CE-18 Anika

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Influence Lines: An influence line is a diagram showing the variation in the shear, moment, stress in a member, reaction, or other direct function at a particular section or point or member, due to a unit load moving across the structure.

Construction of Influence Line: An influence line 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 point.

Purpose of Influence Lines:

Influence lines can be used for two very important purposes:

1. To determine what position of live loads will lead to a maximum value of the particular function for which an influence line has been constructed.
2. To compute the value of that function with the loads so placed or, in fact, for any loading condition.

Theorem 1. To obtain the maximum value of a function due to a single concentrated live load, the load should be placed at the point where the ordinate to the influence line for that function is a maximum.

Theorem 2. The value of a function due to the action of a single concentrated live load equals the product of the magnitude of the load and the ordinate to the influence line for that function, measured at the point of application of the load.

Theorem 3. To obtain the maximum value of a function due to a uniformly distributed live load, the load should be placed over all those portions of the structure for which the ordinates to the influence line for that function have the sign of the character of the function desired.

Theorem 4. The value of a function due to a uniformly distributed live load is equal to the product of the intensity of the loading and the net area under that portion of the influence line, for that function under consideration, which corresponds to the portion of the structure loaded.

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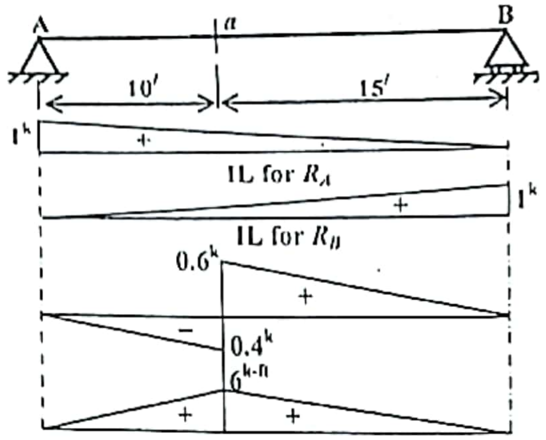
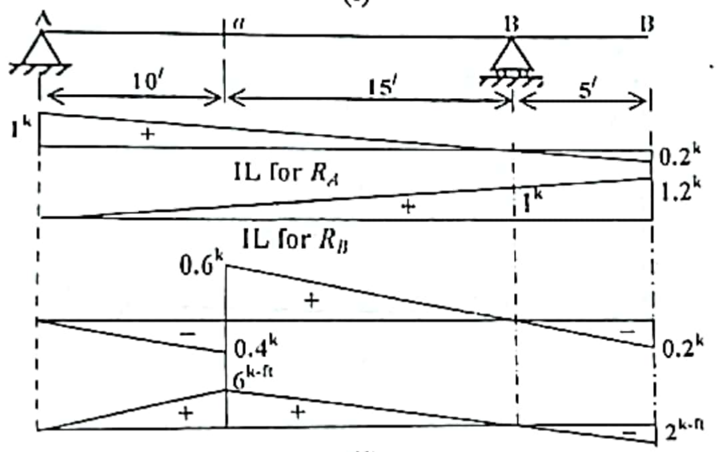
Q.1. Draw IL diagrams for R_A, R_B, V_a and M_a of the following structures as a unit load moves from A to B.

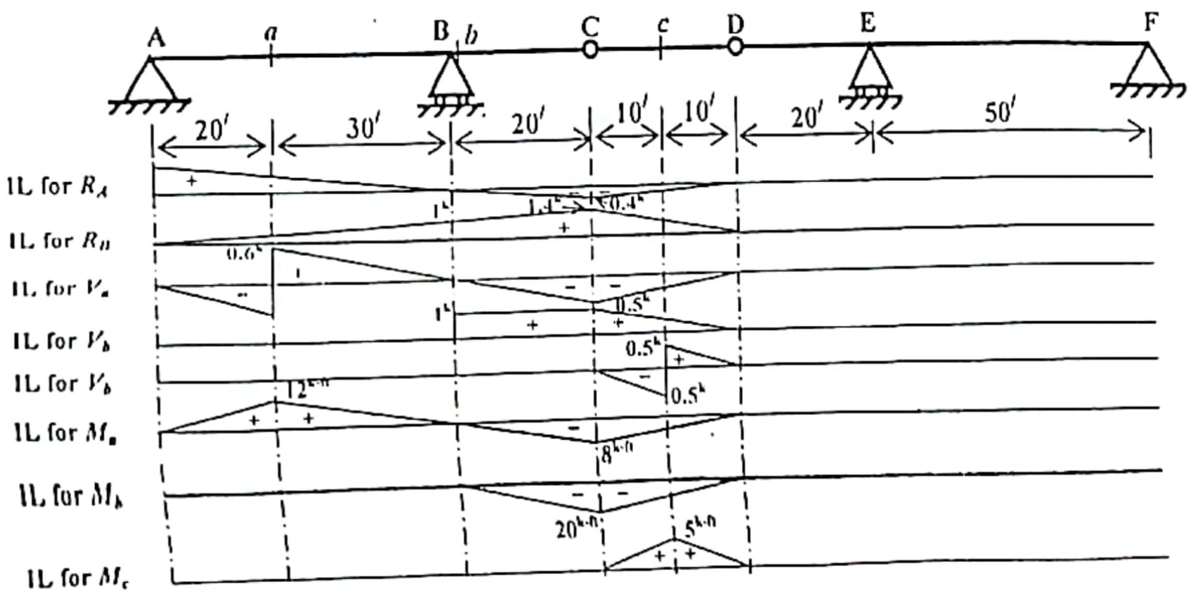


(i)



(ii)

Q.2. Draw IL diagrams for R_A, R_B, V_a, V_b, V_c, M_a, M_b and M_c of the following balance cantilever bridge as a unit load moves from A to F.



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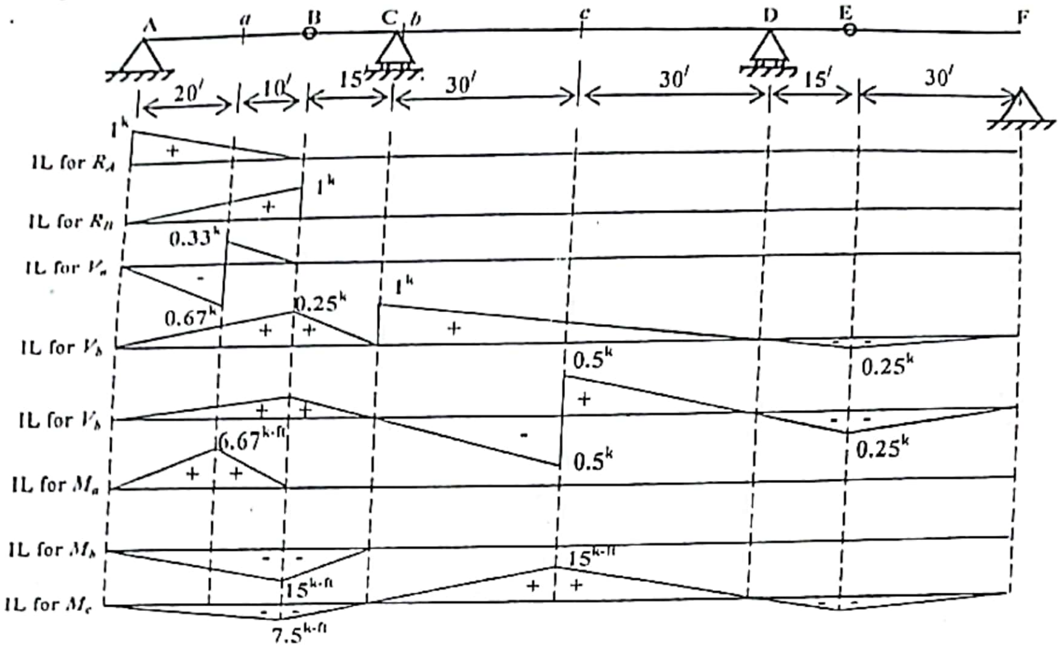
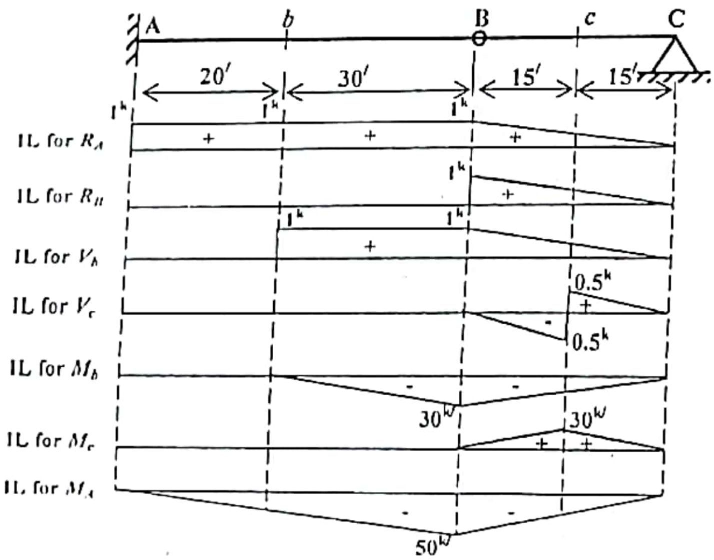
Q.3. Draw IL diagrams for R_A, R_B, V_a, V_b, V_c, M_a, M_b and M_c of the balance cantilever bridge as shown below in a line diagram as a unit load moves from A to F.



Prob. 3

Q.4. Draw IL diagrams for R_A, R_B, V_b, V_c, M_b, M_c and reactive moment at support M_A of the following compound beam as a unit load moves from A to C.



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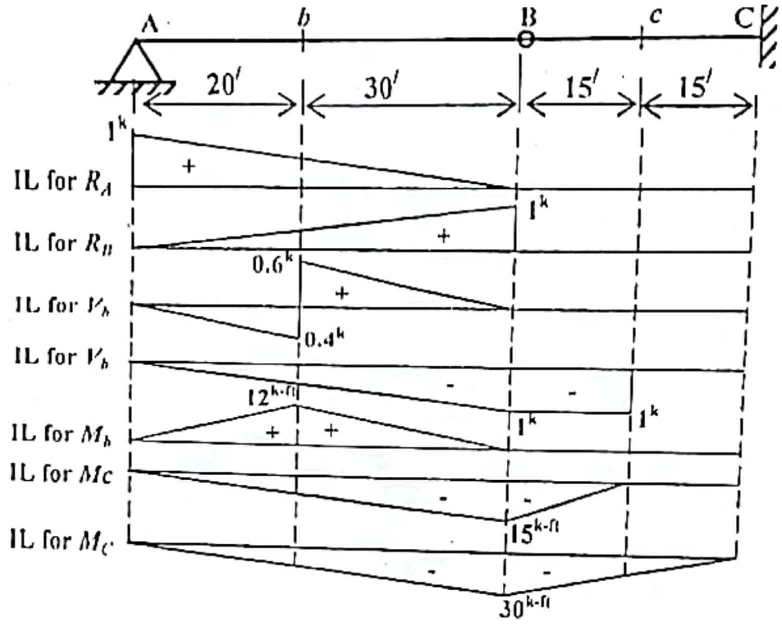
Q.5. Draw IL diagrams for R_A, R_B, V_b, V_c, M_b, M_c and M_C (reactive moment) of the balance cantilever bridge as shown below in a line diagram as a unit load moves from A to F.



Prob. 5

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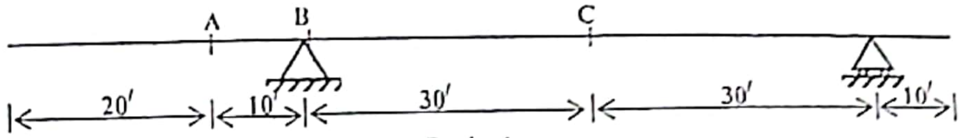
1. Draw the influence lines for shear and the influence lines for moment at A, B, and C in the beam. B is just to the right of the left support. A unit load moves from left to right end of beams. (Shedd & Vawter, p-138, Prob.- 88)

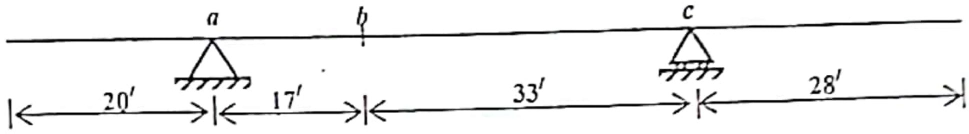


Prob. 1

2.(i) Draw the influence lines for shear at sections *a*, *b*, and *c*; *a* and *c* are to be taken an infinitesimal distance to the left of the supports.

(ii) Draw the influence lines for moment at *a*, *b*, and *c*.

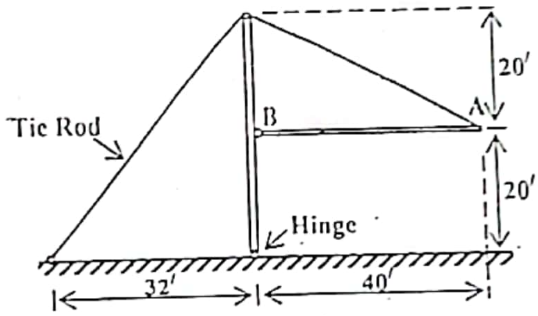
(iii) Draw the influence lines for shear at *a* and *c* when they are an infinitesimal distance to the right of the supports. (Shedd & Vawter, p-139, Prob.- 89)



Prob. 2

3.(i) Draw the influence line for vertical component of the tie rod reaction as a unit load moves from A to B.(Shedd & Vawter, p-139, Prob.- 90)

(ii) Draw the influence line for moment in the must at B as a unit load moves from A to B.



Prob. 3

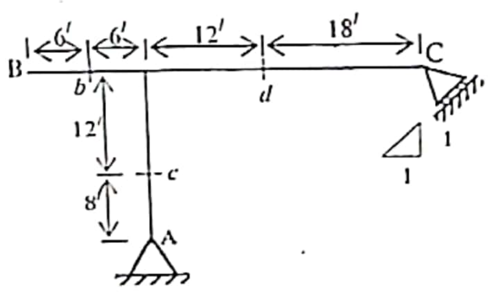
4. Draw the following influence lines for the structure shown. In all cases the unit load moves between B and C.(Shedd & Vawter, p-139, Prob.- 89)

(i) Vertical component of the reaction at A.

(ii) Shear and moment at *b*.

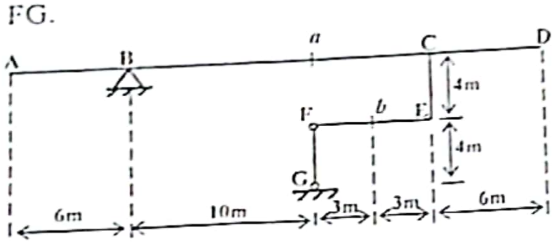
(iii) Shear and moment at *c*.

(iv) Shear and moment at *d*.



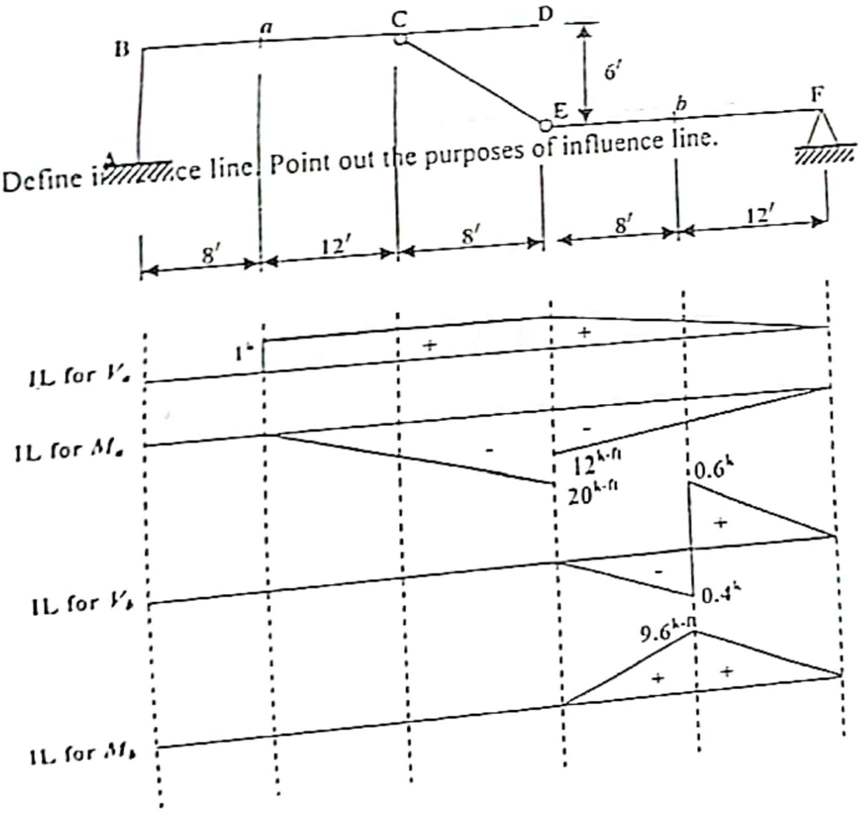
Prob. 19

19. As a unit load moves from A to D on the following structure, draw the influence lines for shear and moment at sections *a*, and *b*. Also, draw the influence lines for reaction in member FG.



Prob. 20

21. As a unit load moves from A to D and E to F on the following structure, draw the influence lines for shear and moment at sections *a*, and *b*. Also, draw the influence lines for reaction in member FG.



Q.1(a). Define influence line. Point out the purposes of influence line.

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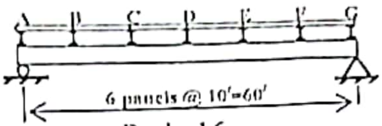
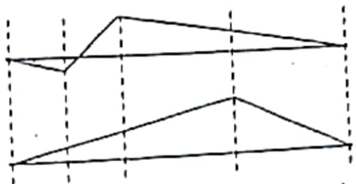
16. For the girder shown, construct the influence lines for (i) shear in panel BC and (ii) moment at E. (Norris & Wilbur, 4th Ed, p-172)



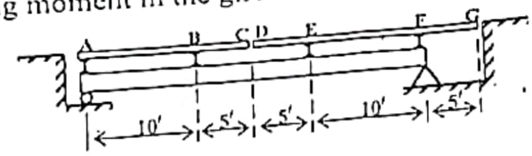
Prob. 16

V_B = - 1/6 k, V_C = +2/3 k

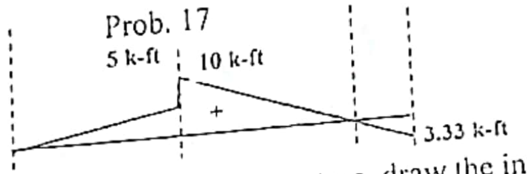


M_E = +13.33 k-ft

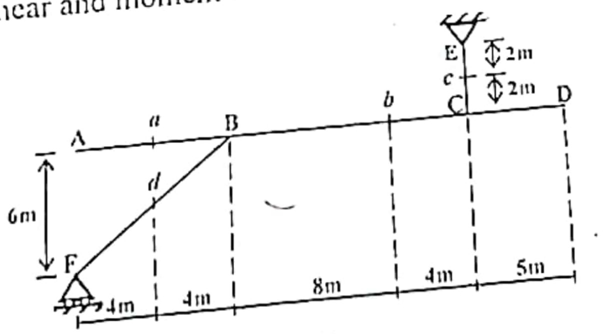
17. Note the unusual stringer arrangement for this girder. Construct the influence lines for the bending moment in the girder at E. (Norris & Wilbur, 4th Ed, p-173)



Prob. 17

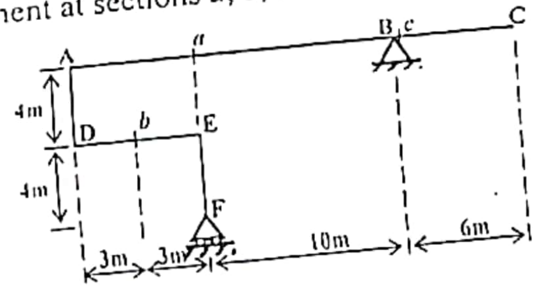


As a unit load moves from A to D on the following structure, draw the influence lines for shear and moment at sections *a*, *b*, *c*, and *d*.



Prob. 18

18. As a unit load moves from A to D on the following structure, draw the influence lines for shear and moment at sections *a*, *b*, and *c*(just to the right of B).



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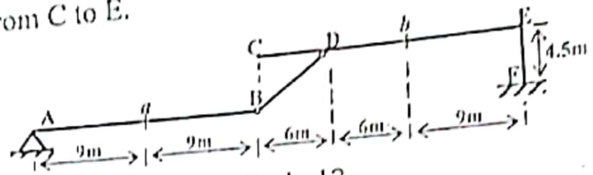
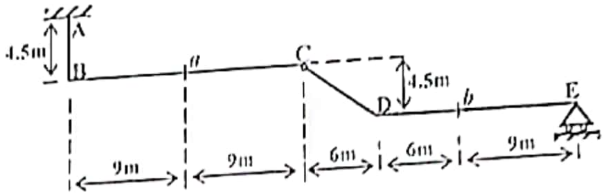
Prob. 11

12. Draw the influence lines for R_{BD}, M_F, V_a, V_b, M_a and M_b as a unit load moves from A to B and from C to E.



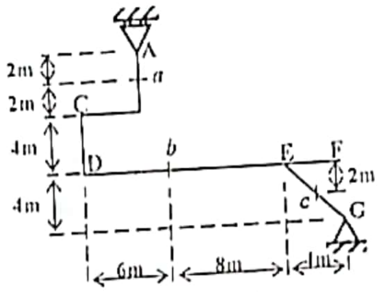
Prob. 12

13. Draw the influence lines for M_A, V_a, V_b, M_a and M_b as a unit load moves from B to C and from D to E.



Prob. 13

14. Draw the influence lines for V_a, V_b, V_c, M_a, M_b and M_c as a unit load moves from D to F.



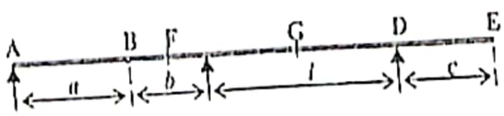
Prob. 14

15. As a unit load moves from A to E on the following structure, draw the influence lines for: (Vazirani & Ratwani, Vol-I, p-502)

(i) Reactions R_A, R_B, R_C, and R_D.

(ii) Shear and moment at F.

(iii) Shear and moment at G.



Prob. 15

Prob. 8

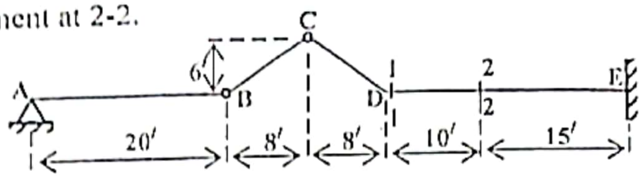
9. As a unit load moves from A to B and from D to E on the following structure, draw the influence lines for:

(i) Reaction at support A.

(ii) Reaction in the member BC.

(iii) Shear and moment at 1-1(Just to the right of D).

(iv) Shear and moment at 2-2.



Prob. 9

When 1k at A

R_A = 1k; F_{BC} = 0.0; $V_{1\text{-}1}$ = 0.0; $V_{2\text{-}2}$ = 0.0; $M_{1\text{-}1}$ = 0.0; $M_{2\text{-}2}$ = 0.0

When 1k at B

R_A = -1.33k; F_{BC} = 1.66k; $V_{1\text{-}1}$ = -1.0; $V_{2\text{-}2}$ = -1.0; $M_{1\text{-}1}$ = -16.0k-ft; $M_{2\text{-}2}$ = -26.0 k-ft

When 1k at D

R_A = 0.0k; F_{BC} = 0.0k; $V_{1\text{-}1}$ = -1.0; $V_{2\text{-}2}$ = -1.0; $M_{1\text{-}1}$ = 0.0 k-ft; $M_{2\text{-}2}$ = -10.0 k-ft

When 1k at right of 1-1

R_A = 0.0k; F_{BC} = 0.0k; $V_{1\text{-}1}$ = 0.0; $V_{2\text{-}2}$ = -1.0; $M_{1\text{-}1}$ = 0.0 k-ft; $M_{2\text{-}2}$ = -10.0 k-ft

When 1k at left of 2-2

R_A = 0.0k; F_{BC} = 0.0k; $V_{1\text{-}1}$ = 0.0; $V_{2\text{-}2}$ = -1.0; $M_{1\text{-}1}$ = 0.0 k-ft; $M_{2\text{-}2}$ = 0.0 k-ft

When 1k at left of 2-2

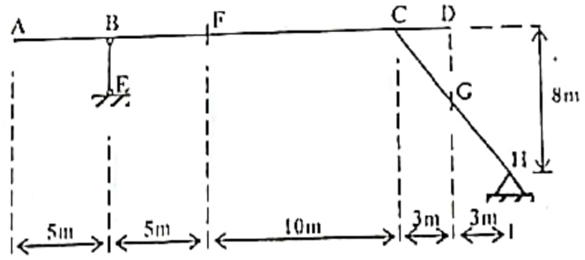
R_A = 0.0k; F_{BC} = 0.0k; $V_{1\text{-}1}$ = 0.0; $V_{2\text{-}2}$ = 0.0; $M_{1\text{-}1}$ = 0.0 k-ft; $M_{2\text{-}2}$ = 0.0 k-ft

10. As a unit load moves from A to D on the following structure, draw the influence lines for:

(i) Reaction in the member BE.

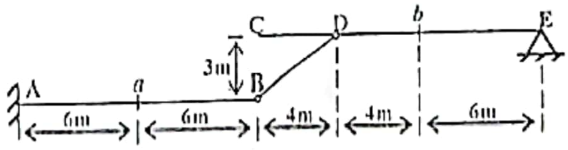
(ii) Shear and moment at F.

(iii) Shear and moment at G.



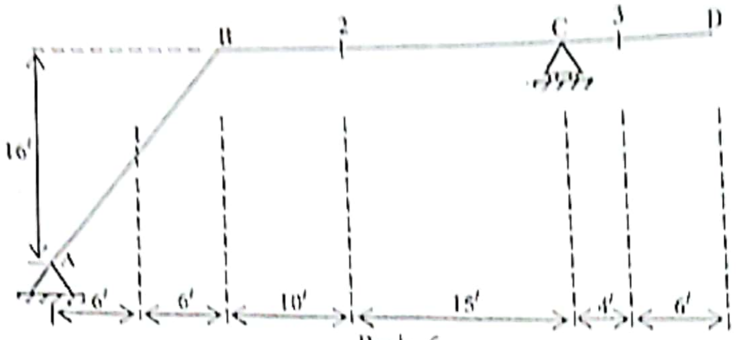
Prob. 10

11. Draw the influence lines for R_{BD}, M_A, V_a, V_b, M_a and M_b as a unit load moves from A to B and from C to E.



6. Draw the following influence lines for the structure shown. In all cases the load moves from B to D. (Shedd & Vawter, p-140, Prob.- 93)

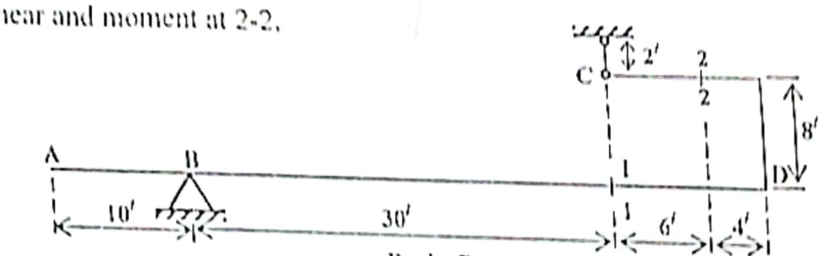
(i) Reaction at C.
(ii) Shear and moment at 1.
(v) Shear and moment at 2.
(vi) Shear and moment at 3.



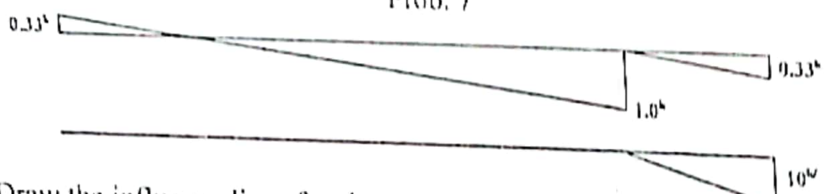
Prob. 6

7. As a unit load moves from A to D, draw the influence lines for: (Shedd & Vawter, p-141, Prob.- 96)

(i) Shear and moment at 1-1.
(ii) Shear and moment at 2-2.

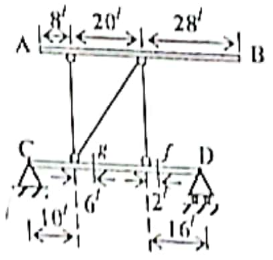


Prob. 7



8.(i) Draw the influence lines for shear and moment at f, in the beam CD of the frame shown, as a unit load moves from A to B.

(ii) Draw the influence lines for shear and moment at g in the same beam for the same movement of the unit load. (Shedd & Vawter, p-141, Prob.- 97)



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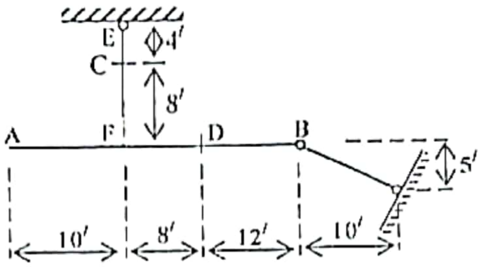
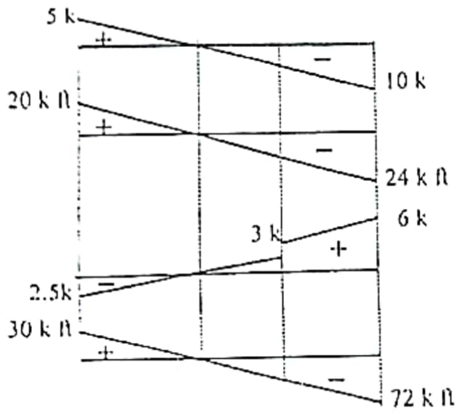
Prob. 4

5. Draw the influence lines for shear and moment at C and D in the beam shown as a unit load moves from A to B. (Shedd & Vawter, p-140, Prob.- 92)



Prob. 5



<u>When 1^k at A</u>

$R_H = 5.59k$, $R_{Hx} = 5.0k$, $R_{Hy} = 2.5k$; $V_C = 5.0k$, $V_D = -2.5k$, $M_C = 20k\ ft$, $M_D = 30k\ ft$.

<u>When 1^k at F</u>

$R_H = 0.0$, $R_{Hx} = 0.0k$, $R_{Hy} = 0.0k$; $V_C = 0.0k$, $V_D = 0.0k$, $M_C = 0k\ ft$, $M_D = 0k\ ft$,

<u>When 1^k at left of B</u>

$R_H = 4.472k$, $R_{Hx} = -4k$, $R_{Hy} = -2k$; $V_D = 2k$, $M_D = -24k\ ft$,

<u>When 1^k at left of B</u>

$R_H = 4.472k$, $R_{Hx} = -4k$, $R_{Hy} = -2k$; $V_D = 3k$, $M_D = -24k\ ft$,

<u>When 1^k at B</u>

$R_H = 11.18k$, $R_{Hx} = -10k$, $R_{Hy} = -5.0k$; $V_C = -10k$, $V_D = 6k$, $M_C = -40k\ ft$, $M_D = -72k\ ft$.

Criteria for the maximum reaction of a simple beam subjected to series of concentrated loads move from right to left.

CE-16

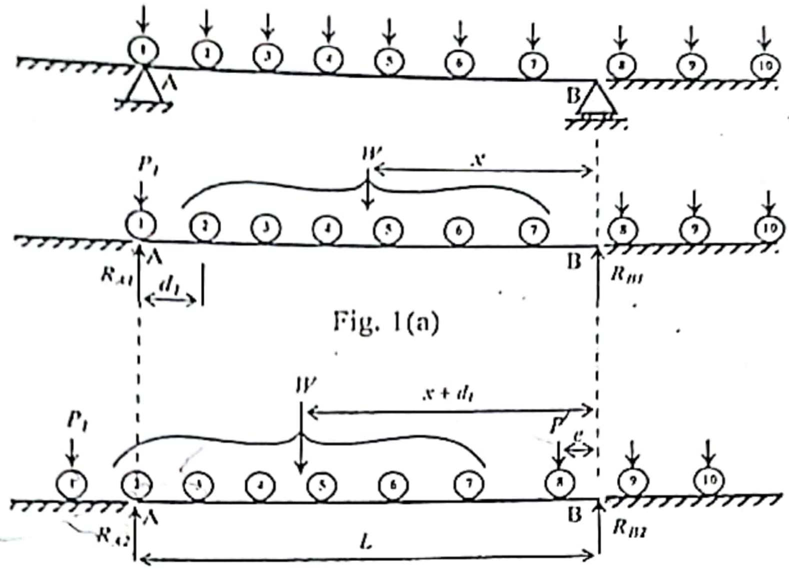


Fig. 1(a)

Fig. 1(a)

Let, P_l = the load which was over the left support and is moved off the span after movement.

d_l = the distance between P_l and the following wheel.

L = span length of the beam.

$W = \sum P$ = the sum of all the loads which are on the span before movement and stay on during movement.

P' = the load which enters in the span after the movement.

e= the distance of load P' from right support at B.

From Fig. 1(a), before the movement of wheels,

$$\sum M_B = R_{A1}L - Wx - P_1L = 0$$

or, $$R_{A1} = \frac{Wx}{L} + P_1 \quad (1)$$

From Fig. 1(b), after the movement of wheels,

$$\sum M_B = R_{A2}L - W(d_1 + x) - P'e = 0$$

or, $$R_{A2} = \frac{W(d_1 + x)}{L} + \frac{P'e}{L} \quad (2)$$

The change in reaction at support A due to the movement of the wheel can be obtained by subtracting Eq. (1) from Eq. (2), then equation is given by

$$\Delta R = R_{A2} - R_{A1} = \frac{W(d_1 + x)}{L} + \frac{P'e}{L} - \frac{Wx}{L} - P_1$$

or, $$\Delta R = \frac{Wd_1}{L} + \frac{P'e}{L} - P_1 \quad (3)$$

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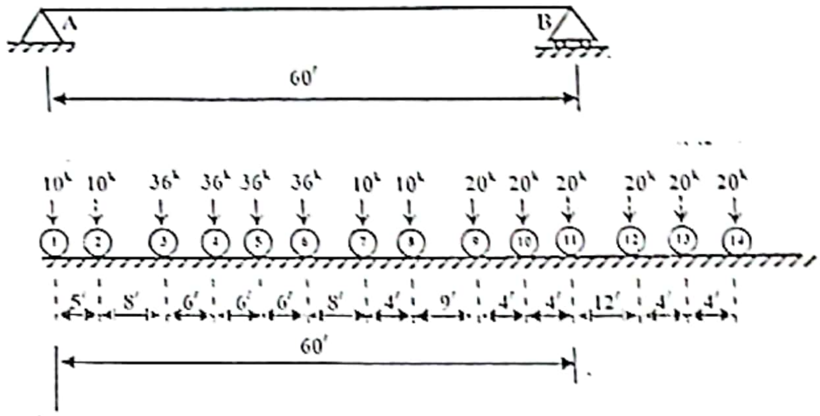
$$\text{or,} \qquad \Delta R = \frac{\sum Pd_1}{L} + \frac{P'e}{L} - P_1 \qquad (4)$$

N.B. In the above expression, P_l is the first wheel as shown in Fig. 1. However, for the subsequent action wheel 2 must be replaced by P_l. Similarly, P_8 is P' in the expression which is outside of span before movement and enters in the span after movement. The wheel 8 must be replaced by wheel 9. This procedure continues till the ΔR changes its sign of character.

Example1



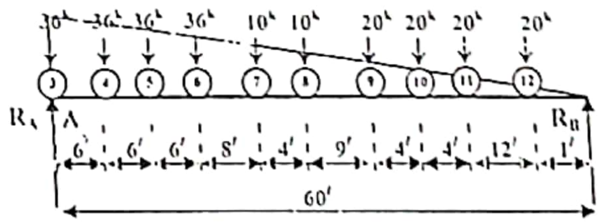
Criteria for maximum reaction

$$\Delta R = \frac{\sum Pd_1}{L} + \frac{P'e}{L} - P_1$$

Wheel 1-2 $\quad \Delta R = \dfrac{234 \times 5}{60} + 0 - 10 = \textit{an increase}$

Wheel 2-3 $\quad \Delta R = \dfrac{224 \times 8}{60} + 20 \times \dfrac{1}{60} - 10 = \textit{an increase}$

Wheel 3-4 $\quad \Delta R = \dfrac{208 \times 6}{60} + 20 \times \dfrac{3}{60} - 36 = \textit{a decrease}$



$$R_A = \frac{1}{60}[1\times20+13\times20+17\times20+21\times20+30\times10+34\times10+42\times36+48\times36+54\times36+60\times36]$$

$= 150.4$ kips

From Fig. 2(b), the reaction at left support before the movement of wheels R_{A1} can be obtained as follows:

$$\sum M_B = R_{A1}L - P''(L-d_2) - Wx_1 - P_1(d_1+x_2) = 0$$

or, $$R_{A1} = \frac{Wx_1}{L} + P_1\frac{(d_1+x_2)}{L} + P''\frac{(L-d_2)}{L}$$

Now, shear force of the section,

$$V_1 = R_{A1} - P''$$

$$V_1 = \frac{Wx_1}{L} + P\frac{(d_1+x_2)}{L} + P''\frac{(L-d_2)}{L} - P''$$

$$V_1 = \frac{Wx_1}{L} + P\frac{(d_1+x_2)}{L} - \frac{P''d_2}{L} \qquad (1)$$

From Fig. 2(c), the reaction at left support after the movement of wheels R_{A2} can be obtained as follows:

$$\sum M_B = R_{A2}L - W(d_1+x_1) - P_1(2d_1+x_2) - P'e = 0$$

or, $$R_{A2} = \frac{W(d_1+x_1)}{L} + P_1\frac{(2d_1+x_2)}{L} + P'\frac{e}{L}$$

Now, shear force of the section,

$$V_2 = R_{A2} - P_1$$

$$V_2 = \frac{W(d_1+x_1)}{L} + P_1\frac{(2d_1+x_2)}{L} + P'\frac{e}{L} - P_1 \qquad (2)$$

The change in shear at this section due to the movement of the wheel can be obtained by subtracting Eq. (1) from Eq. (2),

$$\Delta V = V_2 - V_1 = \frac{W(d_1+x_1)}{L} + P_1\frac{(2d_1+x_2)}{L} + P'\frac{e}{L} - P_1 - \frac{Wx_1}{L} - P\frac{(d_1+x_2)}{L} + \frac{P''d_2}{L}$$

or, $$\Delta V = \frac{(W+P_1)d_1}{L} + \frac{P''d_2}{L} + \frac{P'e}{L} - P_1 \qquad (3)$$

or, $$\Delta V = \frac{\sum Pd_1}{L} + \frac{P''d_2}{L} + \frac{P'e}{L} - P_1 \qquad (4)$$

The maximum shear force at this section will occur when ΔV tends to zero. This procedure continues till the ΔV changes its sign of character.

Criteria for the maximum shear of a simple beam subjected to series of concentrated loads move from right to left.

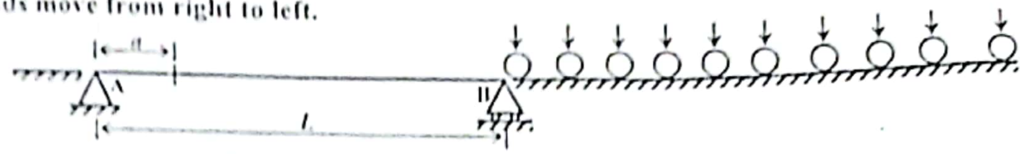


Fig. 2(a)

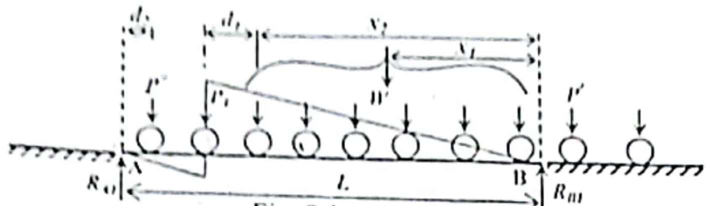


Fig. 2(b)

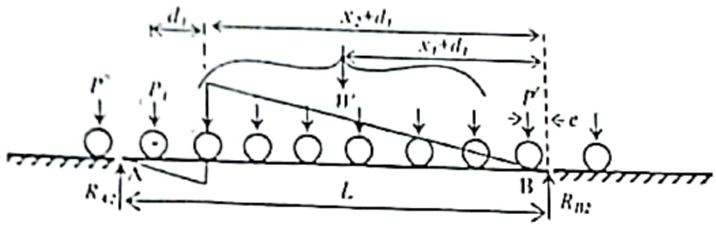


Fig. 2(c)

A simply supported beam of span length L is shown in Fig. 2(a). The beam is subjected to series moving loads. Loads move from right to left and pass through a section at a distance 'a' from the left support. It is required to determine the criteria to obtain the position of loads for maximum shear. Fig. 2(b) and Fig. 2(c) show the position wheel loads before and after movement.

Let, P_1 = the load which was over section and is moved off the section after movement.

P' = the load which was off the span before movement and enter in the span after movement.

P = the load which was in negative shear zone before movement and is moved off the span after movement.

d_1 = the distance between P_1 and the following wheel.

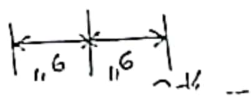
d_2 = the distance of wheel load P'' from left support.

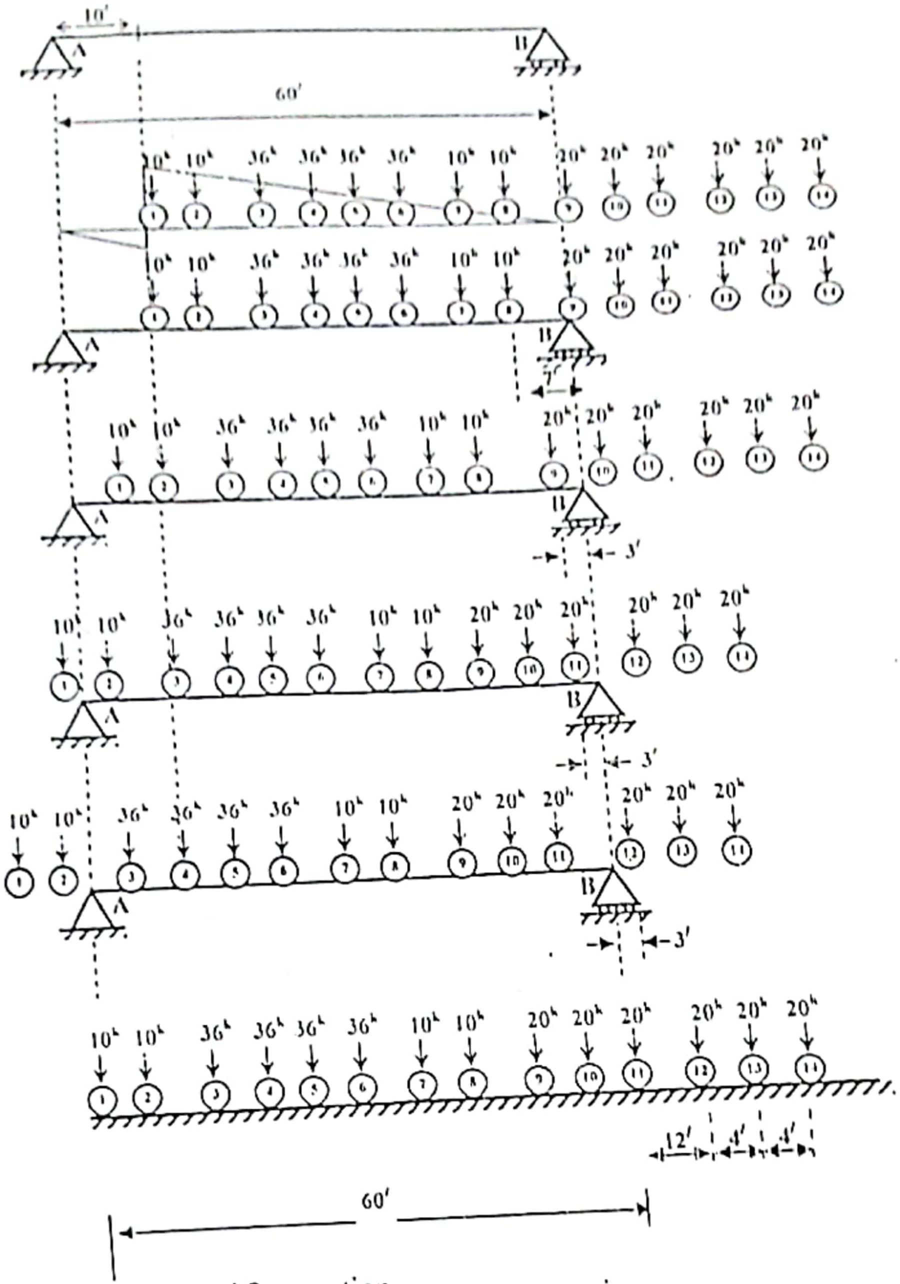
L = span length of the beam.

$W' = \sum P$ = the sum of all the loads which are on the span before movement and stay on during movement.

P = the load which enters in the span after the movement.

e= the distance of load P' from right support at B.





Wheel 1 at section to wheel 2 at section

$$\Delta V = \frac{\sum P d_1}{L} + \frac{P' d_2}{L} + \frac{P' e}{L} - P_1$$

$\sum P = 184k$, $d_1 = 5'$, $P' = 0.0$, $d_2 = 0.0$, $P' = 20k$, $e = 3$, $P_1 = 10k$

$$\Delta V = \frac{184\times5}{60} + \frac{0\times0}{60} + \frac{20\times3}{60} - 10 = 6.33 = \textit{an increase.}$$

Wheel 2 at section to wheel 3 at section

$\sum P = 194k$, $d_1 = 8'$, $P' = 10k$, $d_2 = 5$, $P' = 20k+20k=40k$, $e = (3+7)/2 = 5$, $P_1 = 10k$

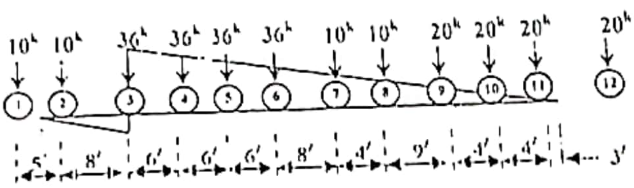
$$\Delta V = \frac{194\times8}{60} + \frac{10\times5}{60} + \frac{40\times5}{60} - 10 = 20.03 = \textit{an increase.}$$

Wheel 3 at section to wheel 4 at section

$\sum P = 224k$, $d_1 = 6'$, $P' = 10k$, $d_2 = 2$, $P' = 0$, $e = 0$, $P_1 = 36k$

$$\Delta V = \frac{224\times6}{60} + \frac{10\times2}{60} + \frac{0\times0}{60} - 36 = -13.27 = \textit{a decrease.}$$

Therefore, wheel 3 will produce maximum shear at the section.



$$V_{max} = \frac{0.9}{50}[3\times20+7\times20+11\times20+20\times10+24\times10+32\times36+38\times36+44\times36+50\times36] - \frac{0.1}{10}[2\times10]$$
$$= 121.752 - 0.2 = 121.552k$$

Criteria for the maximum moment at section of a simple beam subjected to series of concentrated loads move from right to left.

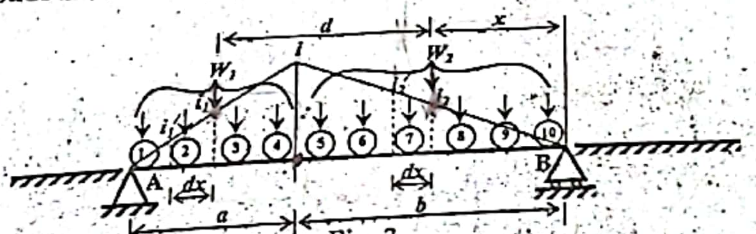


Fig. 3

Let, W_1 = load to the left of the section

W_2 = load to the right of the section

W = total load to the left of the section

i = ordinate of influence line for bending moment at the section

i_1, i_2 = are the ordinates of influence line for bending moment under load W_1 and W_2 before movement.

i_1', i_2' = are the ordinates of influence line for bending moment under load W_1 and W_2 after movement.

Considering the right side of the section as shown in Fig. 3

$$i_2 = \frac{x}{b}i, \quad i_2' = \frac{(x+dx)}{b}i,$$

Corresponding moment, $M_2 = i\frac{x}{b}W_2, \quad M_2' = i\frac{(x+dx)}{b}W_2$

Increase of moment in the right hand side, $\Delta M_2 = M_2' - M_2 = i\frac{W_2}{b}dx$

Considering the left side of the section

$$i_1 = \frac{(L-x-d)}{a}i, \quad i_1' = \frac{(L-x-d-dx)}{a}i,$$

Corresponding moment, $M_1 = i\frac{(L-x-d)}{a}W_1, \quad M_1' = i\frac{(L-x-d-dx)}{a}W_1$

Decrease of moment in the left hand side, $\Delta M_1 = M_1' - M_1 = -i\frac{W_1}{a}dx$

Net increase in moment, $dM = \Delta M_1 + \Delta M_2 = -i\frac{W_1}{a}dx + i\frac{W_2}{b}dx$

Therefore, $\frac{dM}{dx} = -i\frac{W_1}{a} + i\frac{W_2}{b}$

For maximum derivative of moment with respect x must be zero

or, $\frac{dM}{dx} = -i\frac{W_1}{a} + i\frac{W_2}{b} = 0,$ or, $\frac{W_1}{a} = \frac{W_2}{b} = \frac{W_1+W_2}{a+b} = \frac{W}{L}$

The maximum moment at a given section occurs when the intensity of loading on the left side of the section is equal to the intensity of loading on the span.

③ civil-16 series

Criteria for the absolute maximum moment of a simple beam subjected to series of concentrated moving loads.

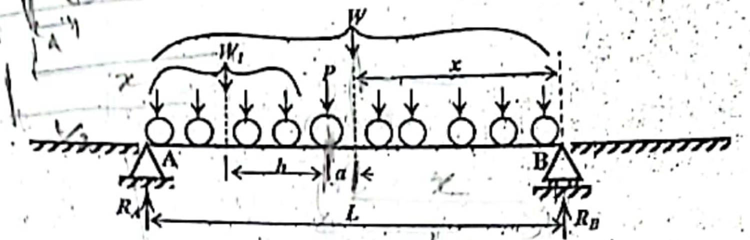


Fig. 4

Fig. 4 represent a simply supported beam subjected to move loads, where

- P = represent one of the loads on the loads under which the maximum moment will occur.
- W_1 = represent the sum of all the loads to the left of P.
- W = the sum of all the loads on the span.
- a = distance between the center of gravity of all the loads and P.
- b = distance between the center of gravity of the loads W_1 and P.
- L = span length of beam.
- R_A = reaction at A due to applied loading.
- R_B = reaction at B due to applied loading.
- x = distance of the center of gravity all the loads to the support B.

The expression of bending moment at the load P

$$M = R_A(L - a - x) - W_1 b$$

in which

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

Then

$$M = \frac{W}{L}(Lx - ax - x^2) - W_1 b$$

Differentiating with respect to x and equating to zero, then the equation takes the form,

$$\frac{dM}{dx} = \frac{W}{L}(L - a - 2x) = 0$$

or, $$x = \frac{L}{2} - \frac{a}{2}$$

Therefore, the maximum moment under any load will occur when that load and the center of gravity of all the loads on the beam are equidistant from the center of the beam.

Criteria for the maximum shear of a floor beam subjected to series of concentrated loads move from right to left.

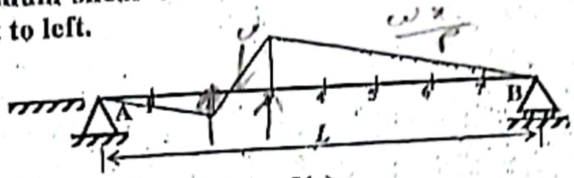


Fig. 5(a)

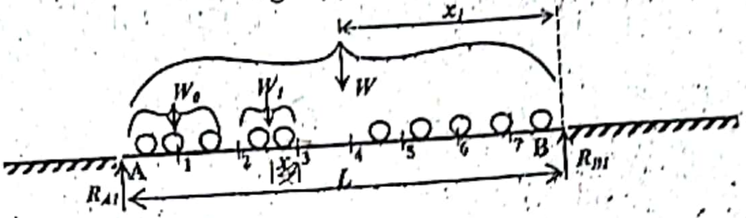


Fig. 5(b)

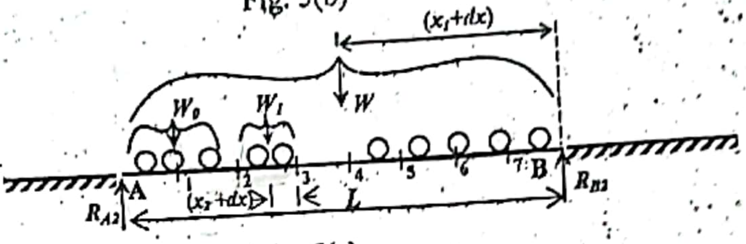
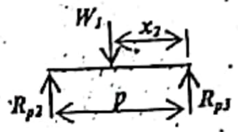


Fig. 5(c)

A simply supported floor beam subjected to moving concentrated loads is shown in Fig. 5. It is required to obtain the criteria for allocating the position of loads to find the maximum shear in a panel. Following notations are used:

W = the sum of all of the loads on the span.
W_o= the sum of all the loads to the left of the panel.
W_1= the sum of all the loads in the panel.
x_1 = the distance of the center of gravity all the loads (W) to right support B.
x_2 = the distance of the center of gravity all the loads within panel to right panel point.
L = span length of beam.

Before movement,



$$\sum M_B = Wx - R_{A1}L = 0;$$

or, $R_{A1} = \frac{Wx}{L}$

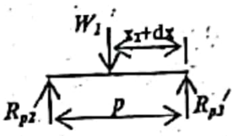
Also, reaction at panel point 2,

$$R_{p2} = \frac{W_1 x_2}{p}$$

Now, shear force within panel(2-3)

$$V_1 = R_{A1} - W_0 - R_{p2} = \frac{Wx}{L} - W_0 - \frac{W_1 x_2}{p} \quad (1)$$

After movement,



$$\sum M_B = W(x+dx) - R_{A1}L = 0;$$

or, $R_{A2} = \dfrac{W(x+dx)}{L}$

Also, reaction at panel point 2,

$$R'_{p1} = \frac{W_1(x_2+dx)}{p}$$

Now, shear force within panel(2-3)

$$V_2 = R_{A2} - W_0 - R'_{p1} = \frac{W(x+dx)}{L} - W_0 - \frac{W_1(x_2+dx)}{p} \quad (2)$$

The change in shear force within panel(2-3) can be obtained by using Eq. (1) and (2)

$$dV = V_2 - V_1 = \frac{W(x+dx)}{L} - W_0 - \frac{W_1(x_2+dx)}{p} - \frac{Wx}{L} + W_0 + \frac{W_1 x_2}{p}$$

or, $dV = V_2 - V_1 = \dfrac{Wdx}{L} - \dfrac{W_1 dx}{p} = 0$

or, $\dfrac{dV}{dx} = \dfrac{W}{L} - \dfrac{W_1}{p}$

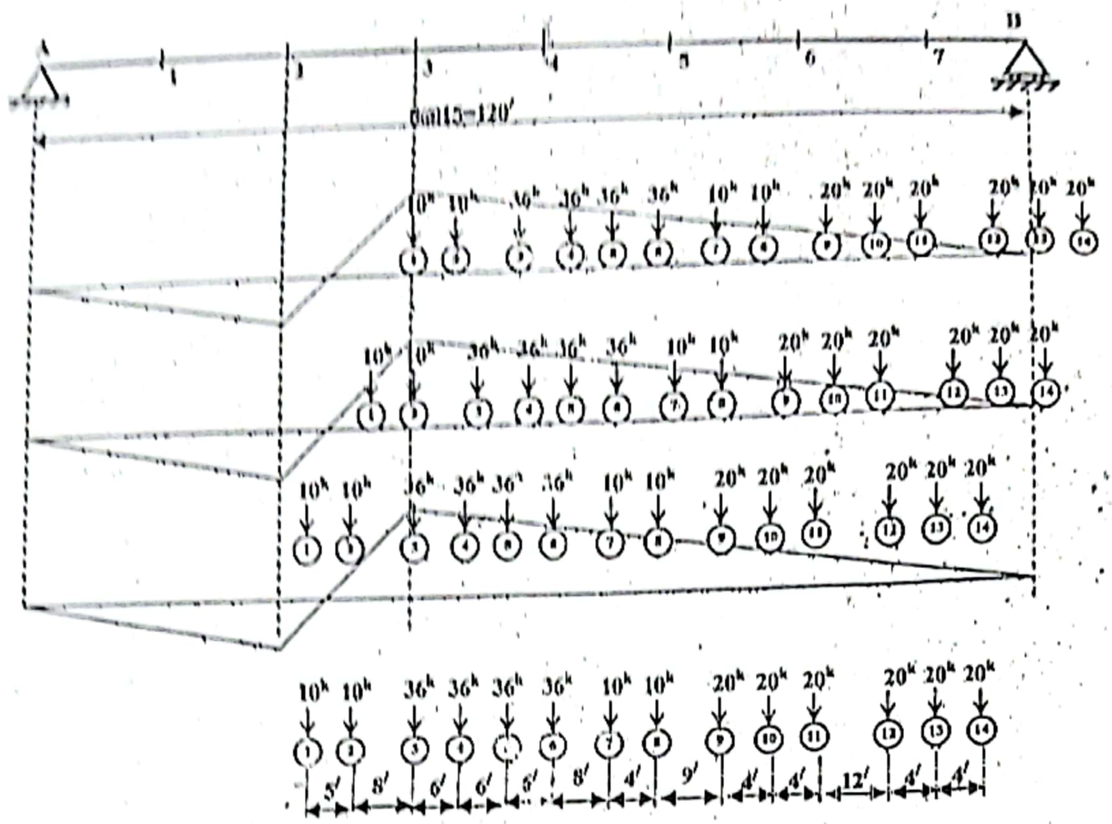
For the maximum value of shear force, the derivative of shear force with respect to x must be equal to zero. Therefore,

$$\frac{W}{L} - \frac{W_1}{p} = 0$$

or, $\dfrac{W}{L} = \dfrac{W_1}{p}$

Therefore, the maximum shear force will occur within panel when the average load in the panel is equal to average load in the span of the beam.

Example 3: Determine the maximum shear within panel 2-3 due to following moving wheel loads.



Wheel 1

To right of p.p. 3 $\frac{264}{120} > \frac{0}{15}$

To left of p.p. 3 $\frac{264}{120} > \frac{10}{15}$ Wheel 1 does not satisfy criterion.

Wheel 2

To right of p.p. 3 $\frac{284}{120} > \frac{10}{15}$

To left of p.p. 3 $\frac{284}{120} > \frac{20}{15}$ Wheel 2 does not satisfy criterion.

Wheel 2

To right of p.p. 3 $\frac{304}{120} > \frac{20}{15}$

To left of p.p. 3 $\frac{304}{120} < \frac{56}{15}$ Wheel 2 does satisfy criterion.

Alternately

Wheel 1

To right of p.p. 3 0

To left of p.p. 3 10 $\frac{264}{8} = 33$ *Does not satisfy.*

Wheel 2

To right of p.p. 3 10

To left of p.p. 3 20 $\frac{284}{8} = 35.5$ *Does not satisfy.*

Wheel 3

To right of p.p. 3 20 } $\frac{304}{8} = 38$ Satisfy.

To left of p.p. 3 50

Criteria for the maximum moment at any section of a compound beam subjected to series of concentrated loads move from right to left.

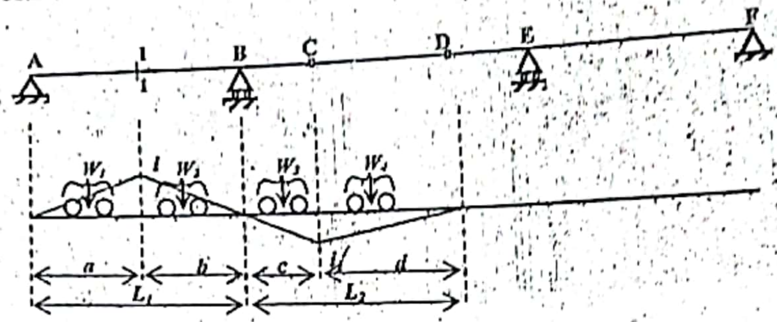


Fig. 6

A line diagram of balance cantilever bridge is shown in the above figure. It is required to obtain the criteria to determine the position moving concentrated loads and hence to find the maximum moment at a section 1-1. As the loads move from the right to left, the moment at section 1-1 will change. The change in moment may be calculated as:

The change in moment due to movement of loads in between A and B,

$$\Delta M_1 = -\frac{i}{a}W_1\Delta x + \frac{i}{b}W_2\Delta x$$

The change in moment due to movement of loads in between B and C,

$$\Delta M_2 = -\frac{i'}{d}W_4\Delta x + \frac{i'}{c}W_3\Delta x$$

The net change in moment,

$$\Delta M = \Delta M_1 + \Delta M_2 = -\frac{i}{a}W_1\Delta x + \frac{i}{b}W_2\Delta x - \frac{i'}{d}W_4\Delta x + \frac{i'}{c}W_3\Delta x \quad (1)$$

From influence line diagram,

$$\frac{i}{b} = \frac{i'}{c}$$

Therefore,

$$i' = \frac{c}{b}i$$

Substitute this value in Eq. (1), we have

$$\Delta M = i\left(\frac{W_2}{b} - \frac{W_1}{a}\right)\Delta x + \frac{c}{b}i\left(\frac{W_3}{c} - \frac{W_4}{d}\right)\Delta x \quad (2)$$

Finally the Eq. (2) can be expressed in differential form as:

$$\frac{dM}{dx} = i\left(\frac{W_2}{b} - \frac{W_1}{a}\right) + \frac{c}{b}i\left(\frac{W_3}{c} - \frac{W_4}{d}\right) \quad (3)$$

To obtain the maximum value of moment, Eq. (3) must be equal to zero. Therefore

$$i\left(\frac{W_2}{b}-\frac{W_1}{a}\right)+\frac{c}{b}i\left(\frac{W_3}{c}-\frac{W_4}{d}\right)=0$$

or, $$\left(\frac{W_2}{b}-\frac{W_1}{a}\right)+\frac{c}{b}\left(\frac{W_3}{c}-\frac{W_4}{d}\right)=0 \quad (4)$$

If there is no load in right side i.e. in between B and C then Eq. (4) takes the form as:

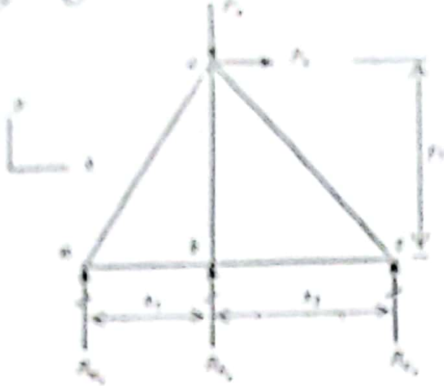
$$\frac{W_2}{b}-\frac{W_1}{a}=0$$

or, $$\frac{W_2}{b}=\frac{W_1}{a}=\frac{W_1+W_2}{a+b}=\frac{W}{L_1}$$

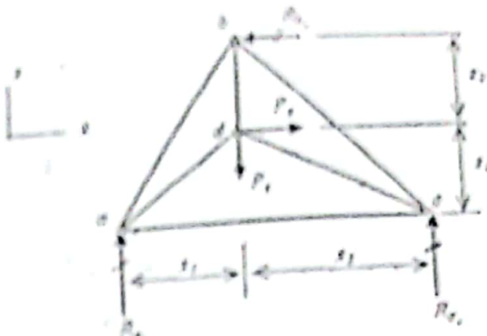
If there is no load in right side i.e. in between B and C then Eq. (4) takes the form as:

$$\frac{W_3}{c}-\frac{W_4}{d}=0$$

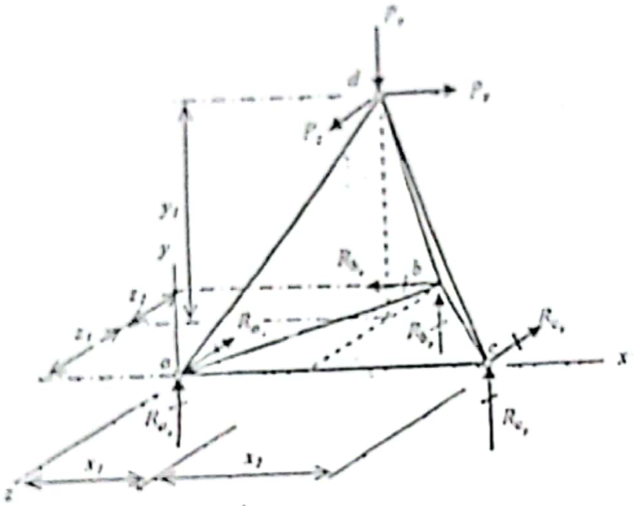
or, $$\frac{W_3}{c}=\frac{W_4}{d}=\frac{W_3+W_4}{c+d}=\frac{W'}{L_2}$$



Elevation



Top View



Typical diagram of space truss.

For three dimensional space trusses, six independent equations of static can be written as follows:

$$\sum F_x = 0, \quad \sum F_y = 0, \quad \sum F_z = 0, \quad \sum M_x = 0, \quad \sum M_y = 0, \quad \sum M_z = 0$$

A necessary (although not sufficient) condition for statical determination of three dimensional truss with respect to both inner and outer forces is that the total number of bars plus the total number of independent reaction components shall equal three times the number of joints.

In general

- $b + r < 3n$, the structure is unstable.
- $b + r = 3n$, the structure is statically determinate.
- $b + r > 3n$, the structure is indeterminate.

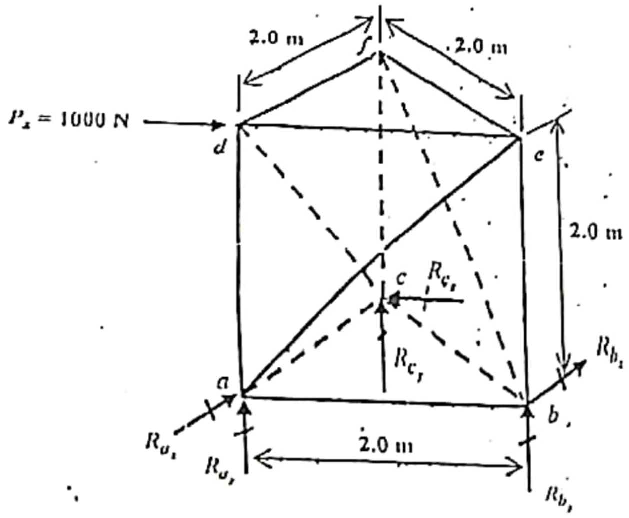
Special Theorems (Norris)

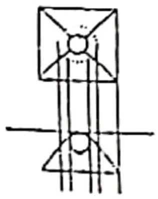
Theorem-1. If all the bars meeting at a joint, with the exception of one bar n, lie in a plane, the component normal to that plane of the force in bar n is equal to the component normal to that plane of any external load or loads applied at that joint.

On the basis of Theorem 1, two corollary theorems can be stated:

Theorem-2. If all the bars meeting at a joint, with the exception of one bar n, lie in a plane, and if no external load is applied at this joint, the force in bar n is equal to zero.

Theorem-3. If all but two bars at a joint having no bar force and these two are not collinear, and if no external loads acts at a joint, the bar force in each of these two bars is zero.





Criteria for the maximum shear of a floor beam subjected to series of concentrated loads move from right to left.

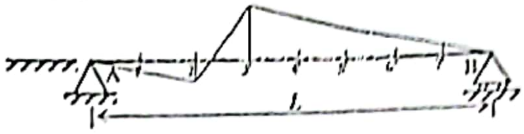


Fig. 5(a)

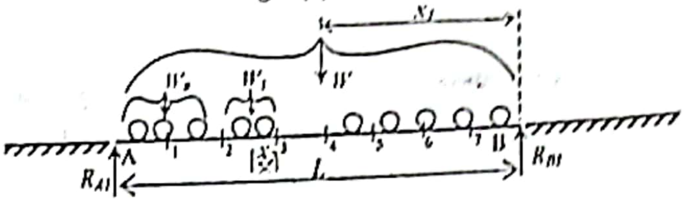


Fig. 5(b)

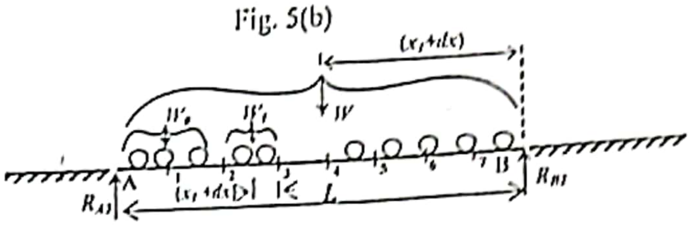
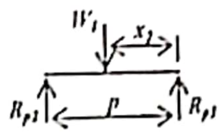


Fig. 5(c)

A simply supported floor beam subjected to moving concentrated loads is shown in Fig. 5. It is required to obtain the criteria for allocating the position of loads to find the maximum shear in a panel. Following notations are used:

W = the sum of all of the loads on the span.
W_o = the sum of all the loads to the left of the panel.
W_l = the sum of all the loads in the panel.
x_l = the distance of the center of gravity all the loads (W) to right support B.
x_2 = the distance of the center of gravity all the loads within panel to right panel point.
L = span length of beam.

Before movement,



$$\sum M_B = Wx_l - R_{Al}L = 0;$$

or, $R_{Al} = \frac{Wx_l}{L}$

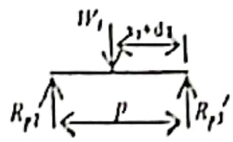
Also, reaction at panel point 2,

$$R_{p2} = \frac{W_1 x_2}{p}$$

Now, shear force within panel(2-3)

$$V_1 = R_{Al} - W_o - R_{p2} = \frac{Wx_l}{L} - W_o - \frac{W_1 x_2}{p} \qquad (1)$$

After movement,



$$\sum M_B = W(x + dx) - R_{Al}L = 0;$$

or, $R_{A1} = \frac{W(x_1 + dx)}{L}$

Also, reaction at panel point 2,

$$R'_{r1} = \frac{W_1(x_2 + dx)}{p}$$

Now, shear force within panel(2-3)

$$V_2 = R_{A1} - W_0 - R'_{r1} = \frac{W(x + dx)}{L} - W_0 - \frac{W_1(x_2 + dx)}{p} \quad (2)$$

The change in shear force within panel(2-3) can be obtained by using Eq. (1) and (2)

$$dV = V_2 - V_1 = \frac{W(x + dx)}{L} - W_0 - \frac{W_1(x_2 + dx)}{p} - \frac{Wx}{L} + W_0 + \frac{W_1 x_2}{p}$$

$$\text{or, } dV = V_2 - V_1 = \frac{W dx}{L} - \frac{W_1 dx}{p} = 0$$

For the maximum value of shear force, the derivative of shear force with respect to x must be equal to zero. Therefore,

$$\frac{W}{L} - \frac{W_1}{p} = 0$$

$$\text{or, } \frac{W}{L} = \frac{W_1}{p}$$

Therefore, the maximum shear force will occur within panel whe[n the average] load in the panel is equal to average load in the span of the beam.

Criteria for the maximum moment at any section of a compound beam subjected to series of concentrated loads move from right to left.

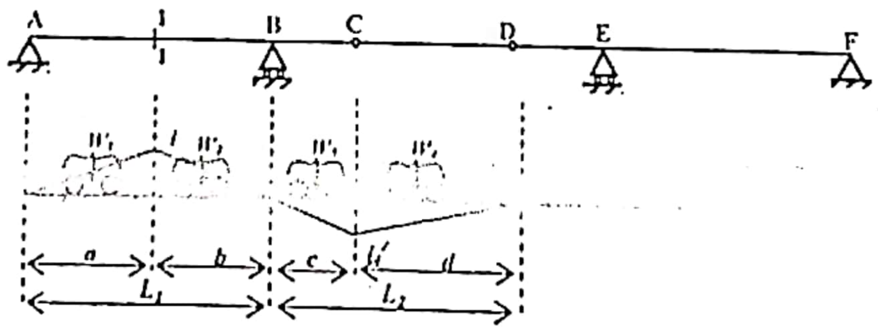


Fig. 6

A line diagram of balance cantilever bridge is shown in the above figure. It is required to obtain the criteria to determine the position moving concentrated loads and hence to find the maximum moment at a section 1-1. As the loads move from the right to left, the moment at section 1-1 will change. The change in moment may be calculated as:

...e change in moment due to movement of loads in between A and B,

$$\Delta M_1 = -\frac{i}{a}W_1\Delta x + \frac{i}{b}W_2\Delta x$$

The change in moment due to movement of loads in between B and C,

$$\Delta M_2 = -\frac{i'}{d}W_4\Delta x + \frac{i'}{c}W_3\Delta x$$

The net change in moment,

$$\Delta M = \Delta M_1 + \Delta M_2 = -\frac{i}{a}W_1\Delta x + \frac{i}{b}W_2\Delta x - \frac{i'}{d}W_4\Delta x + \frac{i'}{c}W_3\Delta x \quad (1)$$

From influence line diagram,

$$\frac{i}{b} = \frac{i'}{c}$$

Therefore,

$$i' = \frac{c}{b}i$$

Substitute this value in Eq. (1), we have

$$\Delta M = i\left(\frac{W_2}{b} - \frac{W_1}{a}\right)\Delta x + \frac{c}{b}i\left(\frac{W_3}{c} - \frac{W_4}{d}\right)\Delta x \quad (2)$$

Finally the Eq. (2) can be expressed in differential form as:

$$\frac{dM}{dx} = i\left(\frac{W_2}{b} - \frac{W_1}{a}\right) + \frac{c}{b}i\left(\frac{W_3}{c} - \frac{W_4}{d}\right) \quad (3)$$

To obtain the maximum value of moment, Eq. (3) must be equal to zero. Therefore

$$i\left(\frac{W_2}{b} - \frac{W_1}{a}\right) + \frac{c}{b}i\left(\frac{W_3}{c} - \frac{W_4}{d}\right) = 0$$

or, $$\left(\frac{W_2}{b} - \frac{W_1}{a}\right) + \frac{c}{b}\left(\frac{W_3}{c} - \frac{W_4}{d}\right) = 0 \quad (4)$$

If there is no load in right side i.e. in between B and C then Eq. (4) takes the form as:

$$\frac{W_2}{b} - \frac{W_1}{a} = 0$$

or, $$\frac{W_2}{b} = \frac{W_1}{a} = \frac{W_1 + W_2}{a+b} = \frac{W}{L_1}$$

If there is no load in right side i.e. in between B and C then Eq. (4) takes the form as:

$$\frac{W_3}{c} - \frac{W_4}{d} = 0$$

or, $$\frac{W_3}{c} = \frac{W_4}{d} = \frac{W_3 + W_4}{c+d} = \frac{W'}{L_2}$$

Criteria for the maximum shear of a floor beam subjected to series of concentrated loads move from right to left.

Or, $R_{A2} = \dfrac{W(x+dx)}{L}$

Also, reaction at panel point 2,

$$R'_{P2} = \frac{W_1(x_2+dx)}{p}$$

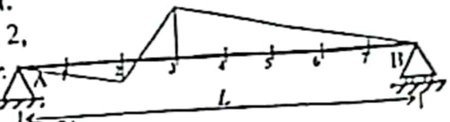
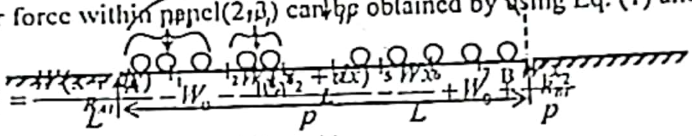


Fig. 5(a)

Now, shear force within panel(2-3)

$$V_2 = R_{A2} - W_0 - R'_{P2} = \frac{W(x+dx)}{L} - W_0 - \frac{W_1(x_2+dx)}{p} \qquad (2)$$

The change in shear force within panel(2-3) can be obtained by using Eq. (1) and (2)

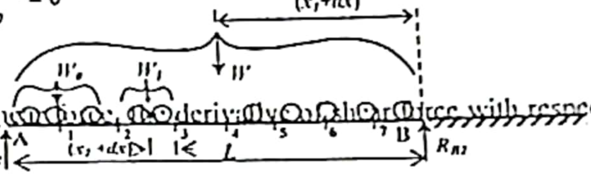


$$dV = V_2 - V_1 = \frac{W(x+dx)}{L} - W_0 - \frac{W_1(x_2+dx)}{p} - \frac{Wx}{L} + W_0 + \frac{W_1x_2}{p}$$

Fig. 5(b)

or, $dV = V_2 - V_1 = \dfrac{Wdx}{L} - \dfrac{W_1dx}{p} = 0$

or, $\dfrac{dV}{dx} = \dfrac{W}{L} - \dfrac{W_1}{p}$



For the maximum value of shear force, derivative of shear force with respect to x must be equal to zero. Therefore,

$$\frac{W}{L} - \frac{W_1}{p} = 0$$

Fig. 5(c)

or, $\dfrac{W}{L} = \dfrac{W_1}{p}$

Therefore, the maximum shear force will occur within panel when the average load in the panel is equal to average load in the span of the beam.

A simply supported floor beam subjected to moving concentrated loads is shown in Fig. 5. It is required to obtain the criteria for allocating the position of loads to find the maximum shear in a panel. Following notations are used:

W = the sum of all of the loads on the span.

W_0 = the sum of all the loads to the left of the panel.

W_1 = the sum of all the loads in the panel.

x = the distance of the center of gravity all the loads (W) to right support B.

x_2 = the distance of the center of gravity all the loads within panel to right panel point.

L = span length of beam.

Criteria for the maximum moment at any section of a compound beam subjected to series of concentrated loads move from right to left.

Before movement,

$$\sum M_B = Wx - R_{A1}L = 0;$$

or, $R_{A1} = \dfrac{Wx}{L}$

Also, reaction at panel point 2,

$$R_{P2} = \frac{W_1x_2}{p}$$

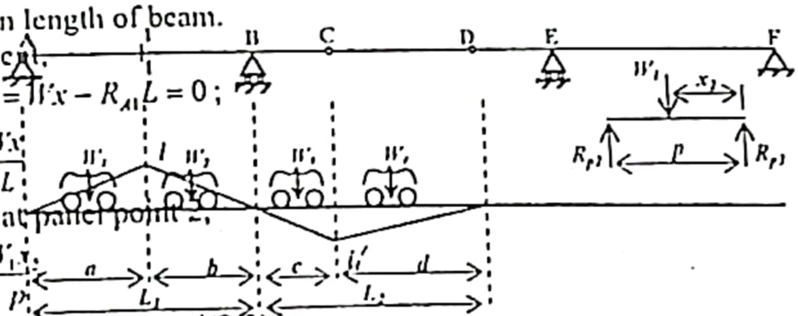


Fig. 6

Now, shear force within panel(2-3)

$$V_1 = R_{A1} - W_0 - R_{P2} = \frac{Wx}{L} - W_0 - \frac{W_1x_2}{p} \qquad (1)$$

After movement,

$$\sum M_B = W(x+dx) - R_{A2}L = 0;$$

A line diagram of balance cantilever bridge is shown in the above figure. It is required to obtain the criteria to determine the position moving concentrated loads and hence to find the maximum moment at a section 1-1. As the loads move from the right to left, the moment at section 1-1 will change. The change in moment may be calculated as:

Derivation of criteria to obtain the location of wheel for the maximum tension in the diagonal member of non-parallel chorded truss.

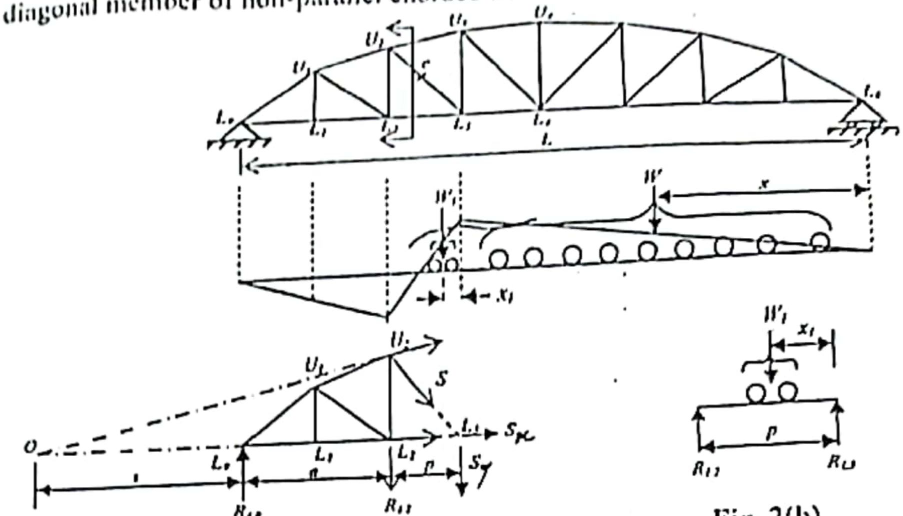


Fig. 2(a)

Fig. 2(b)

Considering the left of section 1-1

Before movement

Reaction at left support, $R_{L01} = \frac{Wx}{L}$, Reaction at panel point L_2, $R_{L21} = \frac{W_1 x_1}{p}$

The vertical component of member force S_{y1} of the member U_2L_3 is obtained by taking moment about O,

$$\sum M_O = 0$$

$$S_{y1}(s+a+p) - \frac{Wx}{L} \times s + \frac{W_1 x_1}{p}(s+a) = 0$$

$$S_{y1} = \frac{Wx}{L}\frac{s}{(s+a+p)} - \frac{W_1 x_1}{p}\frac{(s+a)}{(s+a+p)} \qquad \text{(i)}$$

After movement

Reaction at left support, $R_{L02} = \frac{W(x+dx)}{L}$, Reaction at panel point L_2, $R_{L22} = \frac{W_1(x_1+dx)}{p}$

The vertical component of member force S_{y2} of the member U_2L_3 is obtained by taking moment about O,

$$\sum M_O = 0;$$

$$S_{y2}(s+a+p) - \frac{W(x+dx)}{L} \times s + \frac{W_1(x_1+dx)}{p}(s+a) = 0$$

$$S_{y2} = \frac{W(x+dx)}{L}\frac{s}{(s+a+p)} - \frac{W_1(x_1+dx)}{p}\frac{(s+a)}{(s+a+p)} \qquad \text{(ii)}$$

Subtracting Eq. (i) from Eq. (ii), we have

$$d_u = S_{y2} - S_{y1} = \frac{Wdx}{L}\frac{s}{(s+a+p)} - \frac{W_1 dx}{p}\frac{(s+a)}{(s+a+p)}$$

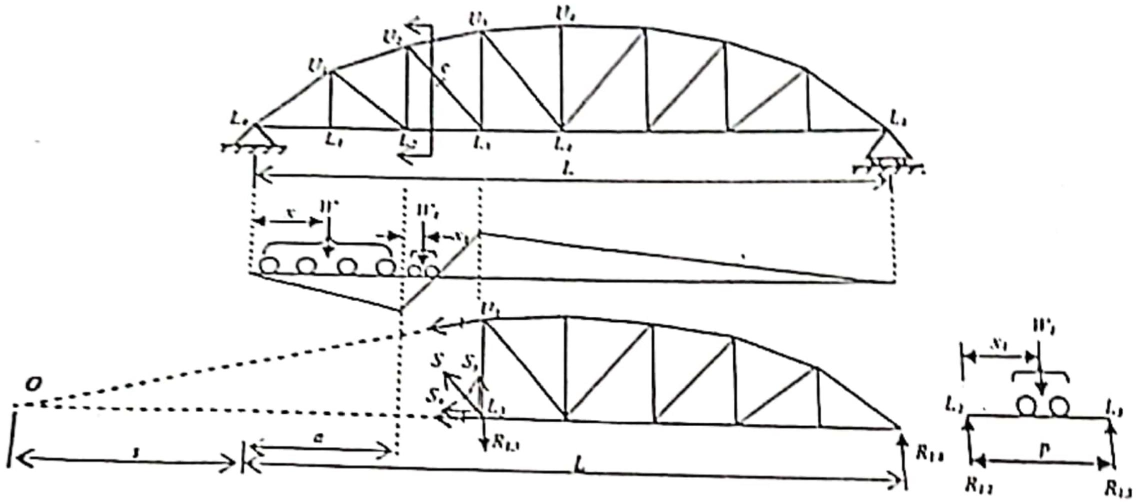
$$\frac{d_{s}}{dx} = \frac{W}{L}\frac{s}{(s+a+p)} - \frac{W_1}{p}\frac{(s+a)}{(s+a+p)} \qquad \text{(iii)}$$

Minimizing Eq. (iii) as $\frac{d_{sv}}{dx} = 0$

$$\frac{W}{L} = \frac{W_1}{p}\frac{(s+a)}{s} \qquad \text{(iv)}$$

Eq. (iv) is the criteria for the maximum positive stress in the diagonal member of truss with non-parallel chord.

Derivation of criteria for maximum negative stress in a diagonal member.



Considering the right of section 1-1

Before movement

Reaction at right support, $R_{L81} = \frac{Wx}{L}$, Reaction at panel point L_3, $R_{L31} = \frac{W_1 x_1}{p}$

The vertical component of member force S_{y1} of the member U_2L_3 is obtained by taking moment about O,

$$\sum M_O = 0$$

$$S_{v1}(s+a+p) - \frac{Wx}{L}\times(s+L) + \frac{W_1 x_1}{p}(s+a+p) = 0$$

$$S_{v1} = \frac{Wx}{L}\frac{(s+L)}{(s+a+p)} - \frac{W_1 x_1}{p} \qquad \text{(i)}$$

After movement

Reaction at right support, $R_{L82} = \frac{W(x+dx)}{L}$, Reaction at panel point L_3, $R_{L32} = \frac{W_1(x_1+dx)}{p}$

The vertical component of member force S_{y2} of the member U_2L_3 is obtained by taking moment about O,

$$\sum M_O = 0;$$

$$S_{vf}(s+a+p) - \frac{W(x+dx)}{L} \times (s+L) + \frac{W_1(x_1+dx)}{p}(s+a+p) = 0$$

$$S_{vf} = \frac{W(x+dx)}{L}\frac{(s+L)}{(s+a+p)} - \frac{W_1(x_1+dx)}{p} \qquad \text{(ii)}$$

Subtracting Eq. (i) from Eq. (ii), we have

$$d_s = S_{vf} - S_{vi} = \frac{W}{L}\frac{(s+L)}{(s+a+p)}dx - \frac{W_1}{p}dx$$

$$\frac{dS_v}{dx} = \frac{W}{L}\frac{(s+L)}{(s+a+p)} - \frac{W_1}{p} = 0 \qquad \text{(iii)}$$

$$\therefore \quad \frac{W}{L} = \frac{W_1}{p}\frac{(s+a+p)}{(s+L)} \qquad \text{(iv)}$$

Derivation of criteria to obtain the location of wheel for the maximum tension in the diagonal member of non-parallel chorded truss.

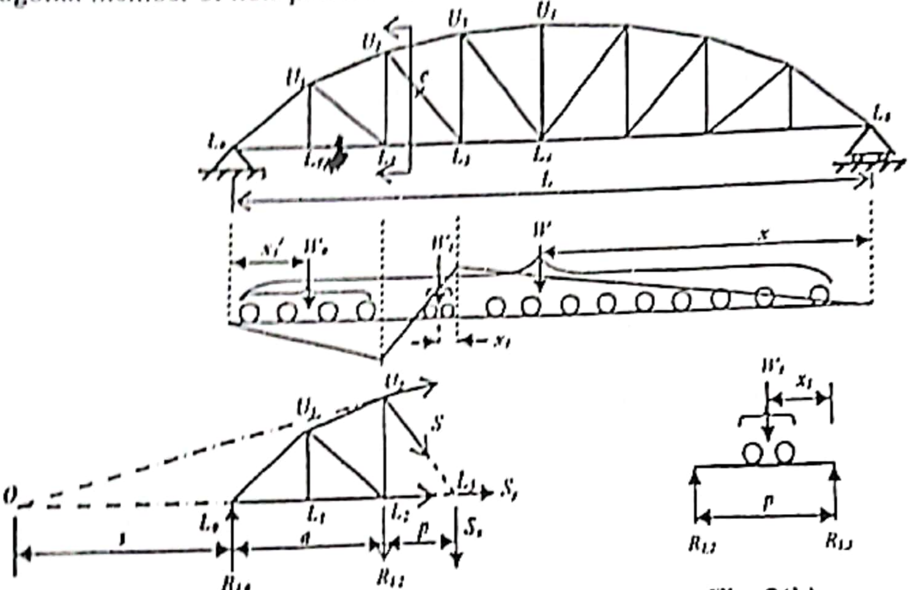


Fig. 2(a)

Fig. 2(b)

Considering the left of section 1-1

Before movement

Reaction at left support, $R_{L0i} = \frac{Wx}{L}$, Reaction at panel point L_2, $R_{L2i} = \frac{W'_1 x_1}{p}$

The vertical component of member force S_{vi} of the member U_2L_3 is obtained by taking moment about O.

$$\sum M_O = 0$$

$$S_{vi}(s+a+p) - \frac{Wx}{L} \times s + \frac{W'_1 x_1}{p}(s+a) + W'_0(s+x'_1) = 0$$

$$S_{vi} = \frac{Wx}{L}\frac{s}{(s+a+p)} - \frac{W'_1 x_1}{p}\frac{(s+a)}{(s+a+p)} - W'_0\frac{(s+x'_1)}{(s+a+p)} \qquad \text{(i)}$$

After movement

Reaction at left support, $R_{L02} = \dfrac{W(x+dx)}{L}$, Reaction at panel point L_2, $R_{L22} = \dfrac{W_1(x_1+dx)}{p}$

The vertical component of member force S_{y2} of the member U_2L_3 is obtained by taking moment about O,

$$\sum M_O = 0;$$

$$S_{y2}(s+a+p) - \frac{W(x+dx)}{L} \times s + \frac{W_1(x_1+dx)}{p}(s+a) + W_0(s+x_1'-dx) = 0$$

$$S_{y2} = \frac{W(x+dx)}{L}\frac{s}{(s+a+p)} - \frac{W_1(x_1+dx)}{p}\frac{(s+a)}{(s+a+p)} - W_0\frac{(s+x_1'-dx)}{(s+a+p)} \qquad \text{(ii)}$$

Subtracting Eq. (i) from Eq. (ii), we have

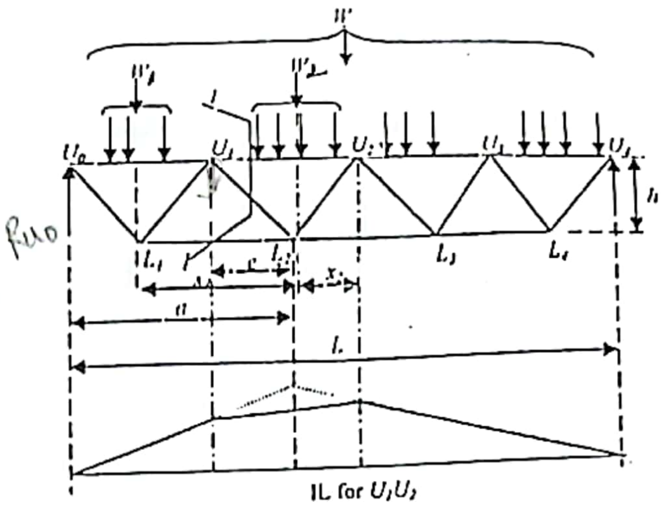
$$d_{S_y} = S_{y2} - S_{y1} = \left[\frac{W}{L}\frac{s}{(s+a+p)} + \frac{W_0}{(s+a+p)} - \frac{W_1}{p}\frac{(s+a)}{(s+a+p)}\right]dx$$

$$\frac{d_{S_y}}{dx} = \left[\frac{W}{L}\frac{s}{(s+a+p)} + \frac{W_0}{(s+a+p)} - \frac{W_1}{p}\frac{(s+a)}{(s+a+p)}\right] = 0$$

$$\therefore \quad \frac{W}{L} + \frac{W_0}{s} = \frac{W_1}{p}\frac{(s+a)}{s} \qquad \text{(iii)}$$

Eq. (iv) is the criteria for the maximum positive stress [illegible] the diagonal member of truss with non-parallel chord.

Criteria for truss without vertical chord



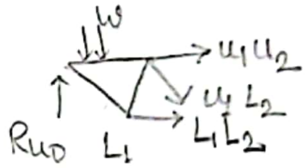
Before movement

$$R_{U_0} = \frac{Wx}{L};$$

$$\sum M_{L_2} = 0;$$

$$R_{U_0} a - W_1 x_1 - \frac{W_2 x_2}{p} e - S_1 h = 0$$

$$S_1 = \frac{Wx}{L}\frac{a}{h} - W_1\frac{x_1}{h} - \frac{W_2 x_2}{p}\frac{e}{h} \qquad \text{(i)}$$



After movement

$$R_{U_0} = \frac{W(x+dx)}{L};$$

$$\sum M_{L_2} = 0;$$

$$R_{U_0} a - W_1(x_1 + dx) - \frac{W_2(x_2 + dx)}{p} e - S_2 h = 0$$

$$S_2 = \frac{W(x+dx)}{L}\frac{a}{h} - \frac{W_1(x_1 + dx)}{h} - \frac{W_2(x_2 + dx)}{p}\frac{e}{h} \qquad \text{(ii)}$$

Subtracting Eq. (i) from Eq. (ii), we have

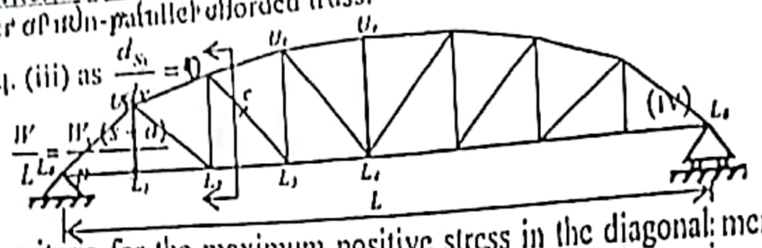
$$ds = S_2 - S_1 = \left[\frac{W}{L}\frac{a}{h} - \frac{W_1}{h} - \frac{W_2}{p}\frac{e}{h}\right]dx$$

$$\frac{ds}{dx} = \left[\frac{W}{L}\frac{a}{h} - \frac{W_1}{h} - \frac{W_2}{p}\frac{e}{h}\right] = 0$$

$$\frac{W}{L} = \frac{W_1 + \frac{W_2 e}{p}}{a} = \frac{W_1 + \frac{W_2}{2}}{a} \qquad \left(\text{when } e = \frac{p}{2}\right)$$

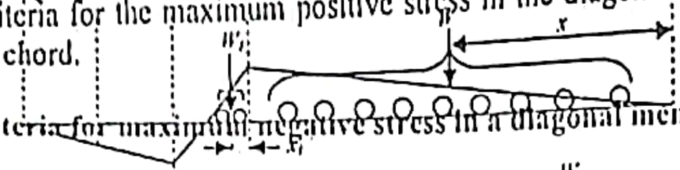
Derivation of criteria to obtain the location of wheel for the maximum tension in the diagonal member of non-parallel chorded truss.

Minimizing Eq. (iii) as $\frac{d_{s}}{dx} = 0$



$\frac{W}{L} = \frac{W_1(s+a)}{p}$ (iv)

Eq. (iv) is the criteria for the maximum positive stress in the diagonal member of truss with non-parallel chord.



Derivation of criteria for maximum negative stress in a diagonal member.

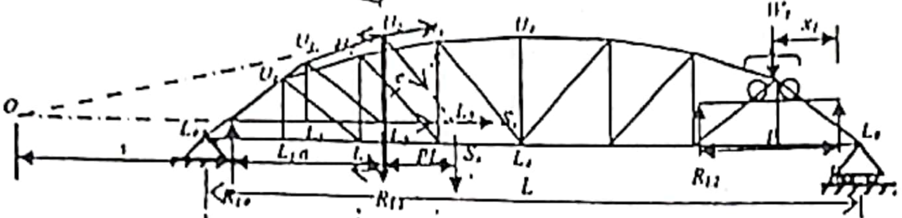


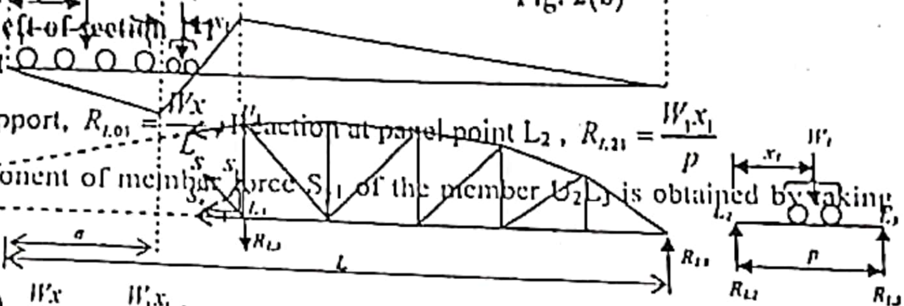
Fig. 2(a) Fig. 2(b)

Considering the left of section 1-1

Before movement

Reaction at left support, $R_{L01} = \frac{Wx}{L}$, Reaction at panel point L_2, $R_{L21} = \frac{W_1x_1}{p}$

The vertical component of member force S_{y1} of the member U_2L_3 is obtained by taking moment about O.



$\sum M_O = 0$

$S_{y1}(s+a+p) - \frac{Wx}{L} \times s + \frac{W_1x_1}{p}(s+a) = 0$

Considering the right of section 1-1

Before movement

$S_{y1} = \frac{Wx}{L}\frac{s}{(s+a+p)} - \frac{W_1x_1}{p}\frac{(s+a)}{(s+a+p)}$ (i)

After movement

Reaction at right support, $R_{L81} = \frac{Wx}{L}$, Reaction at panel point L_3, $R_{L31} = \frac{W_1x_1}{p}$

Reaction at left support, $R_{L02} = \frac{W(x+dx)}{L}$, Reaction at panel point L_2, $R_{L22} = \frac{W_1(x_1+dx)}{p}$

The vertical component of member force S_{y1} of the member U_2L_3 is obtained by taking moment about O.

The vertical component of member force S_{y2} of the member U_2L_3 is obtained by taking moment about O.

$\sum M_O = 0$

$S_{y1}(s+a+p) - \frac{Wx}{L} \times (s+L) + \frac{W_1x_1}{p}(s+a+p) = 0$

$S_{y2}(s+a+p) - \frac{W(x+dx)}{L} s + \frac{W_1(x_1+dx)}{p}(s+a) = 0$

$S_{y1} = \frac{Wx}{L}\frac{(s+L)}{(s+a+p)} - \frac{W_1x_1}{p}$ (i)

After movement

$S_{y2} = \frac{W(x+dx)}{L}\frac{s}{(s+a+p)} - \frac{W_1(x_1+dx)}{p}\frac{(s+a)}{(s+a+p)}$ (ii)

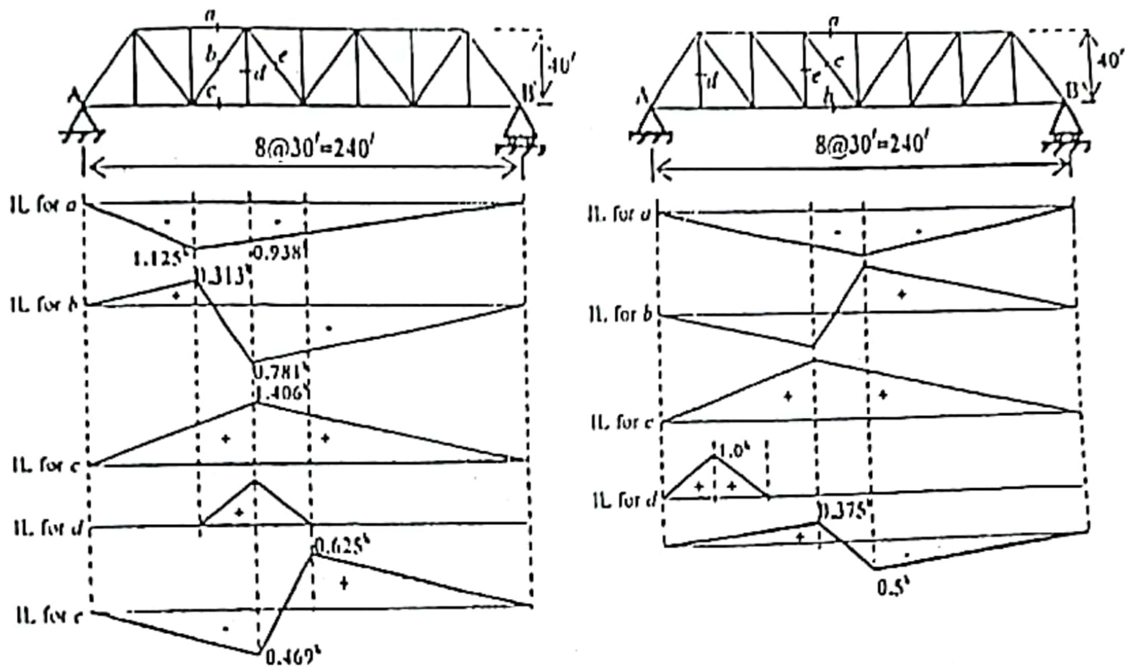
Subtracting Eq. (i) from Eq. (ii), we have

Reaction at right support, $R_{L82} = \frac{W(x+dx)}{L}$, Reaction at panel point L_3, $R_{L32} = \frac{W_1(x_1+dx)}{p}$

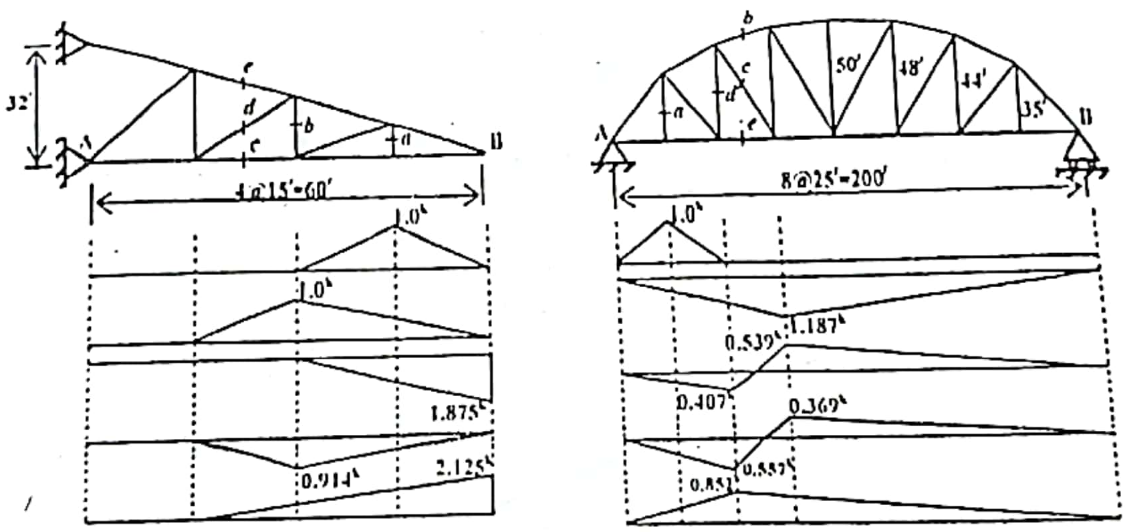
$\frac{W\,dx}{L}\frac{s}{(s+a+p)} - \frac{W_1\,dx}{p}\frac{(s+a)}{(s+a+p)}$

The vertical component of member force S_{y2} of the member U_2L_3 is obtained by taking moment about O.

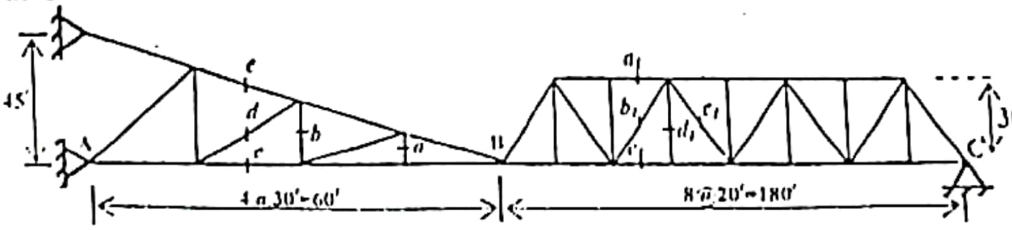
Q.1. As a unit load moves from A to B, draw influence line diagrams for stress in members a, b, c, d and e of the following trusses.



Q.2. As a unit load moves from A to B, draw influence line diagrams for stress in members a, b, c, d and e of the following trusses.



Q.3. As a unit load moves from A to C, draw influence line diagrams for stress in members a, b, c, d, e, a_1, b_1, c_1, d_1, and e_1 of the following truss. Assume support at C as a roller.



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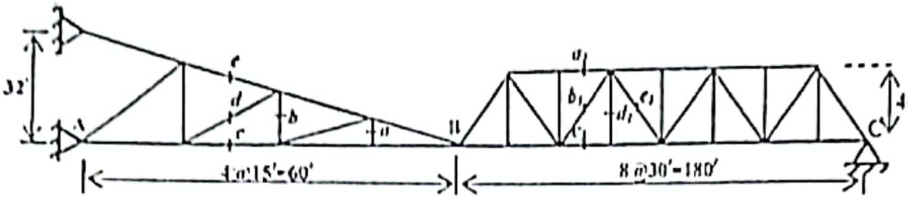
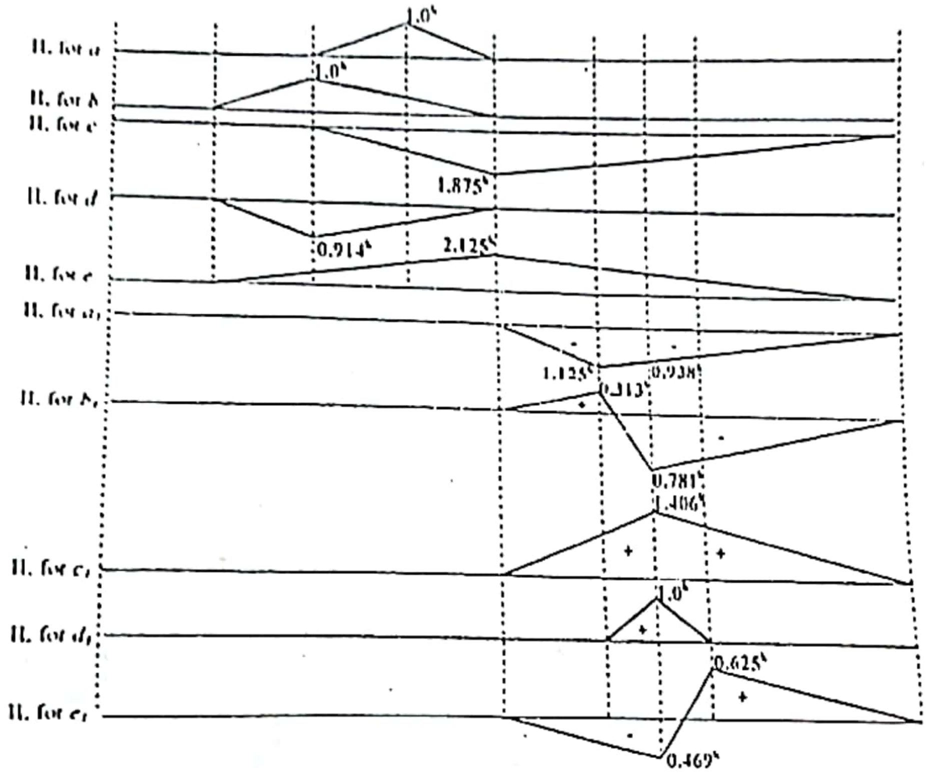
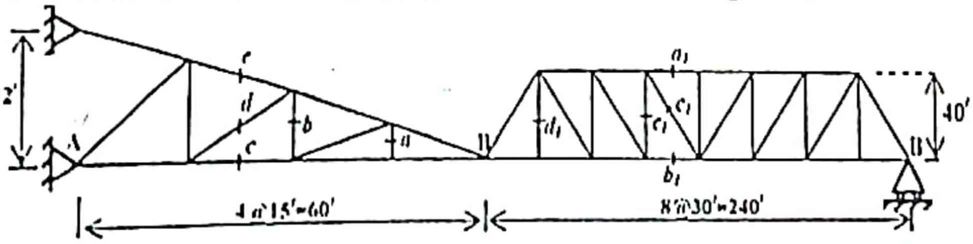
Q.4. As a unit load moves from A to B, draw influence line diagrams for stress in members a, b, c, d, e, a_1, b_1, c_1, d_1, and e_1 of the following trusses. Assume support at C as a roller.

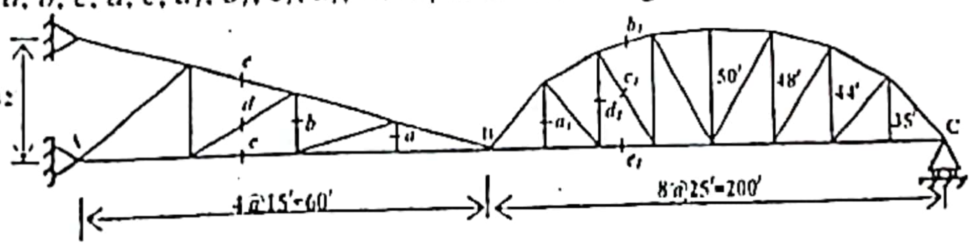




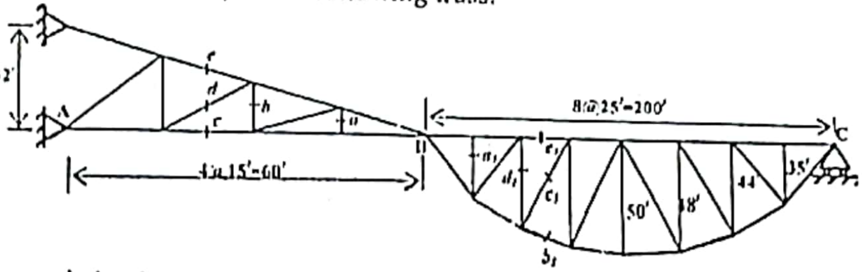
Q.5. As a unit load moves from A to C, draw influence line diagrams for stress in members a, b, c, d, e, a_1, b_1, c_1, d_1, and e_1 of the following truss.



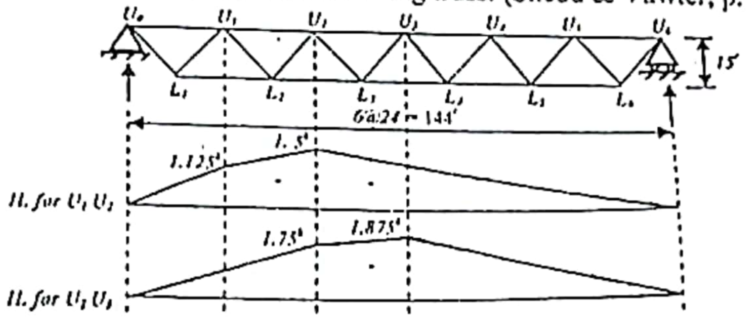
Q.6. As a unit load moves from A to C, draw influence line diagrams for stress in members a, b, c, d, e, a_1, b_1, c_1, d_1, and e_1 of the following truss.



Q.7. As a unit load moves from A to C, draw influence line diagrams for stress in members a, b, c, d, e, a_1, b_1, c_1, d_1, and e_1 of the following truss.



Q.7. As a unit load moves from U_0 to U_6, draw influence line diagrams for stress in members U_1U_2 and U_2U_3 of the following truss. (Shedd & Vawter, p. 277)



Subdivided Trusses:

Q.8. As a unit load moves from U_0 to U_{16}, draw influence line diagrams for stress in members L_4L_5, U_4U_6, U_4M_5, M_5L_6, U_6L_6, U_5M_5, and M_5U_6 of the following truss. (Shedd & Vawter, p. 280)