1.

a-(iii)

b- (iii)

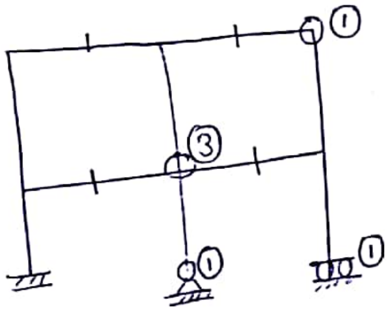
c-(iv)

d-(iv)

e-(iii)

f-(i)

2.



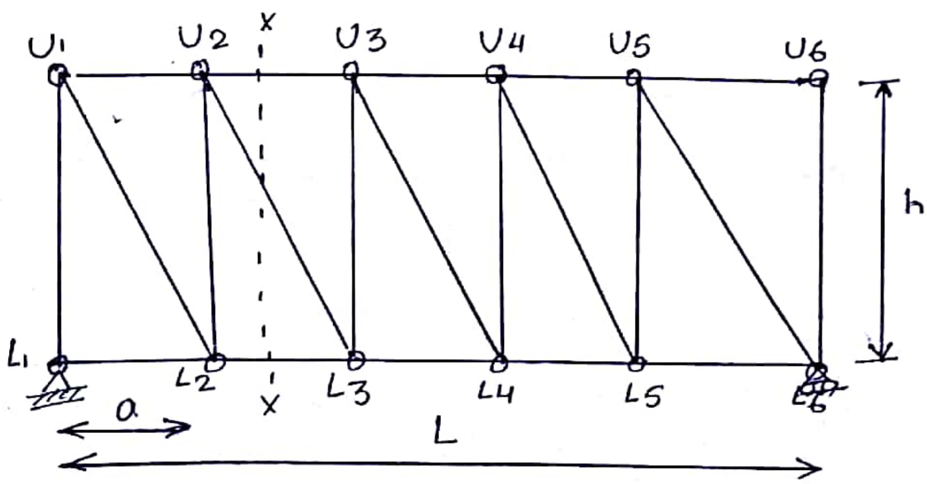
$= 3C - Re$

$= (3 \times 4) - (2) - 1 - 3$

$= 12 - 6$

$= 6$

3)



Case-I when unit load is in zone-I

$\Sigma F_x = 0$, $H_1 = 0$

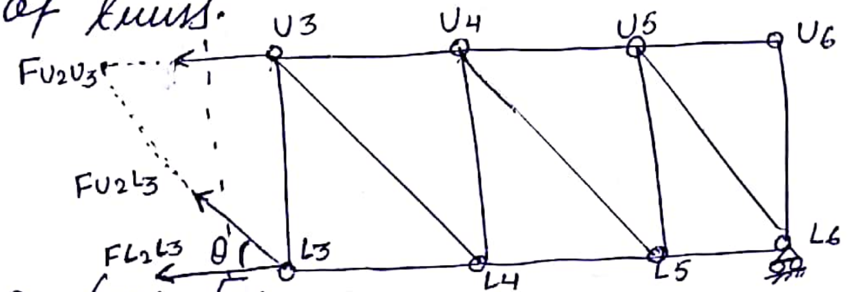
$\Sigma F_y = 0$, $R_1 + R_6 = 1$

also $\Sigma M_6 = 0$

$(R_1 \times L) - 1(L - x) = 0$

$R_1 = \frac{L-x}{L} = \frac{(5a-x)}{5a}$ (linear)

Since unit load is in zone-1, consider right portion of truss.



ILD for $F_{U_2U_3}$

To find $F_{U_2U_3}$ take $\Sigma M_{L_3} = 0$

$-[R_6 \times (L_3L_6)] - F_{U_2U_3} \times h = 0$

$F_{U_2U_3} = -R_6 \times \frac{(L_3L_6)}{h}$

$= -\left(\frac{x}{5a}\right) \times \frac{3a}{h}$

$$\boxed{F_{U_2U_3} = -\frac{3x}{5h}}$$

if unit load at L_1 i.e $x=0$ then $F_{U_2U_3} = 0$

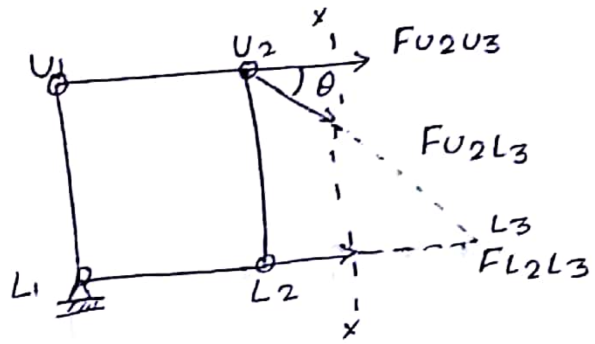
if unit load at $x=a$ then $F_{U_2U_3} = -\frac{3a}{5h}$ [compression]

Case-2. when unit load is in zone-3

$R_1 + R_6 = 1$

$\Sigma M_6 = 0 \Rightarrow (R_1 \times (5a)) - 1(5a - x) = 0$

$R_1 = \left(\frac{5a - x}{5a}\right)$



To find F_{U2U3} take

$\Sigma M_{L3} = 0$

$(R_1 \times 2a) + (F_{U2U3} \times (h)) = 0$

$F_{U2U3} = -\frac{R_1 \times 2a}{h}$

$= -\left(\frac{5a - x}{5a}\right) \times \frac{2a}{h}$

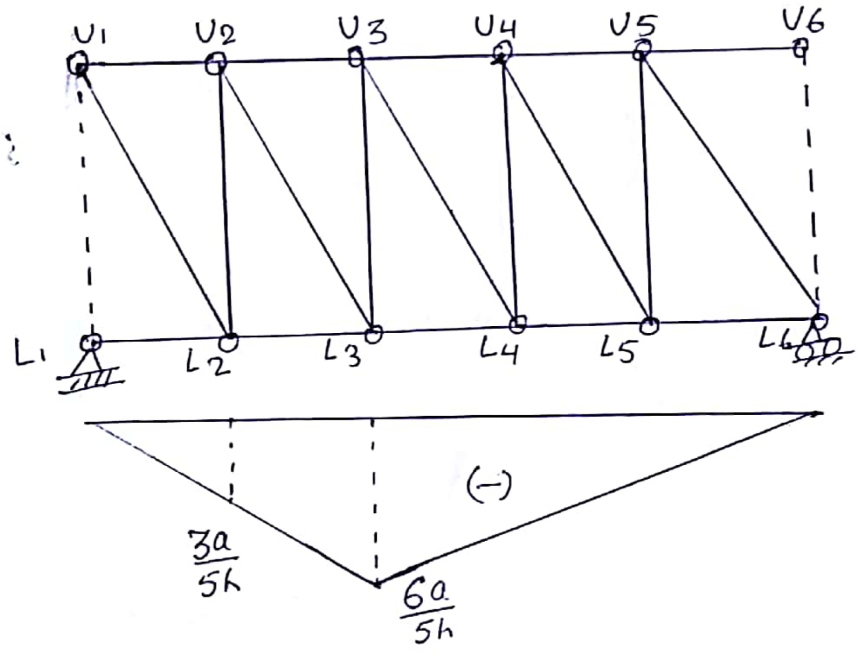
$= -\left(\frac{5a - x}{5h}\right) \cdot 2$ (compression)

if unit load is at L_3 i.e $x = 2a$, then

$F_{U2U3} = -\frac{6a}{5h}$ (compression)

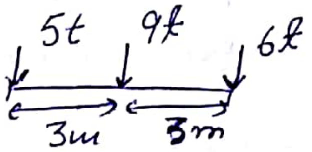
if unit load is at L_6 i.e. $x = 5a$, then

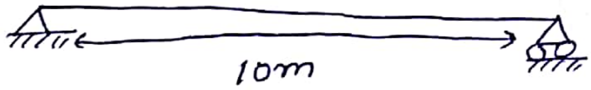
$F_{U2U3} = 0$

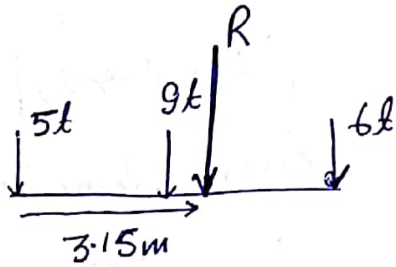


ILD for U2U3

47







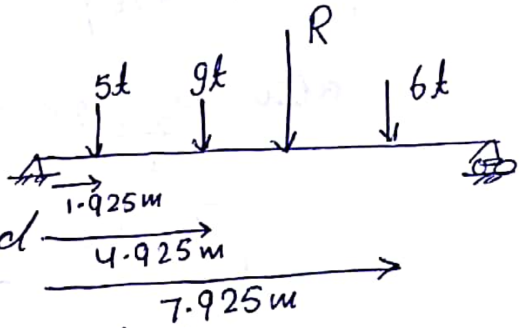
Soln:-

C.G of load System

$$\bar{x} = \frac{w_1\bar{x}_1 + w_2\bar{x}_2 + w_3\bar{x}_3}{w_1+w_2+w_3}$$

$$= \frac{(6\times6) + (9\times3) + (5\times0)}{6+9+5}$$

= 3.15 m from 5t load



Since heavier load 9t is nearest to C.G of load group, hence Max. B.M will occur below. This load for positioning as given below.

$\Sigma M_A = 0$

$(R_B \times 10) - (6\times7.925) - (9\times4.925) - (5\times1.925) = 0$

$R_B = 10.15t$

$R_A = 9.85t$

Absolute Max. B.M = B.M under the load 9t.

$= (R_A \times 4.925) - (5\times3)$

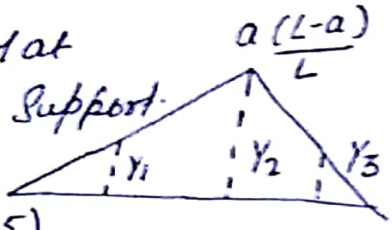
$= (9.85\times4.925) - 15$

$= \underline{33.511}$ tm (at 4.925m from left support)

~~Absol~~ IInd Method (use of ILD)

Sush.S

Ordinate of ILD for M at 4.925 m from left support.



$$Y_2 = \frac{4.925(10-4.925)}{10}$$

$$\boxed{Y_2 = 2.499}$$

from similar triangle.

$$\frac{Y_1}{Y_2} = \frac{1.925}{4.925}$$

$$\boxed{Y_1 = 0.976}$$

also $\frac{Y_3}{Y_2} = \frac{2.075}{5.075}$

$$\boxed{Y_3 = 1.029}$$

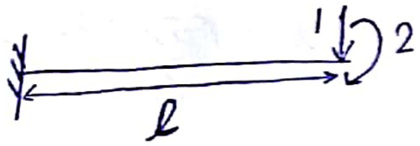
Absolute Max. B.M = B.M under 9 k load

$= (W_1 \times Y_3) + (W_2 \times Y_2) + (W_3 \times Y_1)$

$= (6 \times 1.029) + (9 \times 2.499) + (5 \times 0.976)$

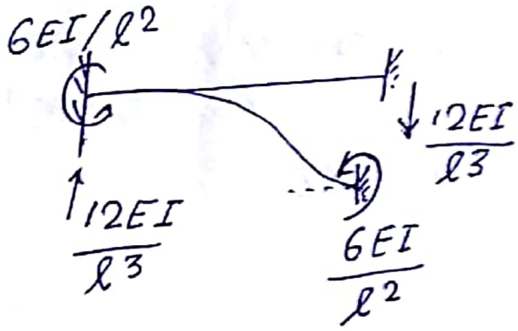
$= \underline{33.54 \, kNm}$

(5)



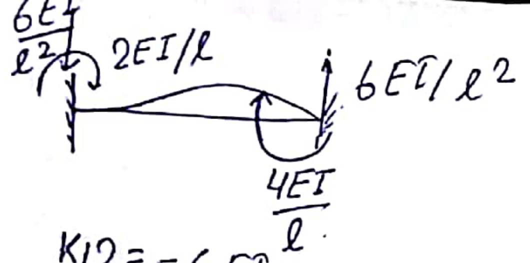
$[K] = [K]_{2\times2}$

$$= \begin{bmatrix} K_{11} & K_{12} \\ K_{21} & K_{22} \end{bmatrix}$$



$K_{11} = 12EI/l^3$

$K_{21} = -6EI/l^2$

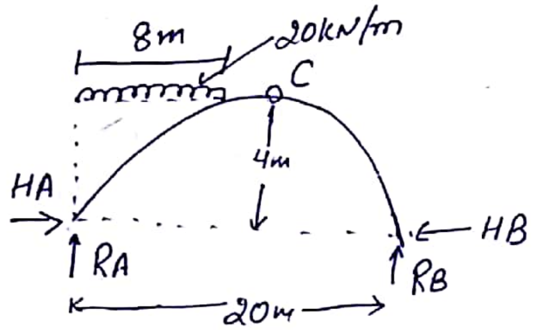


$K_{12} = -\frac{6EI}{l^2}$

$K_{22} = \frac{4EI}{l}$

$$[K] = \begin{bmatrix} \frac{12EI}{l^3} & -\frac{6EI}{l^2} \\ -\frac{6EI}{l^2} & \frac{4EI}{l} \end{bmatrix}$$

(6)



Given:-

Span (l) = 20m

Central rise Y_C = 4m

udl = 20kN/m

Let RA = Vertical reaction at A,

RB = Vertical reaction at B,

taking Moment about A.

$V_B \times 20 = (20 \times 8 \times 4)$

$V_B = \underline{32 kN}$

$V_A = (20 \times 8) - 32$

$= \underline{128 kN}$

Horizontal Thrust at Support.

Taking Moment about C = 0

$(H \times 4) = (V_B \times 10)$

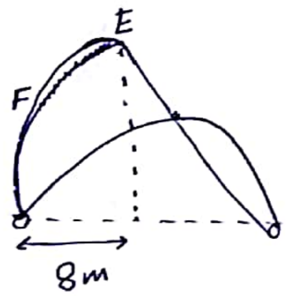
$H = \underline{80 kN}$

Subh (6)

5) Max. positive B.M

First of all, draw B.M as discussed below.

1. Draw the arch ACB with the given span and rise.
2. Since B.M at A, B, C is zero, therefore join B and C and extend it to E, such that horizontal distance of E from A is 8m.
3. Draw a parabolic curve AFE, after locating the point E.



From the (+ve) B.M diagram, we see that Max. (+ve) B.M. takes place in section AD. Let Max. (+ve) B.M takes place at a distance x from A. We know that, Rise at arch at distance x from A,

$$Y = \frac{4Y_C}{l^2} \cdot x \cdot (l-x)$$

$$= \frac{4 \times 4 \, x(20-x)}{20 \times 20}$$

$$= \frac{4x}{5} - \frac{x^2}{25}$$

B.M at at x, distance x from A,

$$M_x = V_A \cdot x - \left(20x \times \frac{x}{2}\right) - HY = 128x - 10x^2 - 80\left[\frac{4x}{5} - \frac{x^2}{25}\right]$$

$$= 128 \cdot x - (10x^2) - 64x + \frac{16x^2}{5}$$

$$= 64x - \frac{34x^2}{5}$$

Now for Max. B.M, Let us differentiate the above equation with respect to x and equate it to zero.

(7)

$$\frac{d}{dx}\left[64x - \frac{34x^2}{5}\right] = 0$$

$$64 - \frac{68x}{5} = 0$$

$$x = \frac{64 \times 5}{68} = 4.7m$$

$\therefore$ Rise of arch at a distance 4.7m from A.

$$Y = \frac{4Yc}{l^2} \cdot x(l-x)$$

$$= \frac{4 \times 4}{20 \times 20} \times 4.7(20-4.7) = 2.88m$$

$\therefore$ Max. positive B.M at distance of 4.7m from A,

$$M_{max} = (V_A x) - \frac{(20 \times 4.7^2)}{2} - HY$$

$$= (128 \times 4.7) - (10 \times 4.7^2) - (80 \times 2.88)$$

$$= 601.6 - 220.9 - 230.4$$

$$= \boxed{150.3 kNm}$$

Max. (-ve) B.M.

Max.(-ve) B.M takes places in Section CB.

Let Max.(-ve) B.M. takes place in the section CB, at a distance x from B.

$\therefore$ Rise of arch at a distance x from B,

$$Y = \frac{4Yc}{l^2} x \cdot (l-x) = \frac{4 \times 4}{20 \times 20} \cdot x(20-x)$$

$$= \frac{x}{25}(20-x)$$

$$= \frac{4x}{5} - \frac{x^2}{25}$$

B.M at a distance x from B.

$$M_x = V_B \times x - HY$$

$$= 32x - 80\left[\frac{4x}{5} - \frac{x^2}{25}\right]$$

$= 32x - 64x + \frac{16x^2}{5}$

$= \frac{16x^2}{5} - 32x$

Now for Max. B.M, let us differentiate above equation with respect to x and equate it to zero.

$$\frac{d}{dx}\left(\frac{16x^2}{5} - 32x\right) = 0$$

$$\frac{32x}{5} - 32 = 0$$

$$x = \frac{32 \times 5}{32}$$

$$x = 5m$$

$\therefore$ Rise of arch at a distance of 5m from B (i.e $\frac{l}{4}$)

$$Y = \frac{3 \times Y_C}{4} = \frac{3 \times 4}{4} = 3m$$

$$M_{max} = (V_B \times x) - (H \times Y)$$

$$= (32 \times 5) - (80 \times 3)$$

$$= \boxed{-80\,kNm.}$$

17 Given:-

Span (l) = 120m

difference b/w the levels of two support (d) = 3m

load = 10kN/m.

Depth of lowest point of the cable from the lower support.

$Y_C = 5 - 3 = 2m.$

Horizontal Thrust on the Cable.

H = Horizontal thrust on the cable.

l_1 = Horizontal length of AC.

l_2 = Horizontal length of CB.

using the relation

$$\frac{l_1}{l_2} = \sqrt{\frac{Yc+d}{Yc}}$$

$$= \sqrt{\frac{3+2}{2}}$$

$$= \sqrt{2.5}$$

$$= 1.58$$

$$\boxed{l_1 = 1.58\,l_2}$$

we know

$$l_1 + l_2 = 120.$$

$$1.58l_2 + l_2 = 120$$

$$2.58l_2 = 120$$

$$l_2 = \frac{120}{2.58} = 46.51\,m$$

$$l_1 = 120 - 46.51$$

$$= 73.49\,m$$

Horizontal Thrust on the cable.

$$H = \frac{wl_1^2}{2(Yc+d)}$$

$$= \frac{10 \times 73.49^2}{2(2+3)}$$

$$\boxed{= 5400.78\,KN.}$$

Max. Tension in the cable.

$$R_A = \frac{wl}{2} + \frac{Hd}{l}$$

$$= \frac{10 \times 120}{2} + \frac{5400.78 \times 3}{120}$$

$$= 600 + 135$$

$$= 735 KN.$$

Max. Tension in cable $= \sqrt{R_A^2 + H^2}$

$$= \sqrt{735^2 + 5402.5^2}$$

$$\boxed{= 5450 KN}$$