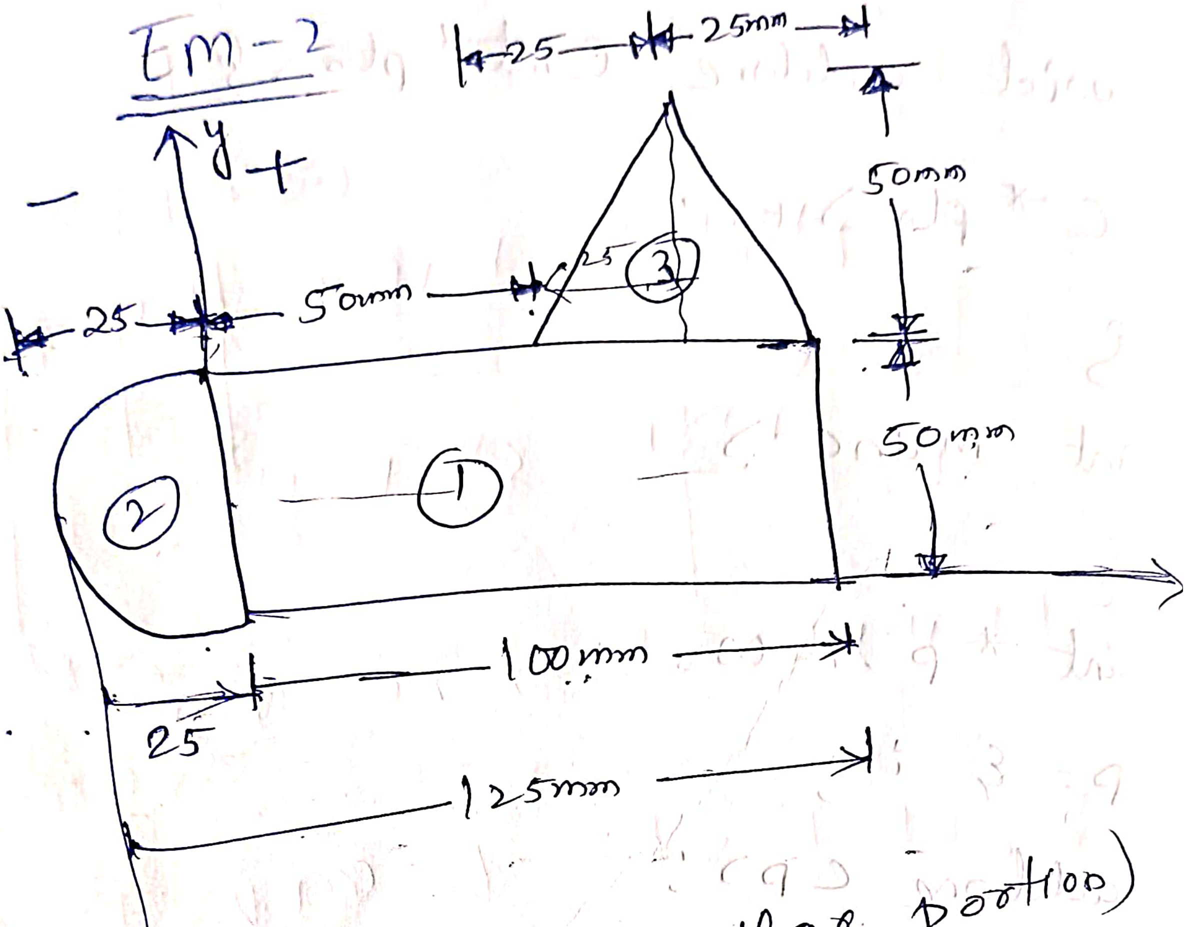
IC

EM-2



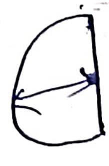
Section 1 :- (Rectangular portion)

$$A_1 = b \times d = 100 \times 50 = 5000\ mm^2$$

$$x_1 = 25 + \frac{100}{2} = 25 + 50 = 75\ mm$$

$$y_1 = \frac{d}{2} = \frac{50}{2} = 25\ mm$$

Section 2 :- Semicircle



$$A_2 = \frac{\pi r^2}{2}$$

$$A_2 = \frac{\pi (25)^2}{2} = 982\ mm^2$$

$$x_2 = 25 - \frac{4r}{3\pi}$$

$$x_2 = 25 - \frac{4 \times 25}{3\pi}$$

$$\boxed{x_2 = 14.4\ mm.}$$

$$y_2 = \frac{25}{2} = 12.5\ mm.$$

Section 3 :- (triangle)

$$a_3 = \frac{1}{2} b \times h.$$

$$= \frac{1}{2} 50 \times 50$$

$$a_3 = 1250\ mm^2$$

$$x_3 = 25 + 50 + 25 = 100\ mm.$$

$$y_3 = 50 + \frac{h}{3}$$

$$y_3 = 50 + \frac{50}{3} = 66.7\ mm.$$

Centroid about x-axis

$$\bar{x} = \frac{a_1x_1 + a_2x_2 + a_3x_3}{a_1 + a_2 + a_3}$$

$$\bar{x} = \frac{5000 \times 95 + 982 \times 14.4 + 1250 \times 1}{5000 + 982 + 1256}$$

$$\boxed{\bar{x} = 71.1 \text{ mm}}$$

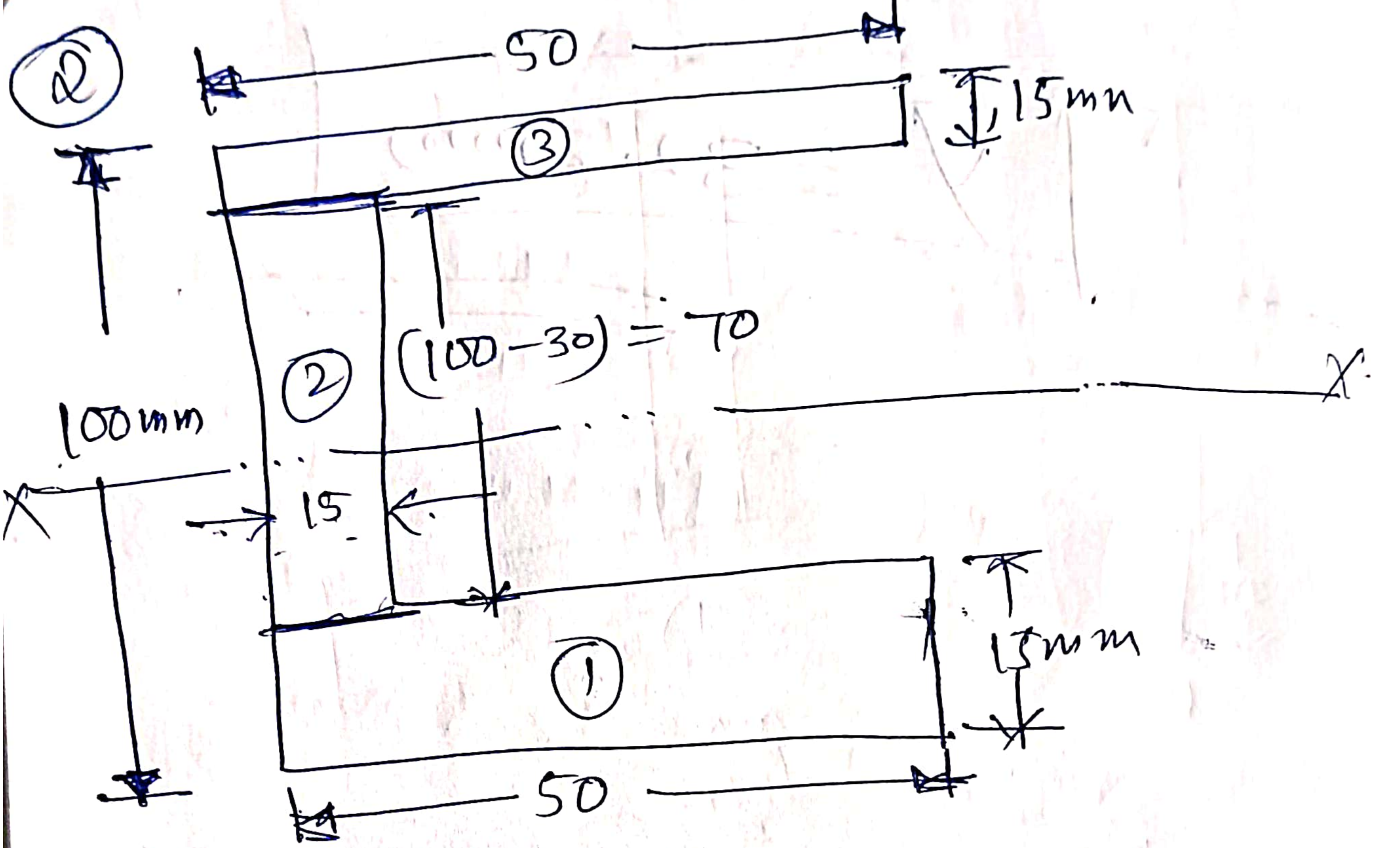
Centroid about y-axis

$$\bar{y} = \frac{a_1y_1 + a_2y_2 + a_3y_3}{a_1 + a_2 + a_3}$$

$$\bar{y} = \frac{5000 \times 25 + 982 \times 12.5 + 1250 \times}{5000 + 982 + 1250}$$

$$\boxed{\bar{y} = 32.2mm}$$

6607

② 

Section 1:- (Rectangle)

$A_1 = b \times d$

$A_1 = 50 \times 15 = 750$

$\boxed{A_1 = 750 mm^2}$

$x_1 = \frac{b}{2} = \frac{50}{2} = 25 mm.$

Section 2:- (Rectangle)

$A_2 = b \times d$

$= 15 \times 70$

$\boxed{A_2 = 1050 mm^2}$

$x_2 = \frac{b}{2}$

$= \frac{15}{2}$

$\boxed{x_2 = 7.5 mm}$

Section 3! – (Rectangle)

$A_3 = b \times d$

$= 50 \times 15$

$=$

$\boxed{A_3 = 750\ mm^2}$

$x_3 = \frac{50}{2}$

$x_3 = 25\ mm$

Centroid about x-axis

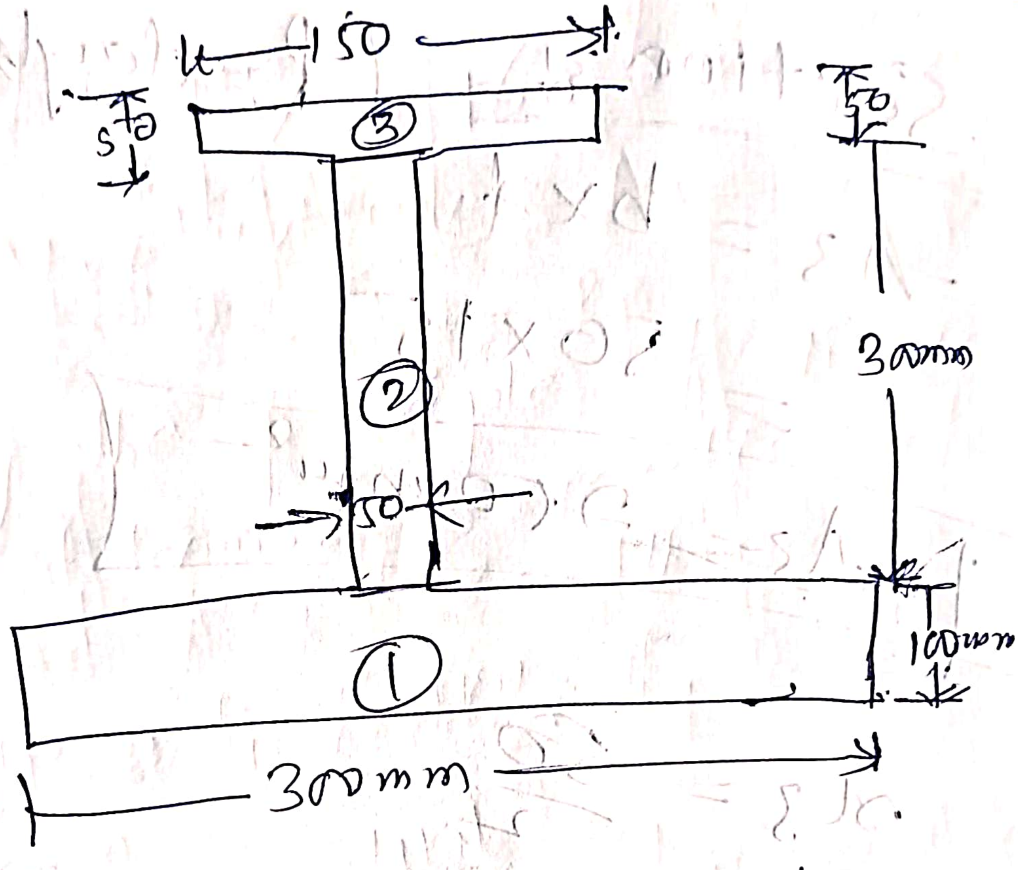
$$\bar{x} = \frac{a_1 x_1 + a_2 x_2 + a_3 x_3}{a_1 + a_2 + a_3}$$

$$= \frac{750 \times 25 + 1050 \times 7.5 + 750 \times 25}{750 + 1050 + 750}$$

$\bar{x} = 17.79$

$\boxed{\bar{x} = 17.08}$ //.

③



Section ① : Rectangle

$A_1 = b \times d$

$A_1 = 300 \times 100 = 30,000\ mm^2$

$y_1 = \frac{d}{2} = \frac{100}{2} = 50mm$

Section 2 :-

$A_2 = b \times d$

$= 50 \times 300$

$A_2 = 15000\ mm^2$

$$y_2 = 100 + \frac{300}{2}$$

$$\boxed{y_2 = 100 + 150}$$

$$\boxed{y_2 = 250\ mm}$$

Section 3:- (Rectangle).

$$A_3 = b \times d$$
$$= 150 \times 50$$
$$\boxed{A_3 = 7500\ mm^2}$$

$$y_3 = 100 + 300 + \frac{50}{2}$$
$$= 400 + 25$$
$$y_3 = 425\ mm$$

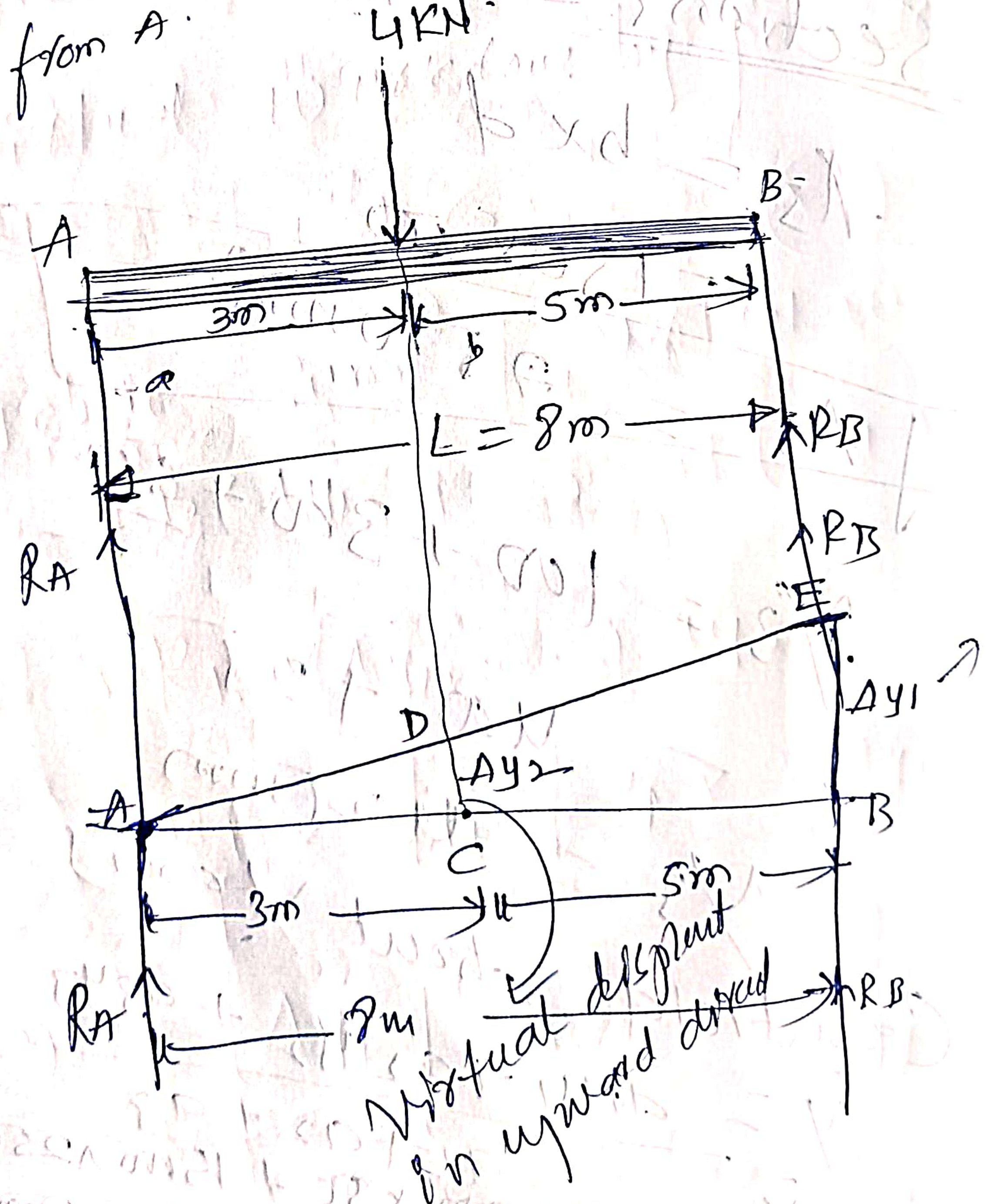
Centroid about y-axis

$$\bar{y} = \frac{a_1 y_1 + a_2 y_2 + a_3 y_3}{a_1 + a_2 + a_3}$$

$$\bar{y} = \frac{30{,}000 \times 50 + 15000 \times 250 + 7500 \times 425}{30{,}000 + 15000 + 7500}$$

$$\boxed{\bar{Y} = 160.7 \text{ mm}}$$

① Using the principle of virtual work, determine the reaction of a beam AB of span 8m. The beam carri point load of 4KN at a distance of 3 m from A.



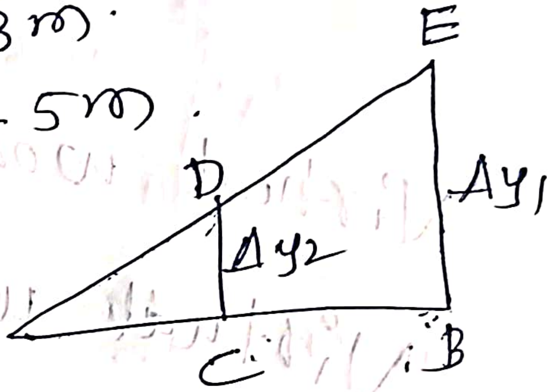
Given data

length of beam, $L = 8m$.

point load $= 4KN$.

distance from A $= 3m$.

distance from B $= 5m$.



using triangle

ΔABE, and ACD

$$\frac{AB}{AC} = \frac{BE}{CD}$$

$$\frac{8}{3} = \frac{\Delta y_1}{\Delta y_2}$$

virtual displacement in upward dirn

$$\boxed{\Delta y_2 = \frac{3}{8}\Delta y_1} \quad \text{--- (1)}$$

Algebric sum of virtual workdone

= virtual workdone by Reaction R_B + Vi

Virtual workdone by Reaction R_B =

Virtual workdone by Reaction R_A =

Virtual workdone by point load:

~~Substitut~~ (2) in eqn (1)

Algebric sum of virtual workdone

$= R_B \times \Delta y_1 + 0 + (-4 \Delta y_2)$

$= R_B \times \Delta y_1 - 4 \Delta y_2$

$= R_B \times \Delta y_1 - 4 \times \frac{3}{8} \Delta y_1$

$0 = \Delta y_1 \left[R_B - 1.5 \right]$

tual workdone by RA + Virtual workdone by point load — (1)

$$\left.\begin{array}{l} R_B \times \Delta y_1 \\ R_A \times 0 = 0 \\ -4 \times \Delta y_2 \end{array}\right\} \text{— (2)}$$

$$\frac{0}{\Delta y_1} = R_B - 1.5$$

$$0 = R_B - 1.5$$

$$\boxed{R_B = 1.5\ KN}$$

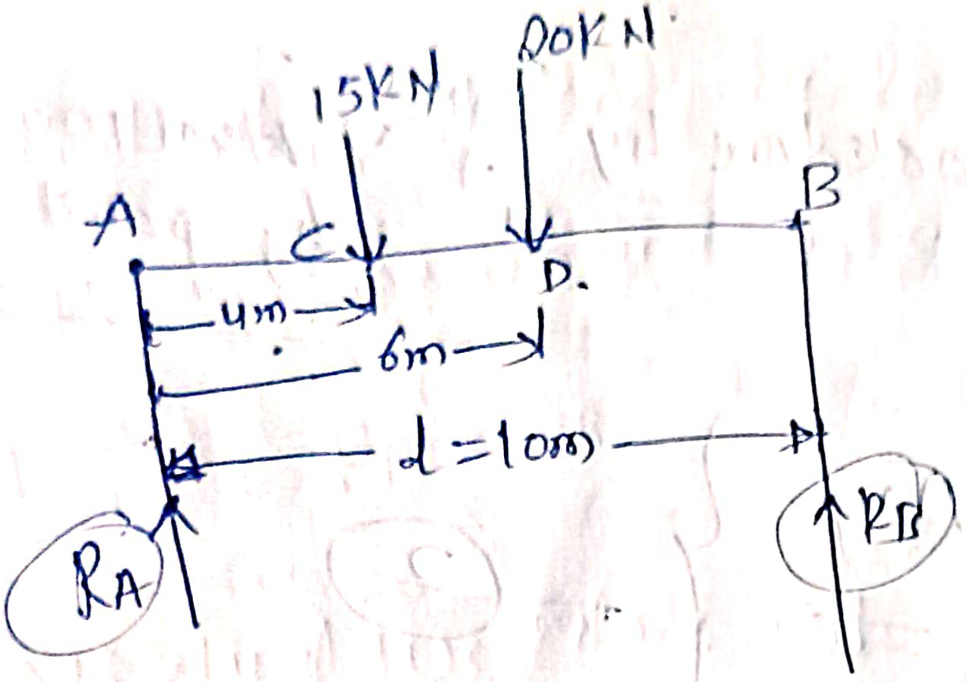
Let $R_A + R_B - 4 = 0$

$R_A + 1.5 - 4 = 0$

$R_A + (-2.5) = 0$ $\quad$ $R_A = 2.5KN$

$R_A - 2.5 = 0$

(2)



<u>Given data</u>

Total length $l = 10m$.

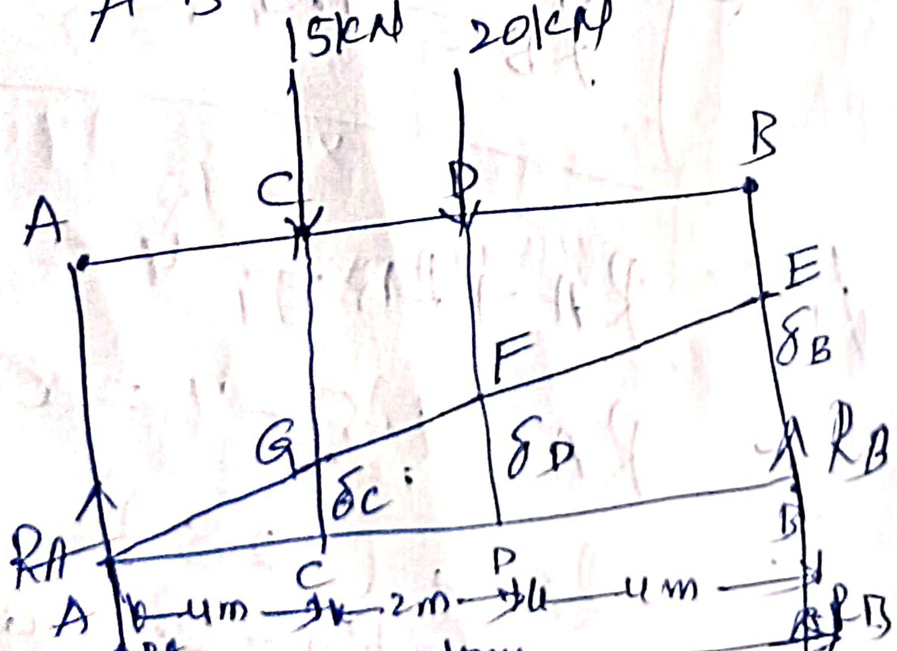
point load at $C = 15KN$.

" " " $D = 20KN$.

Distance $AC = 4m$

Distance $AD = 6m$

Dist $AB = 10m$.



Triangle ΔACG, ADF, ABE.

$$\frac{GC}{AC} = \frac{FD}{AD} = \frac{EB}{AB}.$$

$$\underset{①}{\frac{\delta_C}{4}} = \underset{②}{\frac{\delta_D}{6}} = \underset{③}{\frac{\delta_B}{10}}$$

equating ① & ③

$$\frac{\delta_C}{4} = \frac{\delta_B}{10}$$

$$\delta_C = \frac{4}{10}\delta_B$$

$$\boxed{\delta_C = 0.4\,\delta_B}$$

equating ② & ③

$$\frac{\delta_D}{6} = \frac{\delta_B}{10}$$

$$\delta_D = \frac{6}{10}\delta_B.$$

$$\boxed{\delta_D = 0.6\,\delta_B}$$

Virtual workdone by Reaction at

R_B = R_B × Virtual displacement at B

$$\boxed{R_B = R_B \times \delta_B}$$ — (1)

Virtual workdone by point lo

= − 20 × Virtual displacement at

= − 20 × δ_D

= − 20 × 0.6 δ_B

= − 12 δ_B kN-m — (2)

Virtual workdone by point lo

Virtual displacement

= − 15 × Virtual displacement

= − 15 × δ_C

= − 15 × 0.4 δ_B

= − 6 δ_B kN-m — (3)

Virtual workdone by Reaction at A.

$R_A = R_A \times$ Virtual displacement at A

$= R_A \times 0$

at D $\boxed{R_A = 0 \text{ KN-m}}$ — (II)

D total Virtual workdone. add (I)(II)(III) addi + ...

$= R_B \times \delta_B - 12\delta_B - 6\delta_B + 0$

$0 = R_B \times \delta_B - 18\delta_B$

at C $R_B \times \cancel{\delta_B} = 18 \cancel{\delta_B}$

at C $\boxed{R_B = 18 \text{ kN}}$

kit $R_A + R_B - 15 - 20 = 0$

$R_A + 18 - 15 - 20 = 0$

$\boxed{R_A = 8 \text{ kN}}$