wilscn D. Trueblood

A tickle, a cough, and a sneeze,—The Infirmary.

How many back for the second semester? "Sore-eye special" didn't get you, eh?

What ho, Merry Winter! Hast enjoyed breaking thy neck on the Norge Ski jump?

It pays to advertise. For proof consult our Matrimonial Bureau.

We wonder who so conveniently arranged "Jack in China" drive with "thrift week"—I can't afford it.

"Waiter, what's the strongest you have today?"
"Well, then give me a malted."

Were the contents of the Octopus the cause of its large sale in the Engineering Building? No., it was the picture on the front cover.

A successful Ice and Ski Carnival was held on the university rink and on the Norwegian ski jump on January 24th. The various races were closely contested and showed that we still have plenty of interest in winter sports. A large bonfire and search lights illuminated the ice for evening skating.

Don Slaker—(trying to persuade a brother engineer to give some money to Jack Childs in China)—"Why, do you know, the two thousand women in this school have already given twice as much money as the four thousand men?"

Fellow Engineer—(hunting for an excuse)—"But Don, the girls write home and ask Dad for the money to send Jack to China, and their Dads come right through and say, 'Give Jack $25.00 if you can send him so far away that he will not interrupt your work in the future.'"

CONCRETE FOR PERMANENCE.

"Concrete for permanence" is the much advertised slogan of an association of cement manufacturers, and it seems that the advantages of concrete in building are everywhere recognized, but a new usage was suggested the other day by one of our foremost engineers who brings encouragement to every woman who suffers the annoyance of a glistening nose. Why be bothered with ordinary powder? It wears off if left alone, gets rubbed off if one's admirers are ardent, and blows off if one motors. A puff-full of fine Portland cement will remove every trace of "shiny nose"—and what is better, will not need to be renewed, if applied after washing, when the face is slightly moist. The cement kills all glare, subdues the highlights, and imparts a delicate and permanent finish to the complexion.

The U. W. Mining Club has been fortunate in entertaining men of prominence at its meeting. At the last orgy of eats, Jan. 21, Joseph M. Boyd, president of the Bank of Wisconsin, was the guest of honor. At the conclusion of the banquet royal, Mr. Boyd gave a brief review of his business career and explained the intricacies of banking in a short talk, "What is a Bank?"

The Civil Engineering society elected the following officers for the ensuing semester: W. J. Rheingans, '20, president; I. Rotter, '21, vice-president; C. L. Rich, '21, secretary; C. A. Wiepking, '20, critic; W. C. Thiel, '22, publicity manager.

After Prof. Allen's lecture on fresh air, in which he said it was impossible to define the unit of smell, some of the Engineers immediately got together in the endeavor to determine the unit of smell, with the following conclusion: "The unit, hereafter known as the Geussenhainer, is the concentration in odor required to raise a giraffe's stomach ten feet thirty minutes after feeding.

Weather reports again will be furnished by the University of Wisconsin wireless station. In addition to the wireless telegraph method of transmission, which was in use before the war, there will be used the new wireless telephone, having a radius of from 150 to 200 miles.

J. R. PRICE has been promoted from assistant professor to Associate Professor of Electrical Engineering.

WHAT IS HE?

Prof.: "Of course, we can not be certain of this proof; no one but a fool is positive."

Student: "Are you sure of that, professor?"

Prof.: "I'm positive."

H. B. DOKE, instructor in drawing, leads the faculty bowling league with an average of 167 for 12 games. In a game between the two engineer teams on January 31 he made high score with 261. The Mechanical Engineers, captained by Pat Hyland, stand third and the All Engineers, lead by Jimmie Watson, stand fifth.

Prof. Ray Owen spoke before the Civil Engineering Society on January 22nd, upon "The Operation of the Intelligence Section of G. H. Q."

Popular Engineer (hanging up the receiver)—"There, I told her I couldn't go to her leap-year party. I was *so* busy, don't you know. Oh, boy, isn't it a grand and glorious feeling to turn the tables like that? I believe in the Golden Rule except when the Slide-rule divides the current year by four."

MILTON J. SHOEMAKER, junior chemical, was called home on January 27 by the death of his father.

Two new appointments to the staff of the Electrical Engineering department have been announced. W. R. LYON, a graduate of Worcester in the class of '17, has been appointed instructor of electrical engineering. Mr. Lyon has, for the past two years held a research fellowship at the University of Illinois and receives his E. E. degree there in February. GLENN KOEHLER, a graduate of the University of Illinois in 1918, has also been appointed as an instructor. While in the Signal Corps, Mr. Koehler was engaged in radio development, and since his discharge has been engaged in research work for the Western Union Telegraph Co.

HE PLEADS, BUT NOT ALONE.

I always know a lot of girls
I pass down on the square,
But when I think of stepping out
I haven't one to spare.

Twelve Co-eds stopped to chat with me;
They're all old friends of mine.
I asked that dozen for a date
And heard them all decline.

Most any girl can choose a man
From out the thousands here,
But they really need a Bureau
For this lonesome engineer.

H. W.

THE GUY AROUND THE CORNER says:

"With a Matrimonial Bureau bureauing at 250 lbs. per sq. inch, I rise to say that the most unkindest cut of all is to see my pals of the Flannel Shirt and Slide Rule bartering their freedom for a Whiff of Djer Kiss and a Ten Pound Look, using lusty Forearms to pilot the Enthusiastic—yea, with a Cry out Loud, I say it—the Enthusiastic and Willing co-ed to the Movies and e'en to the Shandy Cop.

"Personally I fell for a Jane a Long time ago, and in One Way it is Good to see the Engineers stepping Out. Out is Right! Maybe I can Hand out a bit of Miss Information, to impede them in the Search for some of that Foreign Education—the kind you get from a Broad—providing you agree that You can't learn Everything in Books.

"It is customary, when meeting a Male friend, to slap him on the Spinal Column and Exclaim, 'Howinellareya, oldsocks!' but in the case of encountering one of your Girl friends you should say, with Lots of Pomme de Tear and Sing Fried, 'Ah, there, how are you, Stockings Old Girl.' Next time you see Her you will Be about as Welcome as a Hun submersible in a Merchant ship Convoy.

"Be sure to Hand out a Good Line. Tell Her about the Labs and your work, and what a Fine Fellow you Hope to be. Don't be a tightwad—show her You are Not the Kind of a Foul Ball to be bothered by Thrift.

"When you arrive at her Domicile after an evening Out, there is no Need to Kiss her if you feel you Have Already done Enough for her. In case you would Still like to Do More for her, then Kiss her Goodnight. If she wants to Know why you did it, Tell her you heard she Had a Past and you Thought you would give her a little Present. After that your Name will be Mud Puppy.

"When you know of a Good Party, call her up and tell Her About the Affair and bring a little Ray of Hope into her life by telling her she can Go with You unless you find Someone else you Like Better.

"A few Evenings spent Fussing and the Engineers will be dragging Their Friends to the Matrimonial Bureau for further Succor; after which it might be a Good Idea to Major in Refrigeration Machines."

MR. J. H. V. FINNEY, instructor in Steam and Gas Engineering, left at the end of the first semester to take charge of the research department of the Isko Company, 2525 Clybourn Ave., Chicago. The company manufactures refrigerating machinery for household use.

FINLEY L. FISBECK, c '19, who has been on construction work with the Aluminum Company of America, has been appointed instructor in hydraulic engineering. He assumed his new duties at the beginning of the semester. His many friends are glad to see him back at Wisconsin.

MR. H. W. BROWN and MR. T. MCLEAN JASPER have recently been appointed to the staff of the Mechanics Department.

Mr. Brown is a graduate of Massachusetts Institute of Technology, class of 1915. For two years he was an assistant in the Materials Testing Laboratory of the Institute and later served for more than two years in the army with the rank of First Lieutenant as Acting Division Gas Officer in France. During the first semester of this year he held a fellowship in Civil Engineering in our College.

Mr. Jasper is a graduate of the University of Illinois, class of 1910, and C. E. 1911. From that time until the outbreak of the war he was engaged on various municipal and sanitary engineering projects in Chicago districts. At the outbreak of the war he went to England and served in the Royal Field Artillery until detached for special duties in training officers and testing and inspecting for the Ministry of Munitions and the Air Board.

After hearing Ray Owen's lecture on his work in the Information Department of G. H. Q in France, we no longer wonder how he knows that our shots on the sun were made at night by the aid of an almanac and the light of a candle.

The practicability of winter aviation was demonstrated by an aeroplane advertising Red Crown gasoline which flew from Milwaukee. During the ice carnival this plane flew over the rink doing aerial stunts and later landed on the snow. The landing gear, a pair of skis, was the unique feature of the plane, and enabled the aviator to alight or take off with ease.

AT THE ENGINEERS' DANCE.

Cooing Co-ed (dancing with slipstick artist)—"Are you taking a course in mechanical drawing?"

The Artist—"To be sure. I wield a pen."

The Fair One—"I suppose you enjoy your work. It must be so interesting."

The Truthful One—"Yes, it is interesting; but there are no thrills to drawing."

The Vamp—"No? Well just try drawing me a little closer—(pause)—Ah-h-h—!!!"

Last night at the "Strand", while the Prizma movies on "Pineapple Cultivation in the Hawaiian Islands" were being shown, we heard a co-ed exclaim to her escort, "Oh, dear, I thought pineapples grew on trees like bananas." We were unable from where we sat to discover whether she wore her galoshes open or not.

That skiing is coming into prominence at Wisconsin is shown by the interest taken in the ski jump back of the Hydraulic Laboratory. The University was well represented at the recent contest at Cary, Illinois, where seven men entered the amateur class and succeeded in getting four places. Hans Gude, the champion jumper of the school, came within one foot of winning first place in the contest.

NO MENTION IS MADE OF THE OUTLET.

"Heral Dy" Timm, widely known in these parts as "Toothpick Timm" is gaining recognition in engineering society circles by reason of the thoroughness with which he collects fines from those members of A. S. M. E. whose fussing dates conflict with society meetings, and also by reason of the simplified system of bookkeeping which he has developed for use in society accounting. The novel feature of the Toothpick system of Society Accounting is the single entry—into Timm's pocket.

OUR IMPRESSIONABLE SOPHS.

Three sophs returning from thrift convocation at 5:30.
First Soph: "Let's stop at Dad's for a malted."
Second and Third Sophs: "You're on."

The State Highway Commission has organized a research laboratory at the University under the direction of Professor M. O. Withey.

Engineer showing his ignorance: "Say, Charlie, how far can a rabbit run into the woods if he can make twenty feet at a jump?"

Charlie, after a few minutes' reflection: "I don't know, how far can he?"

"Half way, you poor simp, for then he'll be going out."

Saturday afternoon—Dean Turneaure stopped at first floor fountain to get a drink, with the usual result.

Monday morning—Plumber is seen fixing fountain.

SCANDAL! WISCONSIN GIRLS ENJOY THEIR SMOKES!

McKillop informs us that the co-eds have created an unprecedented demand for incense. 'Sall right girls; only don't try to burn it in a jimmy pipe?

FAVORITE EXPRESSIONS THAT WE HEAR SO OFTEN.

Lenny Smith—"You will see that again in the final examination. Water is the greatest enemy a road can have, so remember the three fundamental principles of road construction are, (1) Drainage, (2) Drainage, and (3) Drainage." "It follows as night the day."

Prof. Corp—"You must use the energy equation."

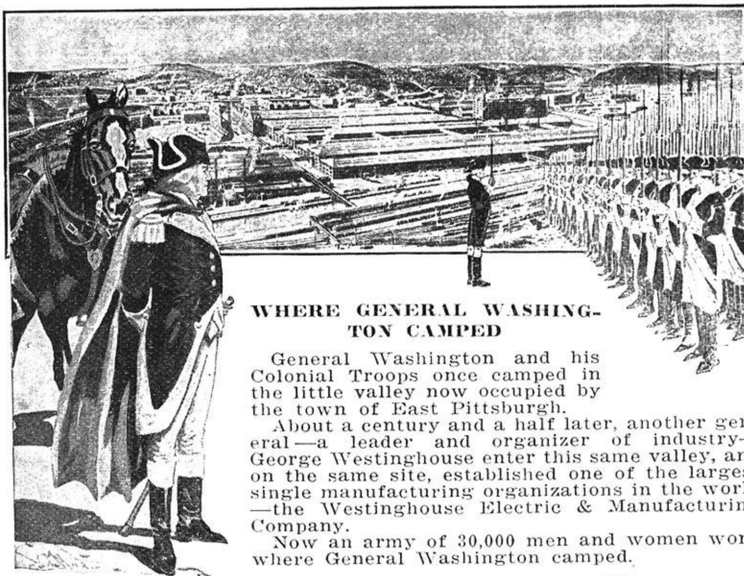
Bob Smith—"And a cry out loud."

Sy Perkins—"Draw a free body and assume the forces to act in one direction."

Jimmie Watson—"Theowetically that is correct."

Bill Kinne—"Follow the Book."

IT BRINGS THEM TO US.



WHERE GENERAL WASHINGTON CAMPED

General Washington and his Colonial Troops once camped in the little valley now occupied by the town of East Pittsburgh.

About a century and a half later, another general—a leader and organizer of industry—George Westinghouse enter this same valley, and on the same site, established one of the largest single manufacturing organizations in the world—the Westinghouse Electric & Manufacturing Company.

Now an army of 30,000 men and women work where General Washington camped.

A Development Which Revolutionized Power House Practice

It was in this historic valley that the first commercially successful turbine-driven Alternating-Current Generator was developed under the direction of George Westinghouse. It was tested in the East Pittsburgh Shops in 1896. The splendid operation of this, and two duplicate machines installed a year later, sounded the death knell of the reciprocating steam engine—then in almost universal use.

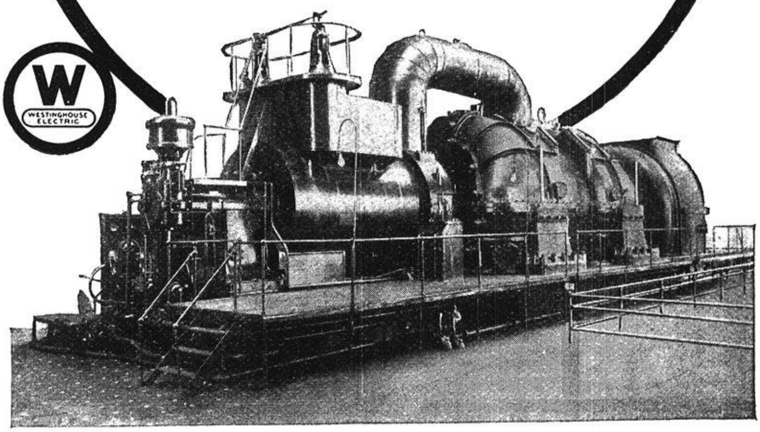
The steam turbine has effected remarkable savings—one of the most evident of which is floor space—the turbine-generator occupying from one-fourth to one-sixth the space occupied by the reciprocating engine. In our large cities, with floor space valued at thousands of dollars a square foot, this is a consideration of great importance.

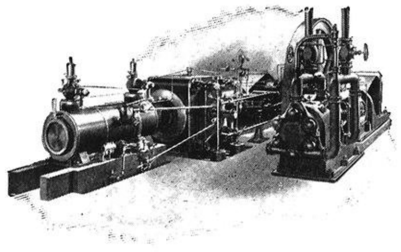
Ever since its organization, the Westinghouse Electric & Manufacturing Company has been foremost in the development of steam and electrical apparatus.

Westinghouse Electric & Manufacturing Co.

East Pittsburgh, Pa.

WESTINGHOUSE ELECTRIC





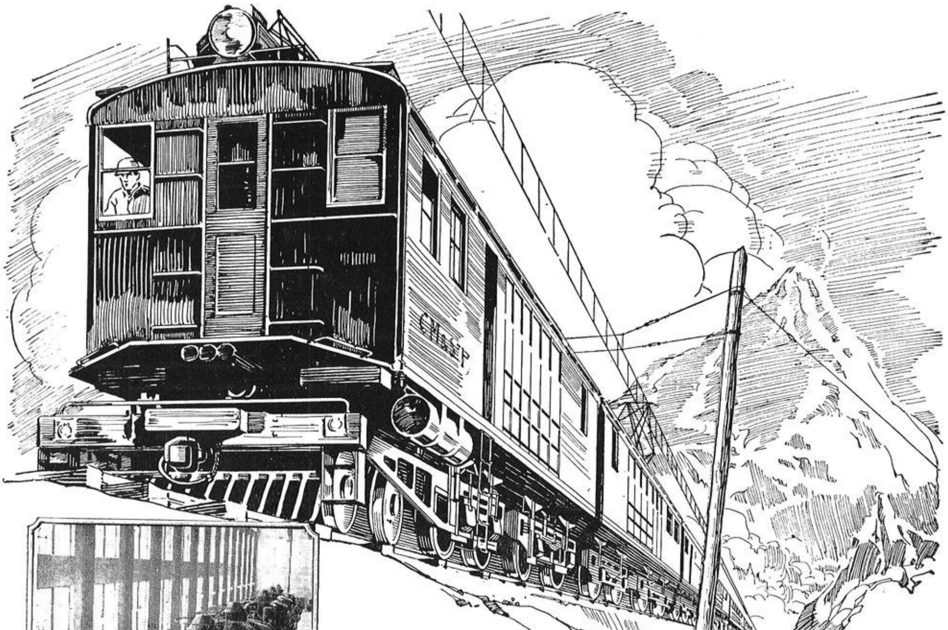
THEY EXPECT US TO DO EVERYTHING.

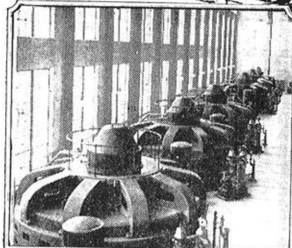
Scenario: Coed hurrying up the Hill with stocking down over her shoetop. Slipstick artist going other way.

He: "Say sister, you're loosing something."

She: (looking down)—"Darn it!"

A. H. G.





Generator room of one of the hydro-electric plants which supply power to the C. M. & St. P.

Some Advantages of Railroad Electrification

Saving the Nation's coal.

Lower maintenance costs.

Greater reliability and fewer delays.

Ability to haul smoothly heavier trains at higher speed.

Operation of electric locomotives unaffected by extreme cold.

Ability to brake trains on descending grades by returning power to the trolley.

The Power of Electricity in Transportation

ELECTRICITY has leveled out the Continental Divide.

On the Chicago, Milwaukee & St. Paul Railway—the world's greatest electrification—giant electric locomotives have thoroughly outclassed their steam rival. Utilizing the abundant energy of distant waterfalls, they lift an ever increasing freight tonnage over the mile-high Rockies and also make traveling clean and comfortable. And their capabilities are not impaired by weather so cold that the steam engine becomes frozen and helpless.

Electric power drives the trains of New York City's subway and elevated systems. It operates the locks and tows the ships through the Panama Canal. It propels the Navy's latest super-dreadnaught, the *New Mexico*. Electric mine locomotives have replaced the slow-moving mule and the electric automobile has also come to do an important service.

Electricity has contributed efficiency and comfort to every form of transportation and in this evolution General Electric apparatus has played a large part—from mighty electric locomotives to the tiny lamp for the automobile.

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

95-128F