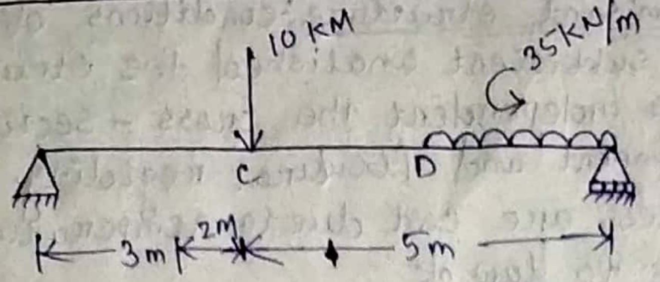
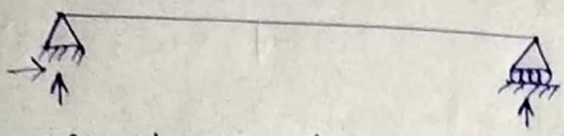
Q)



No. of equlibrium equation = no. of reaction force

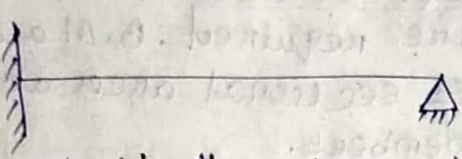
(1)



(simple)

Statically determinant

(2)



(contilever)

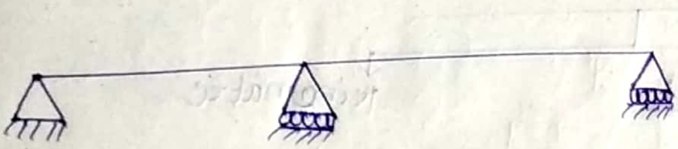
statically determinant

(3)

(fixed)

Statically indetemincnt

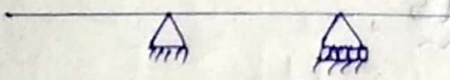
(4)



(~~over hanging~~)

Statically determinant (continous Indeterminant)

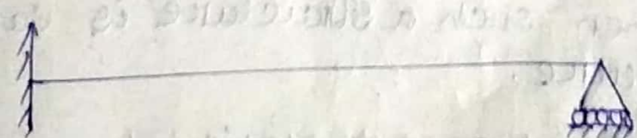
(5)



(over handing)

statically determinant

(6)

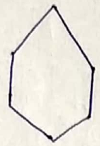


(Hinged)

Statically indeterminant

Statically determinant structure:conditions of equilibrium are sufficient analished the structure B.M. and S.F. is independent the cross - sectional area of the component and flextural regidity of the member. no stress are cast due to temperature changed and due to law of.

$I = \frac{bh^3}{36}$ feet or differential set flement.



→ **Statically indeterminant structure**:-Aditional compatibility conditions are required. B.M and S.F are depends open the cross sectional area and flexural rigidity of the members.

Stress are cost due to temp variation stress are cost due to law of feet or deferential settlement.

Stress = P/ Unit area

indeterminants
- static
  - external
  - internal
- kinematic

Static in determinants ;-

A structure can not be analised for external and internal reactions useing static equilibrium conditions along then such a structure is called indeterminant structure.

(1) $D_s = D_{se} + D_{si}$ where D_s = Degree of static indeterminants

D_{se} = external static determinants.

D_{si} = internal static indeterminants.

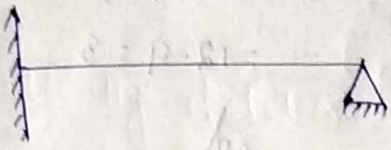
External static indeterminants:-

It is related with the support system of the structure and it is equal to no. of external reaction components in addition to no. of static reaction.

$\left(D_{se} = \underset{\text{no. of reaction}}{r_e} - \underset{\text{no. of equilibrium equation}}{3}\right)$ 2D

$\left(D_{se} = \underset{\text{total external reaction}}{R_e} - 6\right)$ — 3D

$\therefore$ R_e = total external reaction.



$5-3=2$

Internal static Indeterminants:-

It is rainforced to the Geometric stability of the structure. If after knowing the external reactions it is not possible to determine all internal forces or internal reactions. useing static equilibrium equation. along then the structure is set to be internally indeterminant.

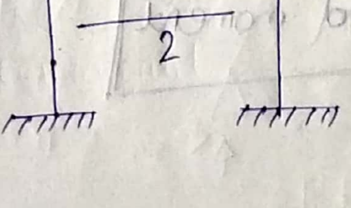
(ii) for geometric stability sufficient no. of members are required to prizerb the same of body.

$D_{si} = 3C - r_r$

C = no. of closed circle.

r_r = released reaction

Ex:-



$6-5=1$

$3\times2 - r_r$

$r_r = \Sigma(m_j - 1)$ — No. of member.

$= 6-1$

$= 5$

$$\boxed{SI = (\alpha m + r) - (\beta j + \gamma)}$$

(... A.f. Rotation)

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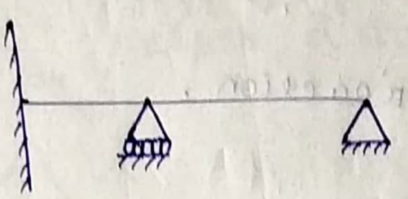
M → no. of member
r → no. of reaction
β → no. of equilibrium equation (3)
j → no. of joints
γ → no. of released



formula

$SI = (3\times2+6) - (3\times3+0)$

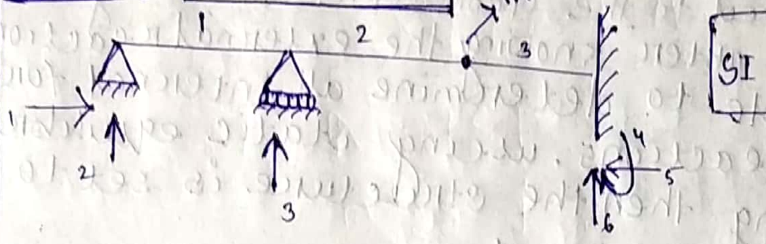
$= 12 - 9 = 3$

$m = 2 \quad \alpha = 3$

$r = 6 \quad j = 3$

$\beta = 3$

Beam:- $\boxed{\text{S.F, AF, moment}}$



$\boxed{SI = (\alpha m + r) - (\beta j + \gamma)}$

Beam ~~S.F, AF, moment~~

$\alpha = 3 \quad \beta = 3$

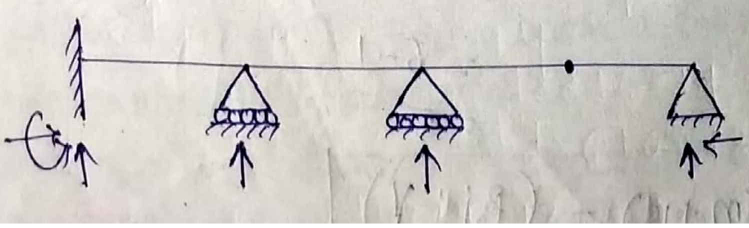
$m = 3 \quad j = 4$

$r = 6 \quad \gamma = 2 - 1 = 1$

$SI = (3\times3+6) - (15-13)$

$= 2$

$\boxed{\text{S.F, A.F, and moment}}$



$\alpha = 3 \quad \beta = 3$

$m = 4 \quad j = 5$

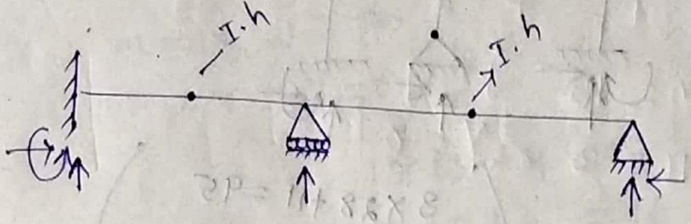
$r = 7 \quad \gamma = 1$

$3 \times 4 + 7 = 19$

$3 \times 5 + 1 = 16$

$SI = 19 - 16$

$= 3$



$\alpha = 3 \quad \beta = 3$

$m = 4 \quad j = 5$

$r = 6 \quad \gamma = 2$

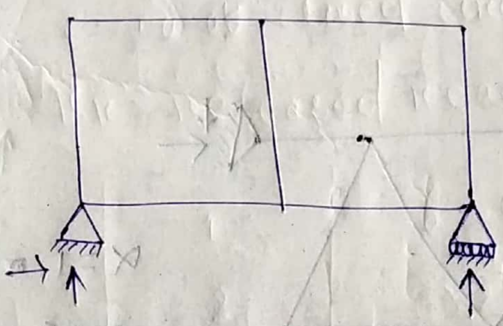
$3 \times 4 + 6 = 18$

$3 \times 5 + 2 = 17$

$SI = 18 - 17$

$= 1$

Truss :-



$\alpha = 1 \quad \beta = 2$

$m = 7 \quad j = 6$

$r = 3 \quad \gamma = 0$

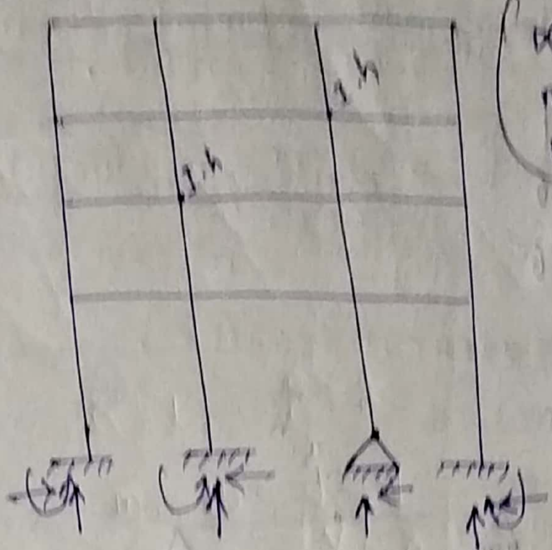
$1 \times 7 + 3 = 10$

$2 \times 6 + 0 = 12$

$SI = 10 - 12$

$= -2$

Frame :-



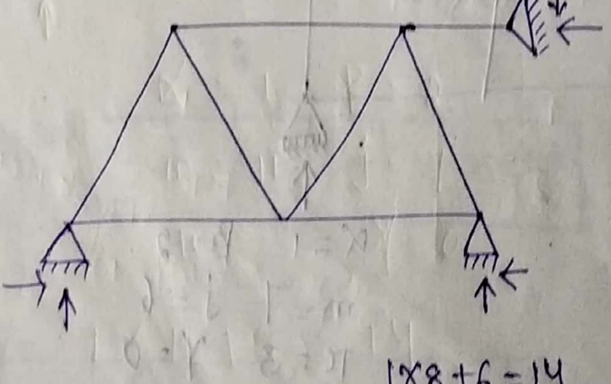
$\alpha = 3 \quad \beta = 3$
$m = 28 \quad j = 20$
$r = 11 \quad \gamma = 0$

$3 \times 28 + 11 = 95$
$3 \times 20 + 0 = 60$
$SI = 95 - 60 = 35$

$\alpha = 3 \quad \beta = 3$
$m = 28 \quad j = 20$
$r = 11 \quad \gamma = 6$

$3 \times 28 + 11 = 95$
$3 \times 20 + 6 = 66$
$SI = 95 - 66 = 29$

Truss :-

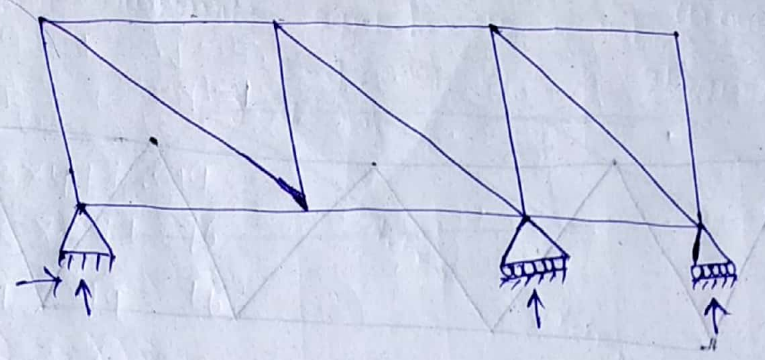


$\alpha = 1 \quad \beta = 2$
$m = 8 \quad j = 6$
$r = 6 \quad \gamma = 0$

$1 \times 8 + 6 = 14$
$2 \times 6 + 0 = 12$
$SI = 14 - 12 = 2$

$II - 6 - 3D$
$II - 3 - 2D \quad EI = r - 3 \quad SI = 35 - 6 = 29$
$II = 27 \quad = 8$

(1)



$\alpha = 1 \quad \beta = 2$

$m = 13 \quad j = 8$

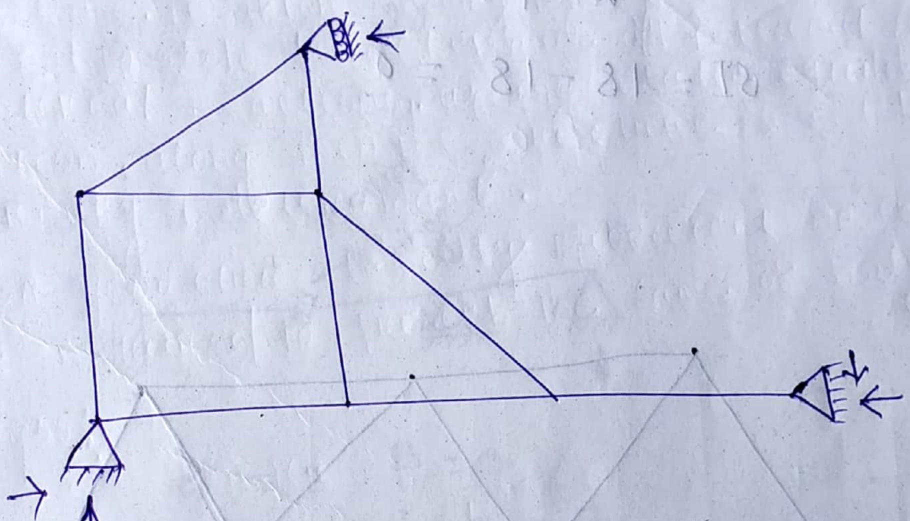
$r = 4 \quad \gamma = 0$

$1 \times 13 + 4 = 17$

$2 \times 8 + 0 = 16$

$SI = 17 - 16 = 1$

(2)



$\alpha = 1 \quad \beta = 2$

$m = 9 \quad j = 7$

$r = 5 \quad \gamma = 0$

$1 \times 9 + 5 = 14$

$2 \times 7 + 0 = 14$

$SI = 14 - 14$

$= 0$

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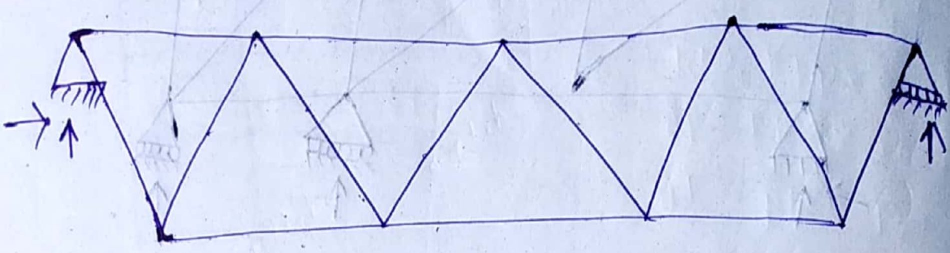
(3)



$\alpha = 1$ $\beta = 2$

$m = 15$ $j = 9$

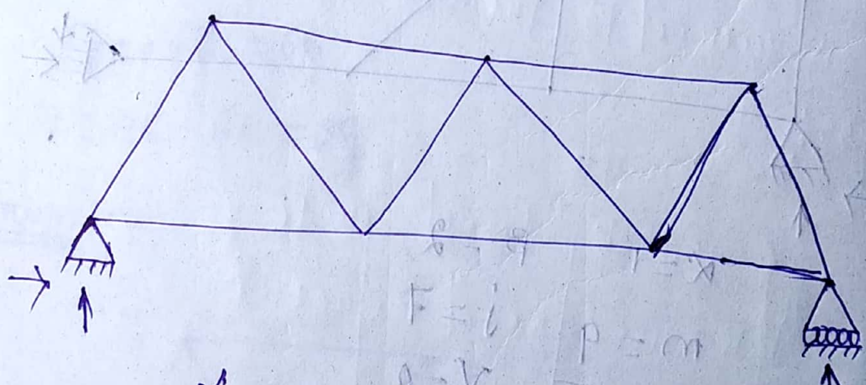
$r = 3$ $\gamma = 0$

$1 \times 15 + 3 = 18$

$2 \times 9 + 0 = 18$

$SI = 18 - 18 = 0$

(4)



$\alpha = 1$ $\beta = 2$

$m = 11$ $j = 7$

$r = 3$ $\gamma = 0$

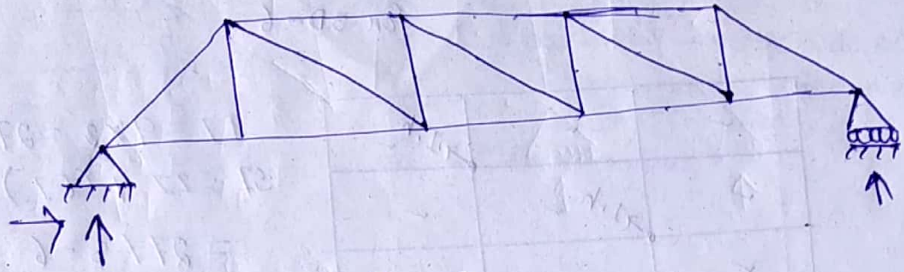
$1 \times 11 + 3 = 14$

$2 \times 7 + 0 = 14$

$SI = 14 - 14$

$= 0$

5



$\alpha = 1 \quad \beta = 2$

$m = 17 \quad j = 10$

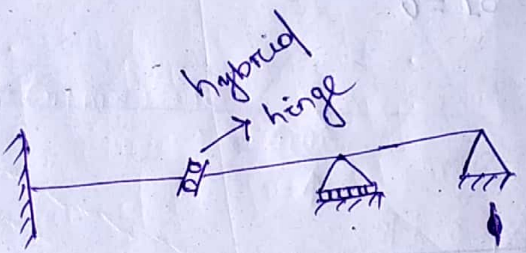
$r = 3 \quad \gamma = 0$

$1 \times 17 + 3 = 20$

$2 \times 10 + 0 = 20$

$SI = 20 - 20$

$= 0$



$\alpha = 3 \quad \beta = 3$

$m = 3 \quad j = 5$

$r = 8 \quad \gamma = 0$

$3 \times 3 + 8 = 17$

$3 \times 5 + 0 = 15$

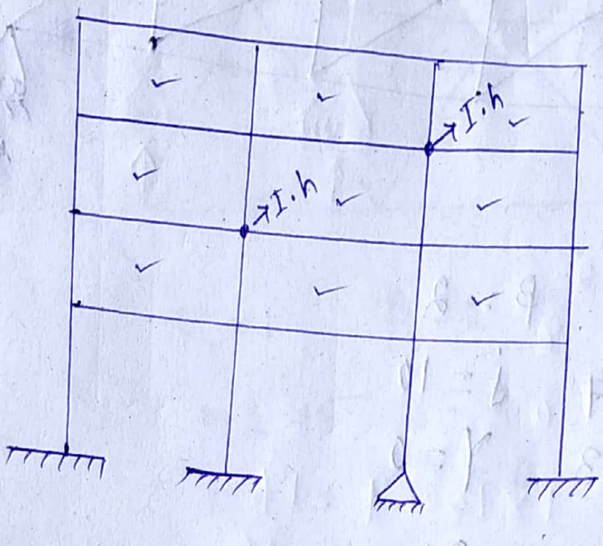
$SI = 17 - 15 = 2$

SI = Static Indeterminate
KI = Kynamatic Indeterminate

$SI = (\alpha m + r) - (\beta j + \gamma)$

Condition (1) For a closed type structure the Internal Indeterminate ( ) is for 2D - 3

for 3D - 6



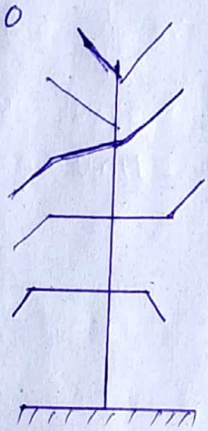
$II = 9 \times 3 = 27$

$SI = II + (EI)$

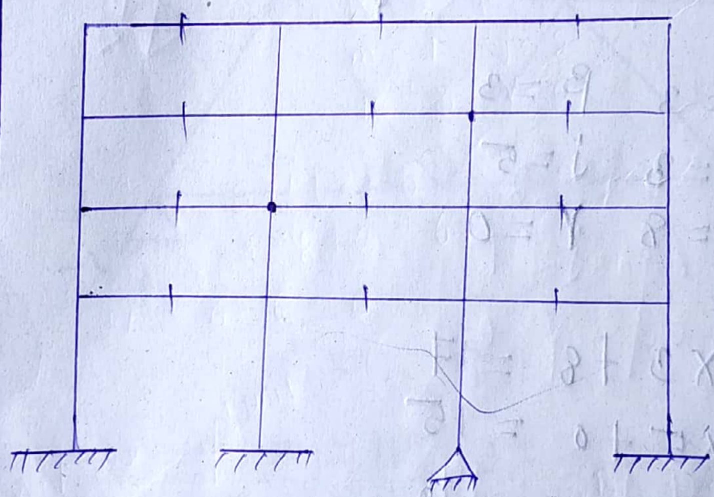
$= 27 + 8 - 6$

$= 29$

for a Cantiliver three types structure the SI = 0



$SI = 0$

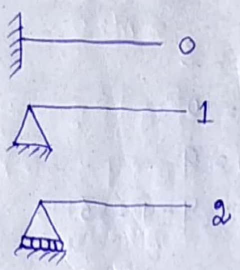


$12 \times 3 = 36 - 7$

$= 29$

KI – Kinamatic Indeterminate (degree of freedom)

formula



$KI = aj - b + r$

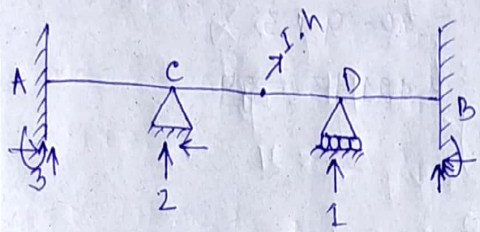
j → No. of joint

b → No. of reaction

r → No. of release

a → No. degree of fredom abelable at is joint.

$a = 3\ (\Delta x, \Delta y, \theta_{xy})$



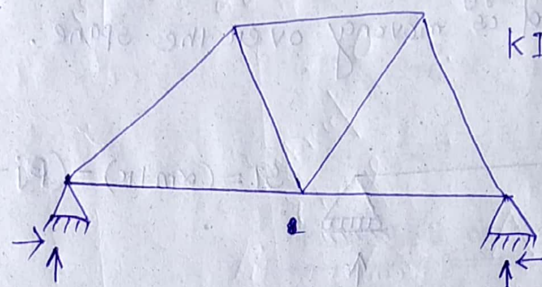
$j = 5 \quad r = 1$

$b = 9$

$KI = 15 - 9 + 1$

$= 7$

Ex:-



$KI = aj - b + r$

$a = 2$

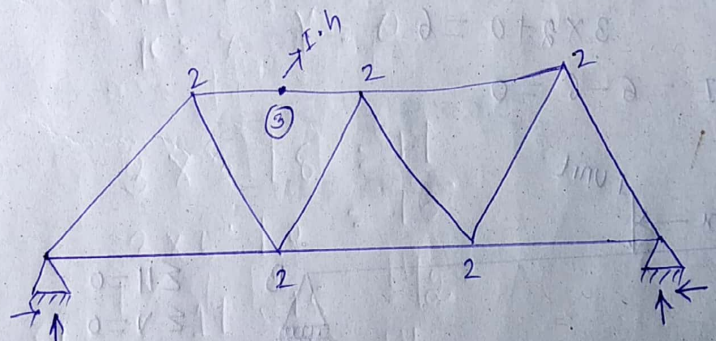
$2 \times 5 - 4 + 0$

$= 10 - 4$

$= 6$

Frame $a = 3$

Ex:-



$2 \times 8 - 4 + 1$

$= 16 - 5$

$= 11$

$a = 2$

$j = 8$

$b = 4$

$r = 1$

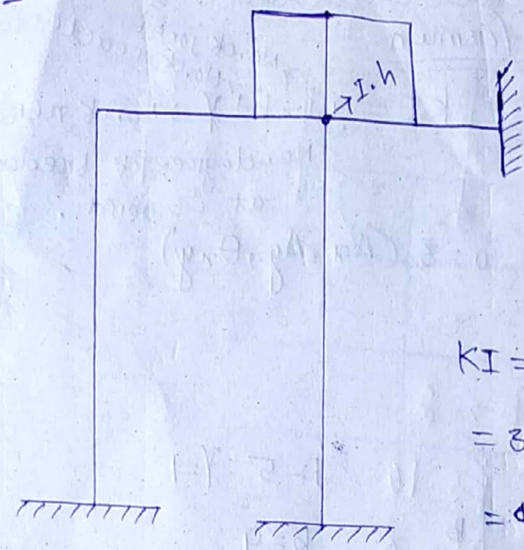
$= (2 \times 8) - (4 + 1)$

$= 16 - 4$

$= 12 + 1$

$= 13$

Ex:-



$a = 3$

$j = 10$

$b = 9$

$r = 4 - 1 = 3$

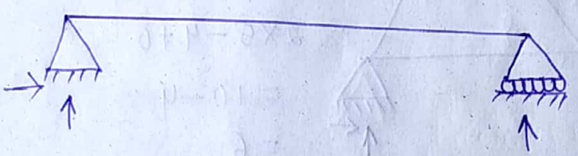
$KI = 3 \times 10 - 9 + 3$

$= 30 - 9 + 3$

$= 21 + 3 = 24$

ILD:- Influence line diagram.

→ is the grafical representation of various function (shear force, bending momment — axial force etc) when a unit load is moving over the spane.



$SI = (\alpha m + r) - (\beta j - \gamma)$

$\alpha = 3 \quad \beta = 3$

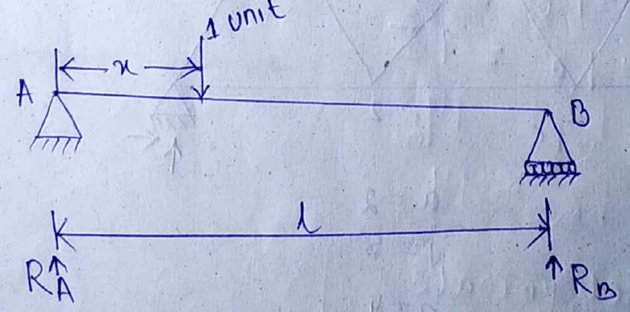
$m = 1 \quad j = 2$

$r = 3 \quad \gamma = 0$

$3 \times 1 + 3 = 6$

$3 \times 2 + 0 = 6$

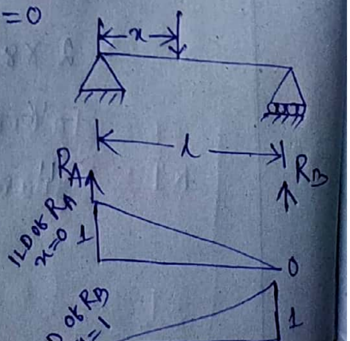
$SI = 6 - 6 = 0$



$\Sigma H = 0$

$\Sigma V = 0$

$\Sigma m = 0$

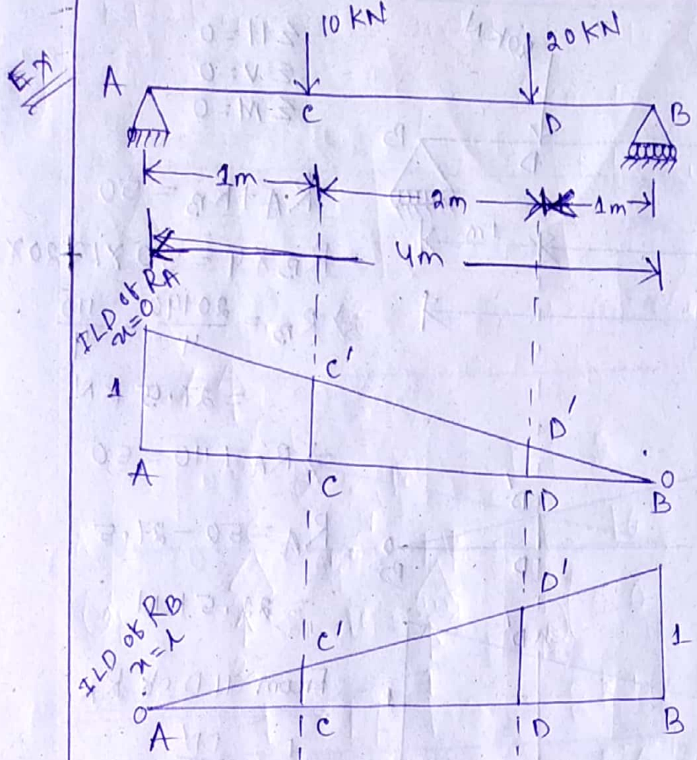


$R_A + R_B = 1$ —— (1) $\Rightarrow R_A = 1 - R_B$

$R_B \times l = x$ $\qquad = 1 - x/l$

value of $\boxed{R_B = x/l}$ —— (2) $\qquad$ value of $\boxed{R_A = 1 - x/l}$

Ex



$\Sigma H = 0$
$\Sigma V = 0$
$\Sigma M = 0$

$R_A + R_B = 30$

$= R_B \times 4 = 10 \times 1 + 20 \times 3$

$\Rightarrow R_B = \frac{70}{4} = 17.5 \text{ KN}$

$\Rightarrow R_A = 30 - 17.5$

$R_A = 12.5 \text{ KN}$

From ILD of R_A

$\frac{1}{L} = \frac{DD'}{L}$

$\Rightarrow DD' = \frac{1}{l}$ — ①

$= \frac{1}{L} = \frac{CC'}{3}$

$\Rightarrow CC' = 3/l$ — ②

$R_A = \cancel{10}^{5} \times \frac{3}{\cancel{4}_2} + \cancel{20}^{5} \times \frac{1}{\cancel{4}}$

$= 5 + 7.5 = 12.5 \text{ KN}$

From ILD of R_B

$\Rightarrow \frac{1}{4} = \frac{CC'}{1}$

$\Rightarrow CC' = \frac{1}{4}$ — ①

$\Rightarrow \frac{1}{4} = \frac{DD'}{3}$

$\Rightarrow DD' = 3/4$

$R_B = \cancel{20}^{5} \times \frac{3}{\cancel{4}} + \cancel{10}^{5} \times \frac{1}{\cancel{4}_2}$

$= 17.5 \text{ KN}$

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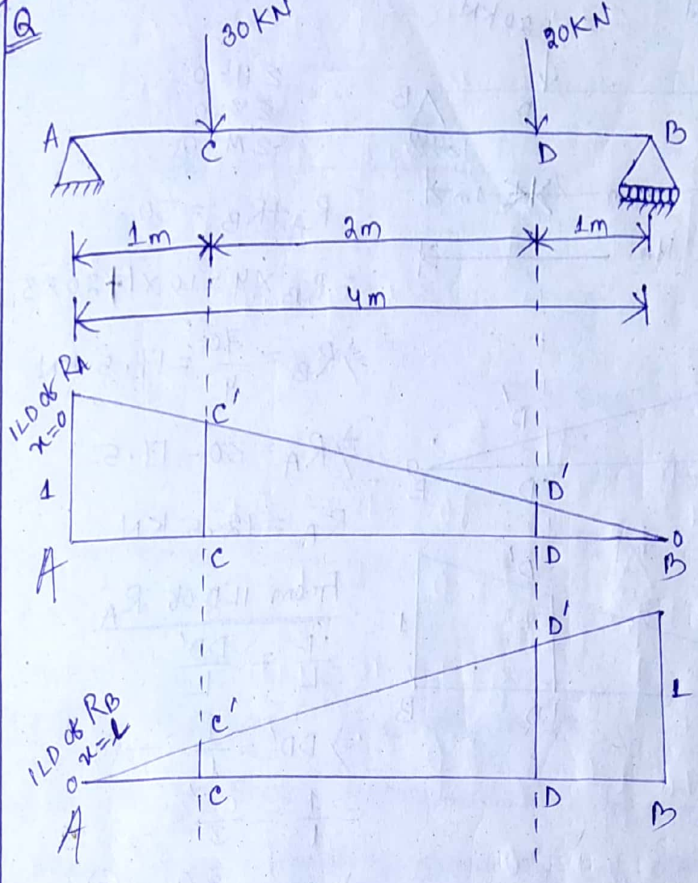
H.W

Q



$\Sigma H = 0$

$\Sigma V = 0$

$\Sigma M = 0$

$R_A + R_B = 50$

$= R_B \times 4 = 30 \times 1 + 20 \times 3$

$\Rightarrow R_B = \frac{20+90}{4} = \frac{110}{4}$

$= 27.5 \text{ KN}$

$\Rightarrow R_A + 110 = 50$

$R_A = 50 - 27.5$

$= 22.5 \text{ KN}$

From ILD of R_A

$\frac{1}{L} = \frac{DD'}{L}$

$\Rightarrow DD' = \frac{1}{l}$ — (1)

$= \frac{1}{l} = \frac{cc'}{3}$

$\Rightarrow cc' = 3/l$ — (2)

$R_A = \cancel{20}^{5} \times \frac{3}{\cancel{4}} + 30 \times \frac{1}{4}$

$= 22.5 \text{ KN}$

From ILD of R_B

$\Rightarrow \frac{1}{4} = \frac{cc'}{1}$

$\Rightarrow cc' = \frac{1}{4}$ — (1)

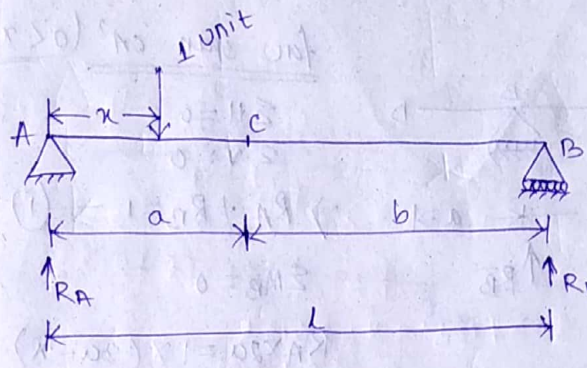
$\Rightarrow \frac{1}{4} = \frac{DD'}{3}$

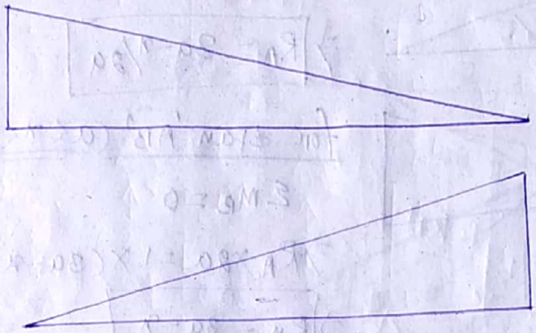
$\Rightarrow DD' = 3/4$

$R_B = \cancel{20}^{5} \times \frac{1}{\cancel{4}} + 30 \times \frac{3}{4}$

$= 27.5 \text{ KN}$

Ex:-



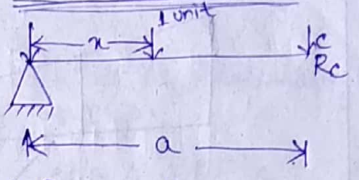


$\boxed{l = a+b}$

$R_A = \frac{l-x}{l}$

$R_B = x/l$

For the span 'AC' $(0<x<a)$



$\Rightarrow R_A = 1 + R_c$

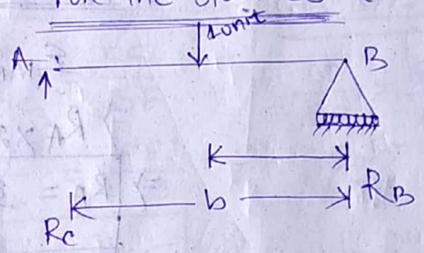
$\Rightarrow R_c = R_A - 1$

$= \frac{l-x}{l} - 1$

$= \frac{l-x-l}{l}$

$\boxed{R_c = -x/l}$

For the span 'CB' $(a<x<l \text{ or } (a+b))$



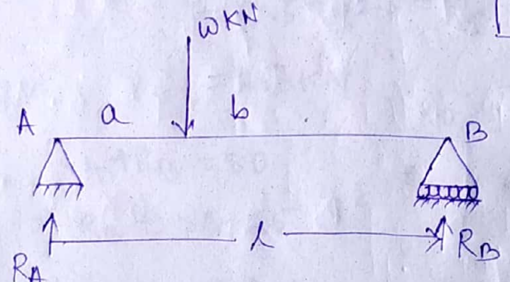
$R_c + R_B = 1$

$R_c = 1 - R_B$

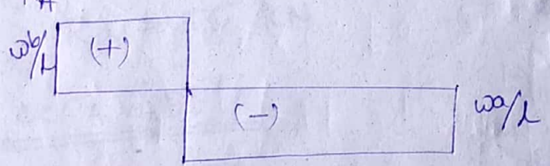
$= 1 - x/l$

$\boxed{R_c = \frac{l-x}{l}}$ Ans

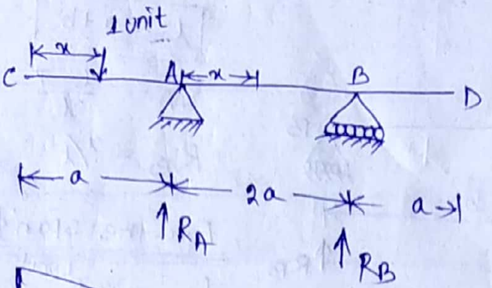
Ex

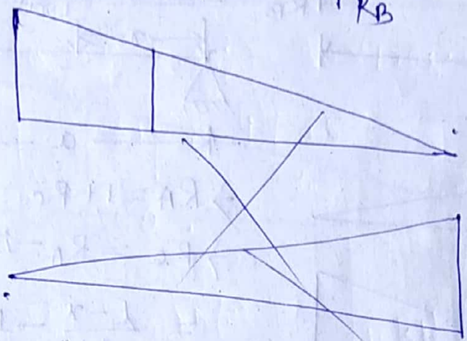


$(0<x<a)$



Q





for span 'CA' $(0 < x < a)$

$\Sigma H = 0$

$\Sigma V = 0$

$\Rightarrow R_A + R_B = 1$ —— (1)

$\Sigma M_B = 0$

$R_A \times 2a = 1 \times (3a - x)$

$\Rightarrow \boxed{R_A = 3a - x/2a}$

for span 'AB' $(a < x < 3a)$

$\Sigma M_B = 0$

$\Rightarrow R_A \times 2a = 1 \times (3a - x)$

$\Rightarrow \boxed{R_A = \frac{3a - x}{2a}}$

for span 'BD' $(3a < x < 4a)$

$\Sigma M_B = 0$

$\Rightarrow R_A \times 2a \times 1 \times (x - 3a) = 0$

$\Rightarrow \boxed{R_A = \frac{3a - x}{2a}}$

$\Rightarrow R_A + R_B = 1$

$\Rightarrow R_B = 1 - R_A$

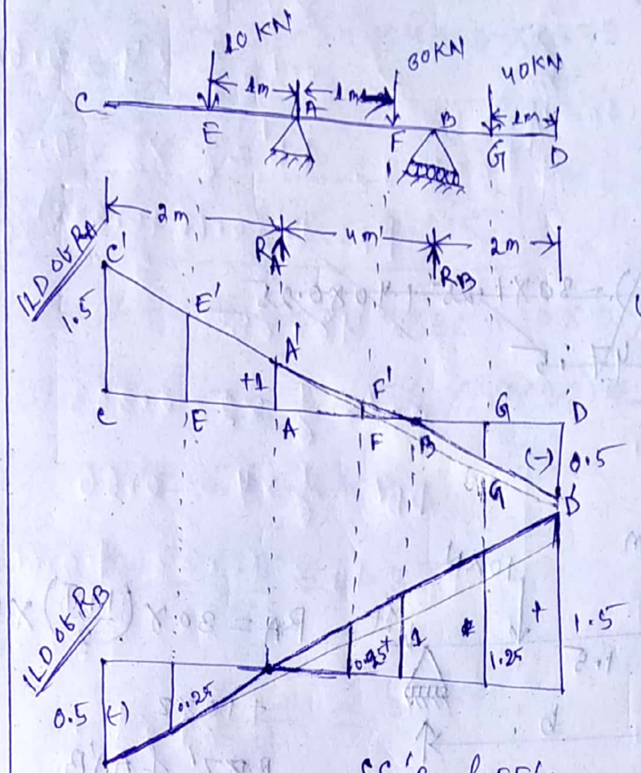
$= 1 - \frac{3a - x}{2a}$

$= \frac{2a - 3a + x}{2a}$

$= \boxed{\frac{x - a}{2a}}$

$\boxed{R_A + R_B = 80}$

Q



for span 'CA'

$R_A \times 4 = 10 \times (6-1)$

$R_A = \frac{60-10}{4}$

$= \frac{50}{4} = 12.5$

Load at R_A, calculating by half of ILD.

cc'B Δ & EE'B

$\frac{cc'}{Bc} = \frac{EE'}{BE}$

$\Rightarrow \frac{1.5}{6} = \frac{EE'}{5}$

~~⇒ EE' = 1.2~~

$\Rightarrow \boxed{EE' = 1.25}$

cc'B & FF'B

$\frac{cc'}{Bc} = \frac{FF'}{BF}$

$\Rightarrow \frac{1.5}{6} = \frac{FF'}{3}$

$\Rightarrow \boxed{FF' = 0.75}$

DD'B & GG'B

$\frac{DD'}{BD} = \frac{GG'}{BG}$

$\Rightarrow \frac{0.5}{2} = \frac{GG'}{1}$

$\Rightarrow GG' = \frac{0.5}{2}$

$= \boxed{0.25}$

$R_A = 10 \times 1.25 + 30 \times 0.75 - 40 \times 0.25$

$= 12.5 + 22.5 - 10$

$= 25$ KN

$R_A + R_B = 80$

$\Rightarrow R_B = 80 - 25$

$R_B = 55$ KN

cc'A & EE'A

$\frac{cc'}{AC} = \frac{EE'}{AE}$

$= \frac{0.5}{2} = \frac{EE'}{1}$

$\Rightarrow EE' = 0.25$

ADD' & AGG'

$\frac{DD'}{AD} = \frac{GG'}{AG}$

$\Rightarrow \frac{1.5}{6} = \frac{GG'}{5}$

$\Rightarrow GG' = 0.25$

ADD' & AFF'

$\frac{DD'}{AD} = \frac{FF'}{AF}$

$\Rightarrow \frac{1.5}{6} = \frac{FF'}{1}$

$\Rightarrow FF' = 0.25$

~~ADD' & ABB'~~

~~$\frac{DD'}{AD} = \frac{BB'}{AB}$~~

~~$\Rightarrow \frac{1.5}{6} = \frac{BB'}{4}$~~

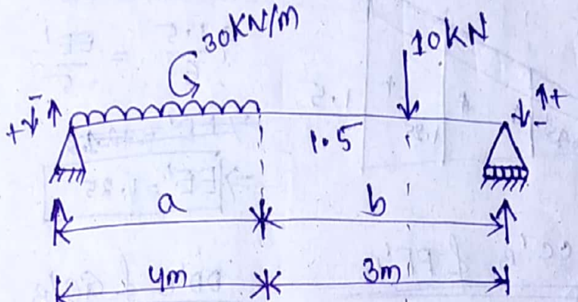
~~$\Rightarrow BB' = 1$~~

~~$R_B = 10 \times (-0.25) - 30 \times 1.25 + 40 \times 0.25$~~

~~$= -2.5 - 47.5$~~

$= -50$.

Q.



$R_A = 30 \times \left(\frac{1+T}{2}\right) \times 4 + 10 \times 2$

BZZ' & AA'B

$\frac{1}{L} = \frac{ZZ'}{1.5}$

$\Rightarrow \frac{1}{7} = \frac{ZZ'}{1.5}$

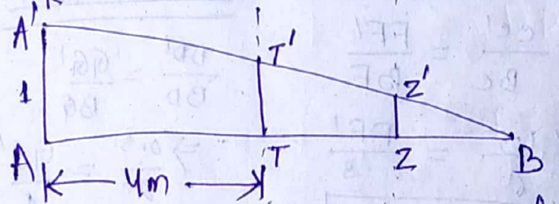
$\Rightarrow ZZ' = 0.214$

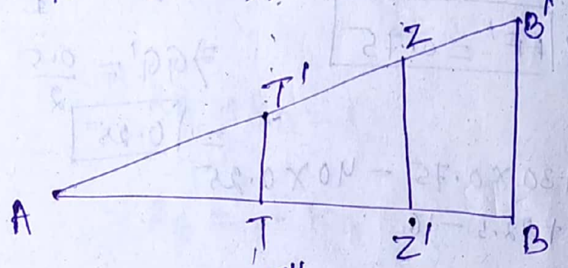
$\frac{1}{L} = \frac{TT'}{3}$

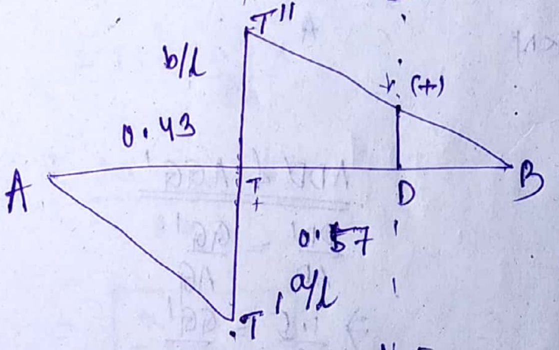
$\Rightarrow \frac{1}{7} = \frac{TT'}{3}$

$\Rightarrow TT' = 0.429$.

$R_A = 30 \times \frac{1+0.429}{2} \times 4 + 10 \times 0.214 = 87.88$



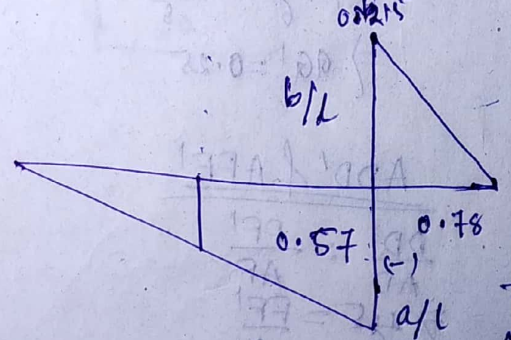




$\frac{1}{L} = \frac{ZZ'}{5.5}$

$\Rightarrow \frac{1}{7} = \frac{ZZ'}{5.5}$

$\Rightarrow ZZ' = 0.78$



$\frac{1}{L} = \frac{TT'}{4}$

$\frac{1}{7} = \frac{TT'}{4}$

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$TT' = 0.57$

$R_B = 30 \times \frac{1}{2} \times 0.57 \times 4 + 10 \times 0.78$

$= 42.$

$\boxed{DD' = \frac{0.43}{3} \times 1.5 = 0.215}$

$SF_C = -\frac{1}{2} \times 0.57 \times 4 \times 30 + 10 \times 0.215 = -32.$

$SF_D = \left(-\frac{1}{2} \times 0.56 \times 4 \times 30\right) - 10 \times 0.78$

$= -41.4 \text{ KN}.$

$\frac{b}{l} = \frac{1.5}{7} = 0.214$

$\frac{a}{l} = \frac{5.5}{7} = 0.78$

$\frac{DD'}{AD} = \frac{CC'}{AC}$

$\Rightarrow \frac{0.78}{5.5} \times \frac{CC'}{4}$

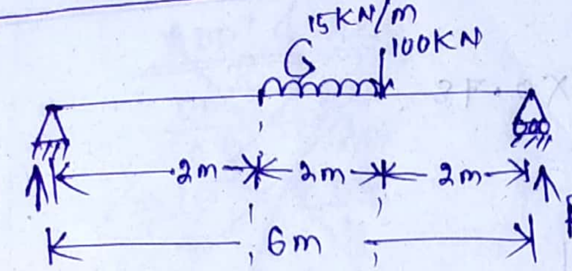
$\Rightarrow CC' = 0.56$

$\cancel{DD' = \frac{0.43}{3} \times 1.5 = 0.215}$

$\cancel{SF_C = -\frac{1}{2} \times 4 \times 0.57 \times 30 + 10 \times 0.215}$

$\cancel{= -32}$

Q



$R_B = 81.7$

$R_A = 48$

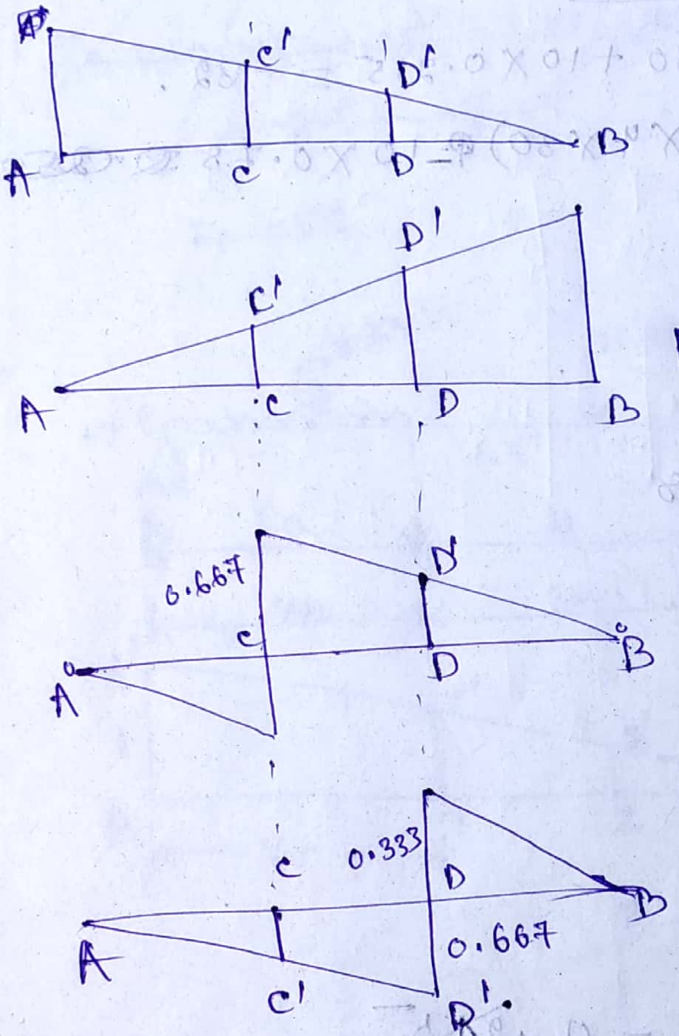
$\Sigma V = 0$

$CC' = \frac{1}{6} \times 4 = 0.667$

$DD' = \frac{1}{6} \times 2 = 0.333$

$R_A = \frac{15\,(0.66 + 0.333)}{2} \times 2 + 100\times$

$= 48.85$



$CC' = \frac{1}{6} \times 2 = 0.333$

$DD' = \frac{1}{6} \times 4 = 0.66$

$R_B = 15 \times \frac{(0.333 + 0.667)}{2} \times 2 + 100 \times 0.667$

$= 81.7$

$DD' = \frac{0.667}{4} \times 2 = 0.3335$

$SF = 100 \times 0.3335 + \frac{(0.667 + 0.3335)}{2} \times 2$

$= 34.351$

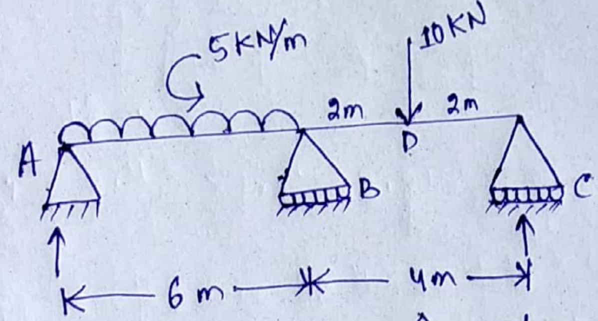
$SF_C = \frac{0.667}{4} \times 2$

$= 0.3335$

Formula :- $\boxed{M_A l_1 + 2M_B(l_1+l_2) + M_C \times l_2 + \frac{6A_1x_1}{l_1} + \frac{6A_2x_2}{l_2} = 0}$

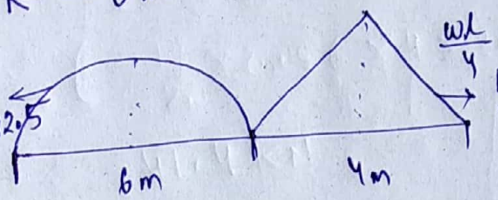
~~THEE~~ THREE MOMENT THEORUM

$x_1 = 3$
$x_2 = 2$



$\frac{wl^2}{8}$

$\frac{5\times36}{8} = 22.5$



$\frac{wl}{4}$

$\frac{10\times4}{4} = 10\,KNm$

$A_1 = \frac{2}{3}\times b\times h = \frac{2}{3}\times6\times22.5 = 90mm^2$

$A_2 = \frac{1}{2}\times b\times h = \frac{1}{2}\times4\times10 = 20mm^2$

$x_1 = 3$ $\quad l_1 = 6$

$x_2 = 2$ $\quad l_2 = 4$

$\boxed{\begin{matrix} M_A = 0 \\ M_C = 0 \end{matrix}}$

$$M_A l_1 + 2M_B(l_1+l_2) + M_C \times l_2 + \frac{6A_1x_1}{l_1} + \frac{6A_2x_2}{l_2} = 0$$

$$0 + 2M_B(6+4) + 0 + \frac{6\times90\times3}{6} + \frac{6\times20\times2}{4} = 0$$

$$\Rightarrow 2M_B\times10 + 330 = 0$$

$$\Rightarrow M_B\times20 = -330$$

$$\Rightarrow M_B = \frac{330}{2} = -16.5$$

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