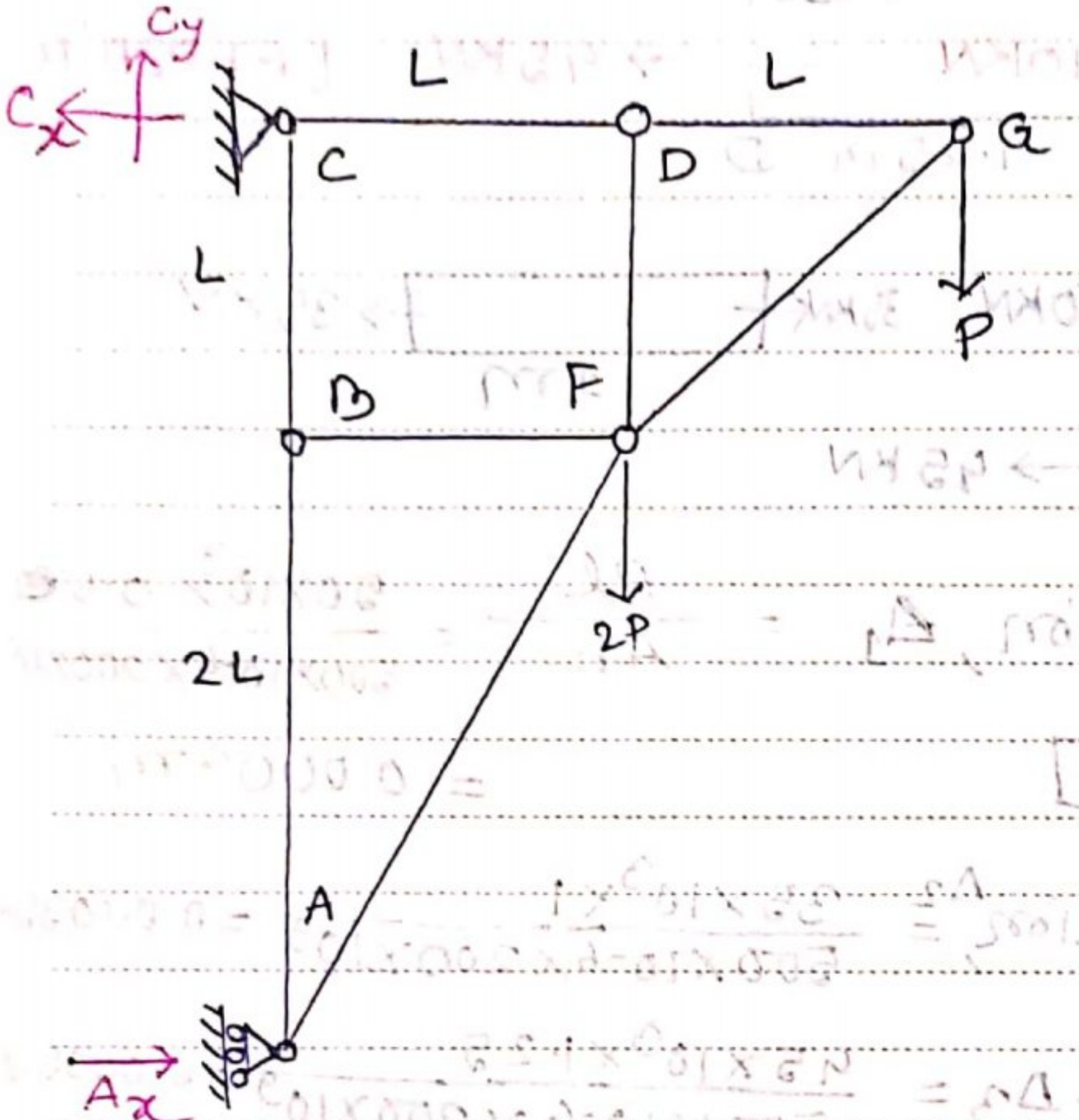
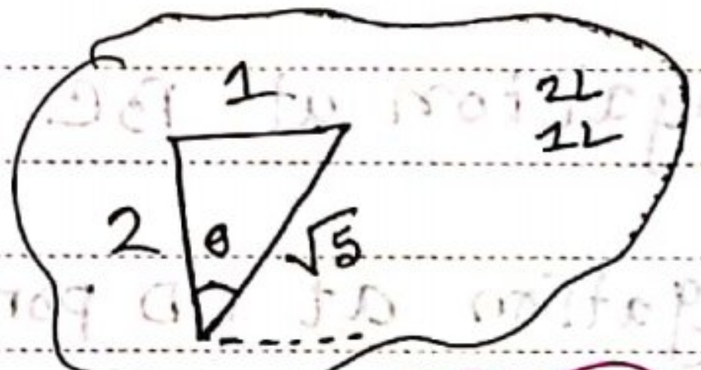
(2) The pinned member shown in below figure carry the loads P & 2P. All bars have cross sectional area A_0. Determine the stresses in bars AB & AF. [BEPZA'16]

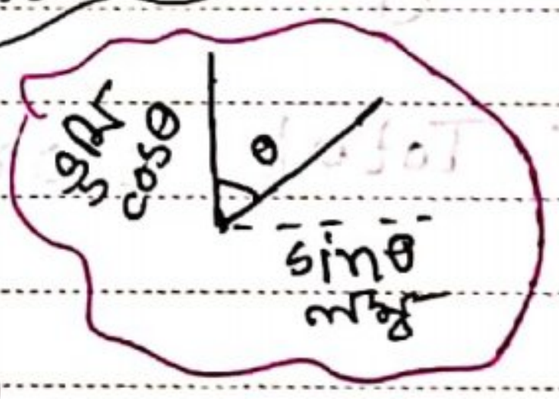


Pinned/hinge
$R_x = 1$
$R_y = 1$

Roller
$R_y = 1$

fixed support
$R_x = 1$
$R_y = 1$
$M = 1$





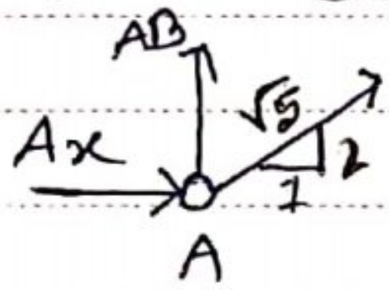
Soln:

Taking moment about C,

$\curvearrowleft \Sigma M_C = P \times 2L + 2P \times L - A_x \times 3L = 0$

$\therefore A_x = \frac{4PL}{3L} = 4/3P$

Free body diagram of point A

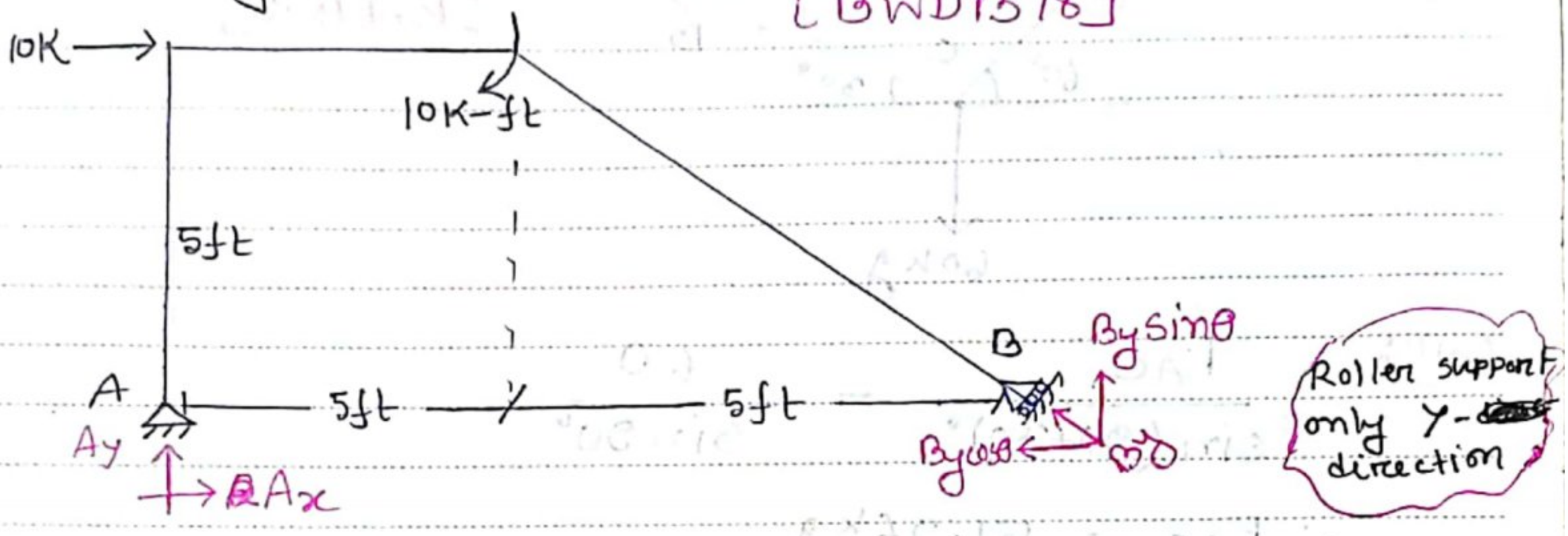


$\Sigma F_x = \frac{4P}{3} + AF \times \frac{1}{\sqrt{5}} = 0 \quad \therefore AF = -\frac{4P\sqrt{5}}{3}$

$\Sigma F_y = AB + \frac{2}{\sqrt{5}} AF = 0 \quad \therefore AB = \frac{8P}{3}$

$\therefore$ Stress $\sigma_{AF} = \frac{-4P\sqrt{5}}{3A}$, $\sigma_{AB} = \frac{-8P}{3A}$

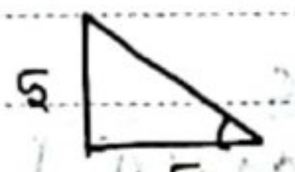
(Q4) Calculate the reactions at supports for the following structure. [BWDB'18]



Soln:

$+ve\circlearrowleft \Sigma M_A = 0$

$\Rightarrow 10\times5 + 10 - By\sin\theta \times 10 = 0$



$\theta = \tan^{-1}\frac{5}{5}$

$= 45°$

$\Rightarrow By = \frac{60}{10\sin45} = \frac{6}{\sin45} = 6\sqrt{2}k$

$\Sigma F_y = 0$

$\Rightarrow Ay + By\sin45 = 0$

$\Rightarrow Ay = -6\sqrt{2}\sin45 = -6k \ (\downarrow)$

$\Sigma F_x = 0$

$\Rightarrow Ax + 10 - 6\sqrt{2}\cos45° = 0$

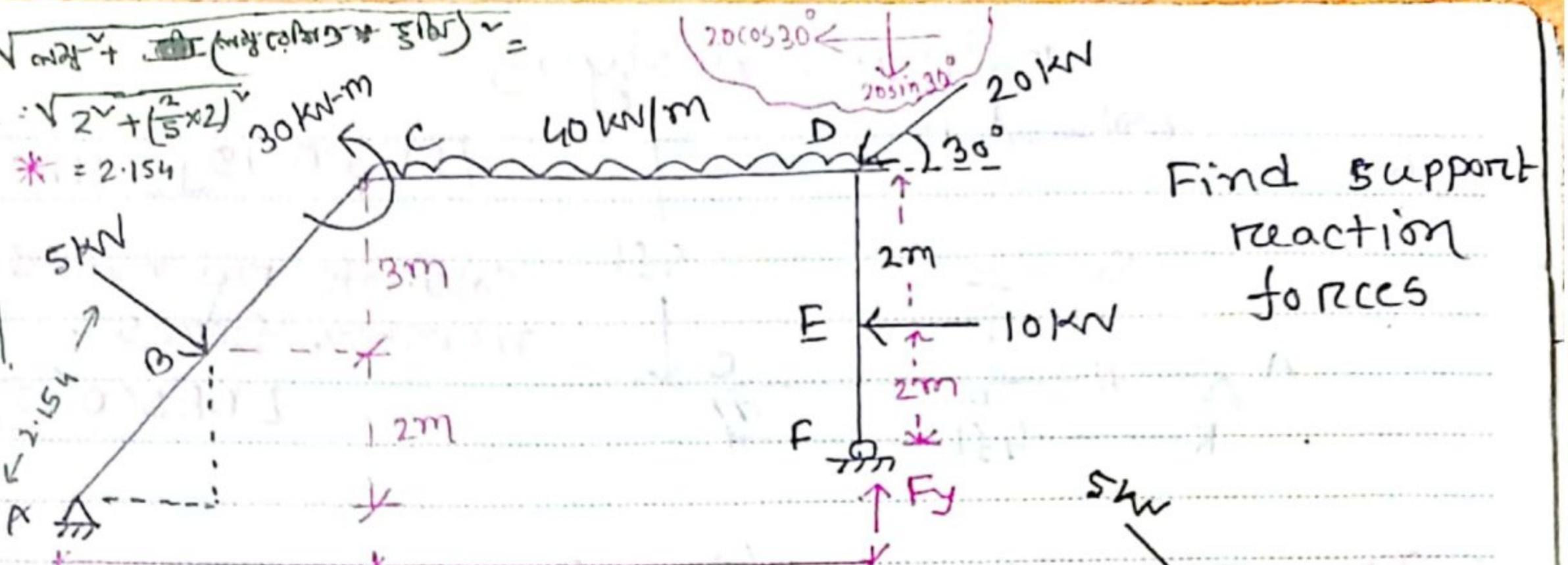
$Ax = 6\sqrt{2}\cos45° - 10 = -4k \ (\leftarrow)$

$\sqrt{\text{ }^2 + \text{ }^2} = \sqrt{2^2 + (\frac{2}{5}\times 2)^2}$

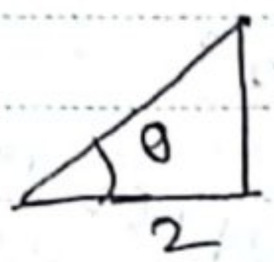
$= \sqrt{2^2 + (\frac{2}{5}\times 2)^2}$

$= 2.154$

Find support reaction forces

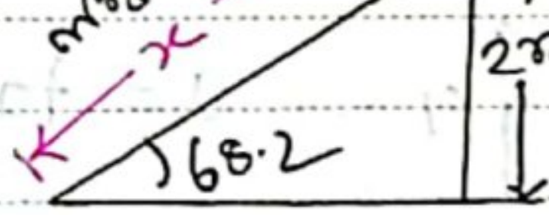


Soln:



$\theta = \tan^{-1}\frac{5}{2}$

$= 68.2°$



$\sin 68.2 = \frac{2}{x}$

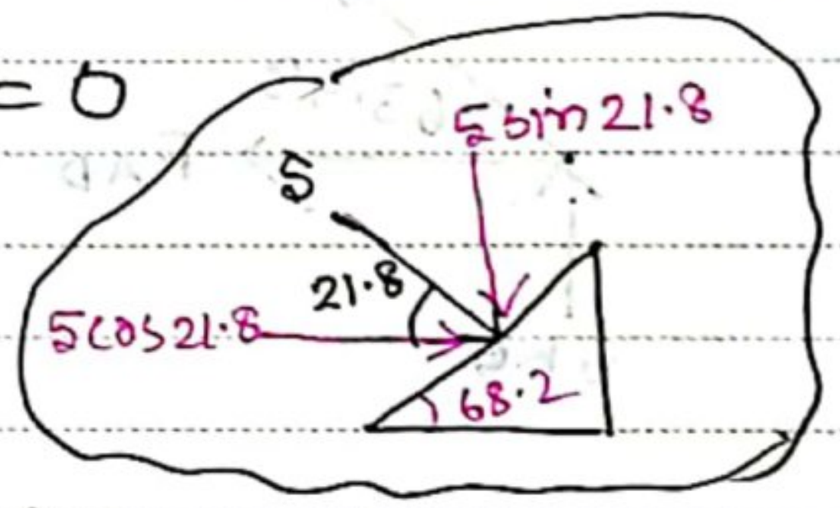
$\therefore x = \frac{2}{\sin 68.2}$

$\Sigma M_A = 0$ (+ve)

$\Rightarrow 5\times \frac{2}{\sin 68.2} - 30 + [40\times 4\times(\frac{4}{2}+2)] - 20\cos 30°\times 5$

$+ 20\sin 30°\times 6 - 10\times 3 - F_y\times 6 = 0$

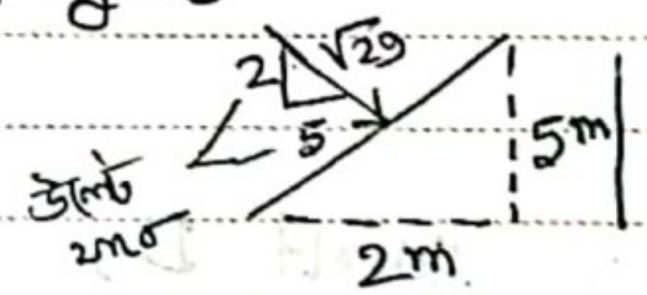
$\therefore F_y = 94.03\,KN(\uparrow)$



$\Sigma F_y = 0\,(\uparrow)$, $\frac{2}{\sqrt{29}}\times 5$

$\Rightarrow A_y - 5\sin 21.8° - 40\times 4 - 20\sin 30° + F_y = 0$

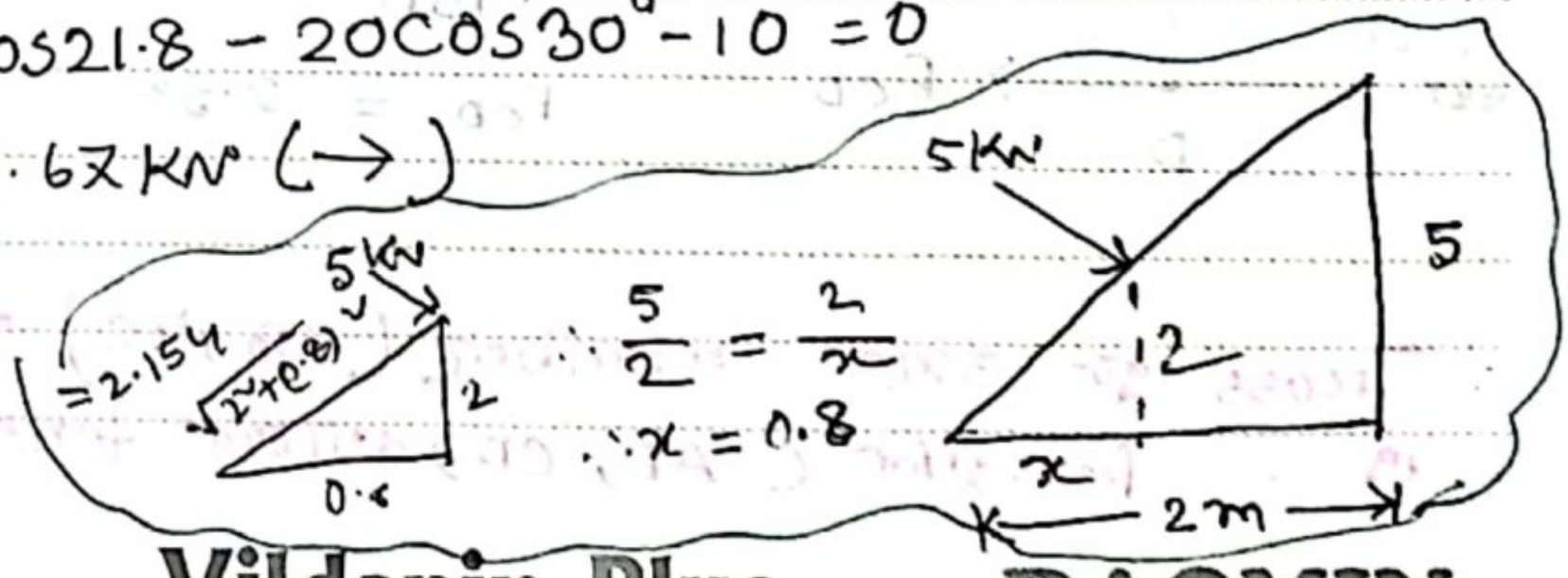
$\Rightarrow A_y = 77.83\,KN$



$\Sigma F_x = 0\,(\rightarrow\leftarrow)$

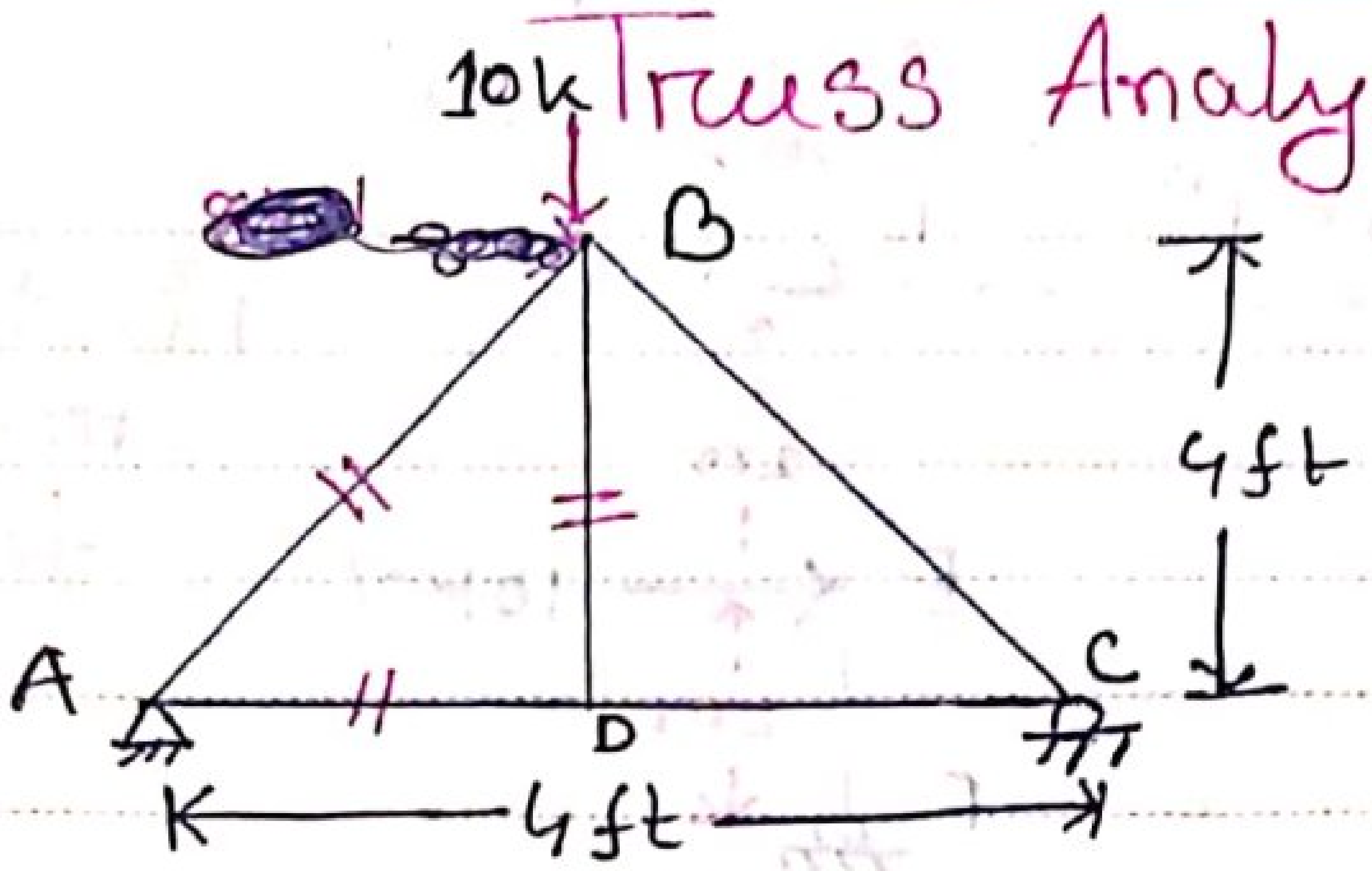
$\Rightarrow A_x + 5\cos 21.8 - 20\cos 30° - 10 = 0$

$\therefore A_x = 22.67\,KN(\rightarrow)$



Truss Analysis

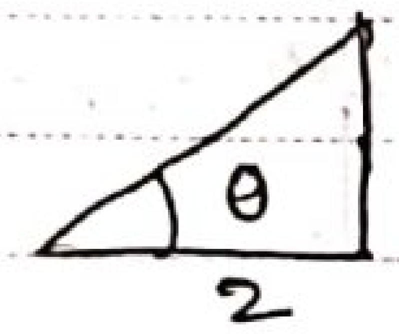
*(6)



[DESCO'19] [BIFPCL'21]

Calculate red marked member forces. [DESCO'19]

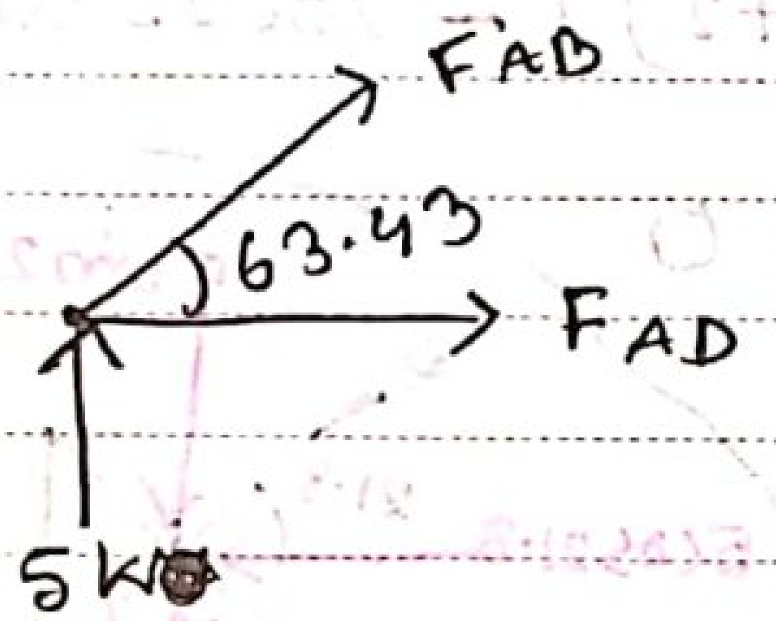
Soln: $R_{Ay} = R_{cy} = 5k(\uparrow)$; $R_{Ax} = 0$



$\therefore \theta = \tan^{-1}\frac{4}{2} = 63.43°$

BIFPCL এ stress চেয়েছিল। তো, আমরা জানি $\frac{Force}{unit\ area} = stress$

At joint A,



$\Sigma F_y = 0$

$\therefore F_{AB}\sin 63.43 = -5$

$\Rightarrow F_{AB} = -5.6k$

$= 5.6k$ (compression)

$\Sigma F_x = 0$

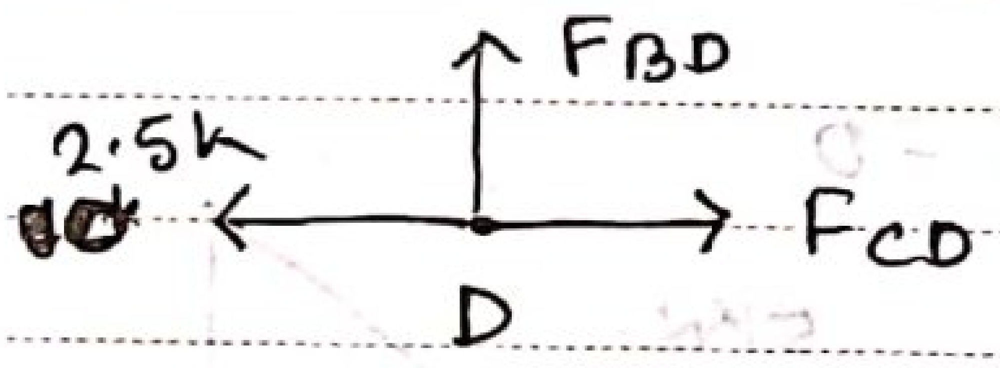
$\therefore F_{AD} + F_{AB}\cos 63.43 = 0$

$\Rightarrow F_{AD} = -F_{AB}\cos 63.43$

$= -(-5.6)\cos 63.43$

$= 2.5k$ (tension)

At joint D,

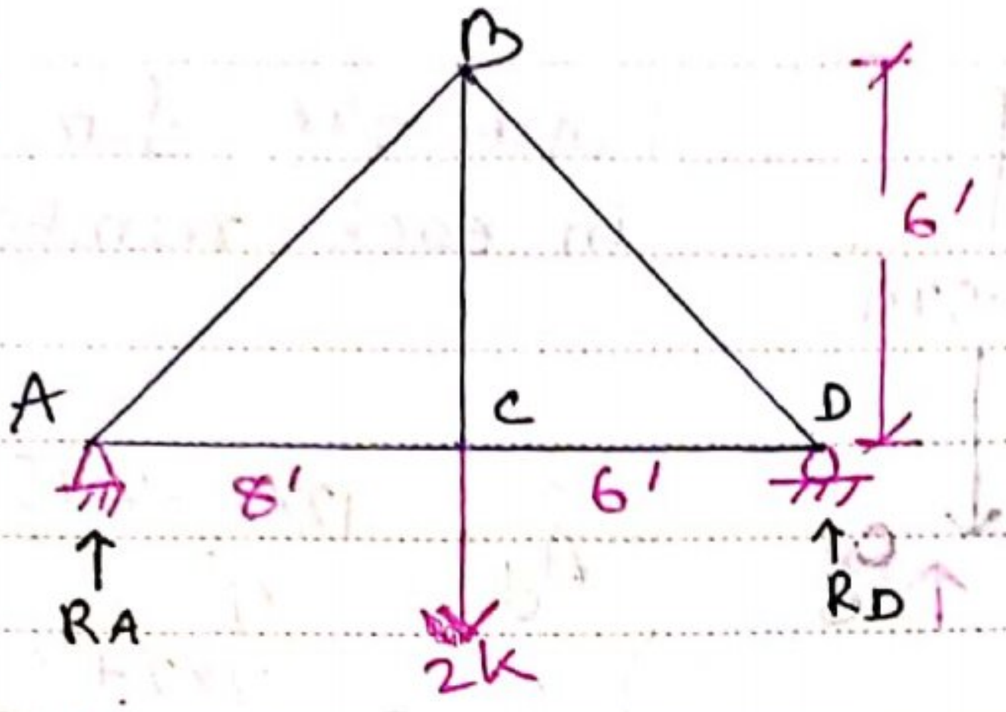


$\therefore F_{BD} = 0$

$F_{CD} = 2.5k$ A

Truss এর উপরের member (AB, BC) গুলোতে compression এ, নিচেরগুলো (AD, CD) গুলোতে tension এ।

(Q7)



Find the axial force for the member AB & AC.

[Titas '18]

Soln:

$\theta = \tan^{-1}\frac{6}{8} = 36.87^\circ$

$\Sigma M_D = 0$

$\therefore R_A \times 14 = 2 \times 6$

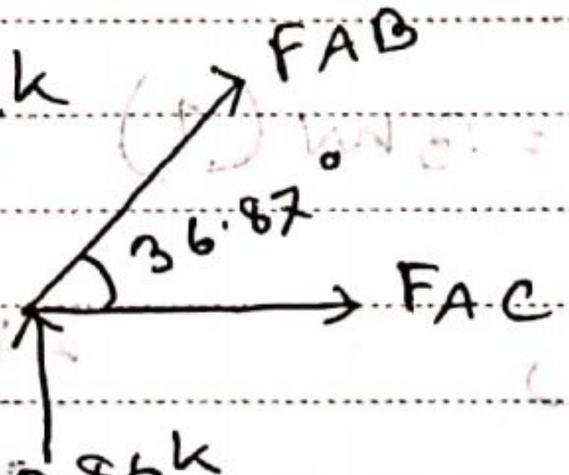
$\therefore R_A = 0.86k$

$\therefore R_D = 2 - 0.86 = 1.14k$

$R_A = 2 \times \frac{6}{8+6} = 0.86k$

$R_D = 2 - 0.86 = 1.14k$

At joint A,



$\Sigma F_y = 0$

$\therefore 0.86 + F_{AB}\sin 36.87 = 0$

$\therefore F_{AB} = -1.43k$

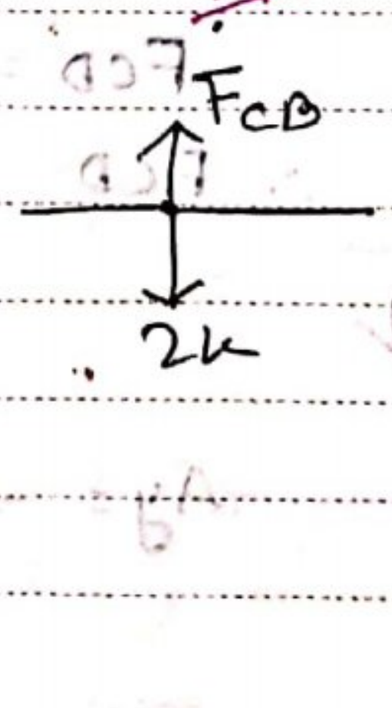
$= 1.43k$ (compression)

$\Sigma F_x = 0$

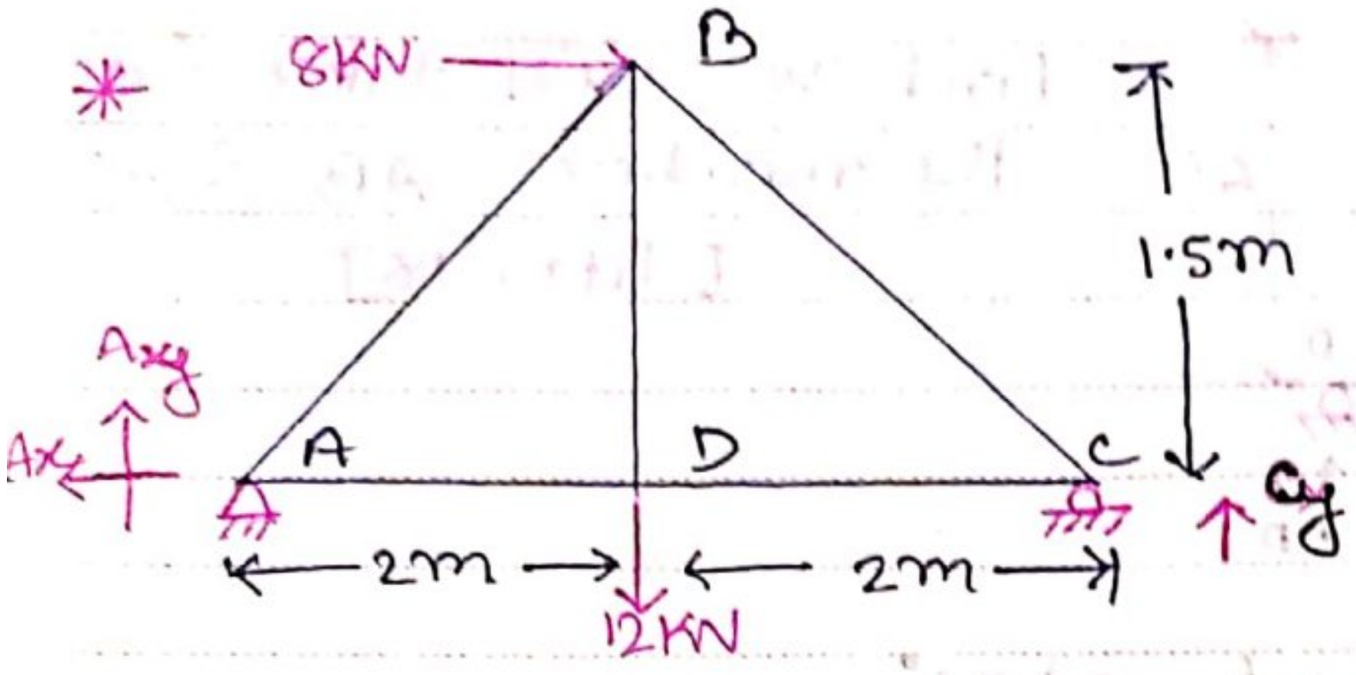
$F_{AC} + F_{AB}\cos 36.87 = 0$

$\Rightarrow F_{AC} - 1.43\cos 36.87 = 0$

$\Rightarrow F_{AC} = 1.146k$ (T)



$F_{CB} = 2k$ (T)



Find the forces in each member.

$A_y = \frac{12\times2 - 8\times1.5}{4} = 3$

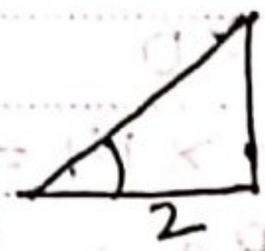
$C_y = \frac{12\times2 + 8\times1.5}{4} = 9$

Soln:

$\Sigma M_A = 0$

$\Rightarrow C_y \times 4 = 8\times1.5 + 12\times2$

$\therefore C_y = 9KN(\uparrow)$

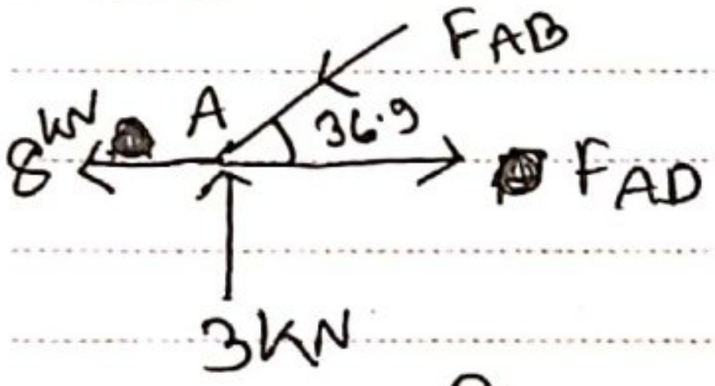


$\theta = \tan^{-1}\frac{1.5}{2}$

$= 36.9°$

$A_y = 12 - 9 = 3KN(\uparrow)$; $A_x = 8KN(\leftarrow)$

At joint A,

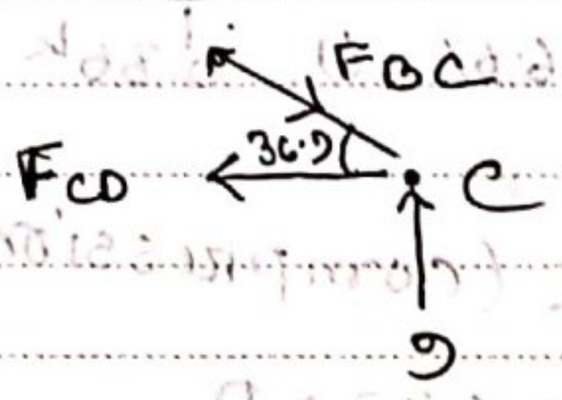


$F_{AB} = \frac{3}{\sin 36.9} = 5KN(C)$

$F_{AB}\cos 36.9 + 8 = F_{AD}$

$\Rightarrow F_{AD} = 12KN(T)$

At joint C



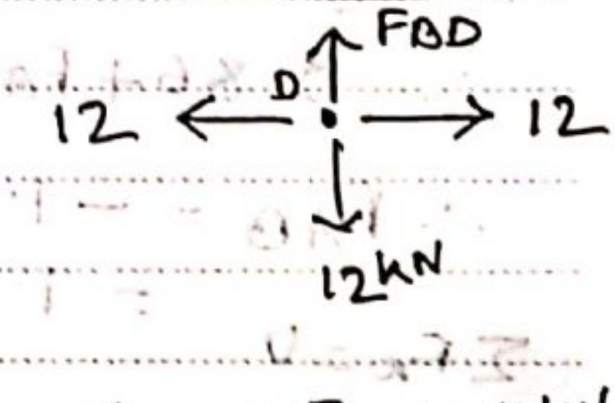
$\Rightarrow F_{BC} = \frac{9}{\sin 36.9}$

$F_{BC} = 15N(C)$

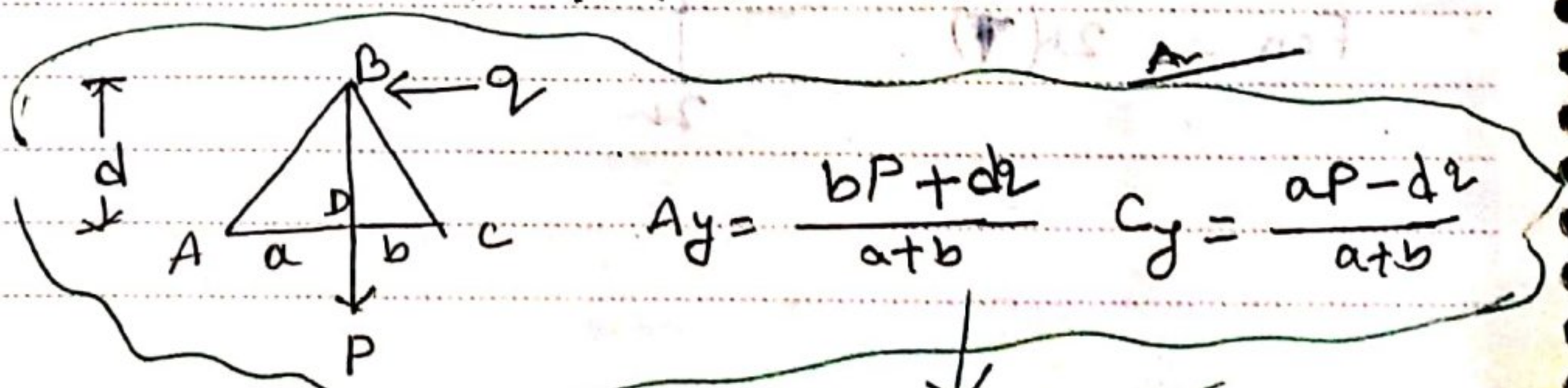
$F_{CD} = 15\cos 36.9$

$\therefore F_{CD} = 12N(T)$

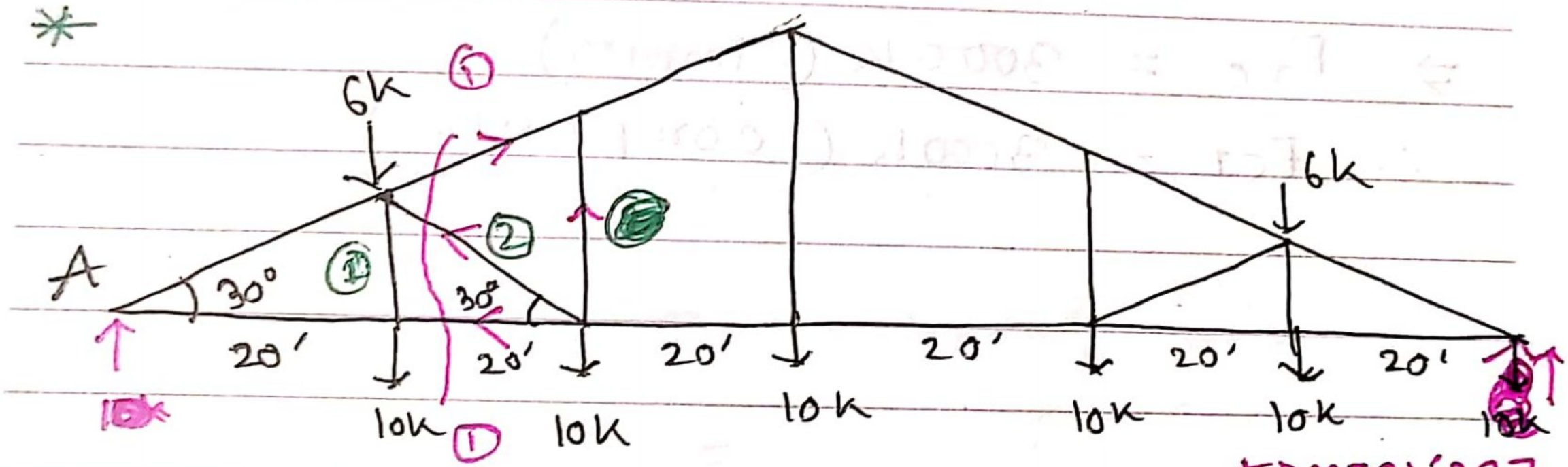
At joint D



$\therefore F_{BD} = 12KN(T)$



$A_y = \frac{bP + dQ}{a+b}$ $C_y = \frac{aP - dQ}{a+b}$



[DMTCL'22]

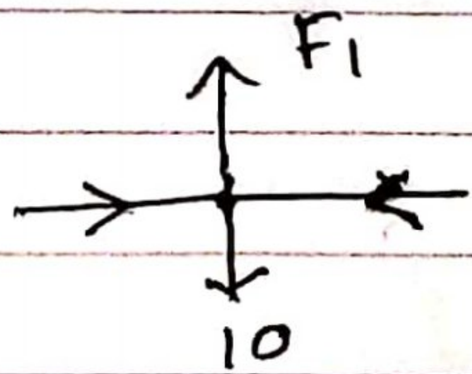
Soln:

$\Rightarrow M_A = 0$

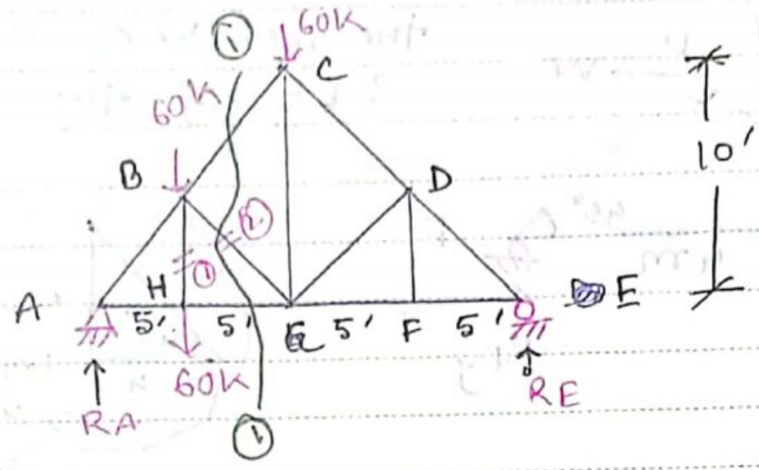
$\Rightarrow 16 \times 20 - F_2 \sin 30^\circ \times 40 = 0$

$\therefore F_2 = 16k$ (compression)

$F_1 = 10k$ (Tension)



Q.8 calculate the load at member 1 & 2 [BCIC'17]



Solⁿ: $\Sigma M_A = 0$

$\therefore R_E \times 20 = 60\times10 + (60+60)\times5$

$\Rightarrow R_E = 60k$

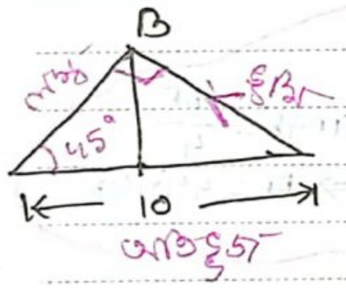
$\therefore R_A = 3\times60 - 60 = 120k$

From left portion of section

$\Sigma M_A = 0$,

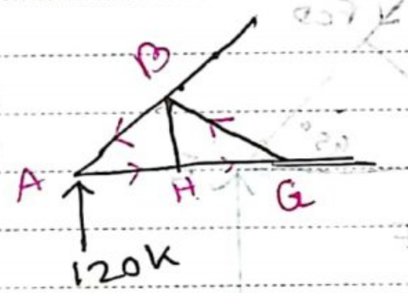
$F_{BG}\times10\sin45^\circ = 120\times5$

$\Rightarrow F_{BG} = 60\sqrt{2}\,k$ (C) Ans:

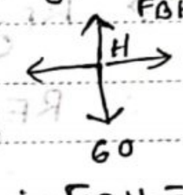


$\sin\theta = \frac{\text{opp}}{10}$

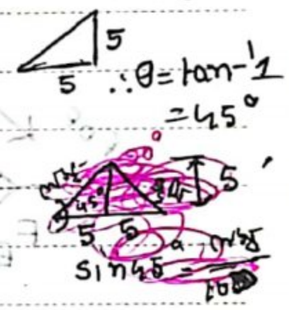
$\therefore \text{opp} = 10\sin45^\circ$



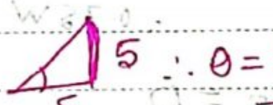
at joint H



$\therefore F_{BH} = 60k$ (T)

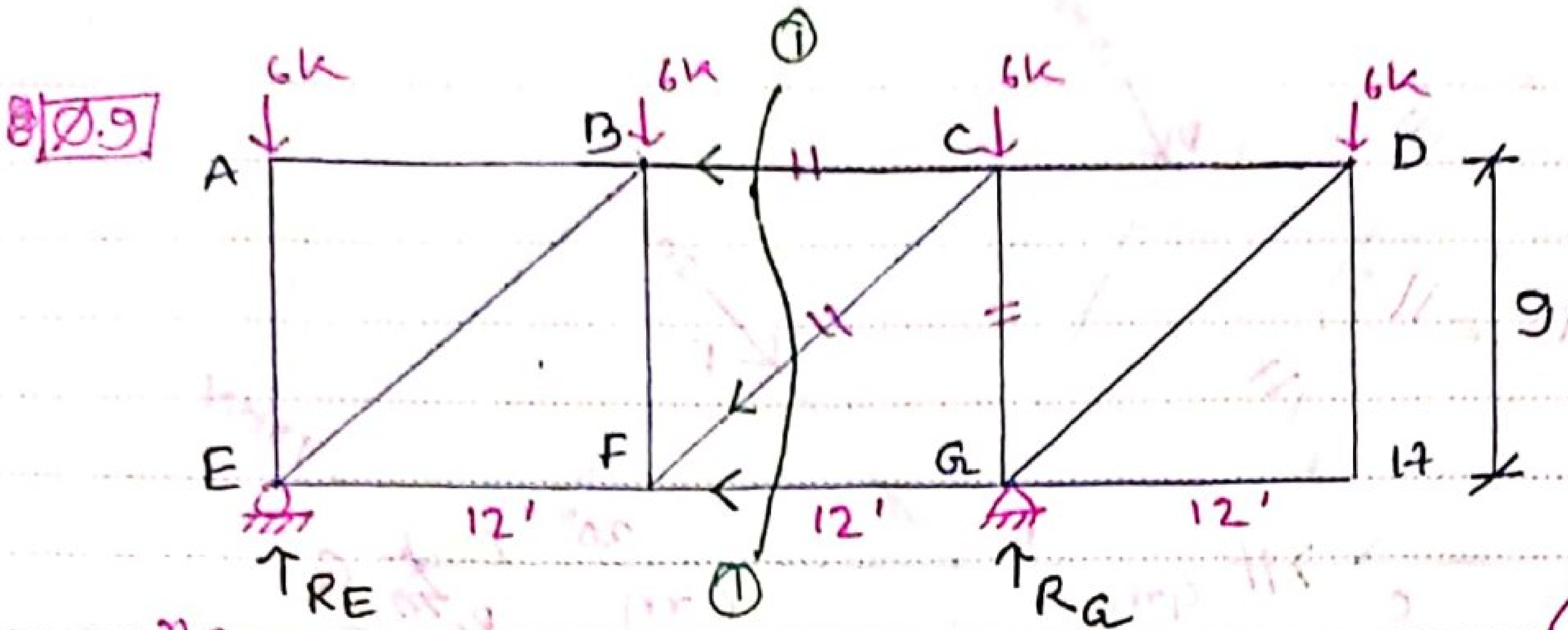


$\therefore \theta = \tan^{-1}1 = 45^\circ$

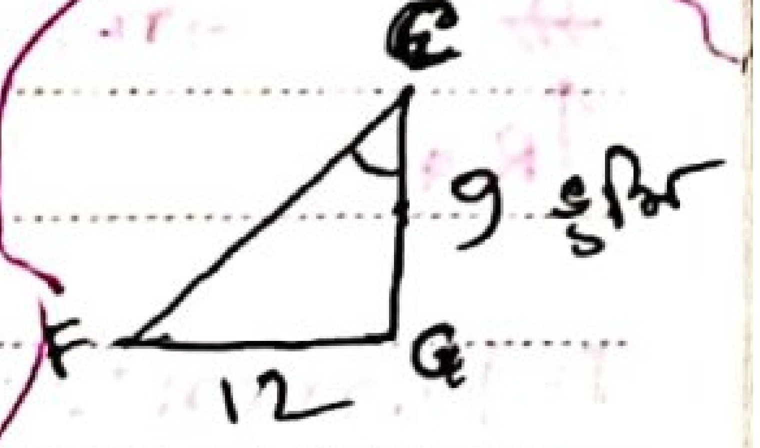


$\therefore \theta = \tan^{-1}1 = 45^\circ$

Q.9



Find the forces of BC, CF, CG [BPDB'15]



তাহলে $\theta = \tan^{-1}\frac{12}{9} = 53.13$

Sol^n:

Taking moment about E,

$\Sigma M_E = 0$

$\Rightarrow R_G \times 24 = 6\times36 + 6\times24 + 6\times12$

$\Rightarrow R_G = 18k$

$\therefore R_E = 6\times4 - 18 = 6k$

Now, $\Sigma M_F = 0$ [+ve ↺] (left side of the section)

$\Rightarrow R_E \times 12 - 6\times12 - F_{BC}\times9 = 0$

$\therefore F_{BC} = 0$

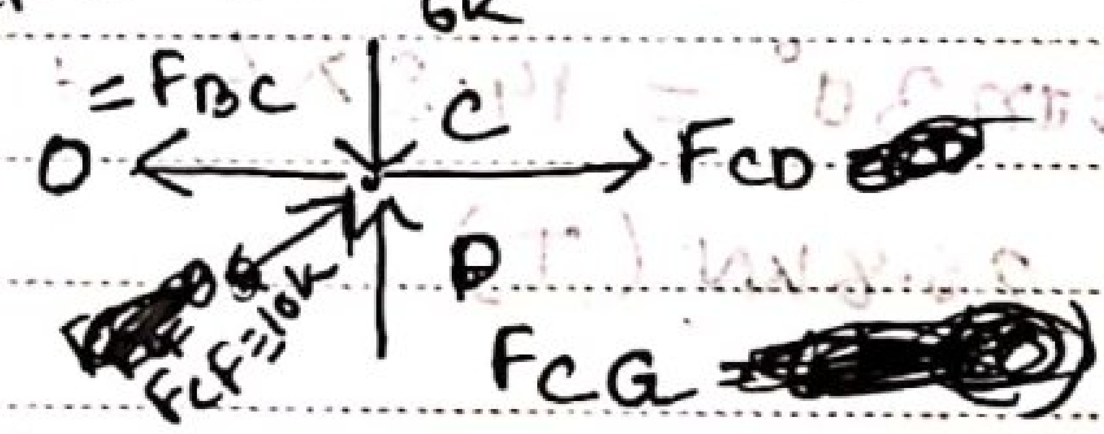
Now, $\Sigma M_G = 0$ [+ve ↺]

$-6\times12 - F_{BC}\times9 - F_{CF}\sin53.13\times9 = 0$

$-6\times24 + R_E\times24$

$\Rightarrow F_{CF} = -10k = 10k$ (compression)

At joint C,



$F_{CG} = 6 + F_{CF}\cos53.13$

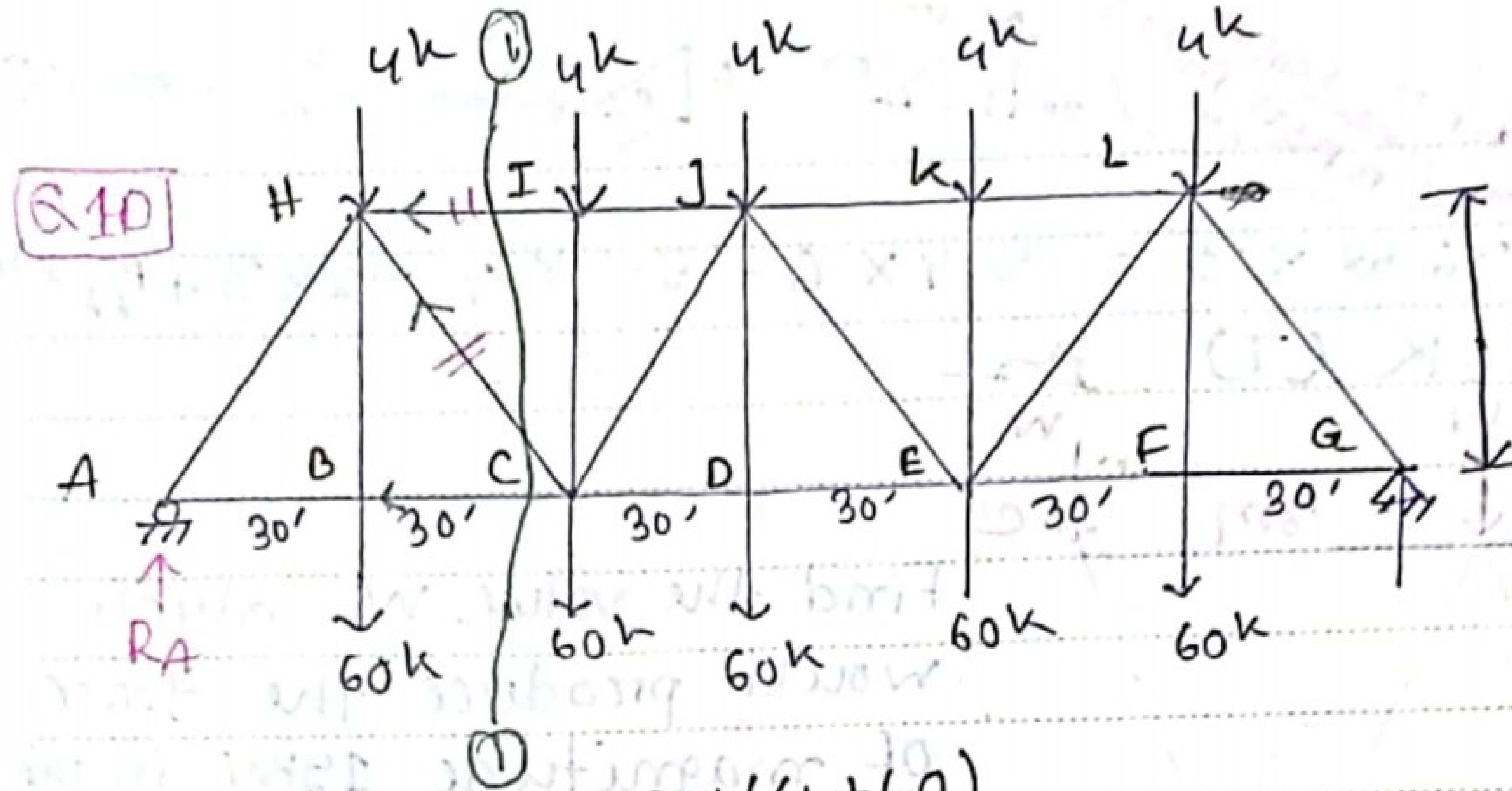
$= 6 - 10\cos53.13 = $ k

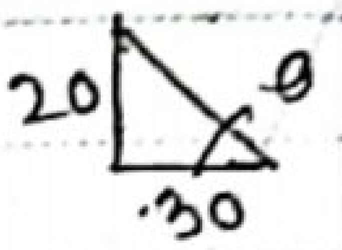
section এ member force আছে F_{BC}, F_{CF}, F_{GF}. F point এ moment নিলে শুধু F_{BC} এবং external load গুলো আসবে কারণ বাকি member force সব F point এ গিয়ে মিলে তাই গুণ করার হিসাব লাগে হবে না। কারণ লম্ব দূরত্ব zero.

similarly G এ moment নিলে free হবে F_{FC}, F_{BC} বাকি সব zero হয়ে যাবে।

Q10

[GTCL'18]





$\theta = \tan^{-1}\frac{20}{30}$

$= 33.7°$

Solⁿ: $R_A = \frac{5\times(4+60)}{2} = 160k$

~~Taking moment about section 1-1, of the left side of section 1-1 [B তে নিলে F_{BC}, F_{CH} cancel হবে, যাবে। A তে নিলে ...]~~

~~$\Sigma M_A = 0$~~

⇒ Taking moment about the left portion of point C. [C তে নিলে F_{BC}, F_{CH} cancel হবে, যাবে]

$\therefore \Sigma M_C = 0$

$\Rightarrow 160\times60 - 64\times30 - F_{HI}\times20 = 0$

$\Rightarrow F_{HI} = 384k$

$\therefore F_{HI} = 384k\ (T)$

$\Sigma M_B = 0$ (F_{BC} cancelled)

$\Rightarrow 160\times30 - HI\times20 - CH\sin33.7\times30 = 0$

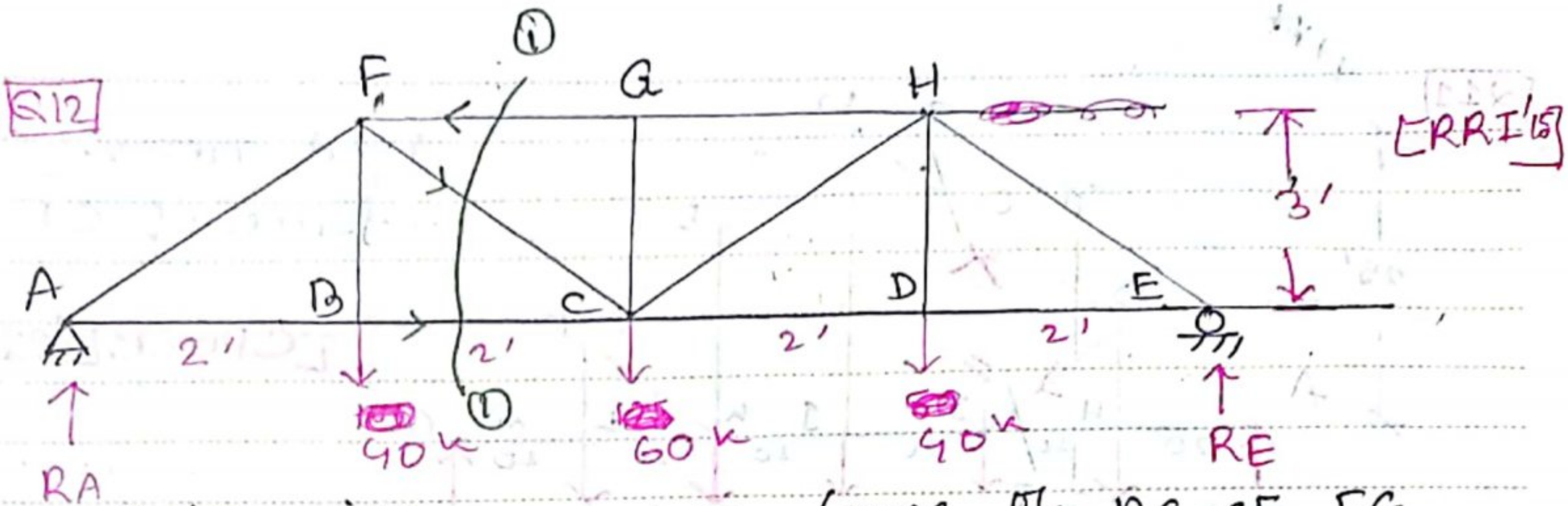
$\Rightarrow 160\times30 - 384\times20 - CH\sin33.7\times30 = 0$

⇒ ~~CH = 749.76k (T)~~

$CH = -173.02k$

$= 173.02k\ (T)$

S12



Determine member force of BC, CF, FG

Soln:

$$R_A = \frac{40+60+40}{2} = 70^K$$

From left side of 1-1 section,

$\Sigma M_F = 0$

$\therefore 70 \times 2 = F_{BC} \times 3$

$\therefore F_{BC} = 46.67^K (T)$

$\Sigma M_B = 0$

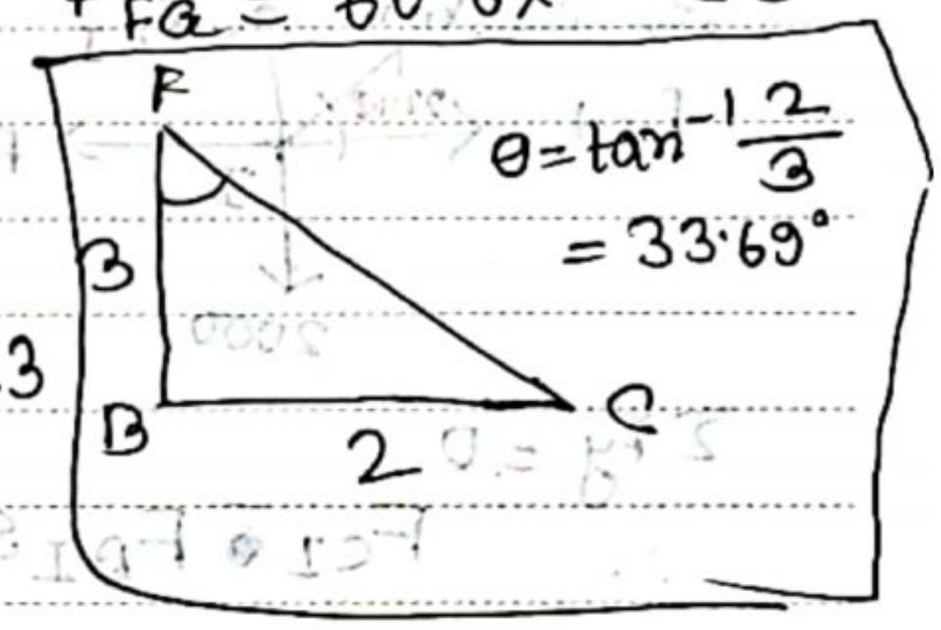
$\Rightarrow 70 \times 2 - F_{FG} \times 3 + F_{FC} \sin 33.69 \times 3 = 0$

$\therefore F_{FC} = 36.06^K (T)$

$\Sigma M_C = 0$

$\therefore 70 \times 4 - 40 \times 2 - F_{FG} \times 3 = 0$

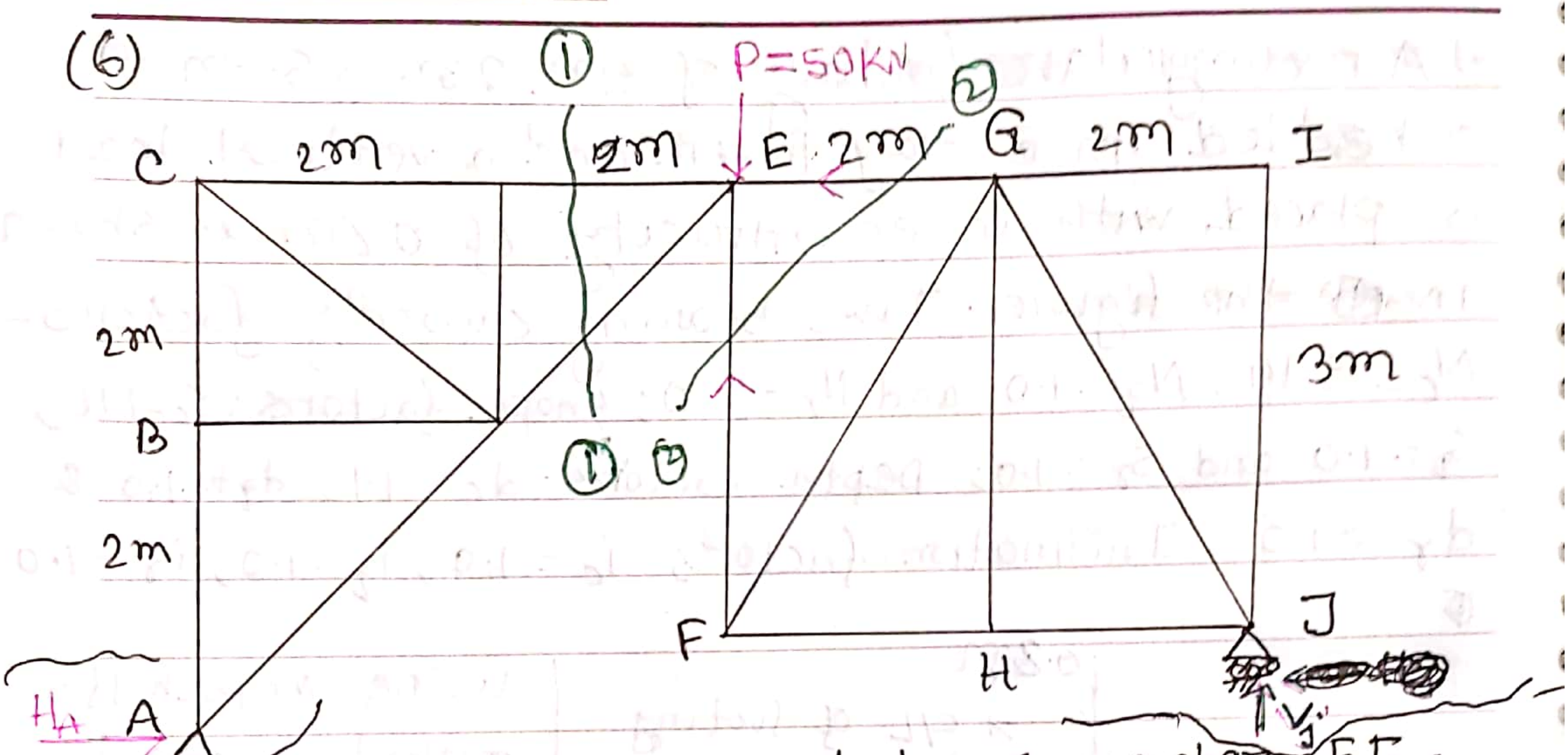
$\therefore F_{FG} = 66.67^K (C)$



Date : / /

Sun	Mon	Tue	Wed	Thu	Fri	Sat

(6)



Calculate the mangnitude of member EF.

[DMTCL Line5South]

Sol^n

$\Sigma M_J = 0$

$\Rightarrow V_A \times 8 - H_A \times 1 - 50 \times 4 = 0$

$\Rightarrow 8V_A - H_A = 200$ ——— (i)

Take left side of section 1-1,

$\Sigma M_E = 0$

$\therefore V_A \times 4 - H_A \times 4 = 0$

$\therefore V_A = H_A$ ——— (ii)

$\therefore$ From eqn (i)

$7V_A = 200 \quad \therefore V_A = 28.57$ KN

$\therefore V_J = 50 - 28.57 = 21.43$ KN

Consider right side of section 2-2,

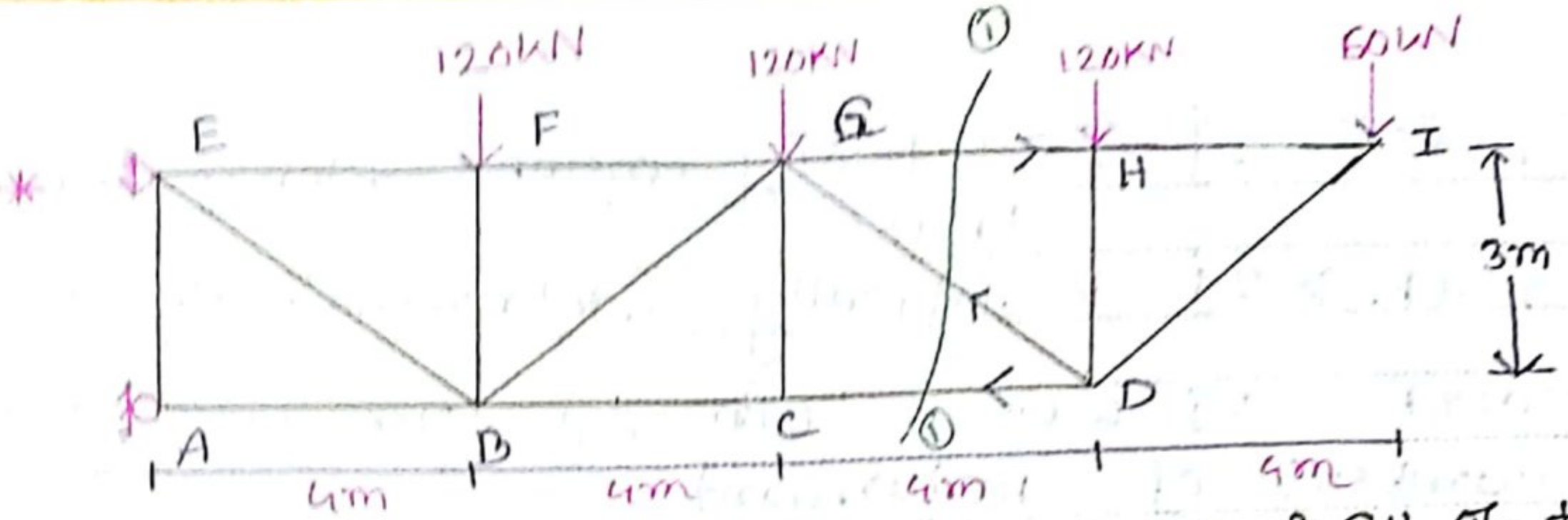
$\Sigma M_G = 0$

$\therefore V_J \times 2 = F_{FE} \times 2$

$\therefore F_{FE} = V_J = 21.43$ KN (T)

$\therefore EF = 21.43$ KN (C)

force at



Determine the forces in members CD, DG, & GH of truss shown in this figure.

Solⁿ:

$\Sigma M_D = 0$

$\Rightarrow 3 \times F_{GH} + 60 \times 4 = 0$

$\therefore F_{GH} = -80KN$

$\therefore F_{GH} = 80KN$ (C)

$\Sigma M_G = 0$

$\Rightarrow 120 \times 4 + 60 \times 8 + F_{CD} \times 3 = 0$

$\therefore F_{CD} = -320KN$

$\therefore F_{CD} = 320KN$ (T)

$\theta = \tan^{-1}\frac{3}{4} = 36.87$

$\Sigma M_C = 0$

$\Rightarrow 60 \times 8 + 120 \times 4 + F_{GH} \times 3 - F_{GD} \sin 36.87 \times 4 = 0$ (-80KN)

$\therefore F_{GD} = 300KN$ (C)

Stability of trusses:

$m + R < 2j \rightarrow$ statically unstable truss

$m + R \geq 2j \rightarrow$ statically stable truss

Stable truss / structure হইলেই খালি চোখে কষে সহজেই solve করা যায়না., কষ্ট structure, statically determinate হইলে সহজেই solve করা যায়, indeterminate হইলে solve করা কঠিন।

m = no. of members
R = total reaction forces
j = no. of joints

P.T.O

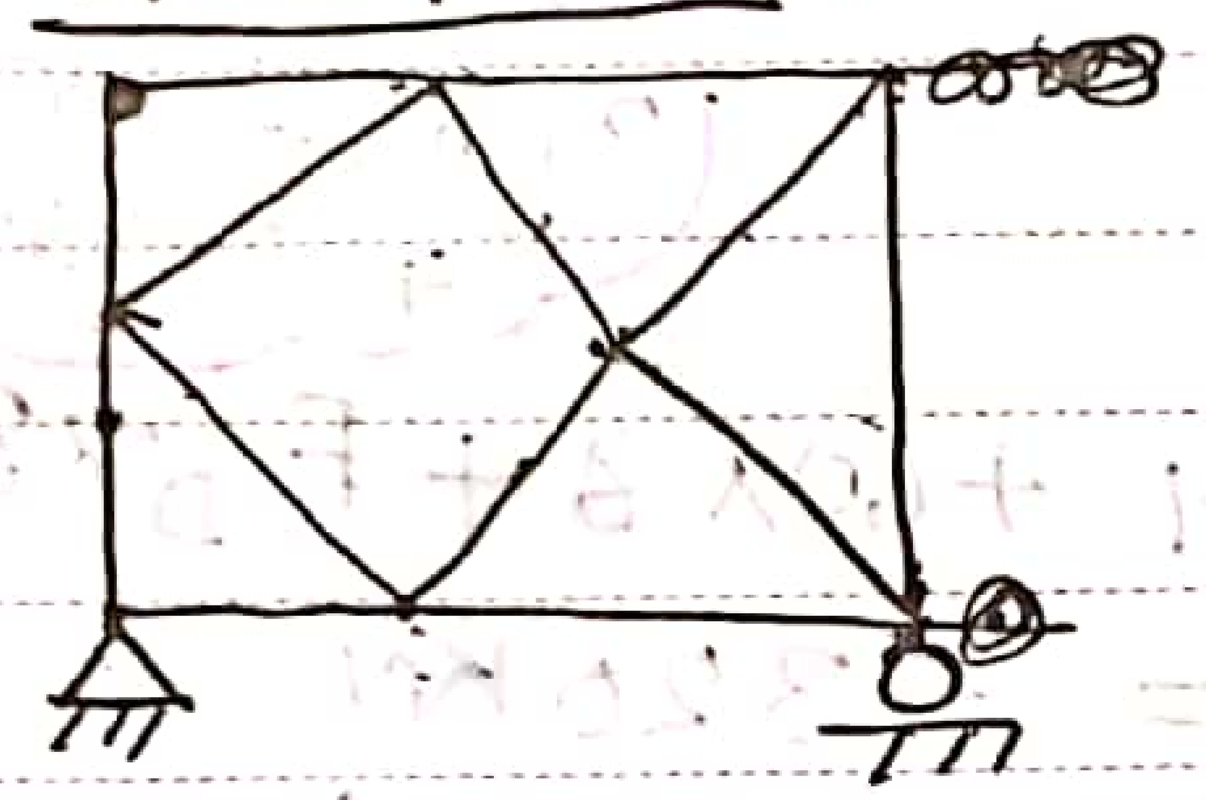
$m+R = 2j \Rightarrow$ statically ~~unstable~~ determinate truss

$m+R > 2j \Rightarrow$ statically indeterminate truss.

* $m+R$, $2j$ থেকে যত বেশি হবে তত হবে number of redundants

Examples :

①



$m+r = 13+3 = 16$

$2j = 2\times 8 = 16$

$\therefore$ stable & determinate

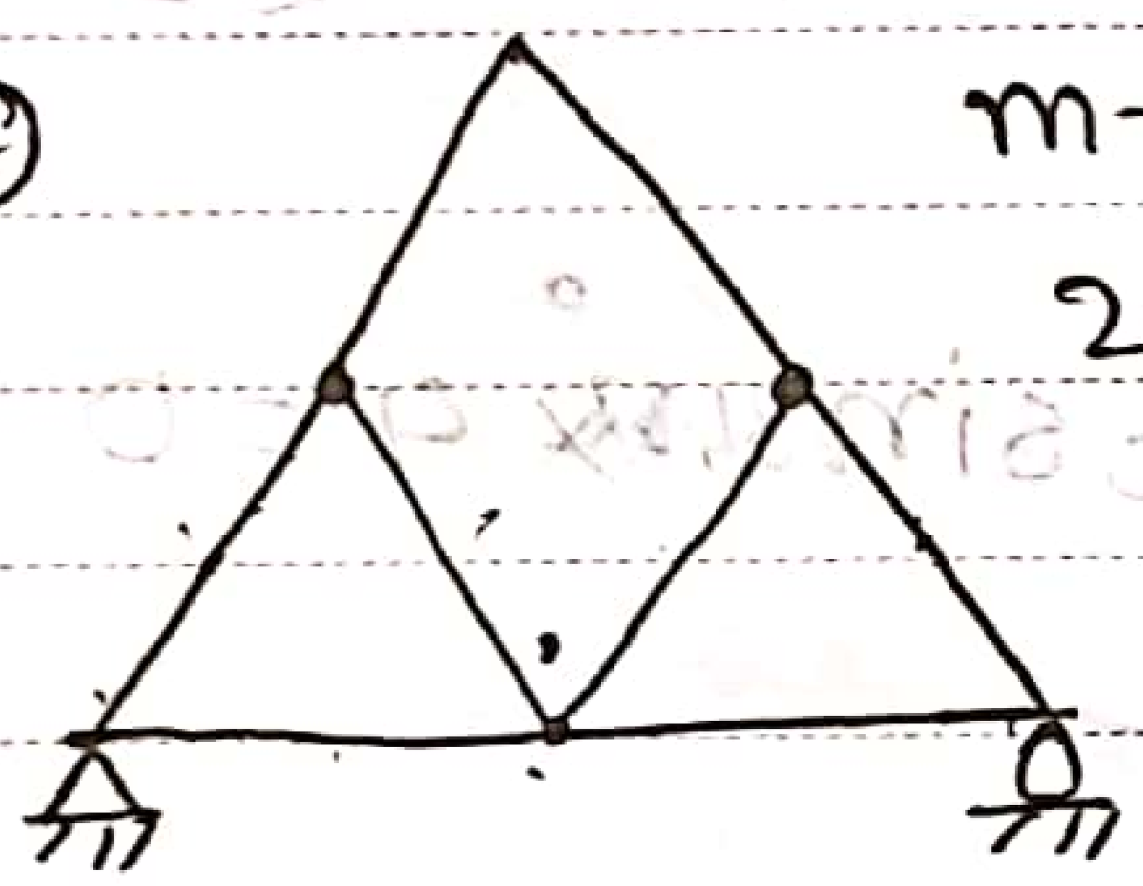
△ ⇒ ↑→ 2টো

○ ⇒ ↑ 1টো

$\therefore r = 3$টে

[MSc' 2019]

②

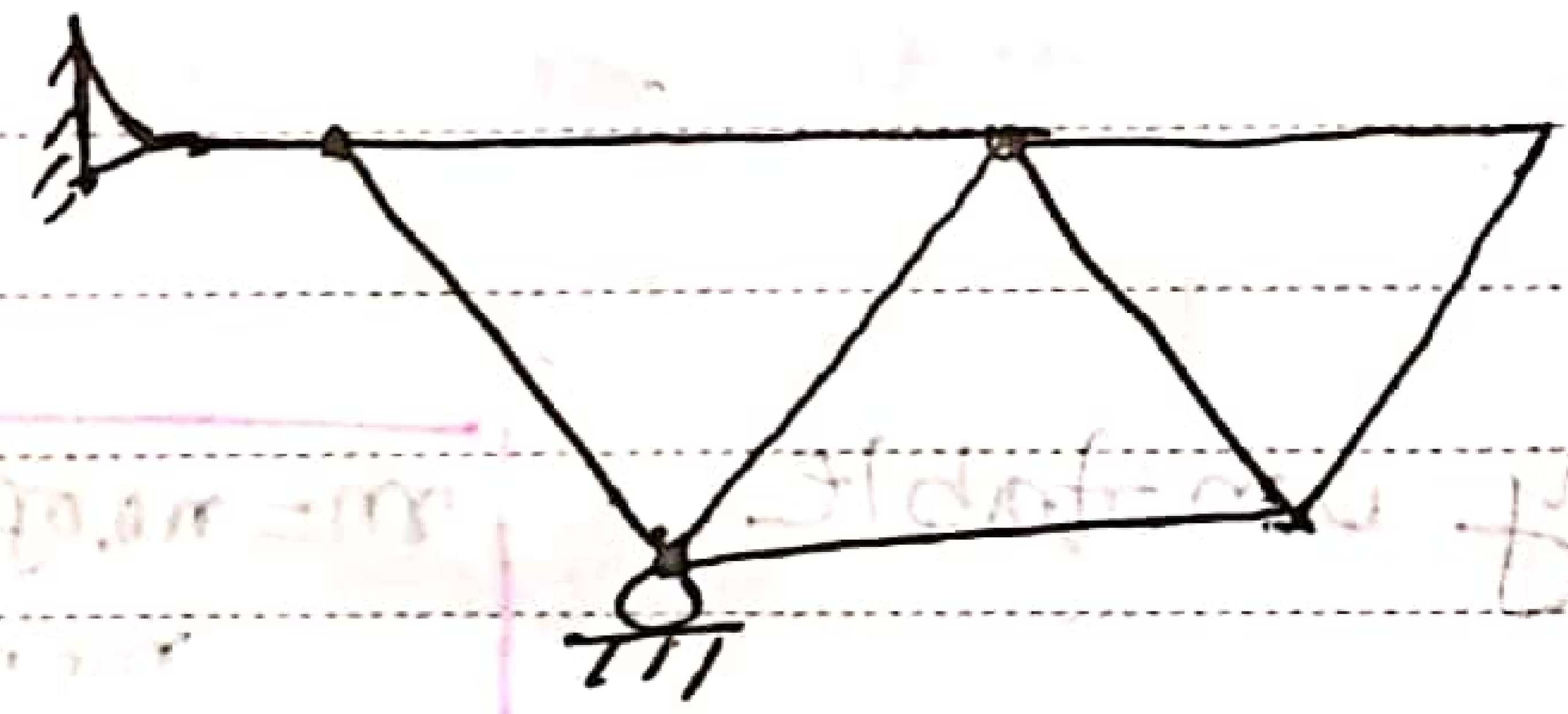


$m+r = 8+3 = 11$

$2j = 2\times 6 = 12$

$\therefore m+r < 2j$

statically unstable

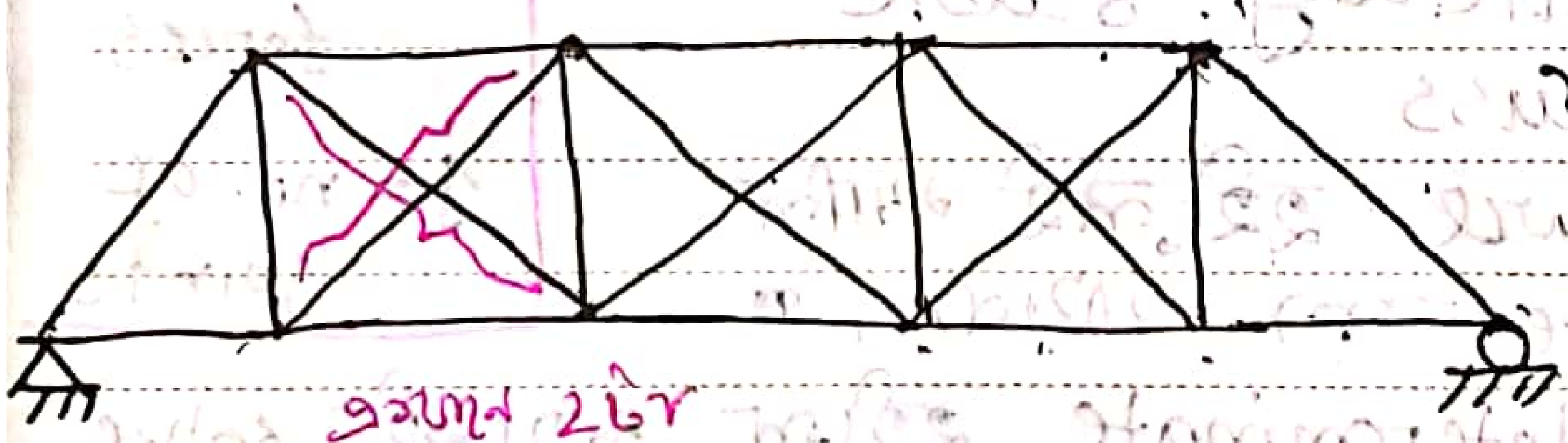


$m+r = 8+3 = 11$

$2j = 2\times 6 = 12$

$\therefore m+r < 2j$

unstable



ওখানে 2টো member থাকবে।

$m+r = 20+3 = 23$

$2j = 2\times 13 = 26$

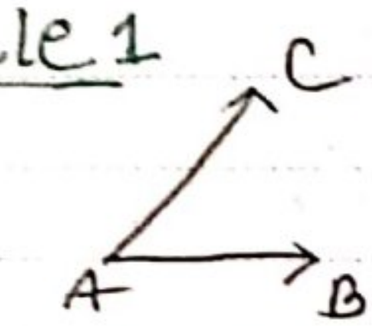
$\therefore$ unstable

~~redundants = 26-23~~
~~= 3~~

~~degree of indeterminacy~~

Zero Force Member in Truss

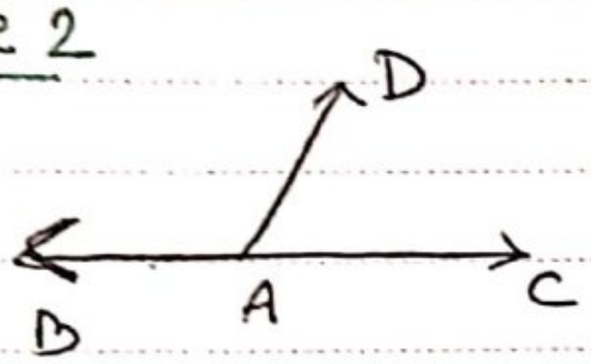
Rule 1



Membe AB & AC both are zero force member if -

(i) both are non-colinear
(ii) have no support reaction at point A
(iii) No external force at point A

Ruk 2

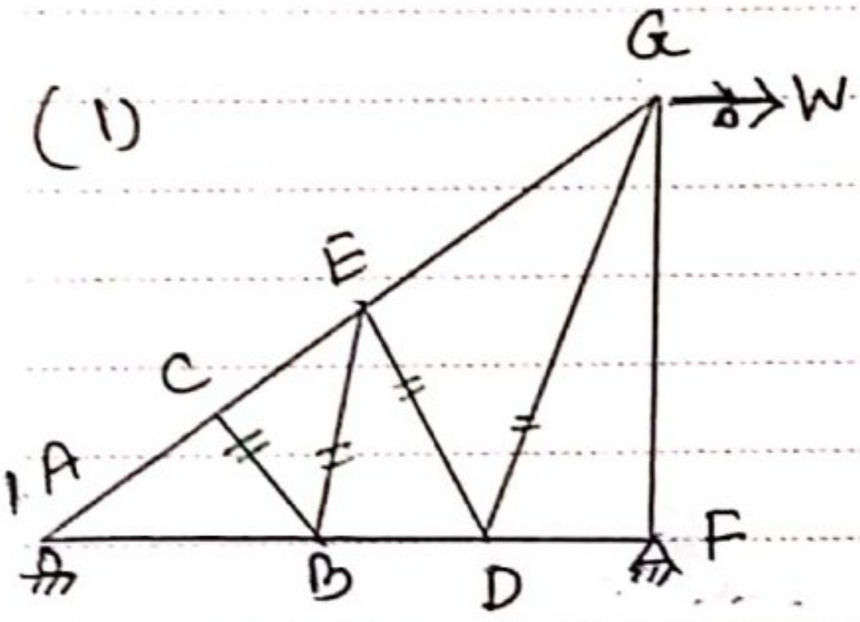


Member AD will be zero force member if (i) AC & AB are colinear (180°)
(ii) No support or external reaction at point.

*** 3 member point ও AC যদি zero হয় এবং AB 3 zero হবে

Examples

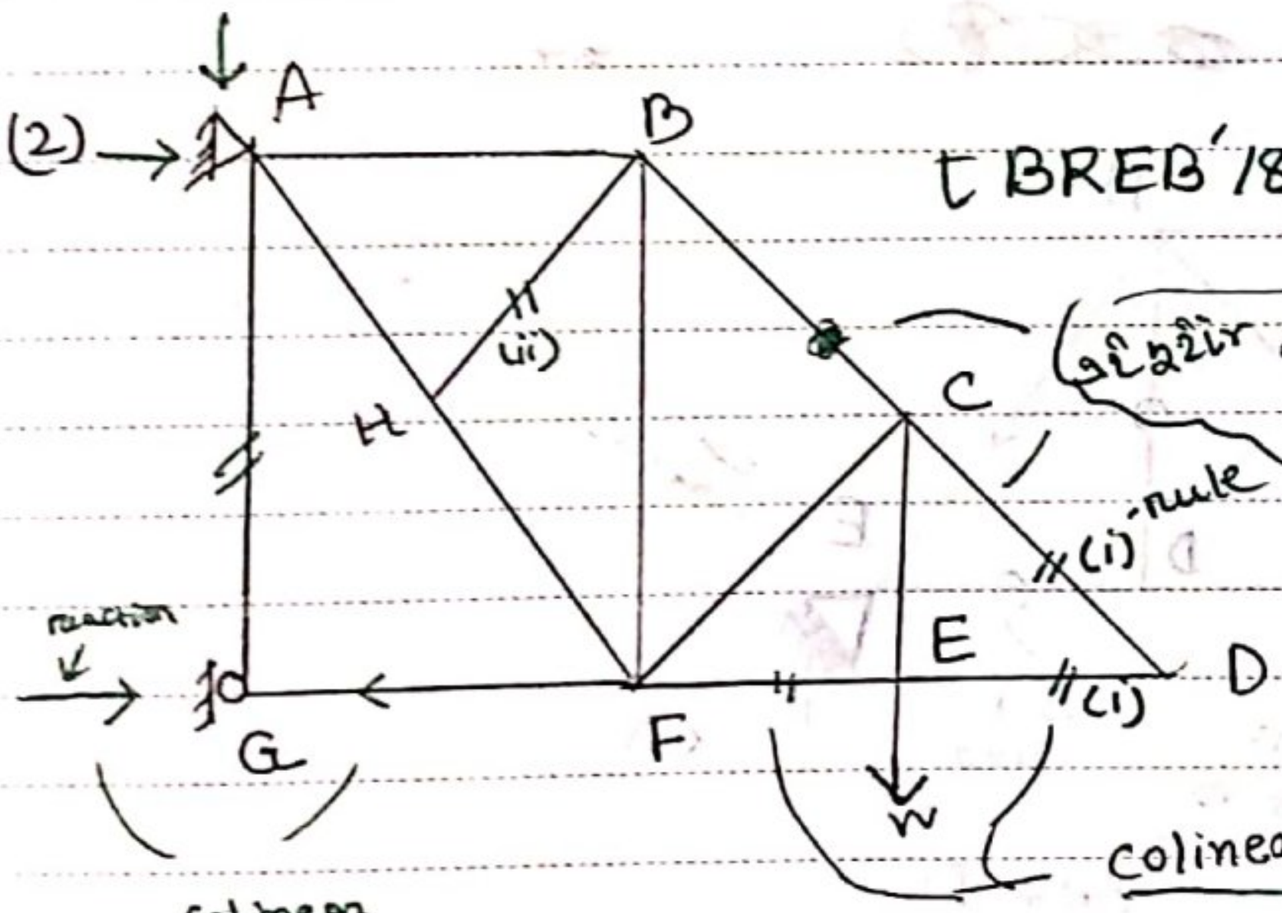
(1)



Find zero force members if load W acts at point G.

Soln: CB, BE, DE, DG are zero force members

(2)



[BREB '18 (MIST) [LGD '18 (MIST)]

colinear. এদের zero এবং আড়াআড়ি zero হবার কথা, কিন্তু zero হওয়ার কারণ C point হল 4 member point, 3 member যদি zero হয়।

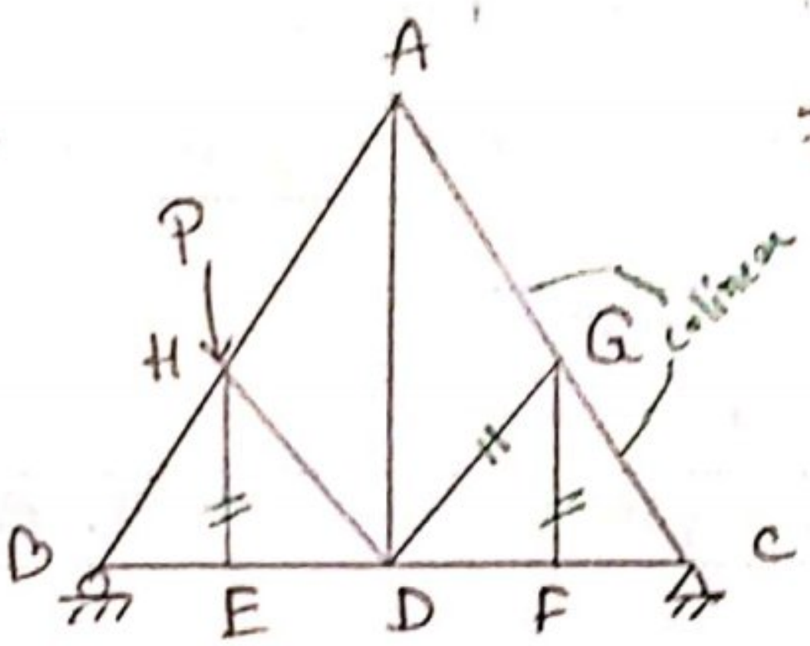
colinear. ED zero এবং EF 3 zero এবং EC।ED

***

colinear
∴ AG = 0

∴ zero force members = AG, BH, CD, DE, EF = 5 Nos

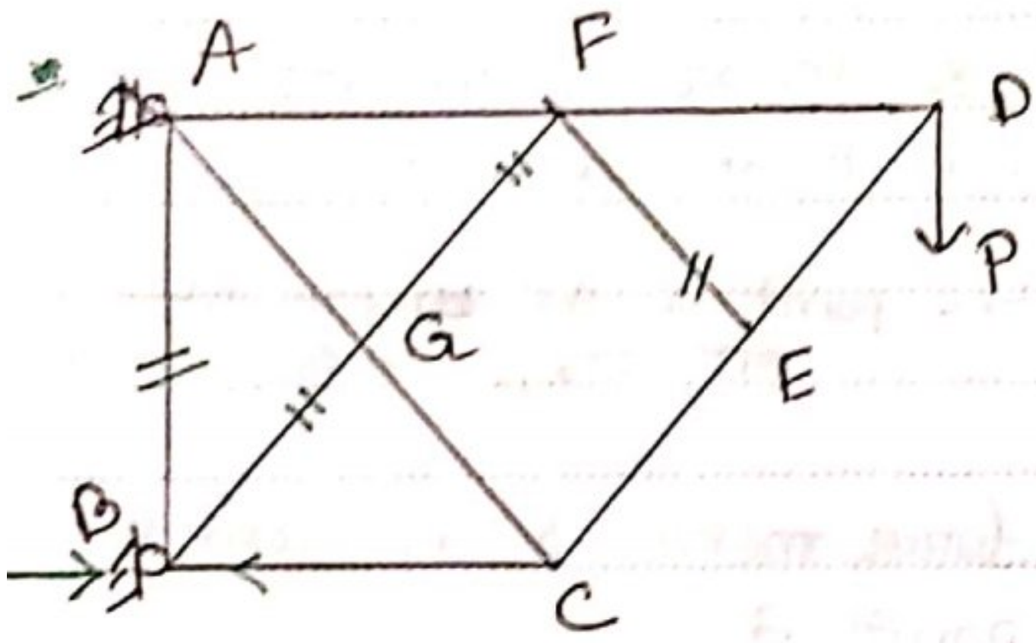
*



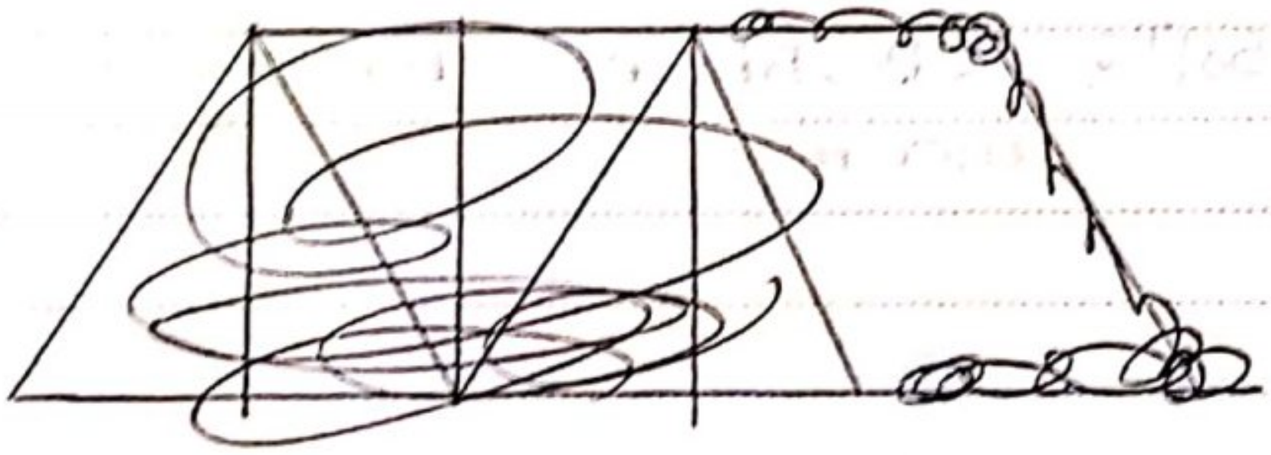
Zero force members

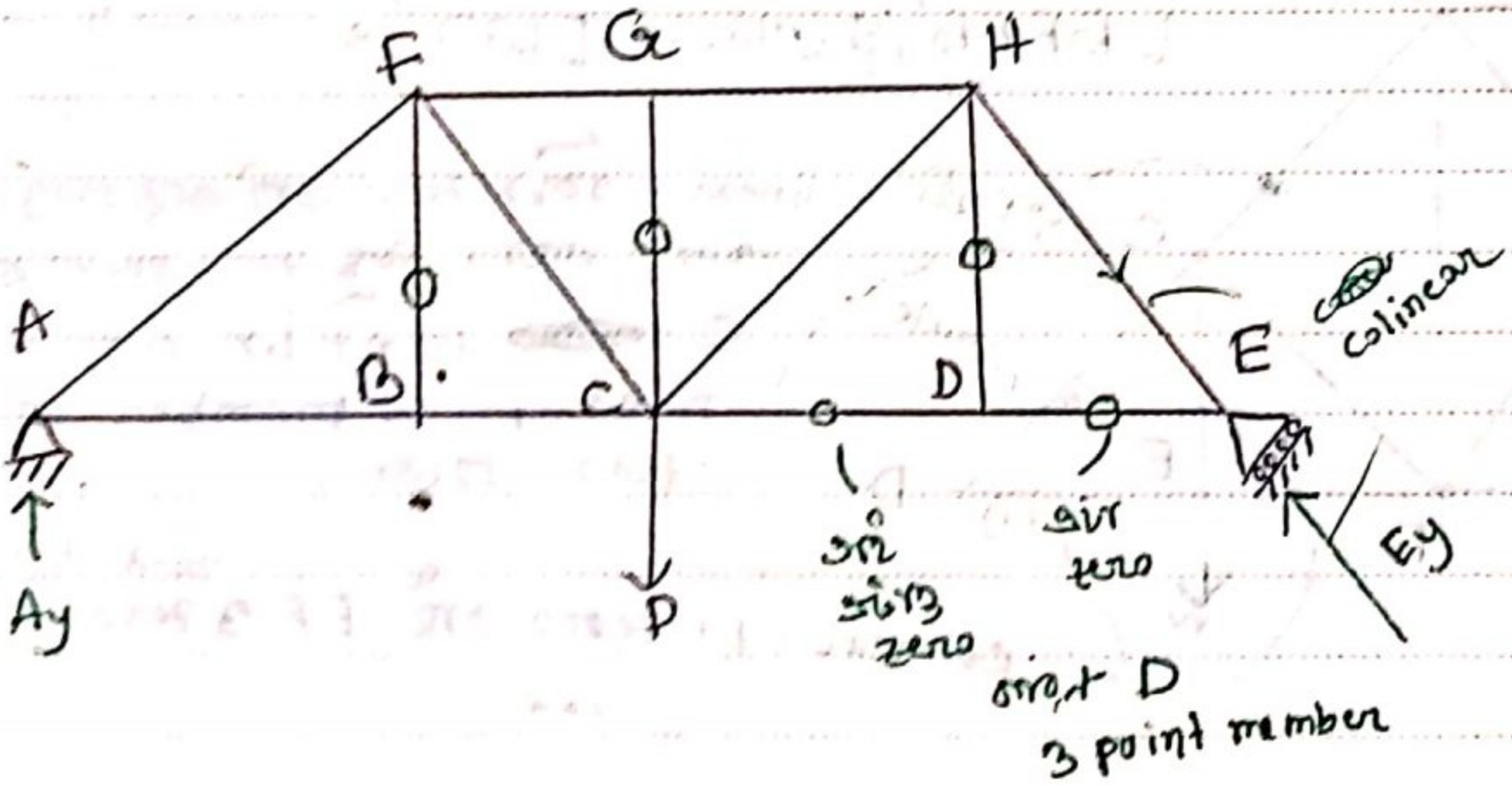
Ans: zero force members
GF, GD, EH

*

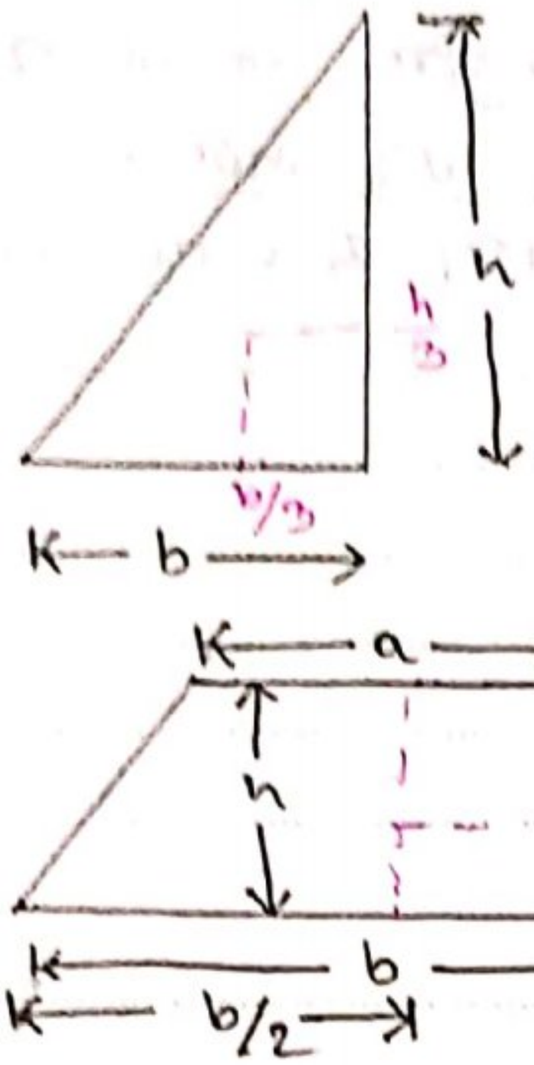


Zero force member = 4 Nos





Center of Gravity & Moment of Inertia

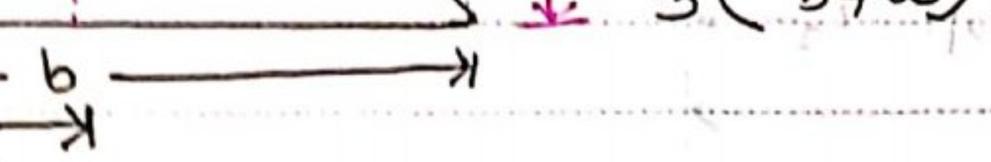


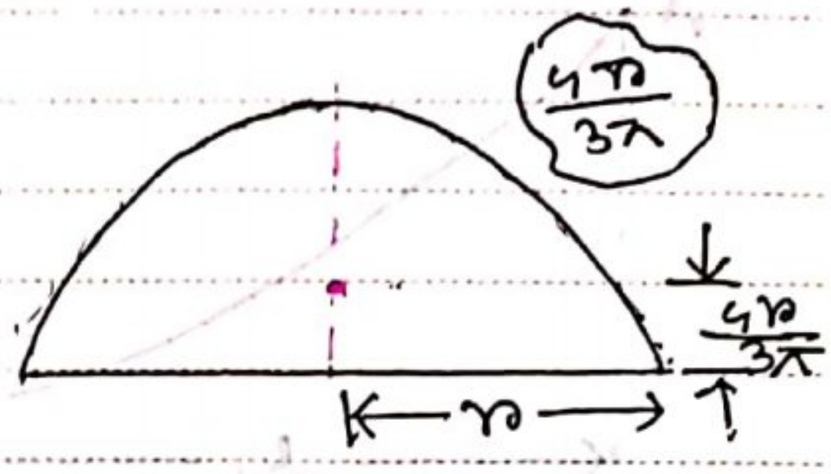
$\bar{x}$

$\bar{x} = \frac{b}{3}$

$\bar{y}$

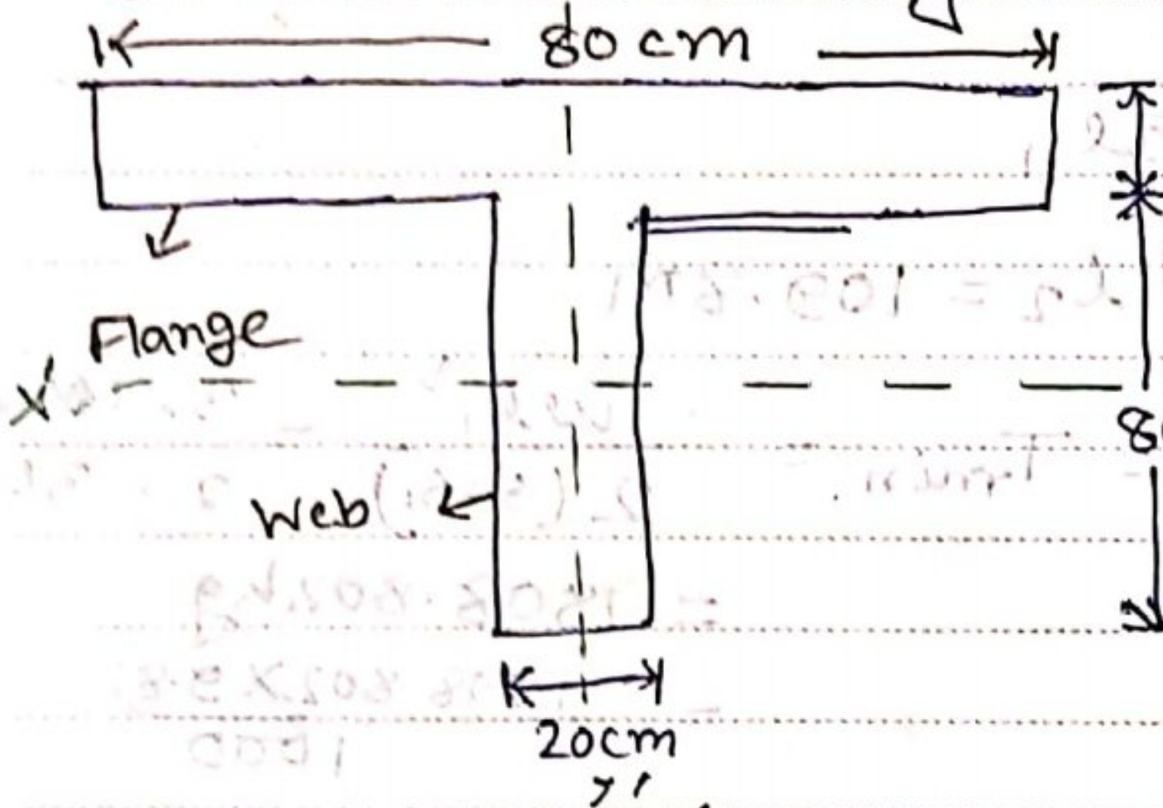
$\bar{y} = h/3$





about its GG

Q15] calculate $\bar{y}$ & moment of inertia ~~I~~ for the following T section



[BEPZA '16]
[RRI '14]

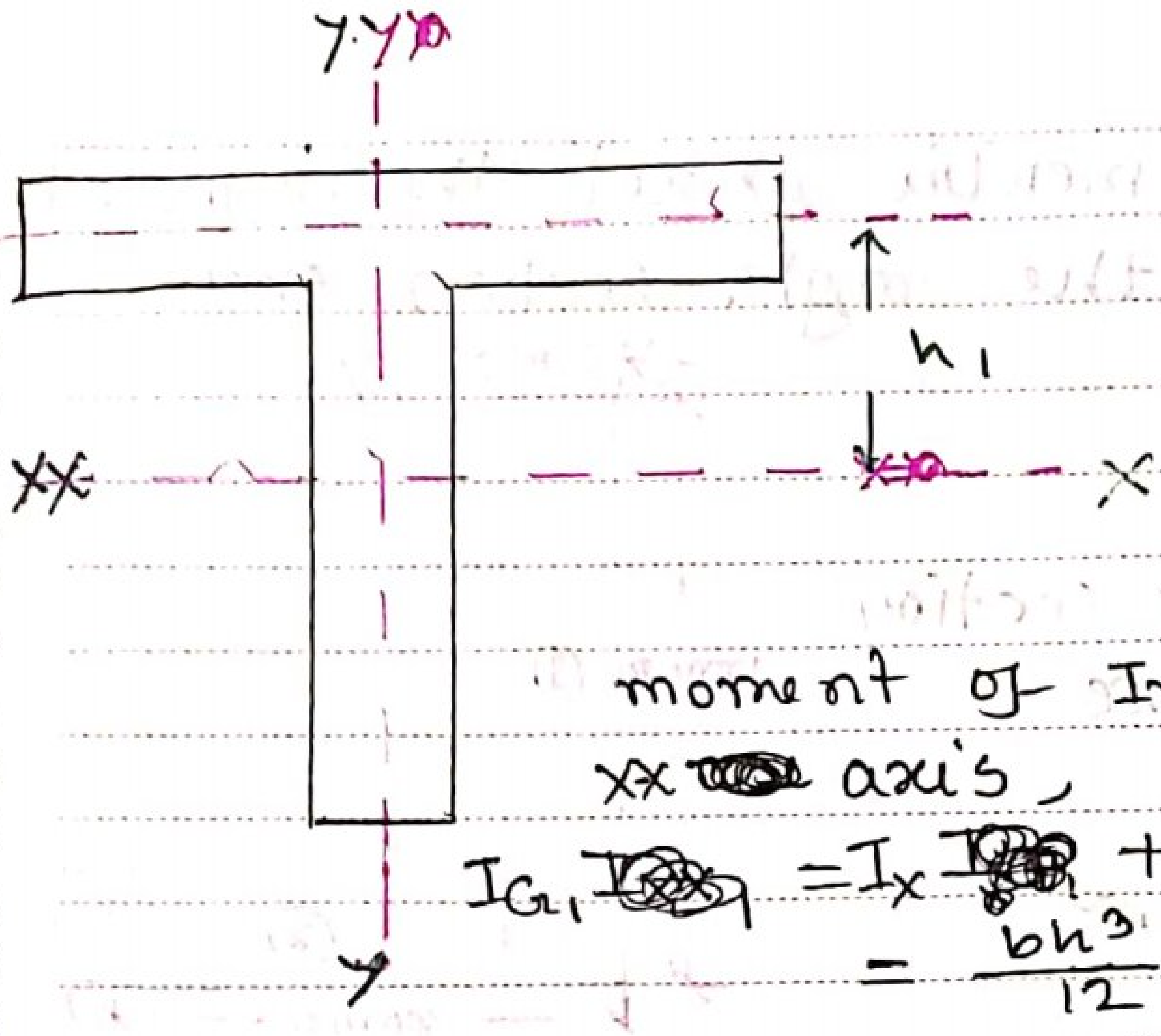
Soln: For flange, $A_1 = 80 \times 20 = 1600 cm^2$

$y_1 = 80 + \frac{20}{2} = 90 cm$

For web, $A_2 = 80 \times 20 = 1600 cm^2$

$y_2 = \frac{80}{2} = 40 cm$

$\therefore \bar{y} = \frac{1600 \times 90 + 1600 \times 40}{1600 + 1600} = 65 cm$



এখানে আমাদের CG র সাপেক্ষে moment of inertia বের করতে হবে। x–x ও y–y অক্ষ CG বরাবর গেছে।

moment of Inertia for flange about XX axis,

$$I_{G_1} = I_x + A_1 h_1$$

$$= \frac{bh^3}{12} + A_1 h_1$$

$$= \frac{80 \times 20^3}{12} + 1600 \times (90 - 65)$$

$$= 1.053 \times 10^6 \text{ cm}^4$$

(for web)

$$I_{x_2} = \frac{20 \times 80^3}{12} + 1600 \times (65 - 40)$$

$$= 1.853 \times 10^6$$

$$\therefore I_{xx} = I_{xx_1} + I_{xx_2} = 2906333.333 \text{ cm}^4 \text{ Ans}$$

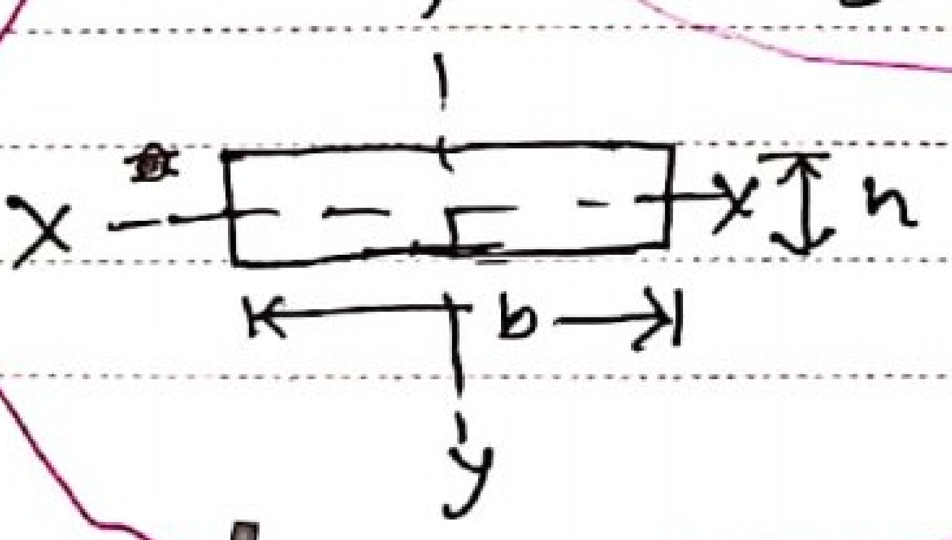
Now, moment of Inertia of T section about Y–Y axis,

[কারণ CG এর y axis একই point এ তাই extra কিছু যোগ করতে হবে না]

$$I_{yy} = I_{yy_1} + I_{yy_2}$$

$$= \frac{20 \times 80^3}{12} + \frac{80 \times 20^3}{12}$$

$$= 906666.67 \text{ cm}^4 \text{ Ans}$$



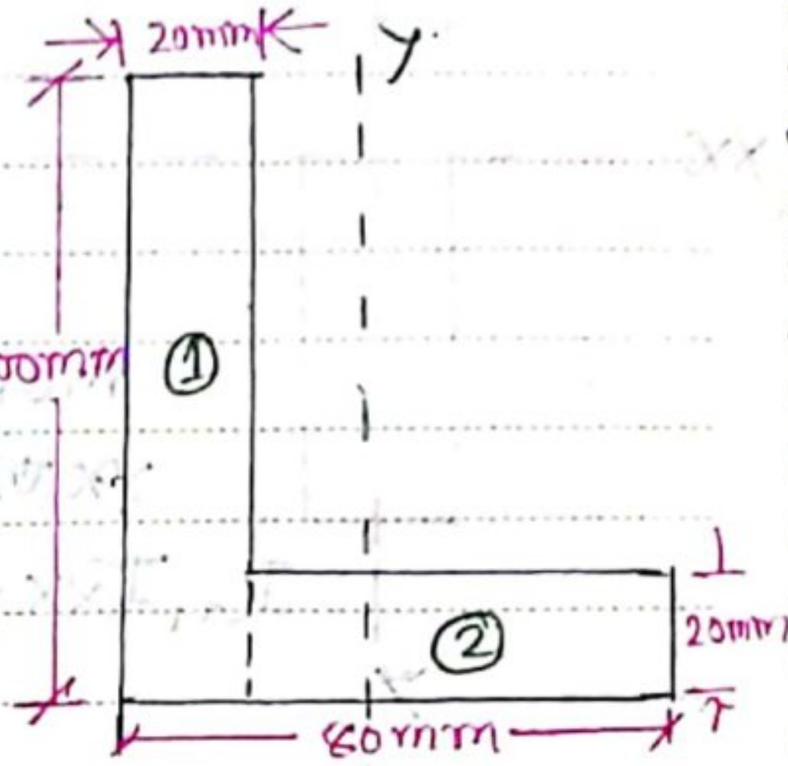
$$I_{xx} = \frac{bh^3}{12}$$

$$I_{yy} = \frac{hb^3}{12}$$

এখানে $\bar{x} = 0$

Janmet Vildapin Plus DAOMIN

* Find the moment of inertia about the centroidal Y-Y axis of the angle section shown in figure.



Soln:

let left face of the angle section be the axis of reference

Rectangle (1),

$A_1 = 100 \times 20 = 2000\ mm^2$

$\bar{x}_1 = 20/2 = 10mm$

Rectangle (2),

$A_2 = (80-20) \times 20 = 1200mm^2$ | $\bar{x}_2 = 20 + \frac{60}{2} = 50mm$

now, $\bar{x} = \frac{2000 \times 10 + 1200 \times 50}{2000 + 1200} = 25mm$

now, $I_{yy(1)} = \frac{100 \times 20^3}{12} + (25-10)^2 \times 2000$

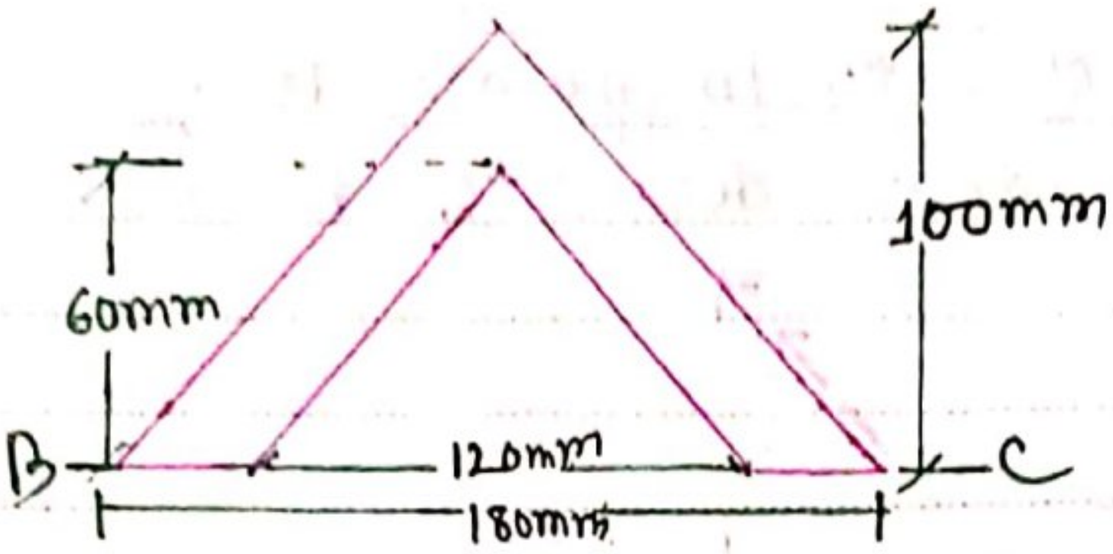
$= 5.16 \times 10^5\ mm^4$

$I_{yy(2)} = \frac{20 \times (60)^3}{12} + 1200 \times (50-25)^2$

$= 1.11 \times 10^6\ mm^4$

$\therefore I_{yy} = I_{yy(1)} + I_{yy(2)} = 1.6267 \times 10^6\ mm^4$ Ans

Q16



Find the moment of inertia of the section about the base BC

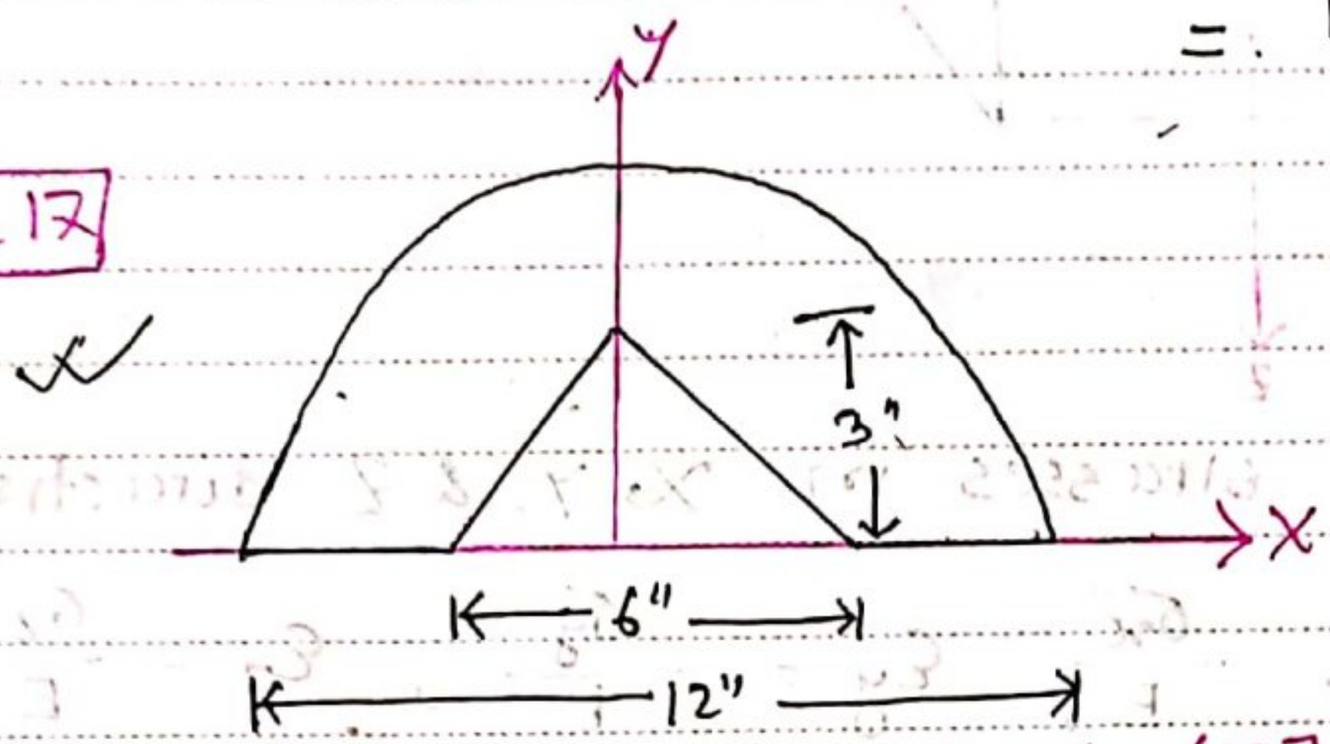
[BUET MSc '18]

Soln:

$$I_{BC} = \frac{BH^3}{12} - \frac{bh^3}{12} = \frac{180 \times 100^3}{12} - \frac{120 \times 60^3}{12}$$

$$= 12.84 \times 10^6 \text{ mm}^4 \quad \underline{\text{Ans}}$$

Q17



Determine Ixx & Iyy [MSc '19]

Soln:

$$I_{xx} = 0.393 r^4 - \frac{bh^3}{12}$$

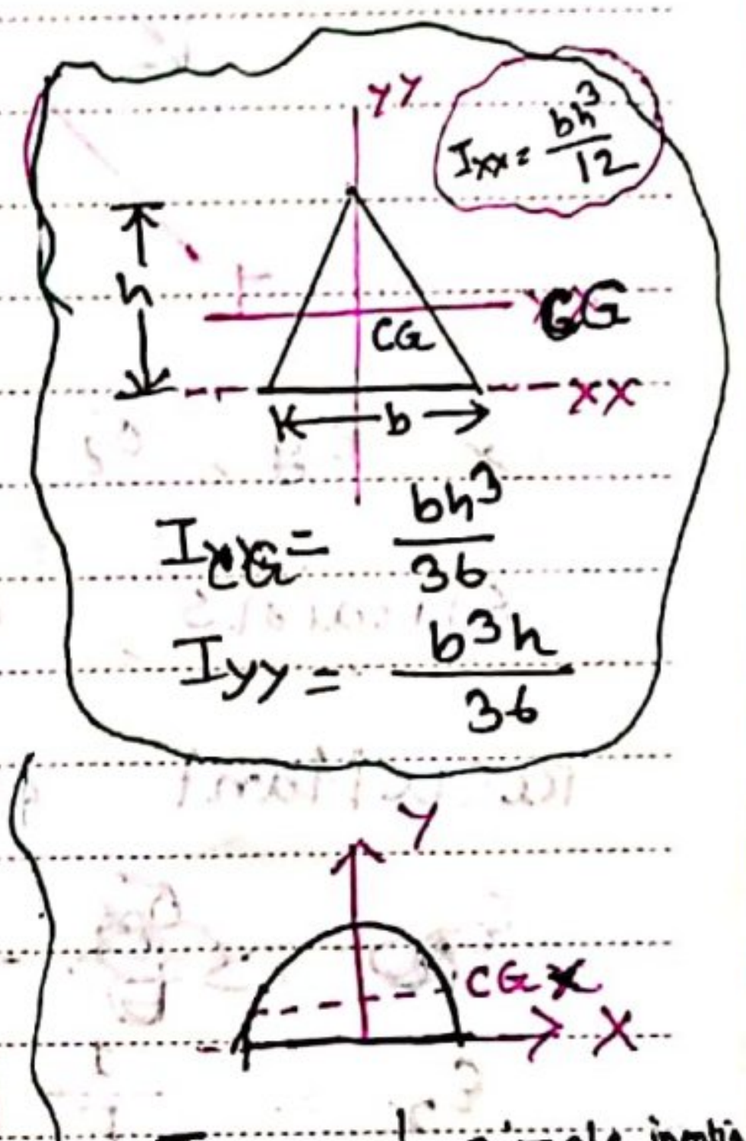
$$= 0.393 \times 6^4 - \frac{6 \times 3^3}{12}$$

$$= 495.828 \text{ in}^4$$

$$I_{yy} = 0.393 r^4 - \frac{hb^3}{36}$$

$$= 0.393 \times \left(\frac{12}{2}\right)^4 - \frac{3 \times 6^3}{36}$$

$$= 491.328 \text{ in}^4$$



$I_{xx} = \frac{1}{2}$ circle inertia

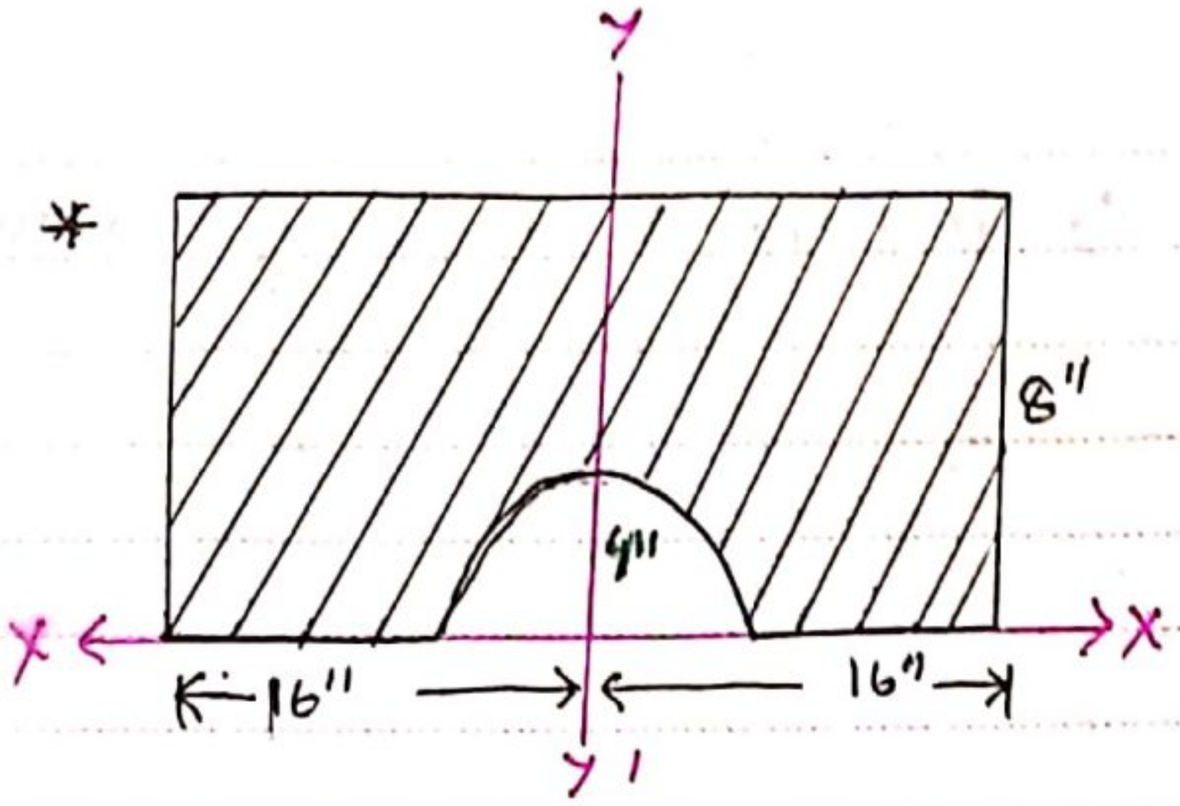
$= \frac{1}{2} \times \frac{\pi}{64} (d)^4$ ***

$= \frac{1}{2} \times \frac{\pi}{64} \times (2r)^4$

$= 0.393 r^4$

$I_{CGx} = 0.11 r^4$ ***

$I_{yy} = 0.393 r^4$



Calculate moment of inertia of the shaded portion about x & y axis. Also find the location of centroid form both x & y axis.

[PGCL'21]

$= \frac{1}{2} \times \frac{\pi d^4}{64} = \frac{\pi d^4}{128} = \frac{\pi}{128} \times (2r)^4$

Soln: $I_{xx} = \frac{(32) \times 8^3}{3} - 0.393 \times 4^4 = 5360.725 \text{ in}^4$

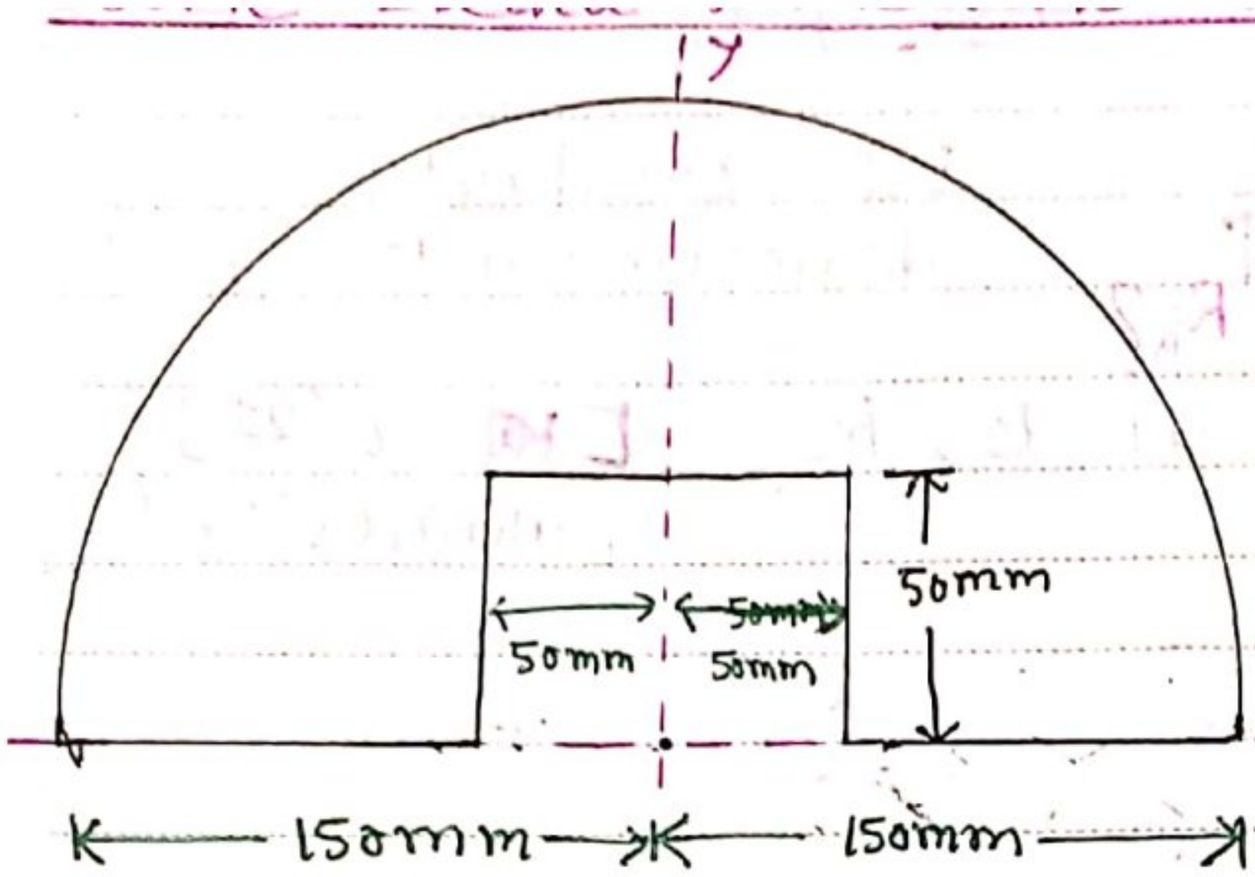
$I_{yy} = \frac{8 \times 32^3}{12} - 0.393 \times 4^4 = 21744.725 \text{ in}^4$

$\frac{4 \times 4}{3\pi}$

location of centroid from x axis, $\bar{y} = \frac{(32 \times 8) \times \frac{8}{2} - \left(\frac{\pi \times 4^4}{2}\right) \times}{(32 \times 8) - \frac{\pi \times 4^2}{2}}$

$= 4.25 \text{ in}$

location of centroid from y axis, $\bar{x} = 0$ Ans



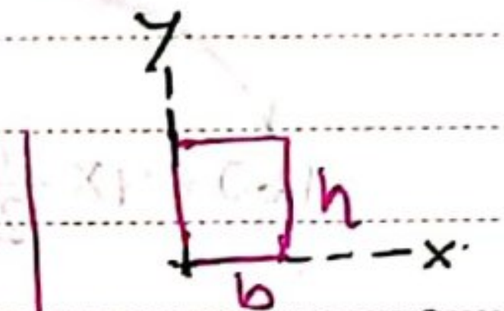
Calculate the moment of inertia about X & Y axes. Also calculate the corresponding radii of gyration r_x & r_y

Soln: Moment of inertia about x axis,

$$I_{xx} = 0.393 r^4 - \frac{bh^3}{3}$$

$$= 0.393 \times (150)^4 - \frac{100 \times 50^3}{3}$$

$$= 194.79 \times 10^6 \text{ mm}^4$$



$$I_{xx} = \frac{bh^3}{3}$$

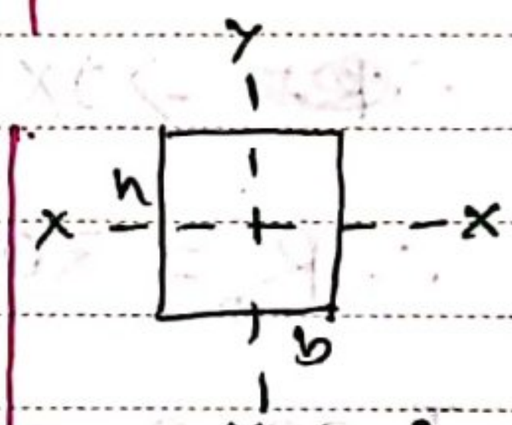
$$I_{yy} = \frac{hb^3}{3}$$

Moment of inertia about y axis,

$$I_{yy} = 0.393 r^4 - \frac{hb^3}{12}$$

$$= 0.393 \times (150)^4 - \frac{50 \times 100^3}{12}$$

$$= 194.79 \times 10^6 \text{ mm}^4$$



$$I_{xx} = \frac{bh^3}{12}$$

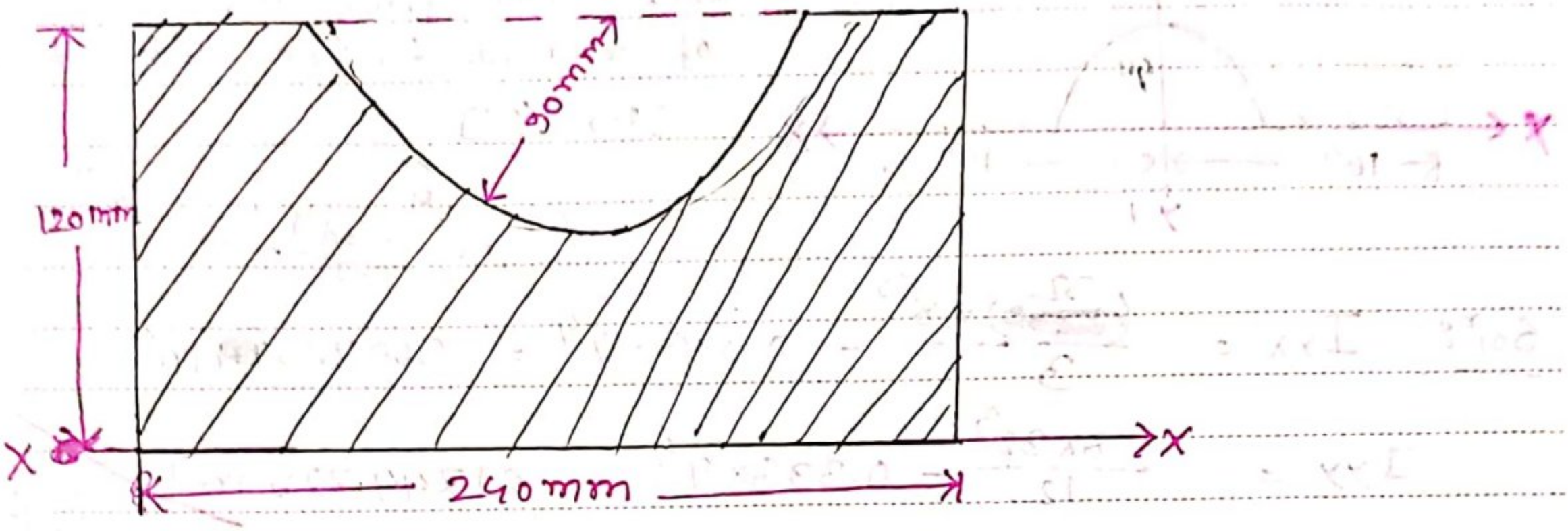
$$I_{yy} = \frac{hb^3}{12}$$

$$A = \frac{\pi \times (150)^2}{2} - (50 \times 100) = 30342.92 \text{ mm}^2$$

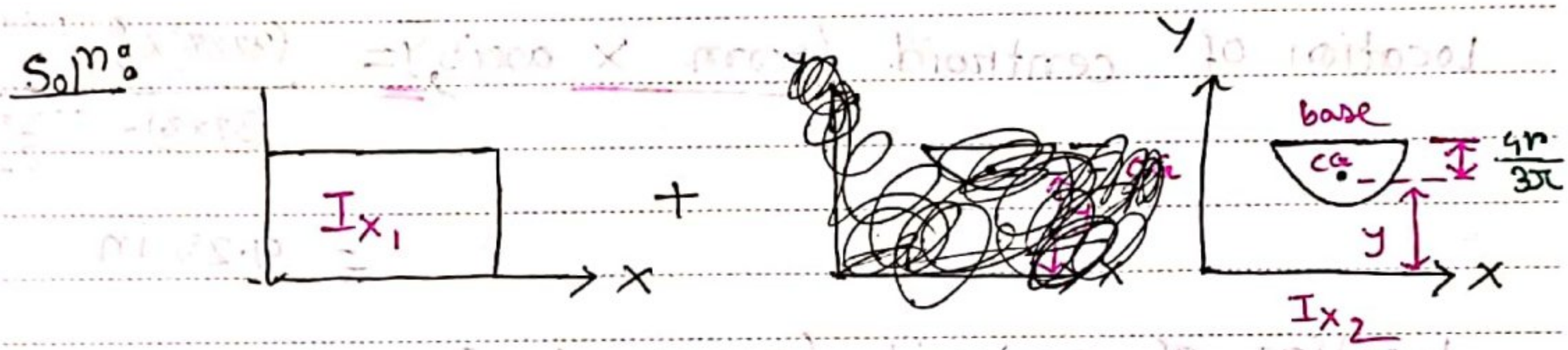
$$r_x = \sqrt{\frac{194.79 \times 10^6}{30342.92}} = 80.12 \text{ mm}$$

$$r_y = \sqrt{\frac{194.79 \times 10^6}{30342.92}} = 80.12 \text{ mm}$$

* Determine the moment of inertia of the shaded area with respect to X axis.



Soln:



Soln: $I_{x_1} = \frac{240 \times 120^3}{3} = 138.24 \times 10^6 \text{ mm}^4$

$I_{x_2} = I_x$ about CG + Area xy^2

$= 0.11 \times r^4 + \frac{\pi r^2}{2} \times \left(120 - \frac{4r}{3\pi}\right)^2$

$= [0.11 \times 90^4] + \frac{\pi \times 90^2}{2} \times \left(120 - \frac{4 \times 90}{3\pi}\right)^2$

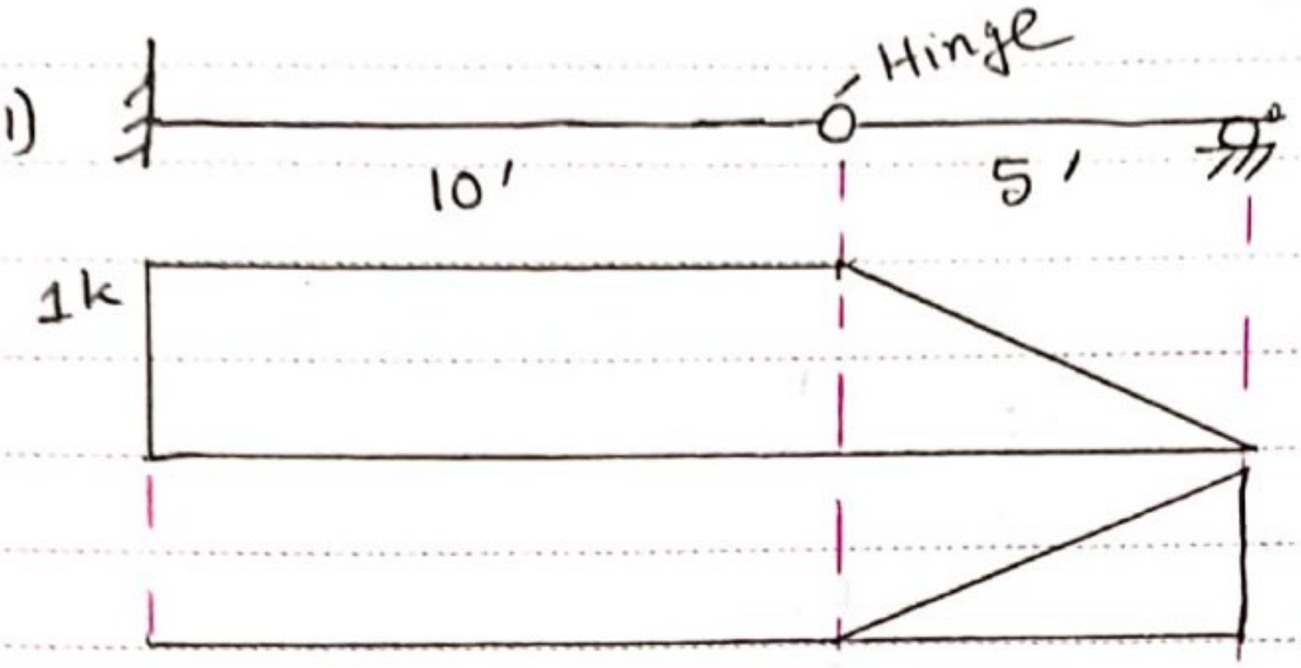
$= 92.358 \times 10^6 \text{ mm}^4$

$\therefore I_x = I_{x_1} - I_{x_2} = (138.24 - 92.358) \times 10^6 \text{ mm}^4$

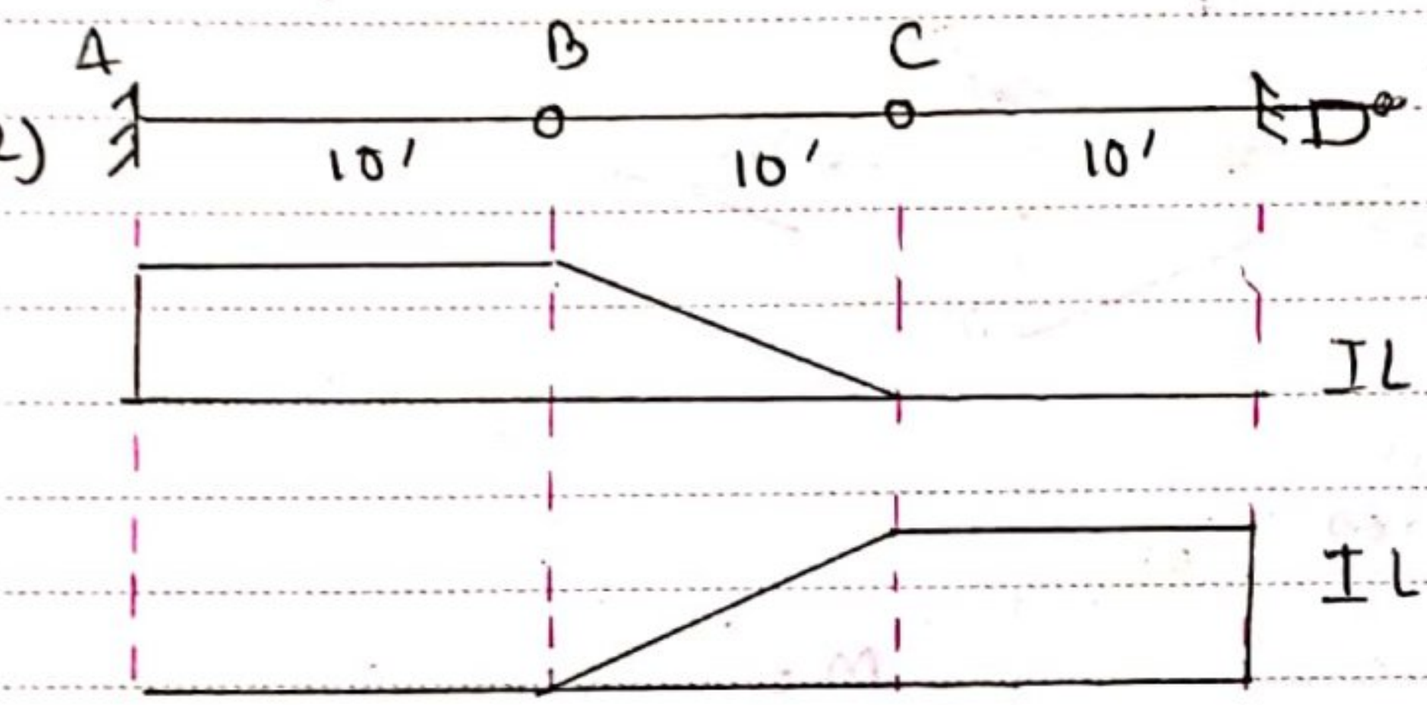
$= 45.882 \times 10^6 \text{ mm}^4$ Ans

Influence Line Diagram

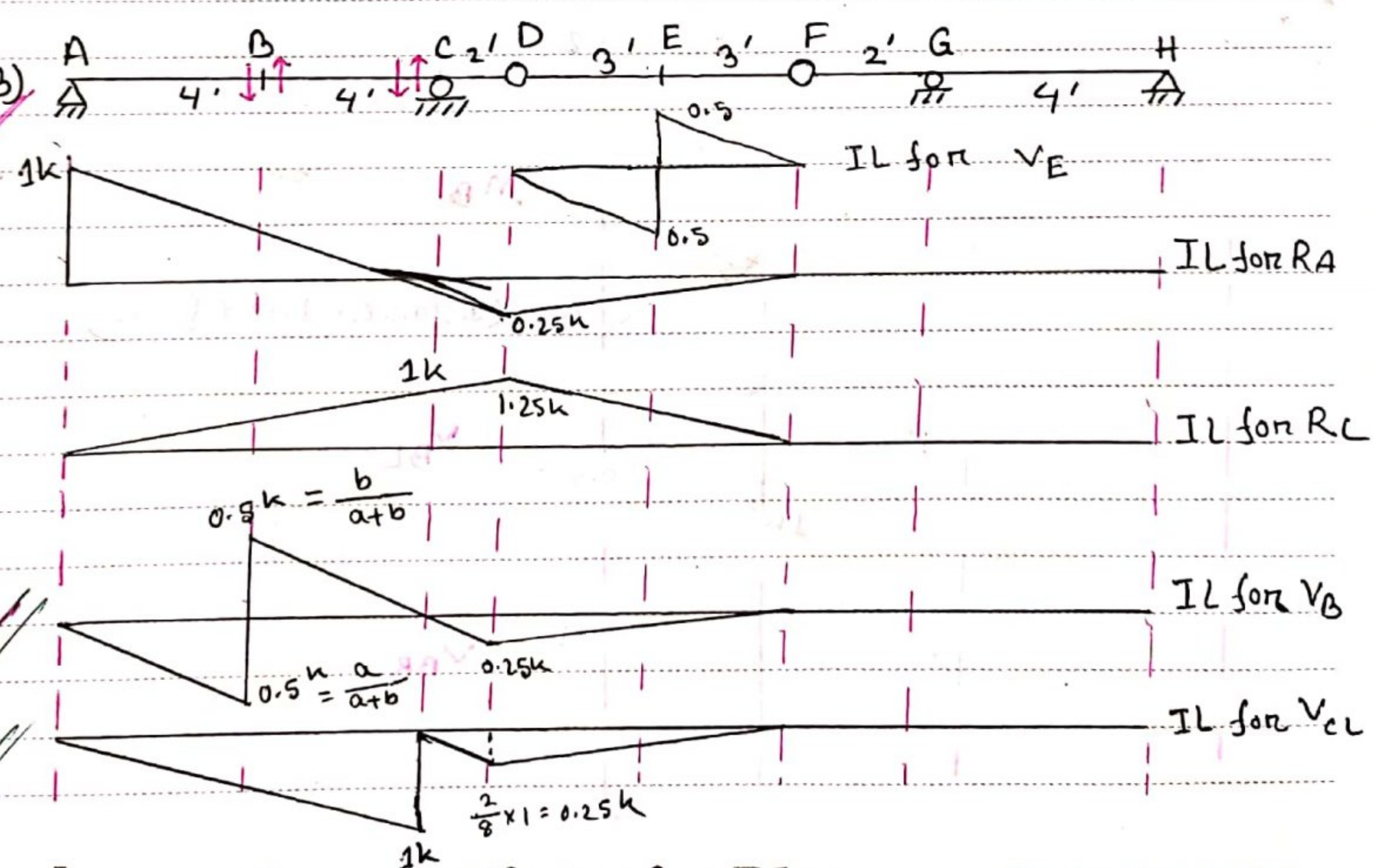
(1)



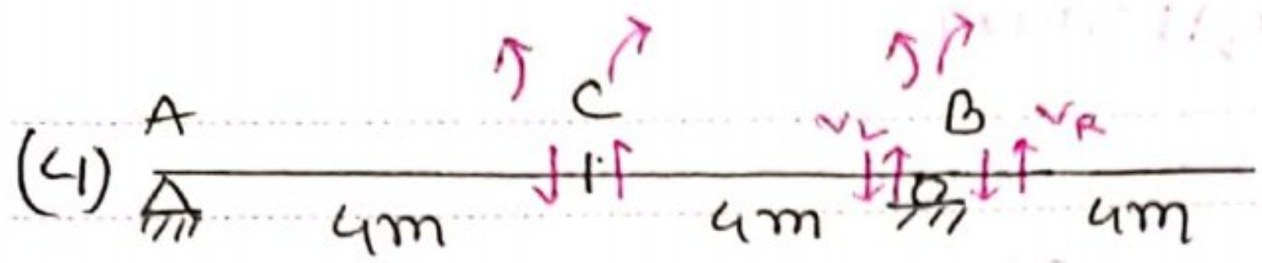
(2)

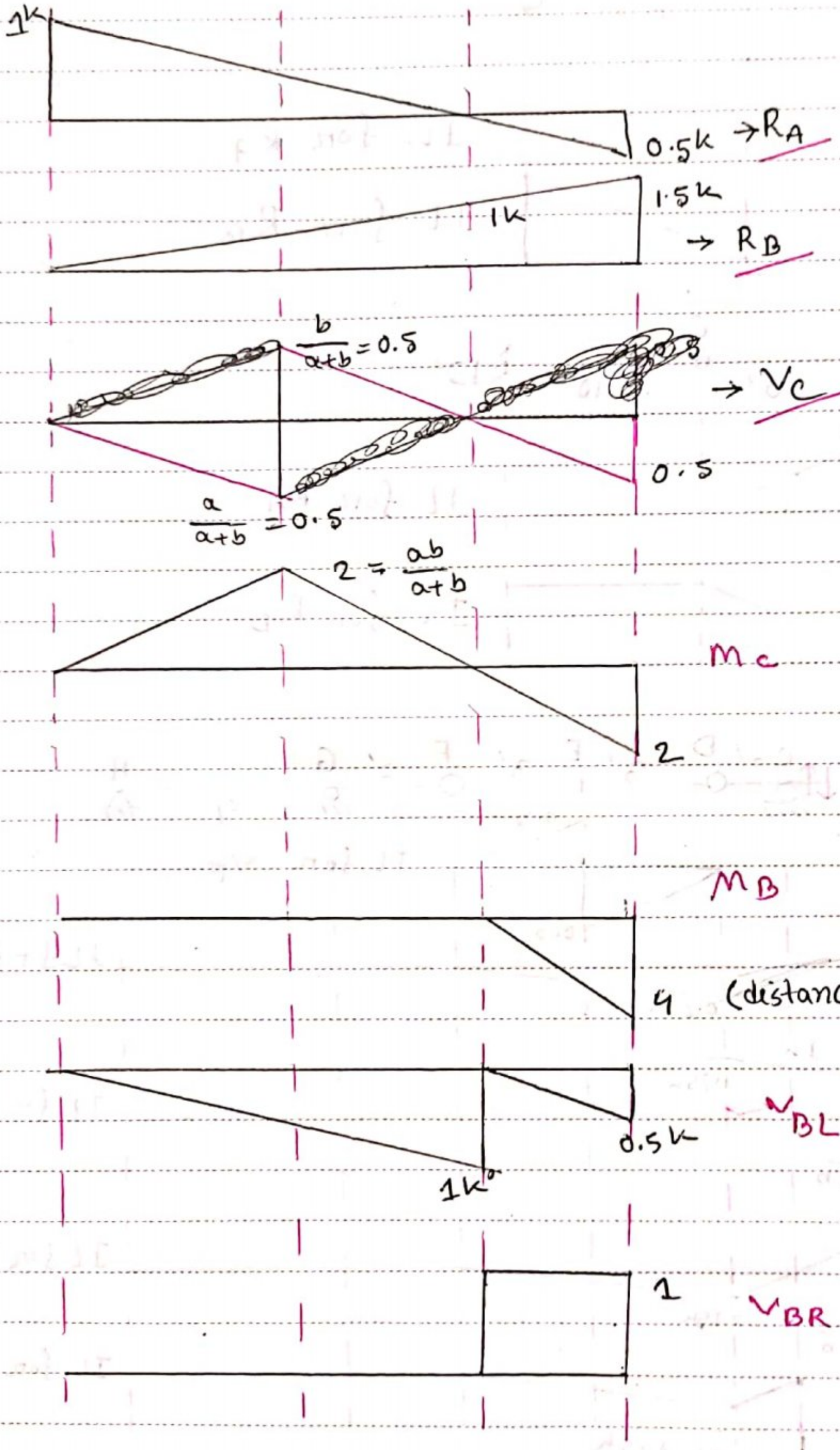


(3)

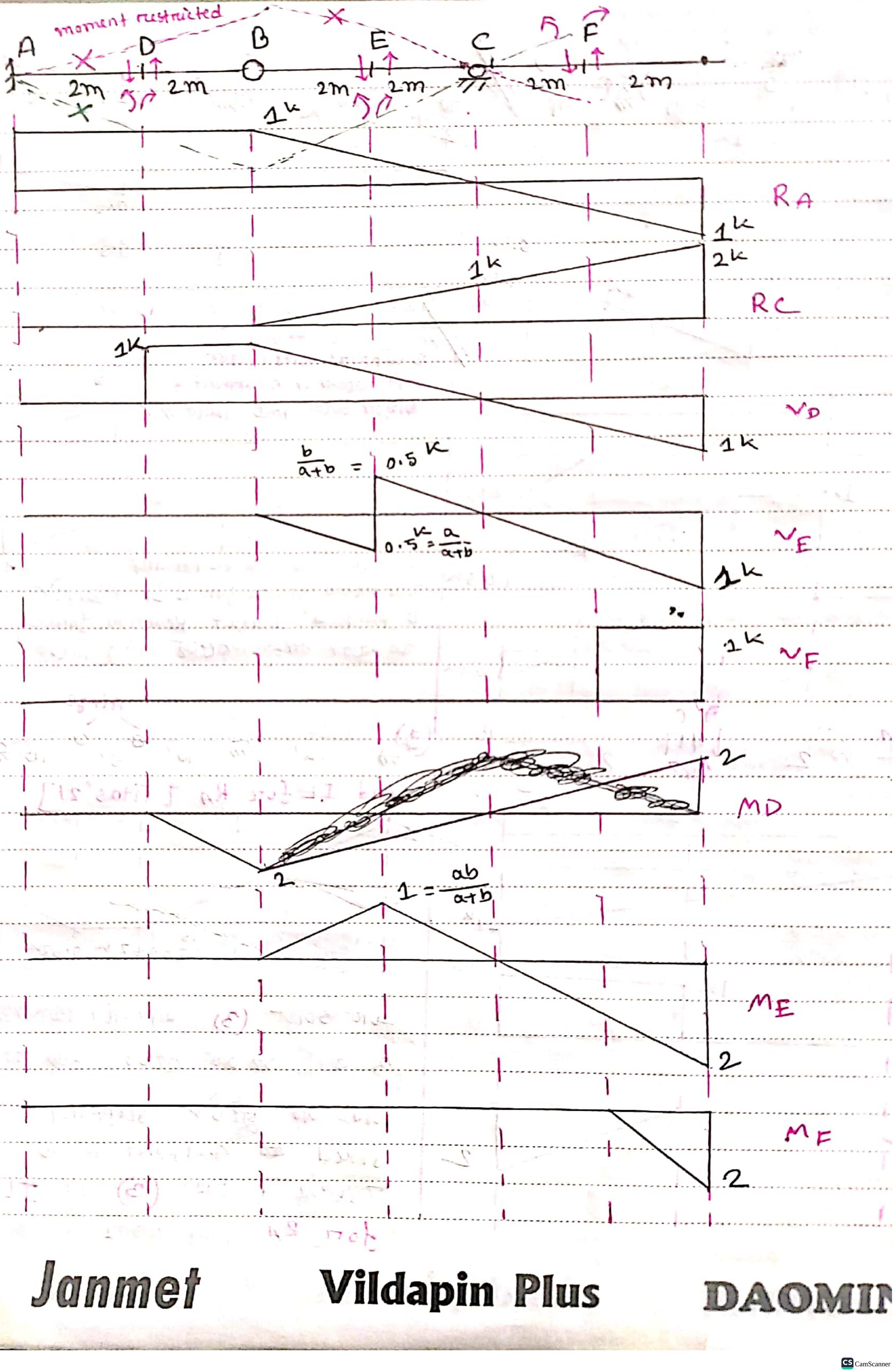


(4)



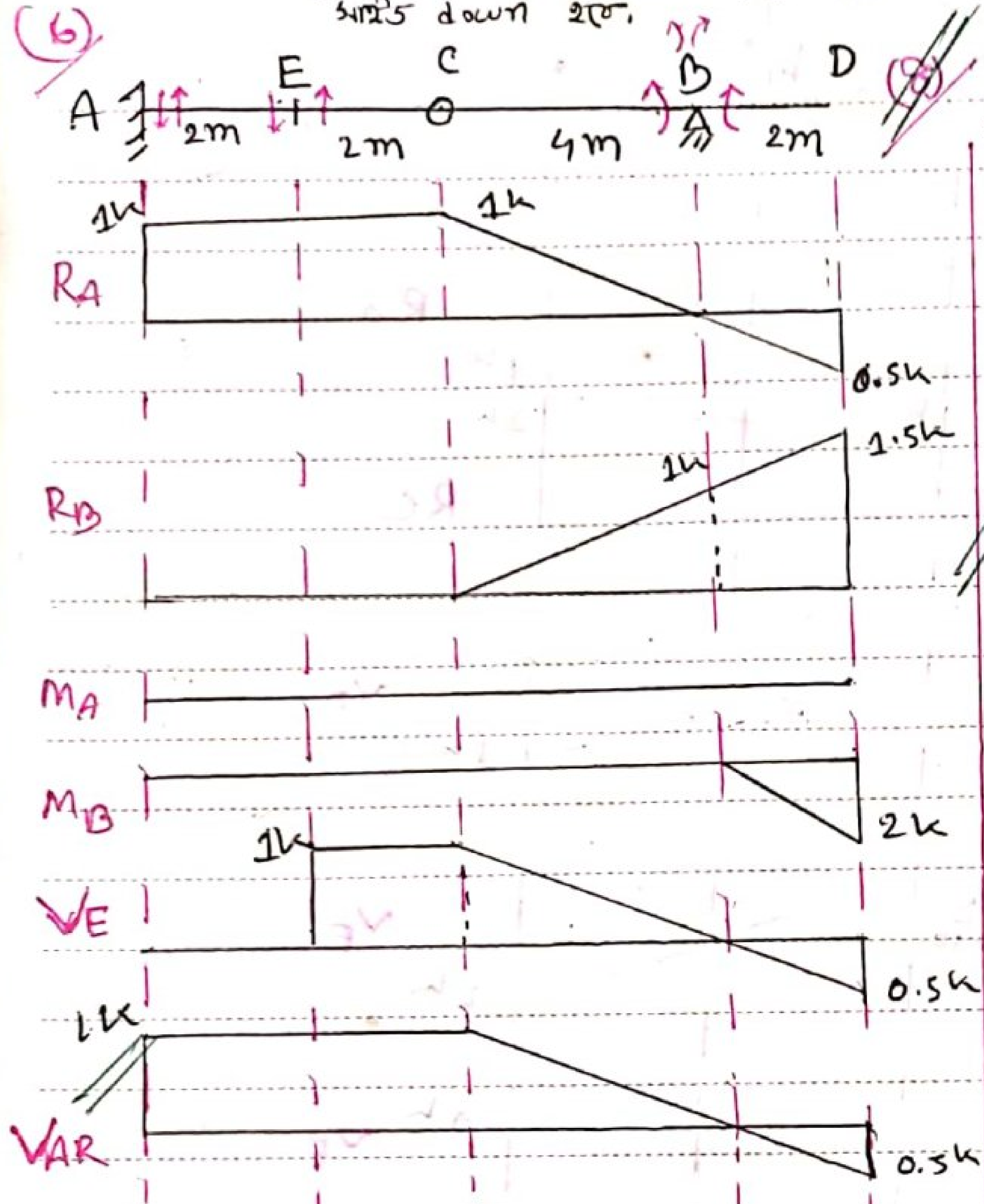


(5)

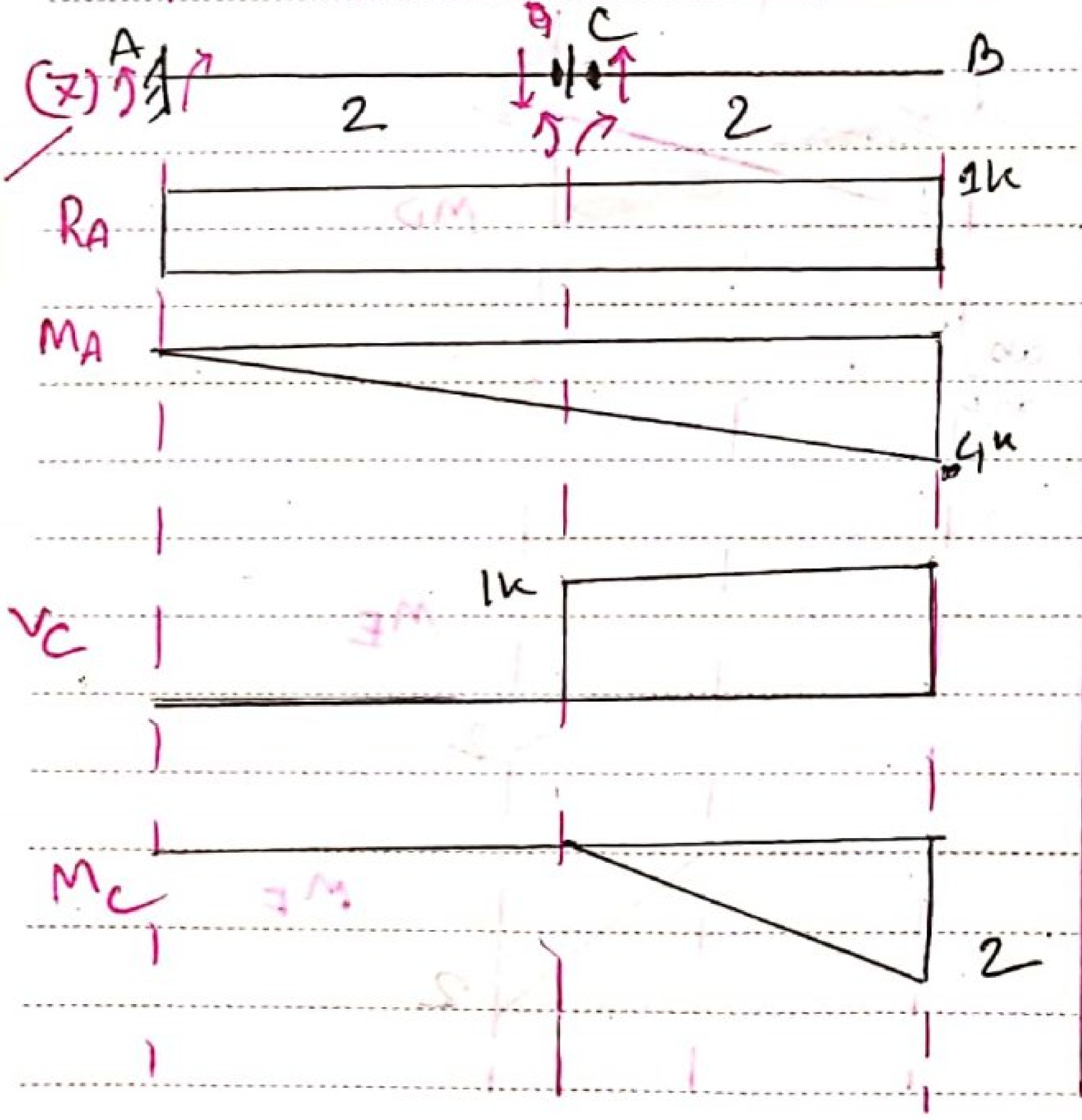


কী কী সাপোর্টে moment দিলে সবসময় বিপরীত সাইড down হবে।

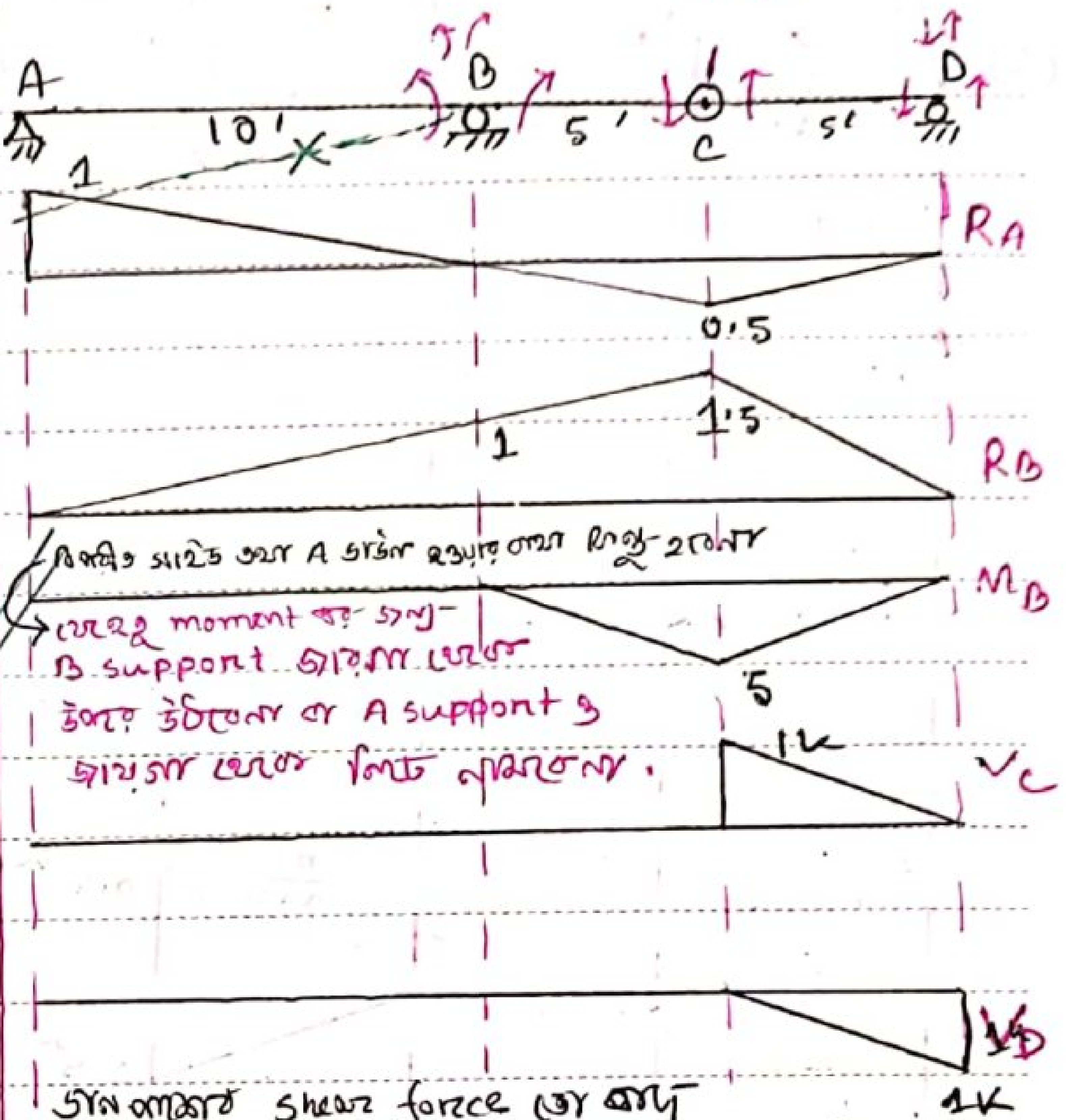
(6)



(7)

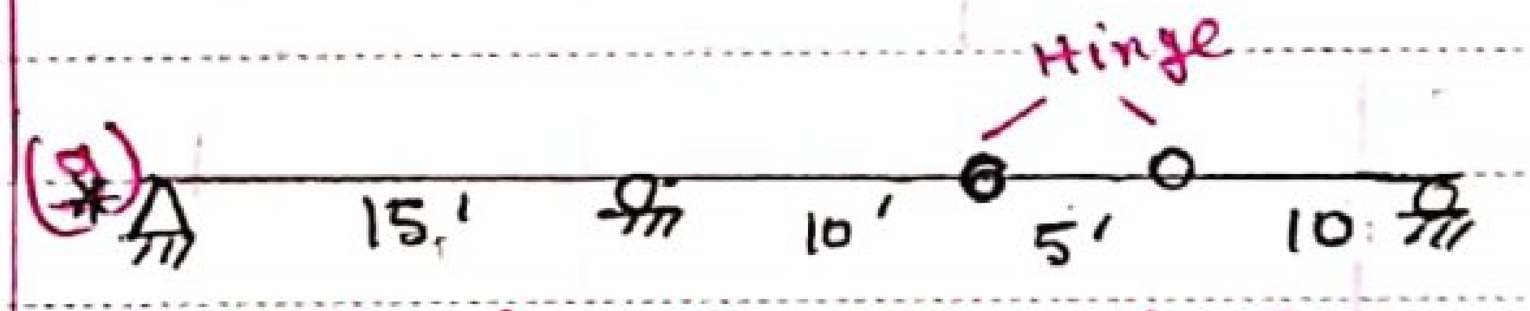


(8)

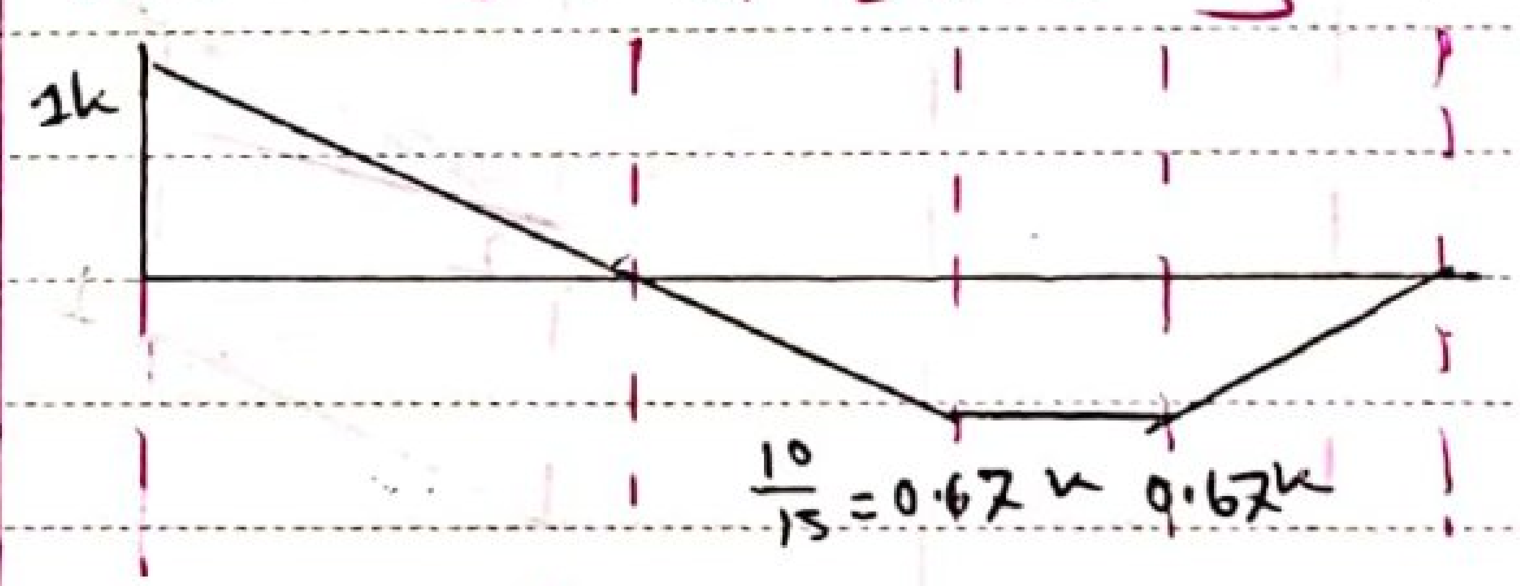


ডান পাশের shear force এর জন্য বাম পাশের shear force টা অর্থাৎ D point এ 1 unit Reaction force এর মতো কাজ করছে কিন্তু নিচের দিকে।

(9)



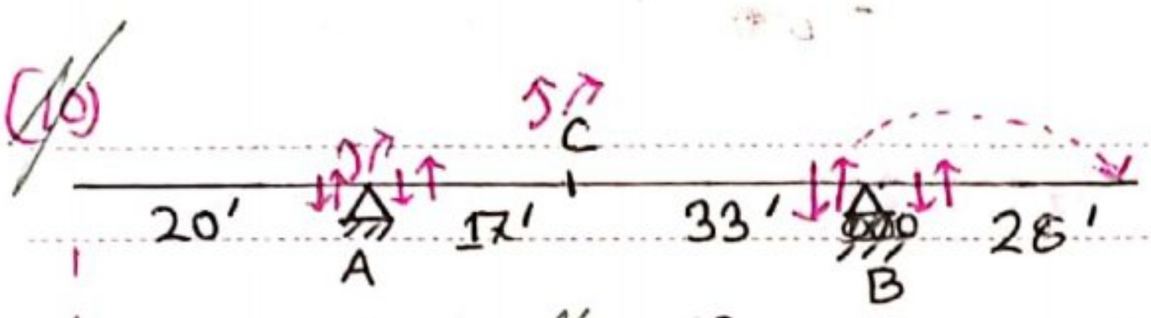
Find IL for R_A [Titas'21]

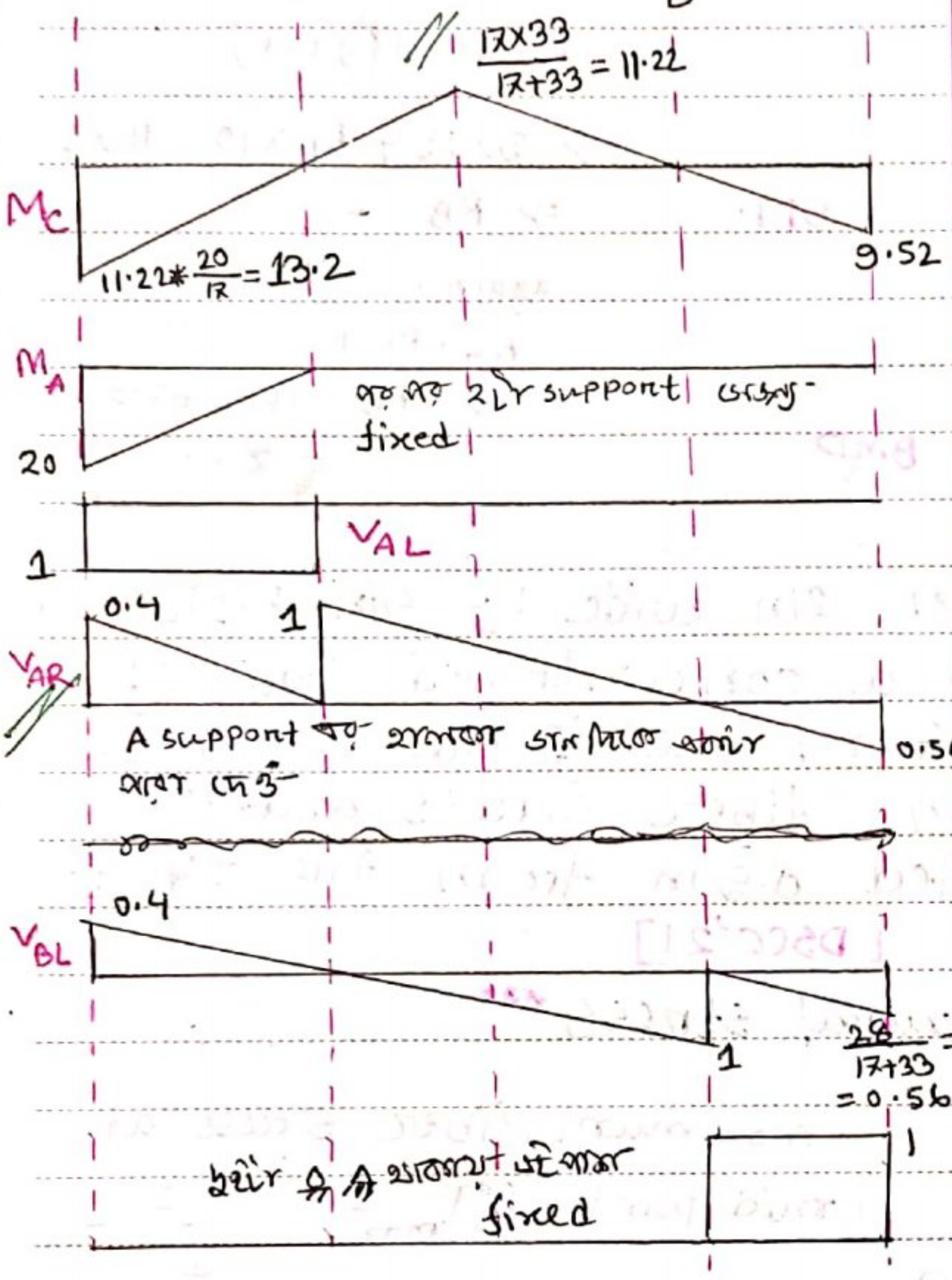


এখানে যেহেতু (3) নাম্বার হিঞ্জ, ৩ য় এবং চতুর্থ হিঞ্জ এর পর এর ফুটিং support টা fixed support এর মত কাজ করছে। তাই (3) এর IL for R_A ভিন্ন আসছে।

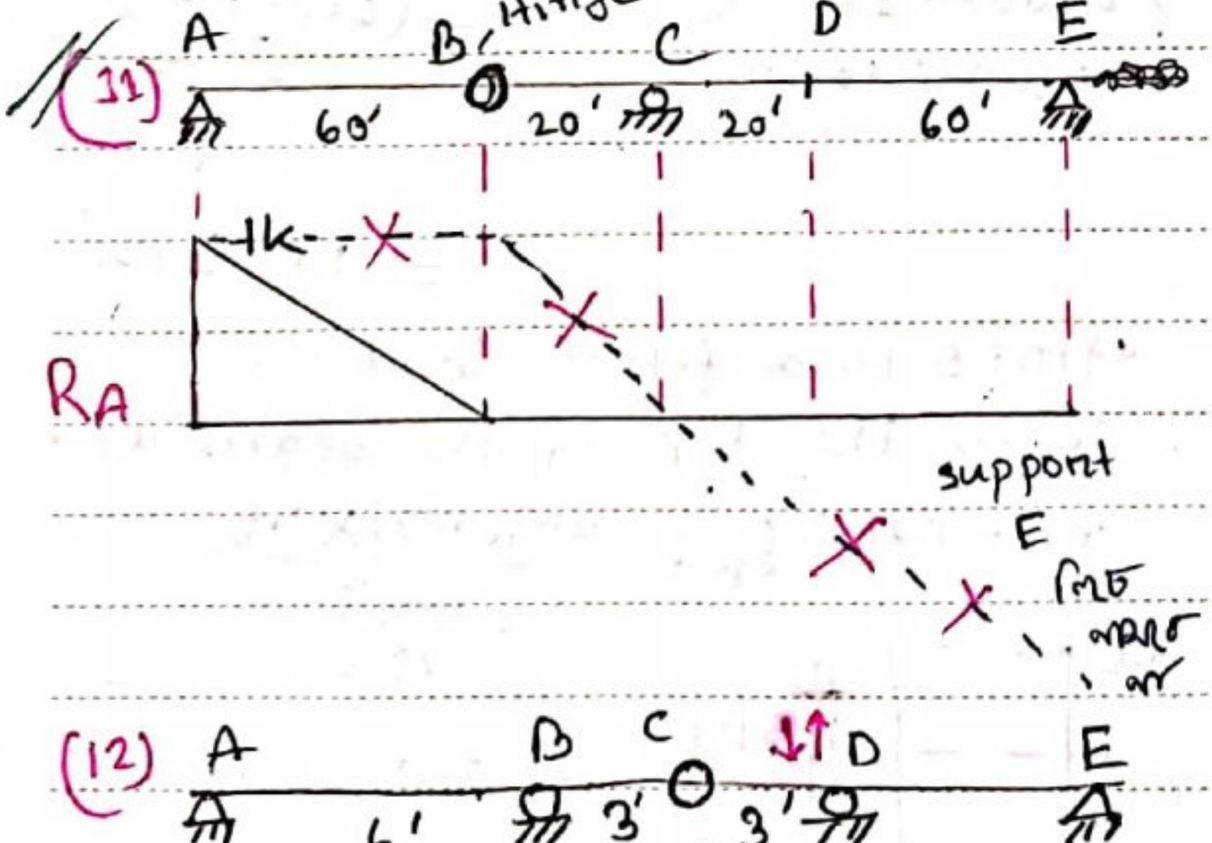
Janmet Vildapin Plus DAOMIN

(10)

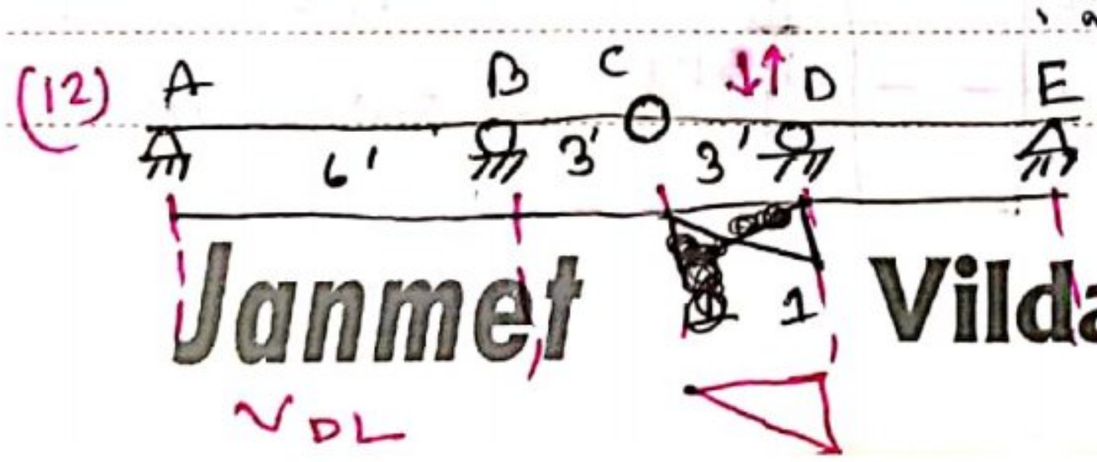




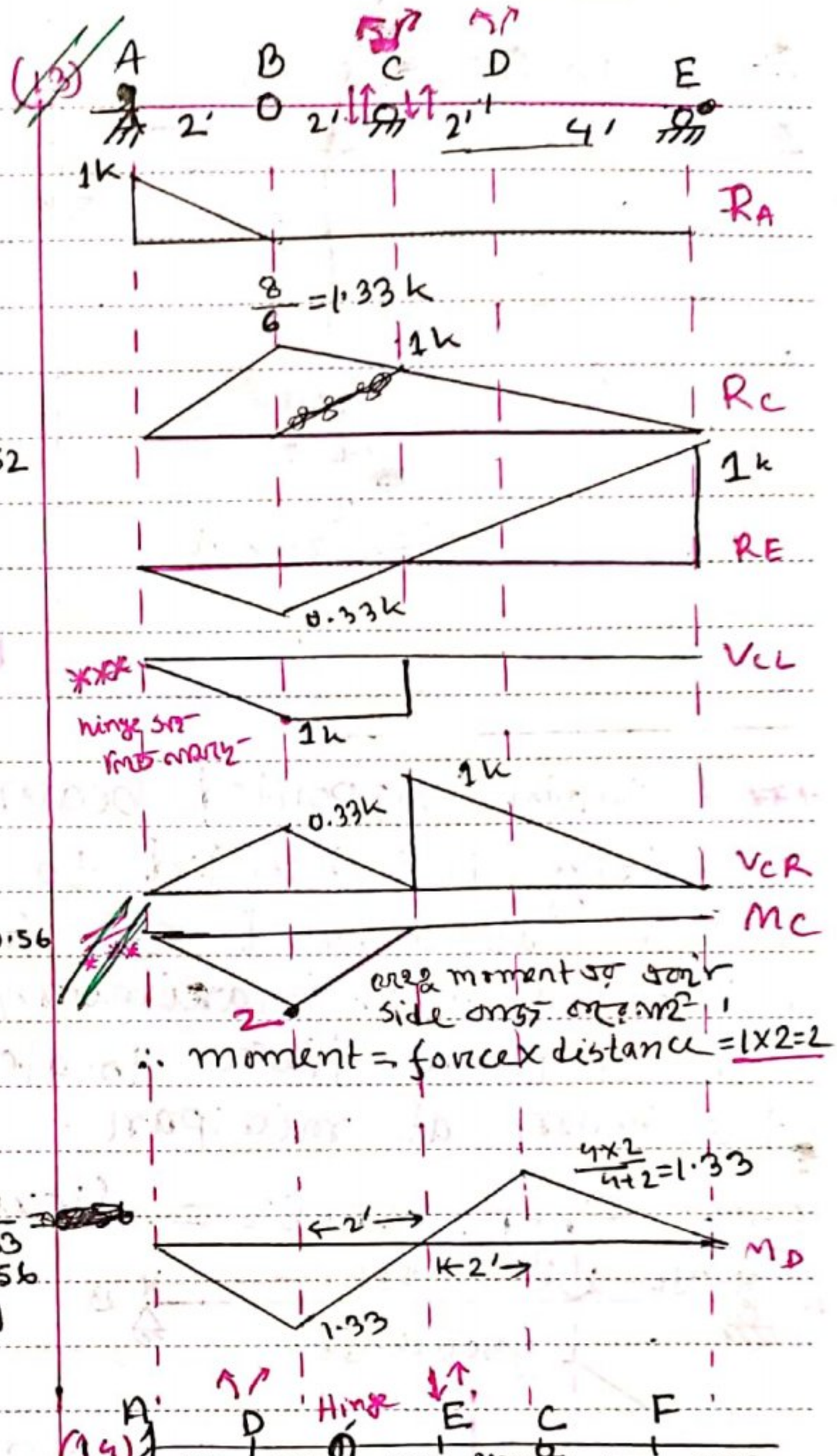
(11)



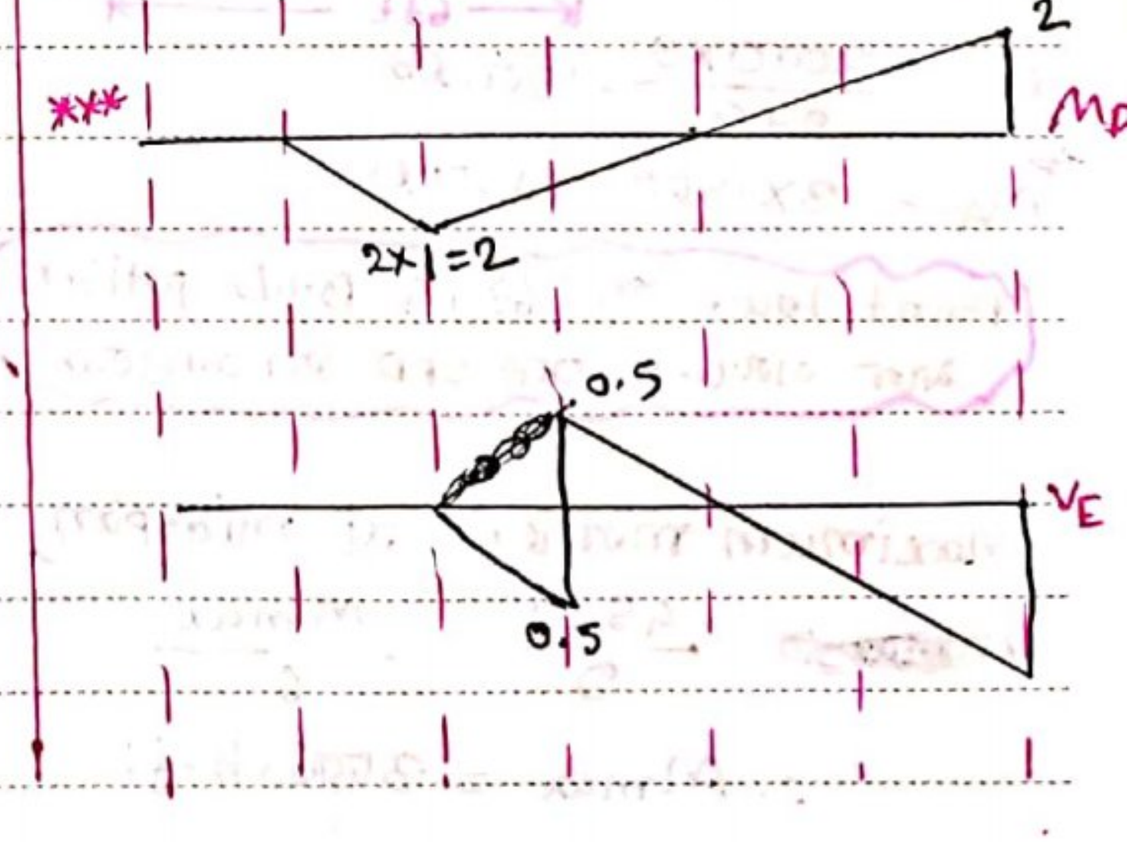
(12)



(13)

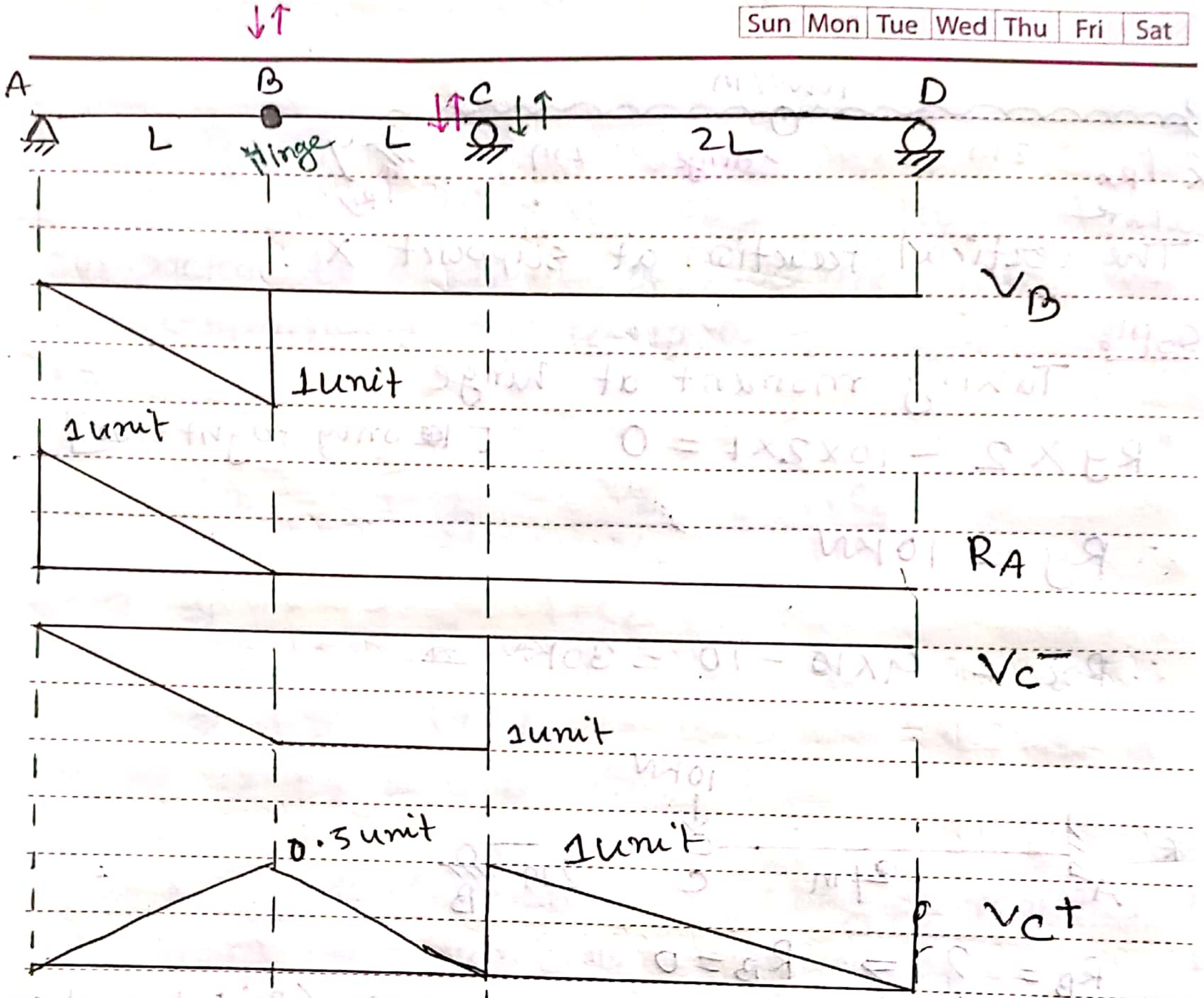


(14)



Date : / /

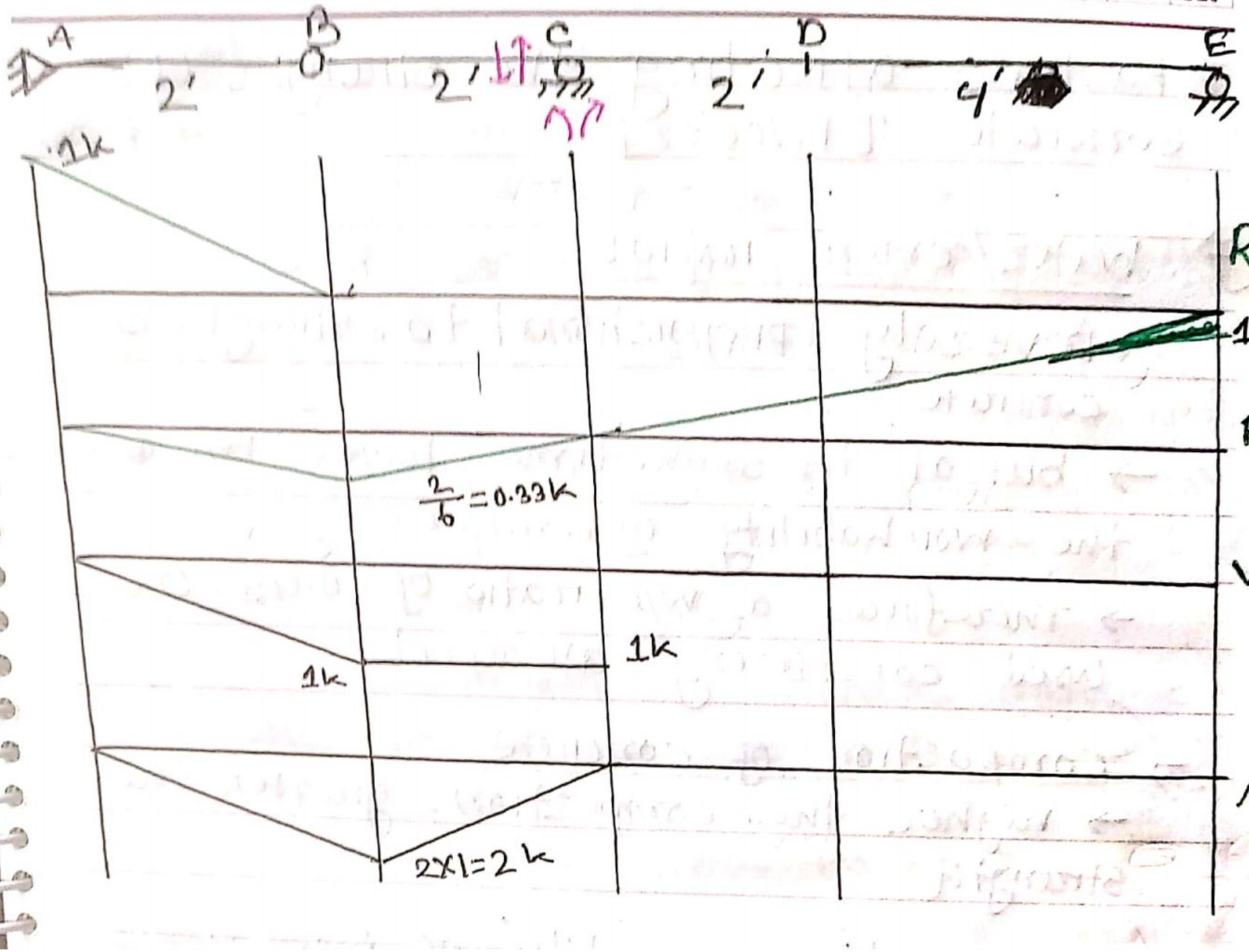
Sun | Mon | Tue | Wed | Thu | Fri | Sat

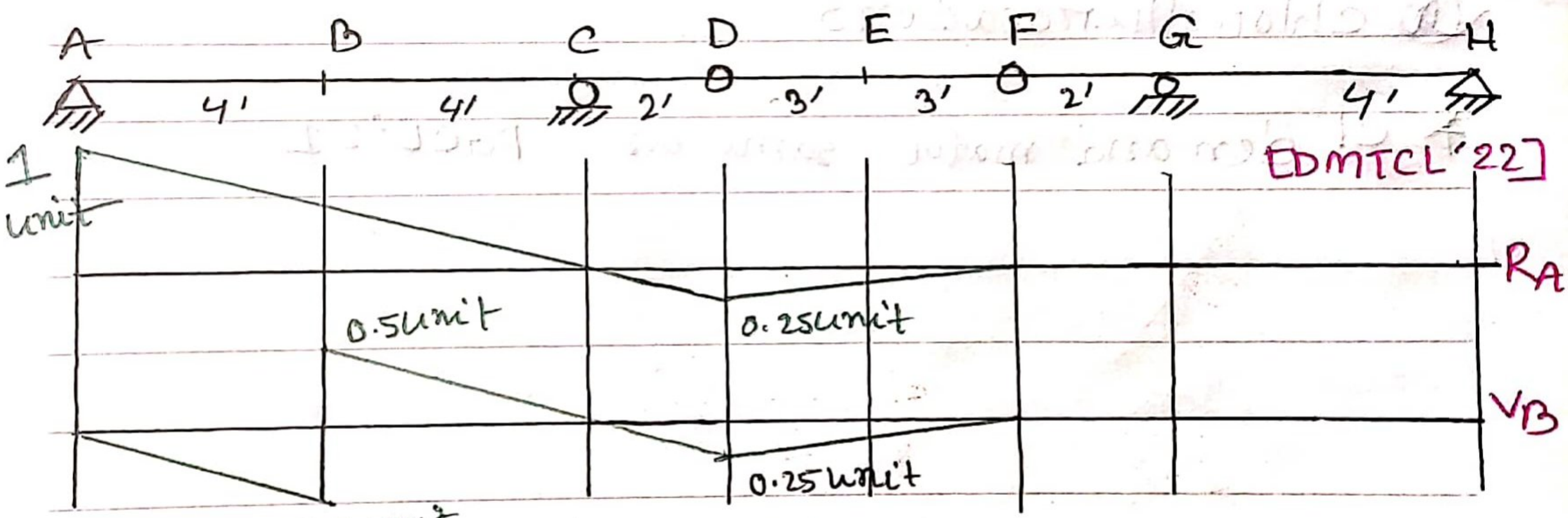


Draw IL for Reaction at A & E
Shear of just left of C & moment at C

Date: [DWGC/22]

Sun | Mon | Tue | Wed | Thu | Fri | Sat



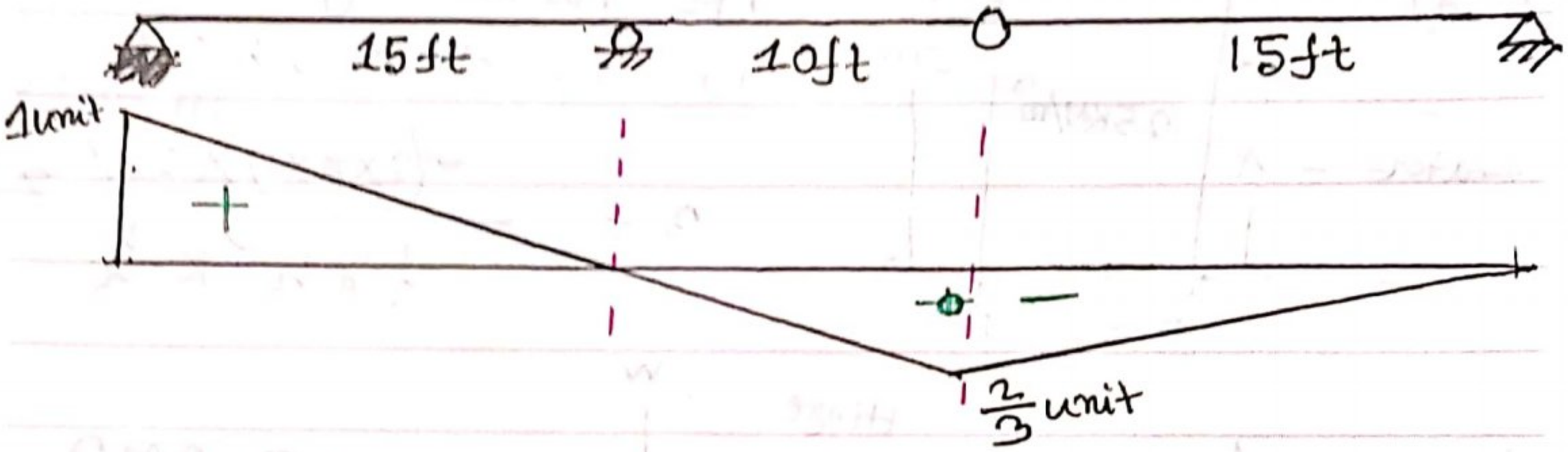


Date : / /

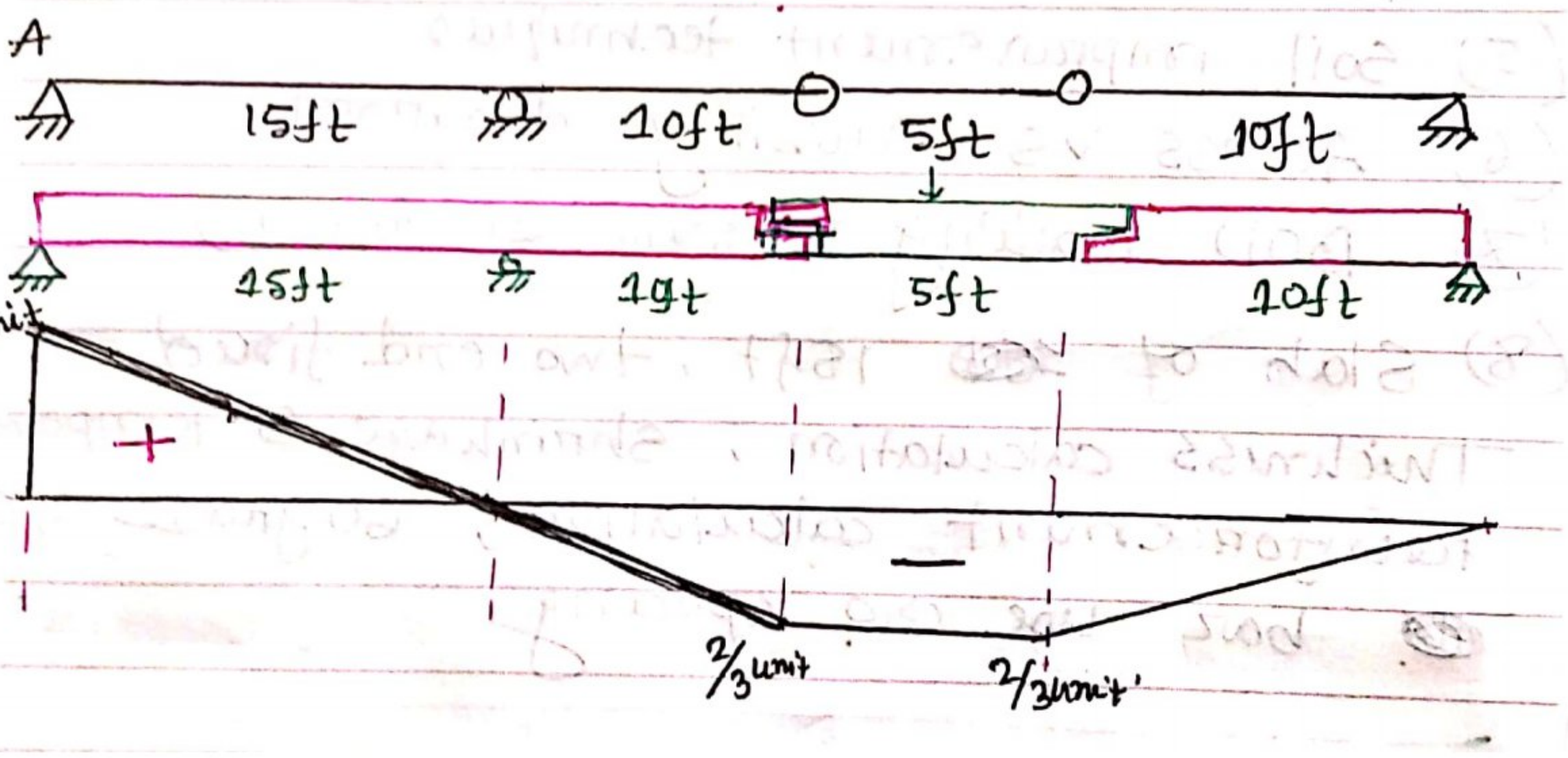
| Sun | Mon | Tue | Wed | Thu | Fri | Sat |

Petro Bangla Questions-2022

(*) Draw IL Diagram for Reaction at A in the given structure.



Titas 2021 : IL for R_A ?



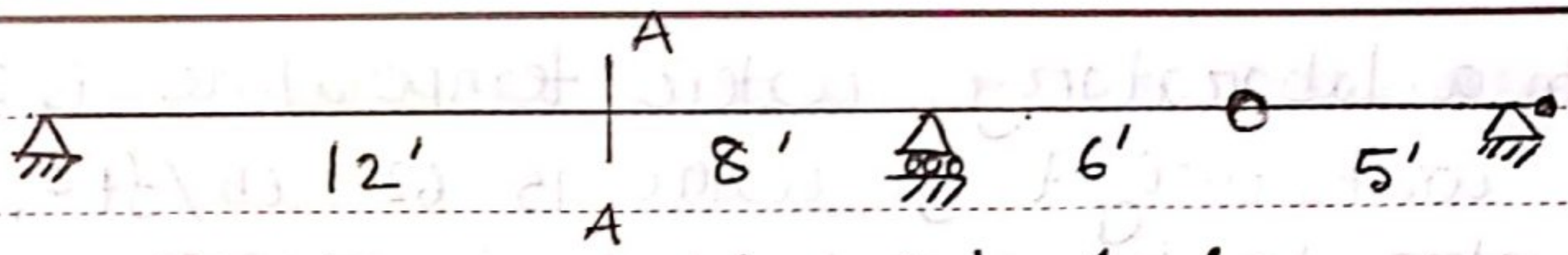
Date: / /

Sun | Mon | Tue | Wed | Thu | Fri | Sat

57

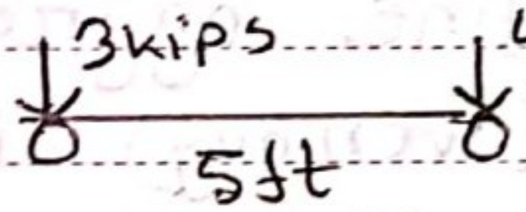
[BAPEX 23]

(5)

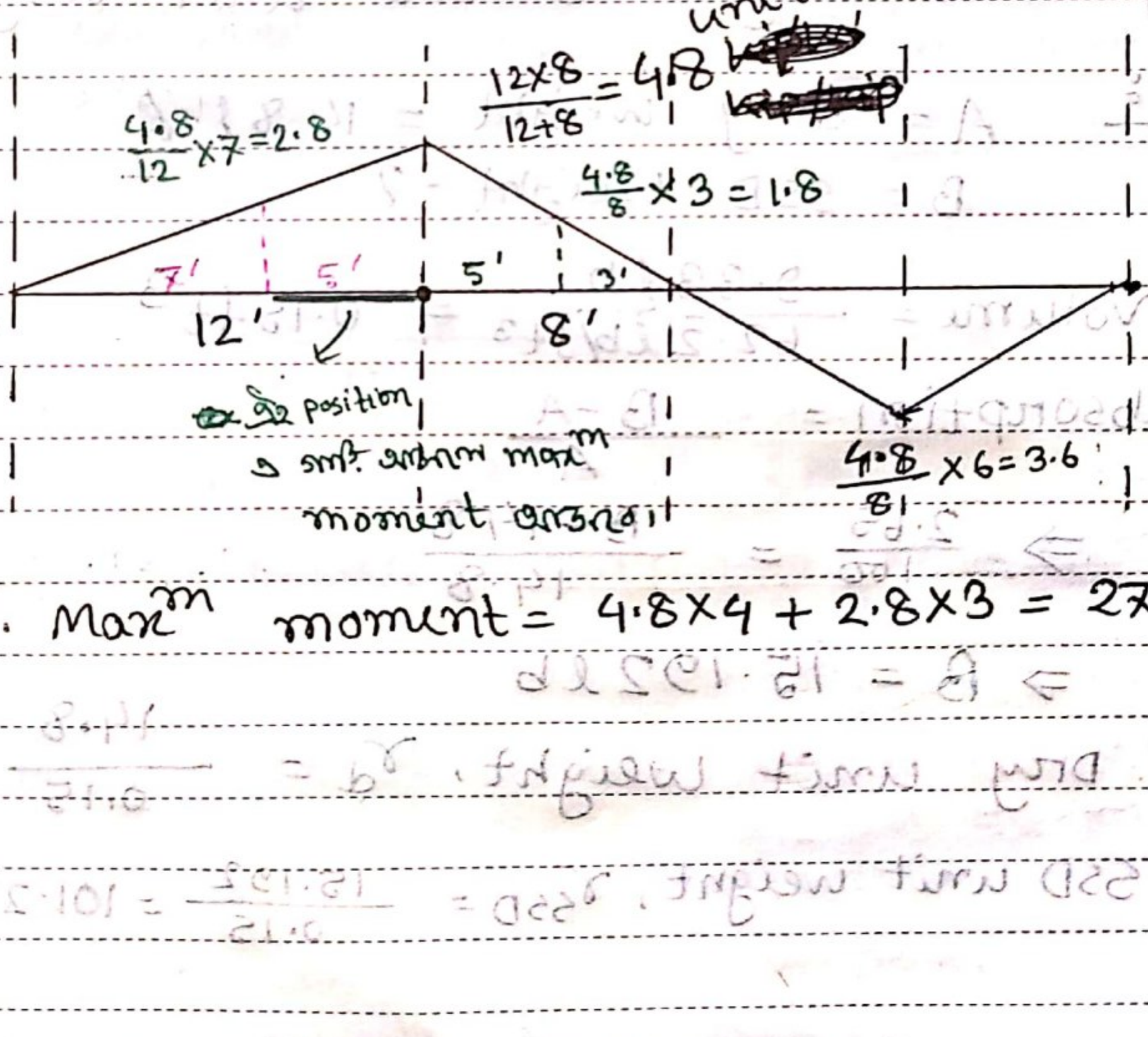


Draw IL diagram at point A for moment.

Also calculate maximum moment for ~~moment~~ moving load

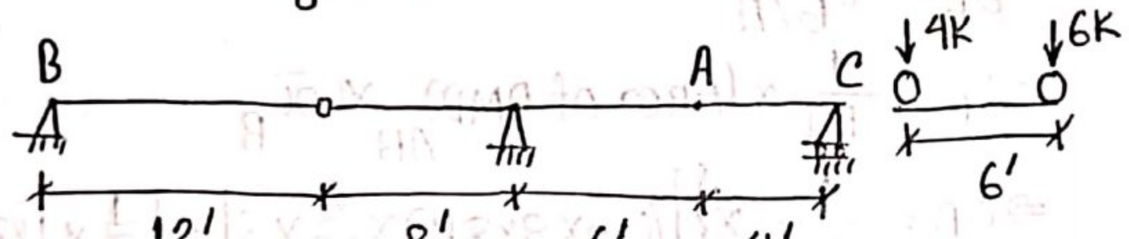


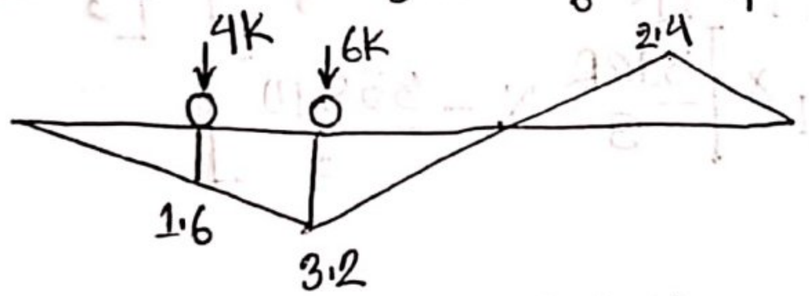
Solution



∴ Max^m moment = 4.8×4 + 2.8×3 = 27.6 K-ft

① Find maximum negative moment at A and maximum reaction at left support

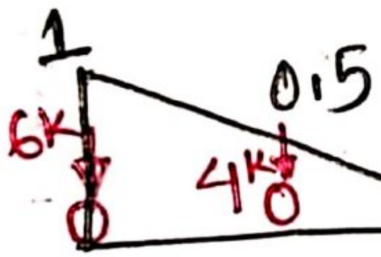




IL for M_A

∴ Maximum negative moment = (4×1.6) + (6×3.2)

= 25.6 k.ft Ans

② 

Max. Reaction = (6×1) + (4×0.5)

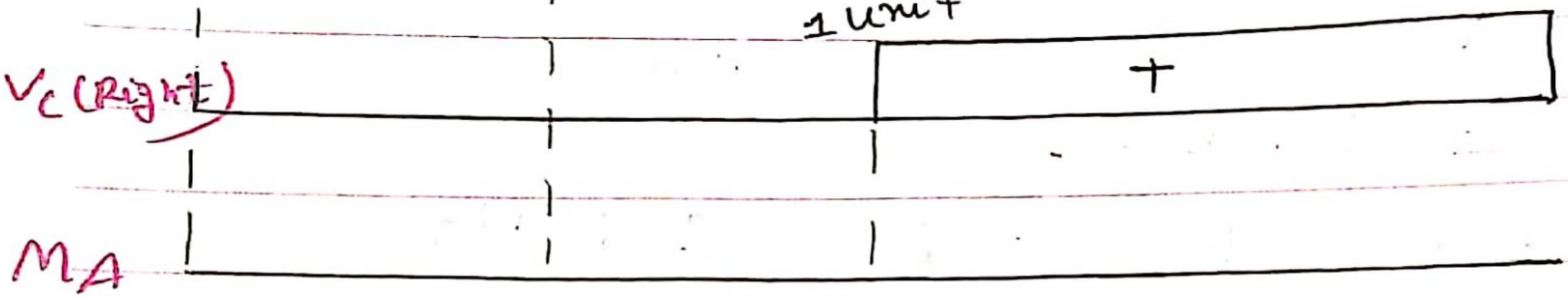
= 8K

Date : / /

Sun	Mon	Tue	Wed	Thu	Fri	Sat

[APSCL'20] [BCMCL'20]

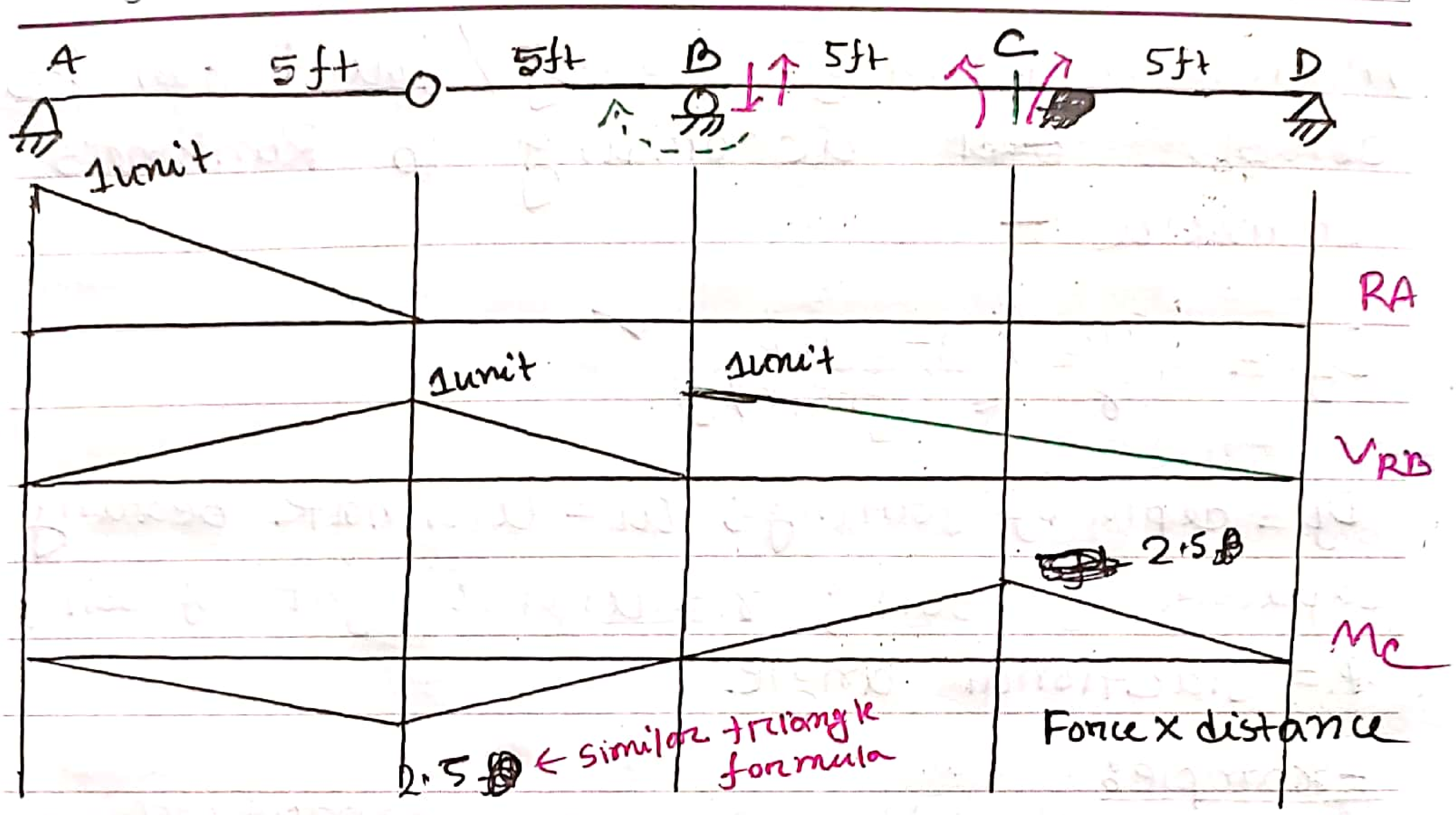
Draw IL for (i) V_C (Right) (ii) M_A.



Date :

Sun | Mon | Tue | Wed | Thu | Fri | Sat

IL for RA, VRB, Mc [BIWTA'19]

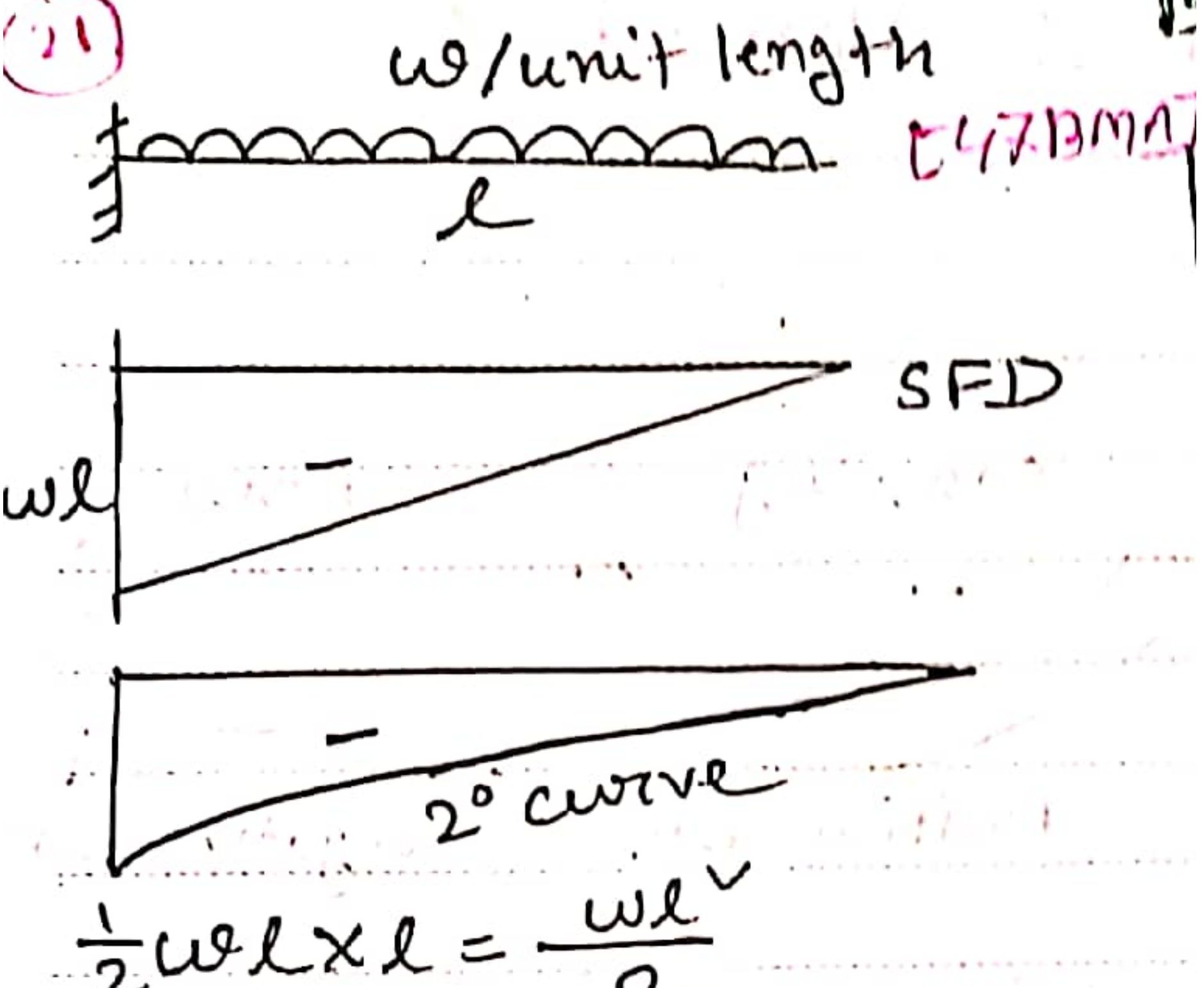


* গুরুত্বপূর্ণ IL, structure নোটে ও আছে সব দেখে নেও হবে।

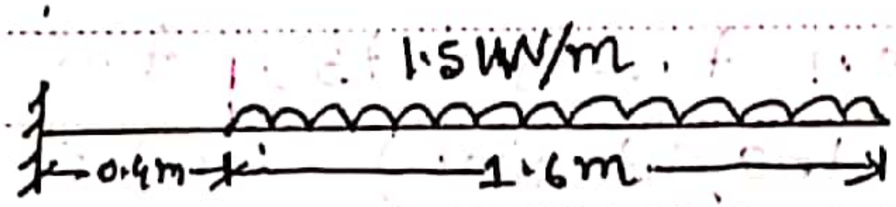
~~Spaciah~~ spacially অংক নম্বর থেওয়ার 3, 6, 8, 10, 11, 13

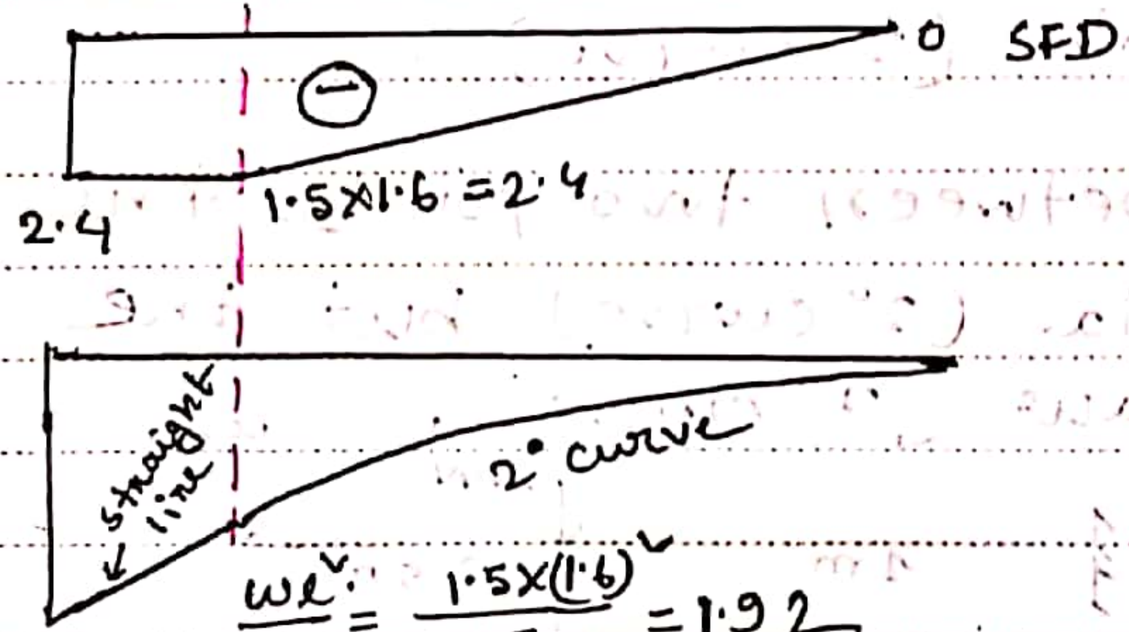
(annotations: 3 → (V_B, V_{CL}); 6 → (V_{AR}); 13 → (M_c))

(11)



$$\frac{1}{2} w l \times l = \frac{w l^2}{2}$$

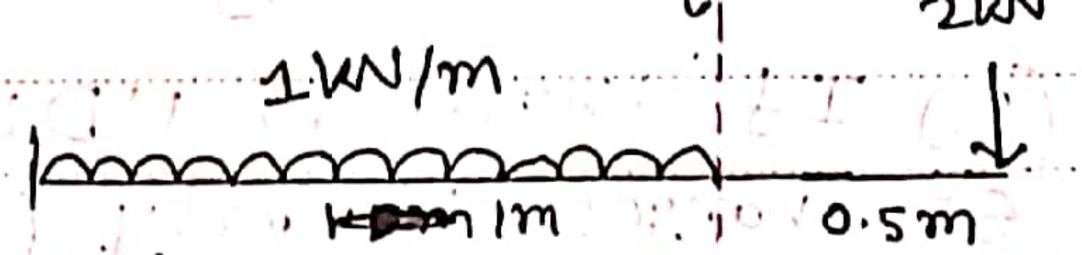


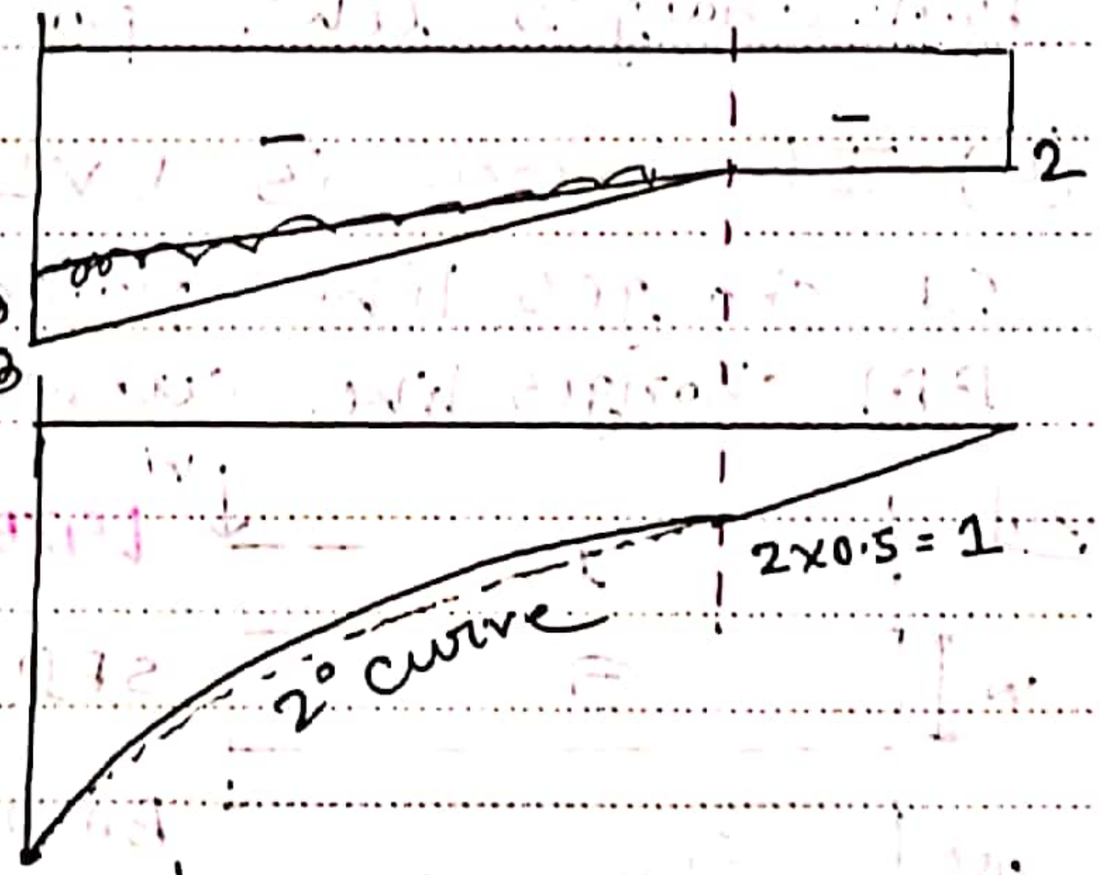


↳ Total area of SFD

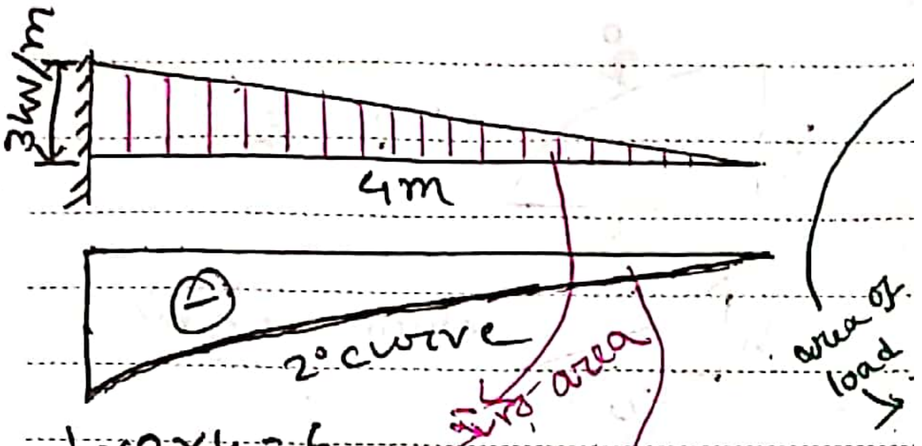
= 1.92 + 2.4×0.4

= 2.88

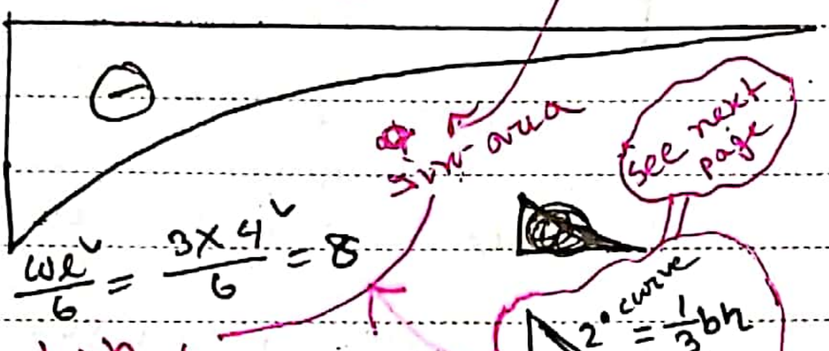




* BMD value = Area of SFD



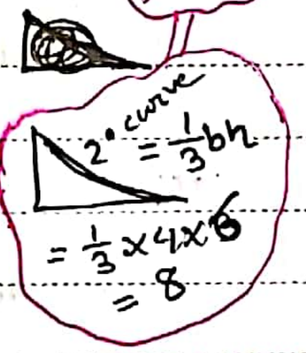
$\frac{1}{2} \times 3 \times 4 = 6$ = area



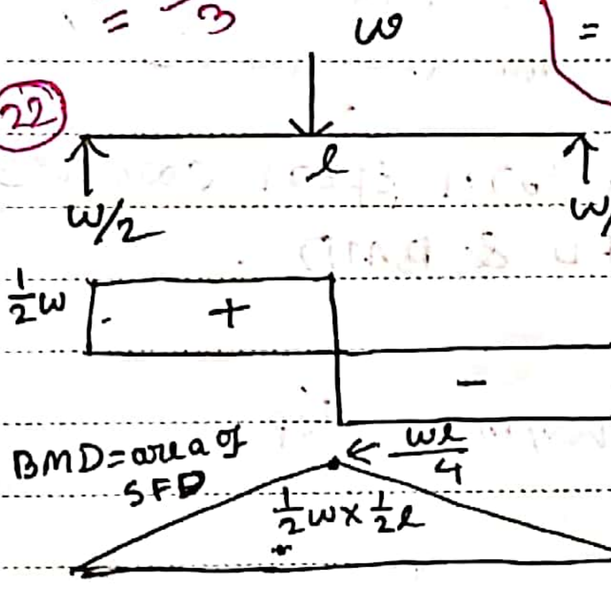
$\frac{wl^2}{6} = \frac{3 \times 4^2}{6} = 8$

$= \frac{1}{3}bh = \frac{4 \times 6}{3} = 8$

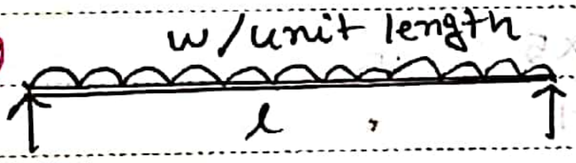
see next page

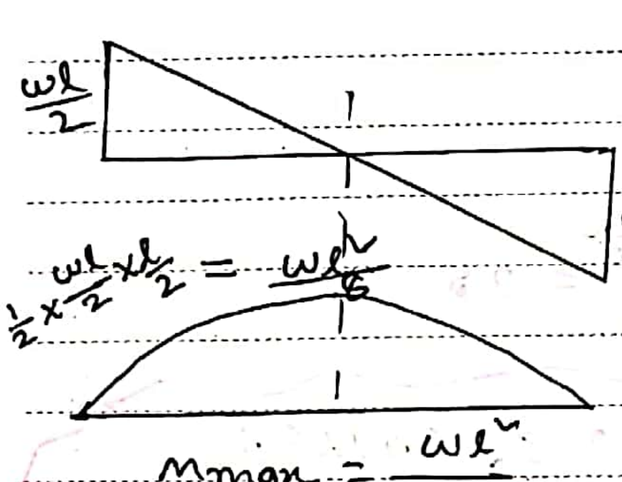


(22) [47BMA]



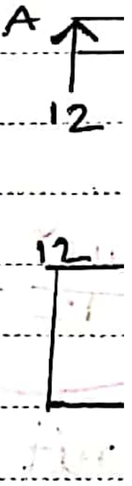
(23) [47BMA]



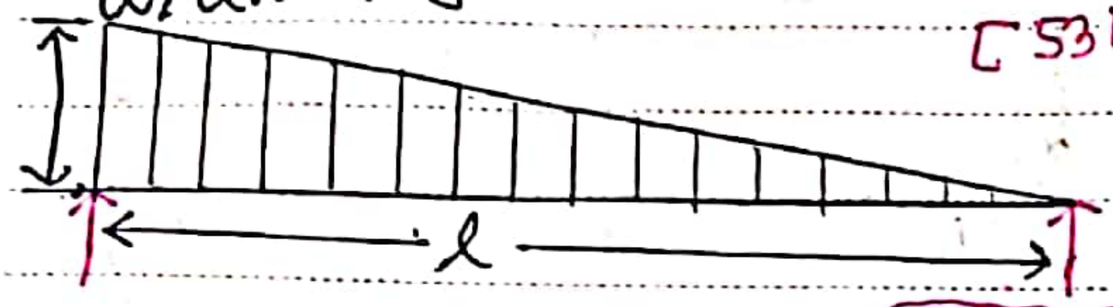


$M_{max} = \frac{wl^2}{8}$

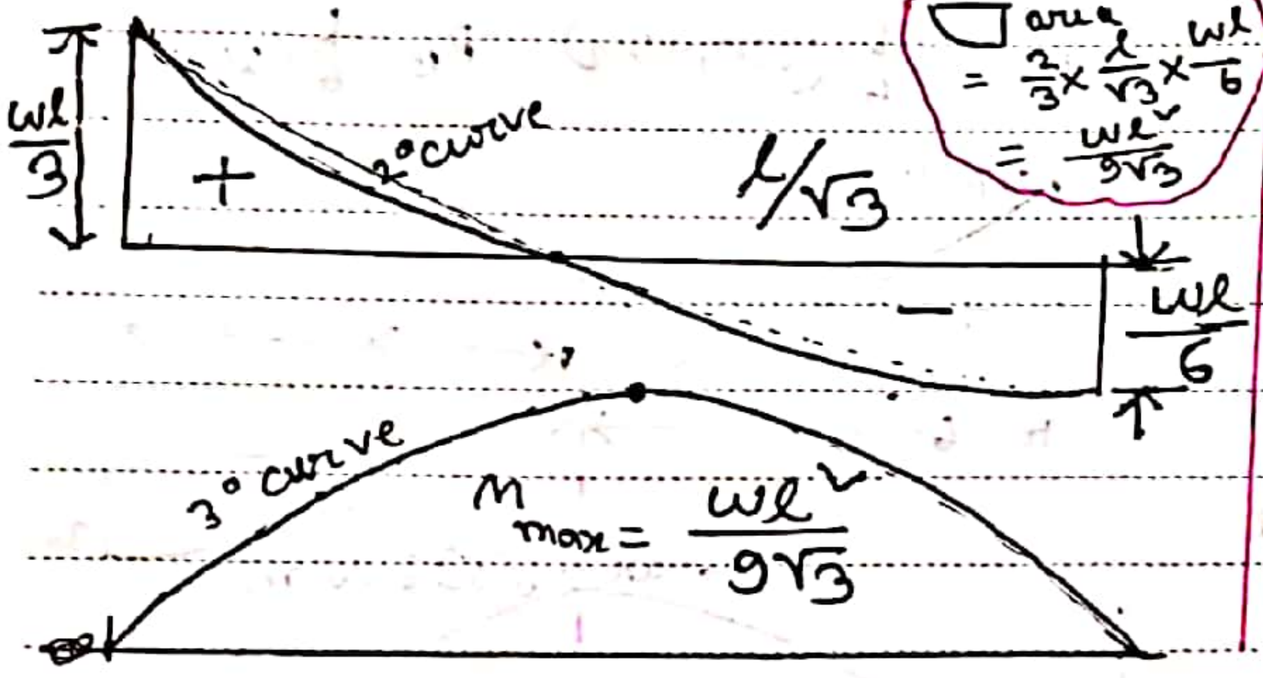
(2) point a shear force zero 2) - (3) max moment max^m 2).

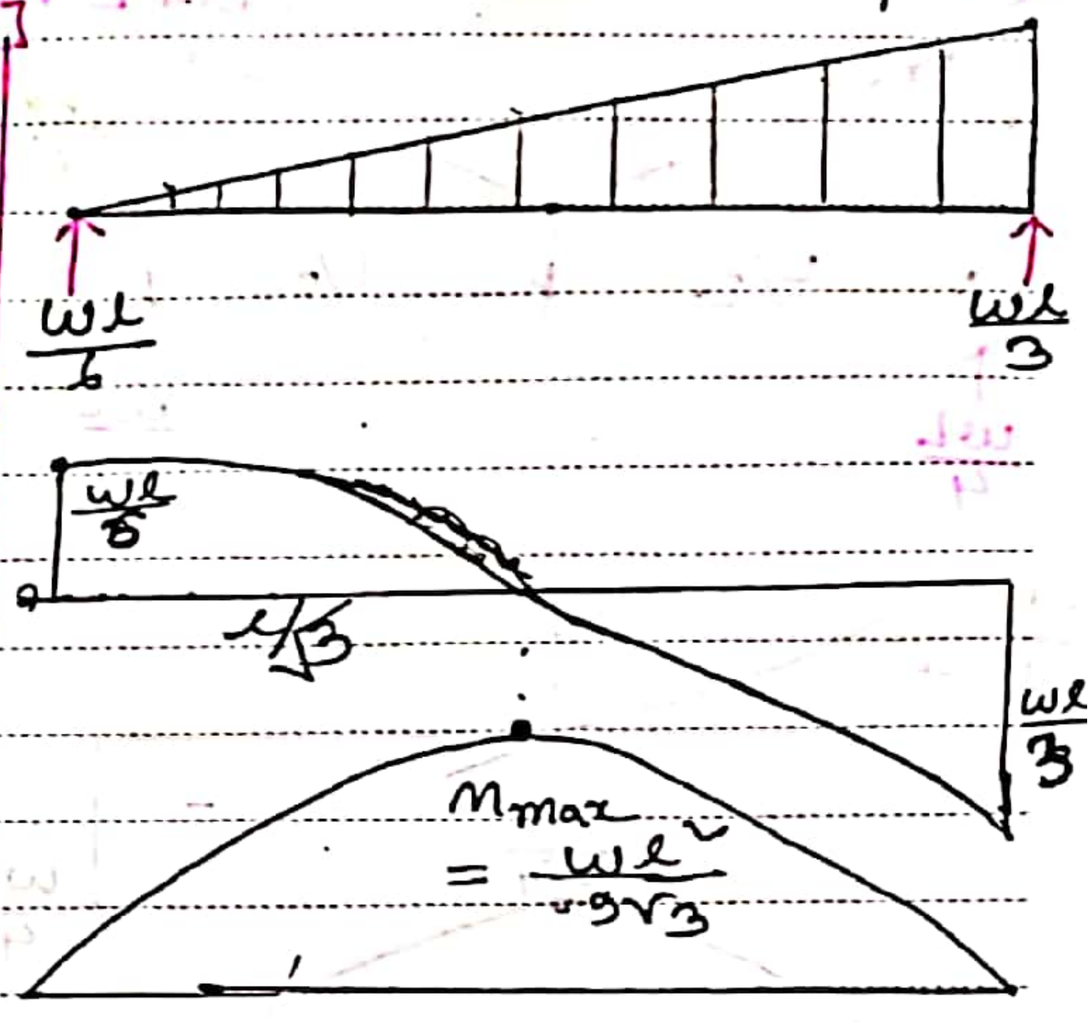


(25) w/unit length



[53 BMA]

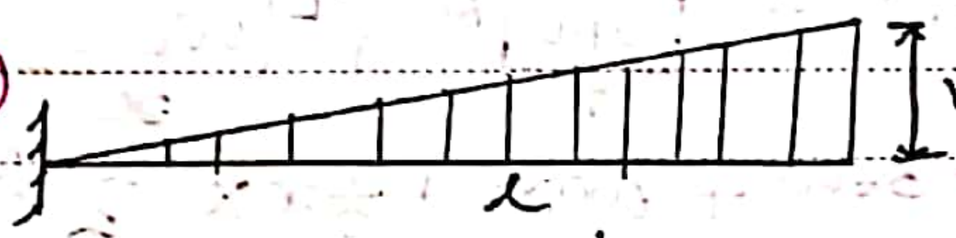




* Simply supported beam এর ক্ষেত্রে ⊕ চিহ্ন থেকে মোমেন্টের দিকে গেলে ◺ shape আর মোমেন্ট শূন্য থেকে চিহ্নের ⊖ দিকে গেলে ◺ shape. [Direction count করতে 2টা support থেকে]

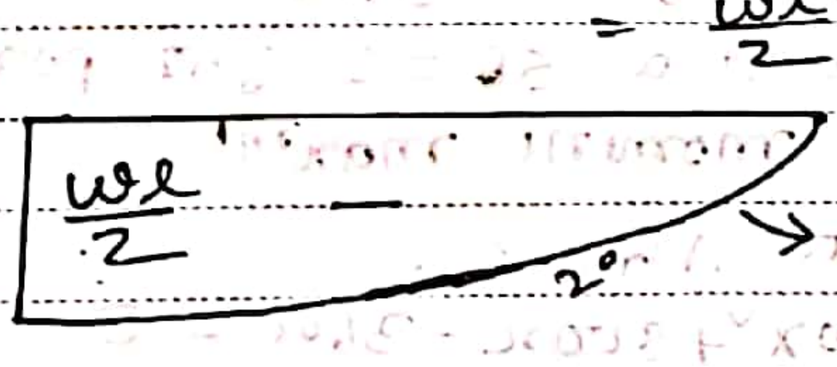
* Cantilever এর ক্ষেত্রে ⊕ চিহ্ন থেকে মোমেন্টের দিকে গেলে ◺ আর মোমেন্ট থেকে চিহ্নের গেলে ◺ [সাপোর্টের দিক থেকে direction count]

(26)



[CUET MSC'20]

Total load = $\frac{1}{2} \times w \times l = \frac{wl}{2}$

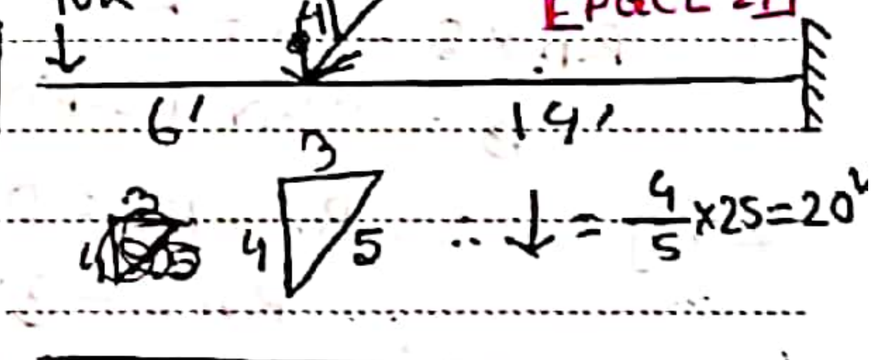


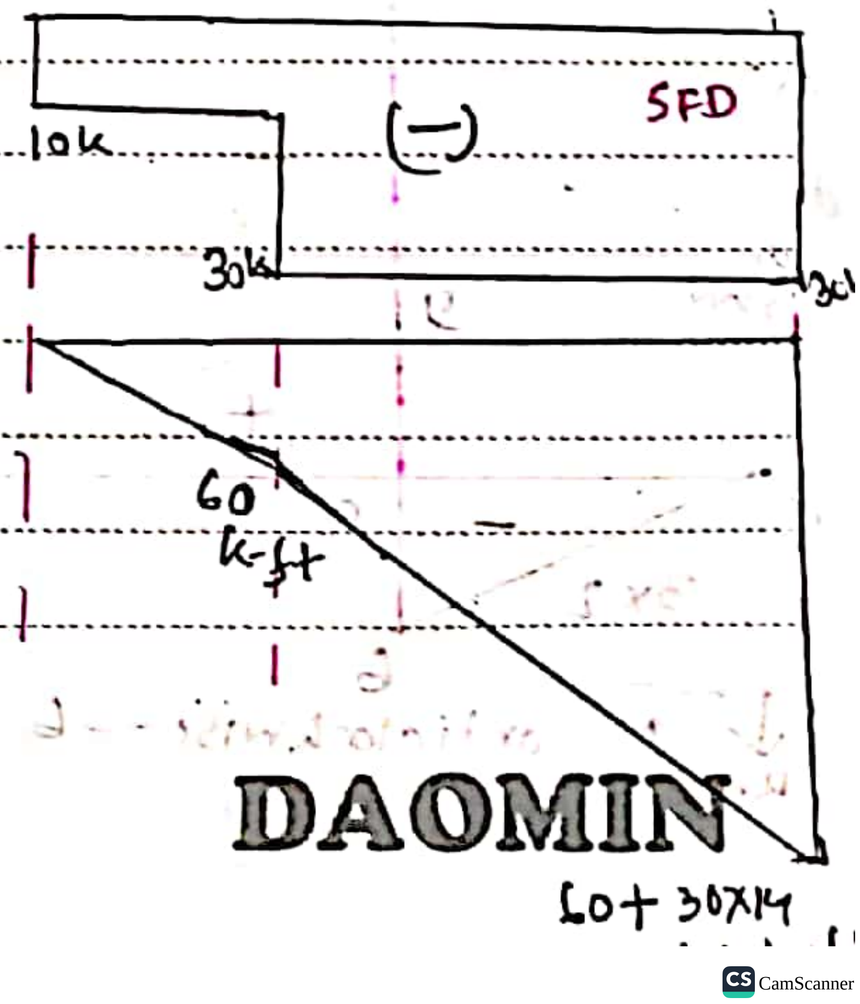
area = $\frac{2}{3} bh$

$= \frac{2}{3} \times l \times \frac{wl}{2}$

$= \frac{wl^2}{3}$

[EPGCL'21]

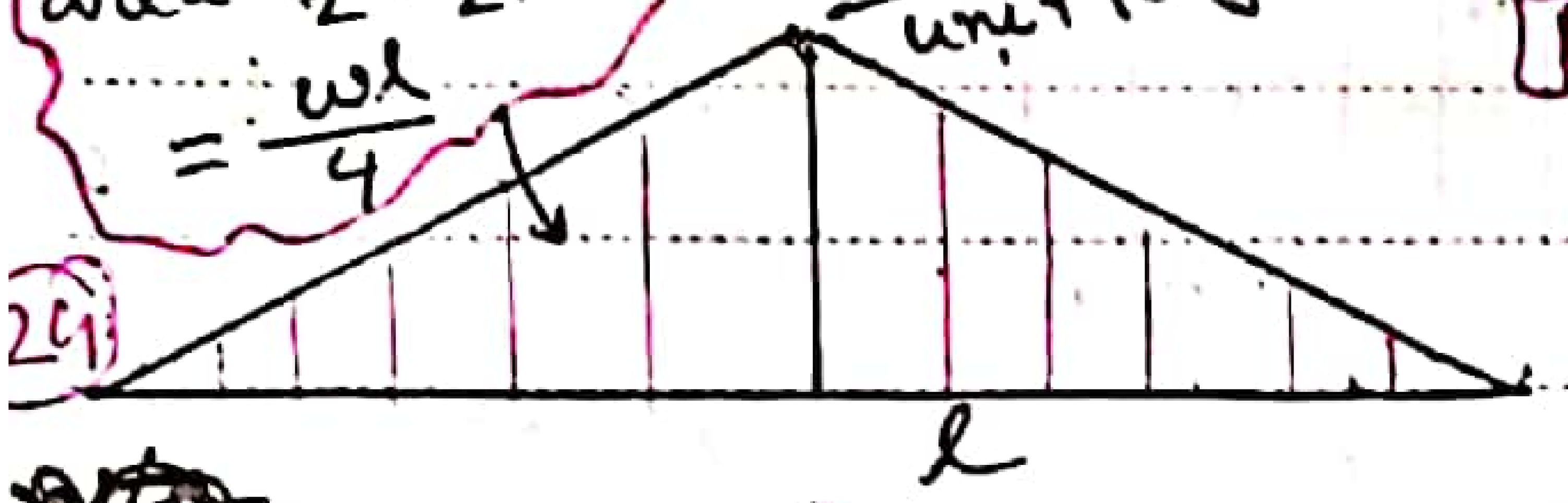


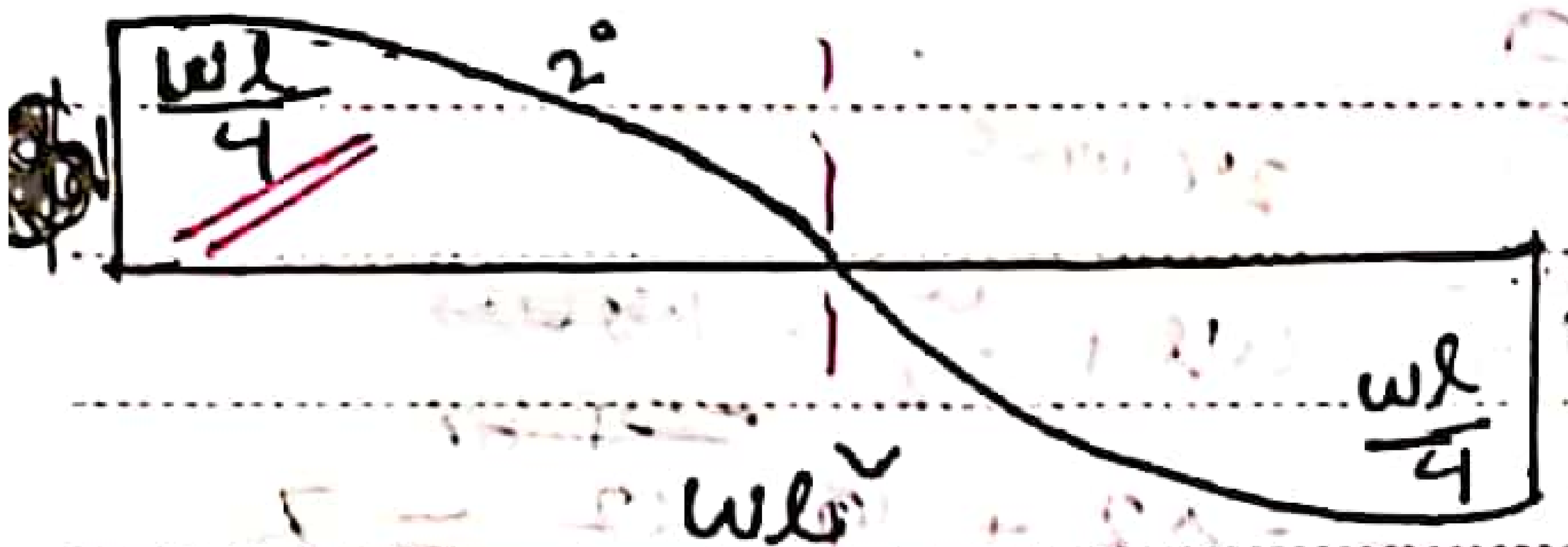


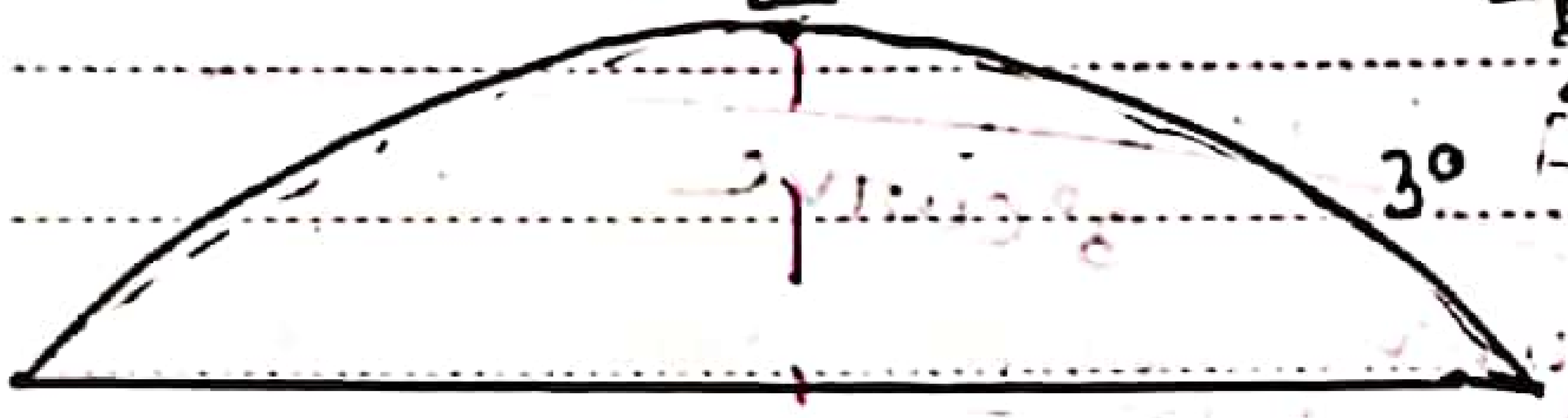
Lot 30X14

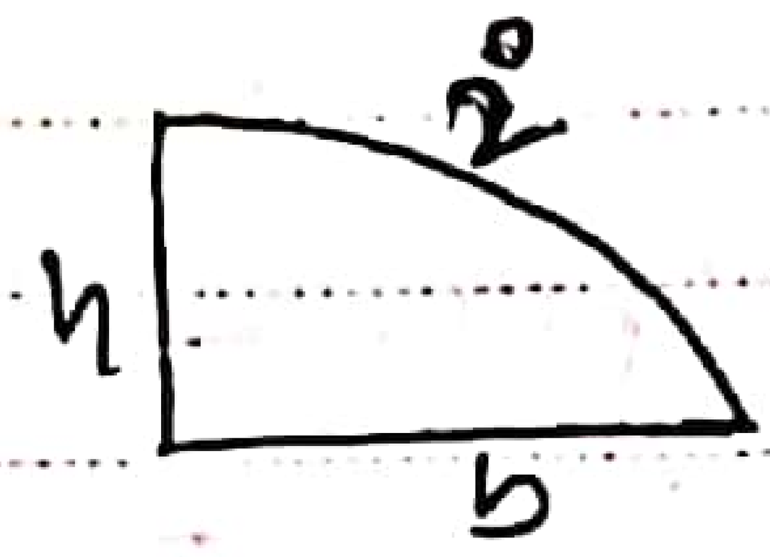
[BREB'18]

area $= \frac{1}{2} \times \frac{l}{2} \times w = \frac{wl}{4}$

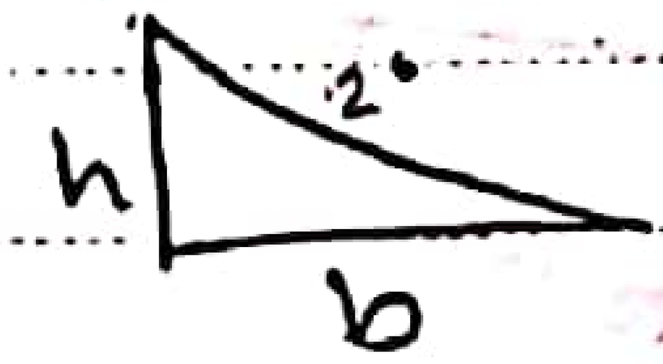








Area $= \frac{2}{3} bh$



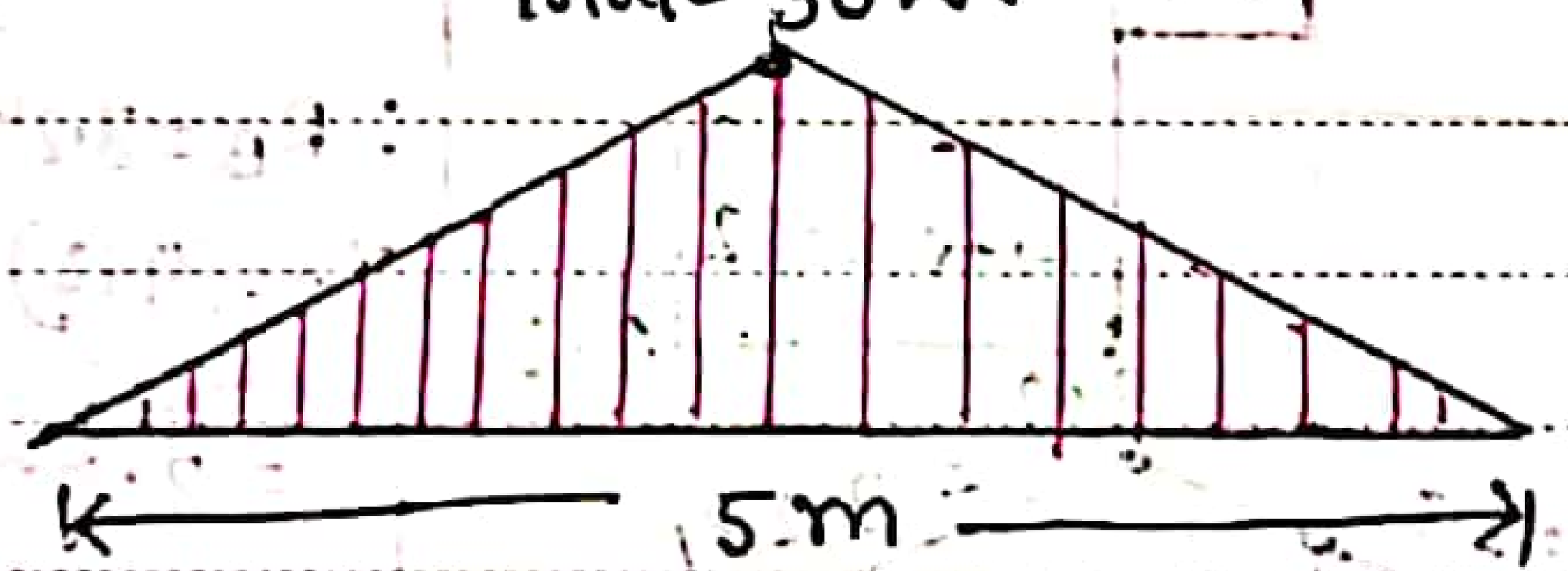
Area $= \frac{1}{3} bh$

 $= \frac{2}{3} bh = \frac{2}{3} \times \frac{l}{2} \times \frac{wl}{4} = \frac{wl^2}{12}$

* SS beam এর ক্ষেত্রে [illegible] curve [illegible] curve।

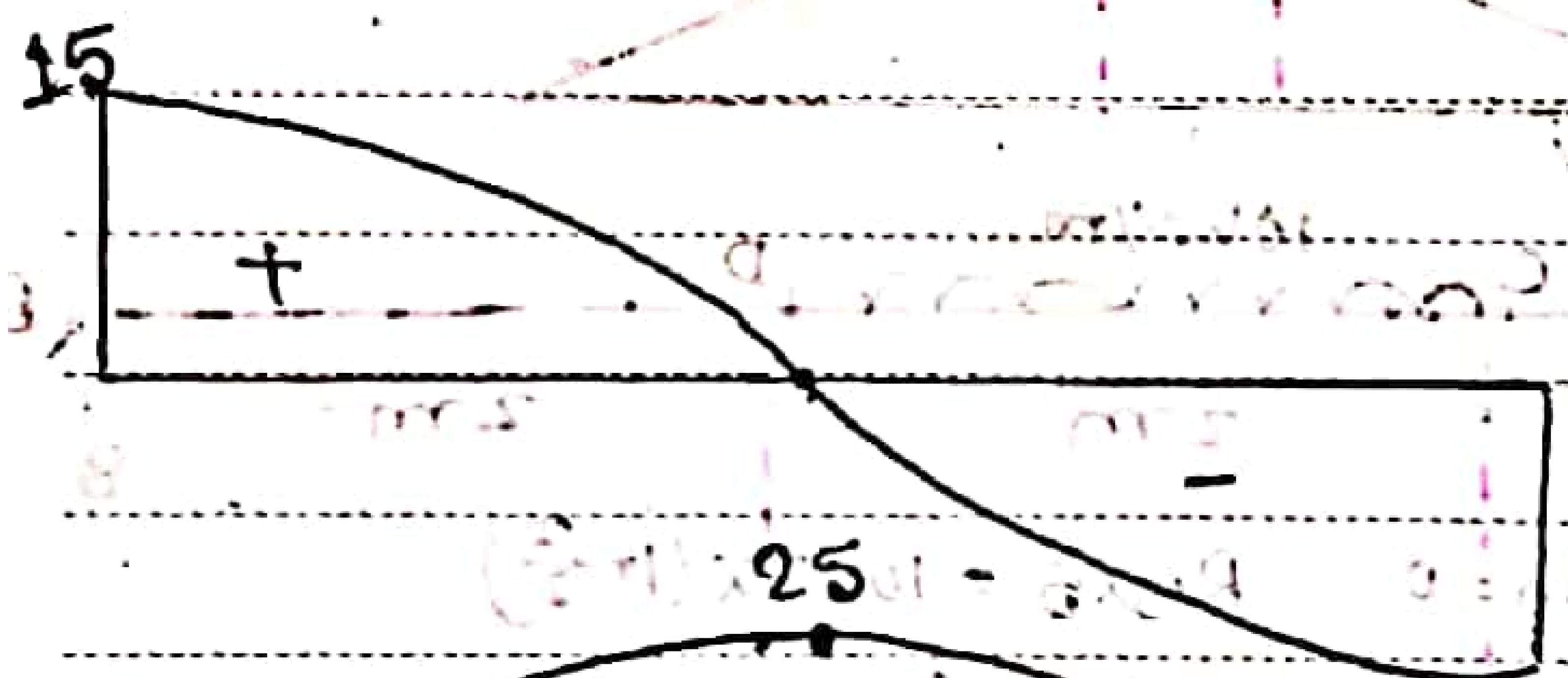
** আর cantilever এর ক্ষেত্রে [illegible]

* A simply supported beam of 5m span carries a triangular load of 30KN. Draw SFD & BMD.

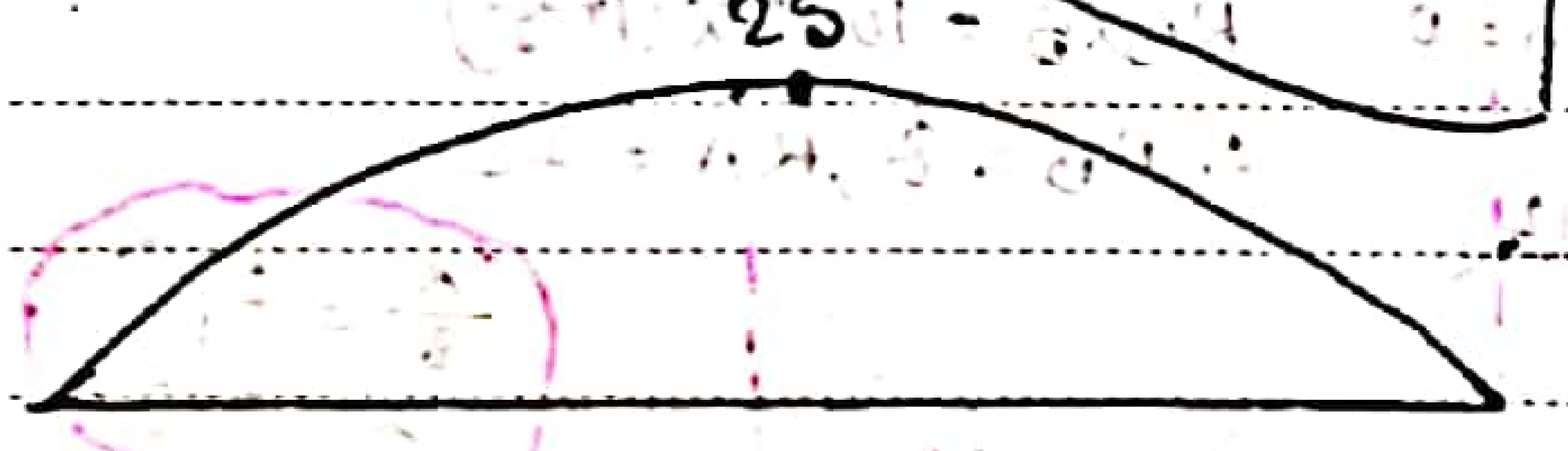


Total = 30

$\therefore \frac{30}{2.5} = 12$ KN/m at top



$\frac{wl}{4} = \frac{12 \times 5}{4} = 15$

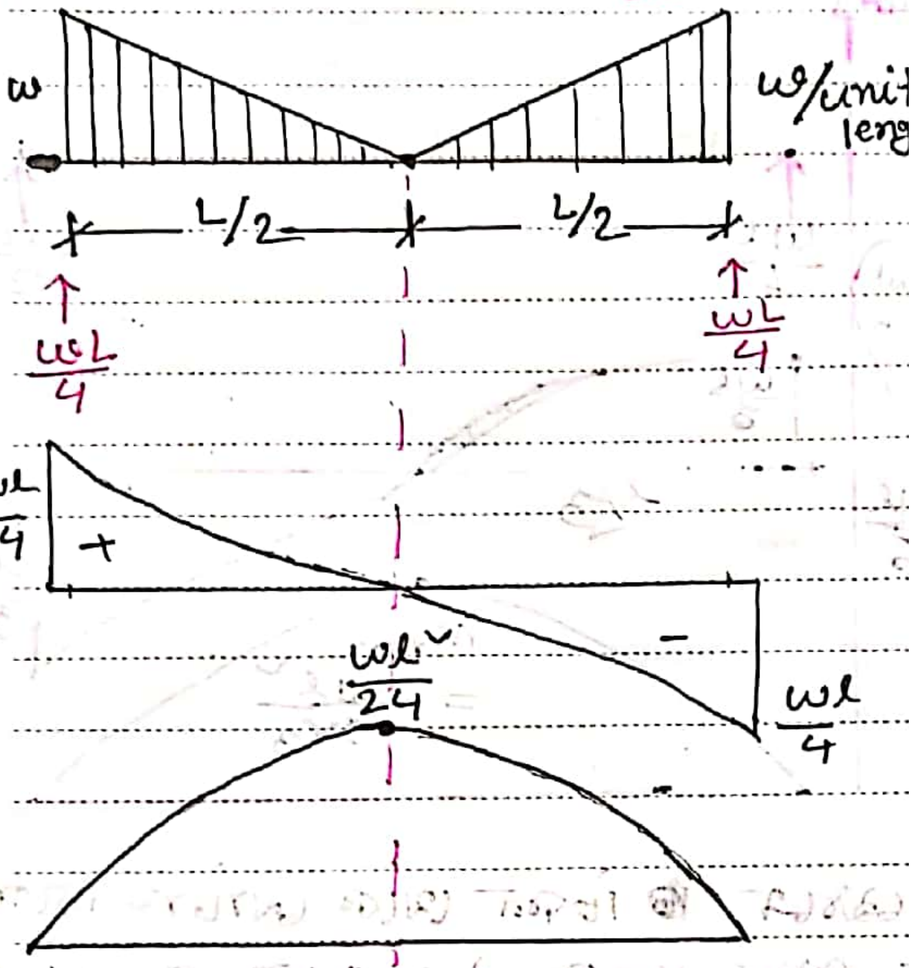


$\frac{wl^2}{12} = \frac{12 \times 5^2}{12} = 25$

*** SFD BMD সবগুলোতে unit লিখতে হবে must
SFD এর জন্য KN or kip, BMD এর জন্য KN-m or k-ft

27

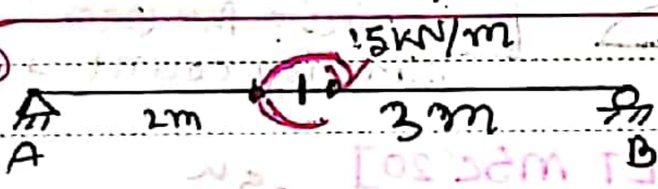
[BREB'18]



$\frac{wL}{4}$ (L/2) $= \frac{1}{3} \times bh = \frac{1}{3} \times \frac{L}{2} \times \frac{wL}{4}$

$= \frac{wL^2}{24}$

28



[5CBMA
[PGCB'15
[DPDC'1
[EGCB'15

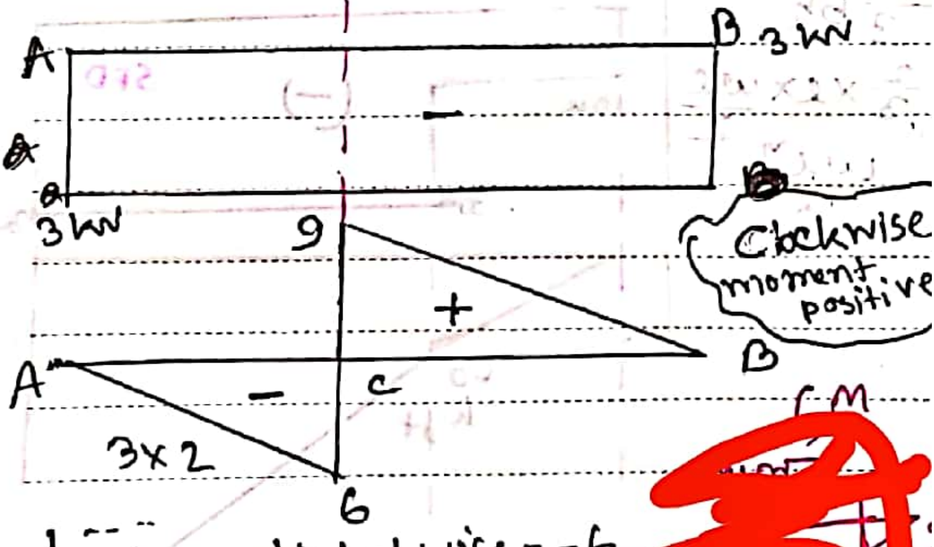
$\Sigma M_A = 0$

$\therefore R_B \times 5 - 15 = 0$

$\therefore R_B = 3KN$ (upward)

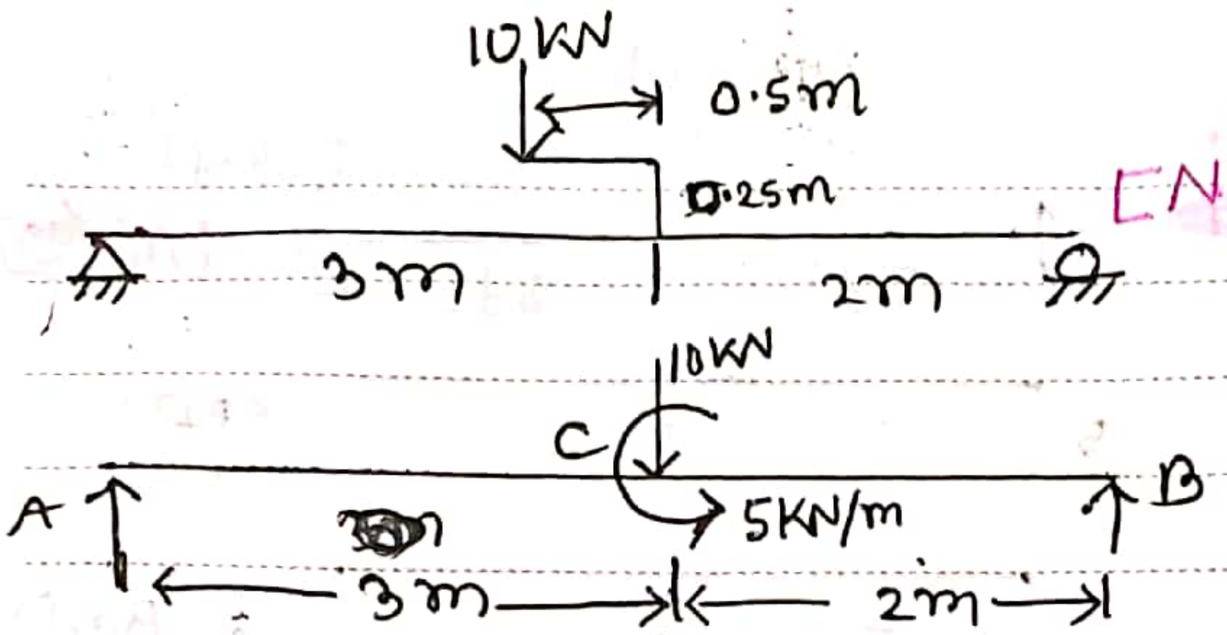
$\Sigma F_y = 0 \quad \therefore R_A + R_B = 0$ [No loads

$\therefore R_A = -3KN$ (downwar

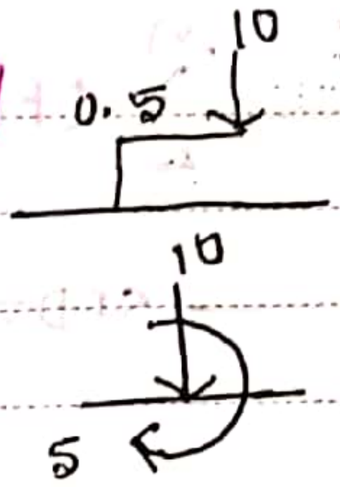


↓ RA

anticlockwise = −6



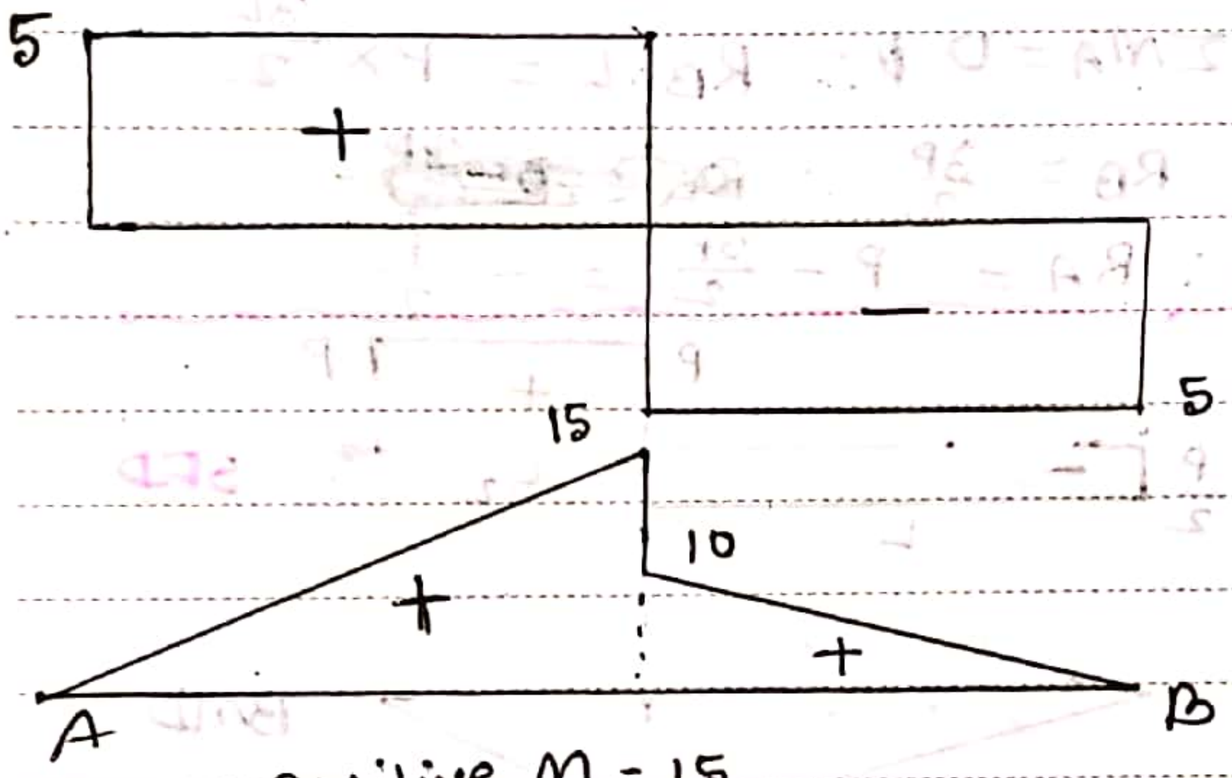
[NPCB'19]



$\Sigma M_A = 0$

$\therefore R_B \times 5 + 10 \times 3 - 5 = 0$

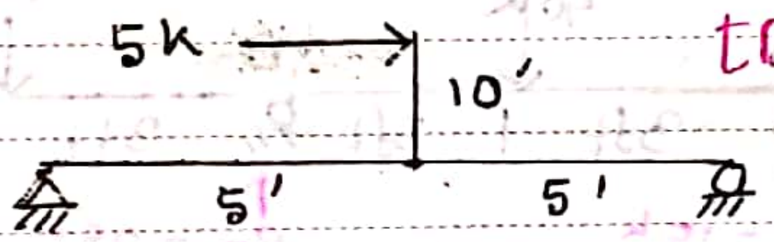
$\therefore R_B = 5 \quad R_A = 5$



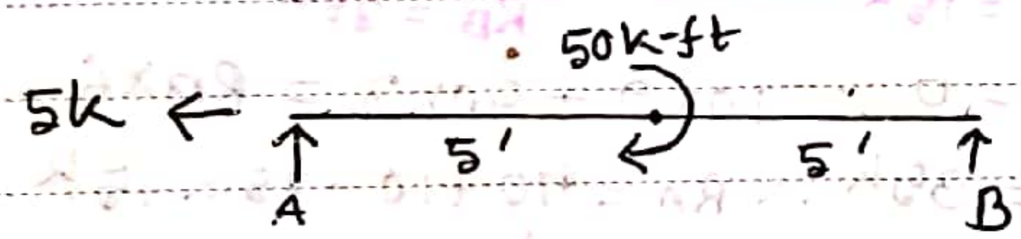
positive $M = 15$

negative $M = 5$

(29)

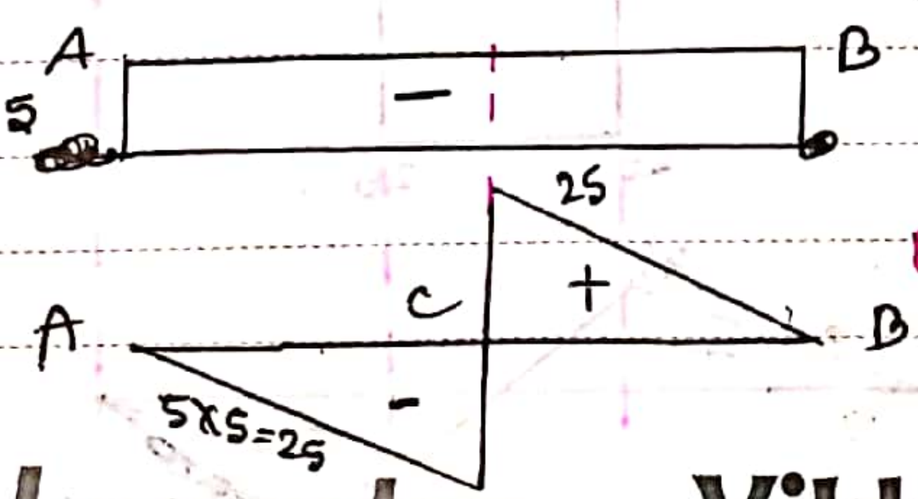


[BIWTA'19]



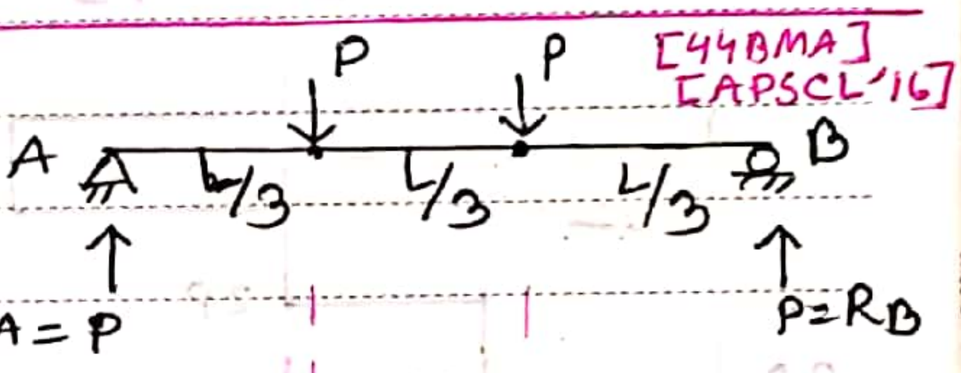
$\Sigma M_A = R_B \times 10 = 50$

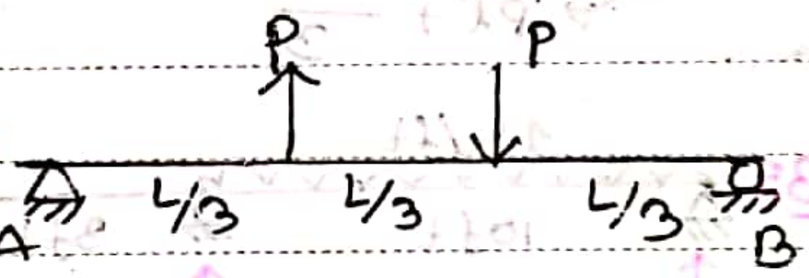
$\therefore R_B = 5^k \quad \therefore R_A = -5^k$



(30)

[44BMA]
[APSCL'16]



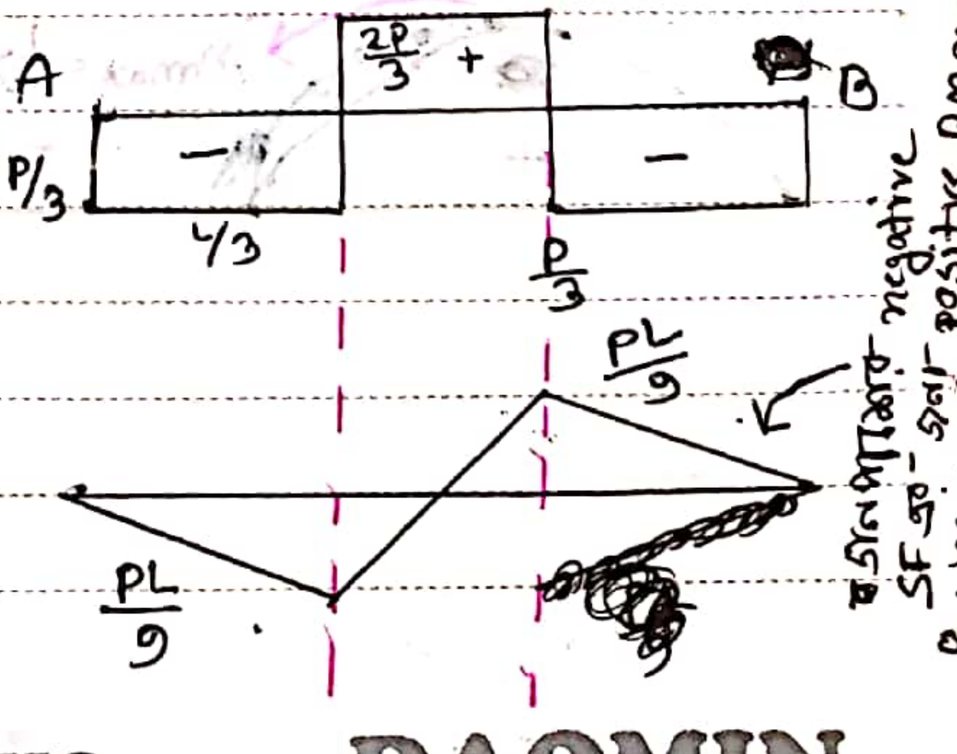


$\Sigma M_A = 0$

$\therefore R_B \times L + \frac{PL}{3} = \frac{2PL}{3}$

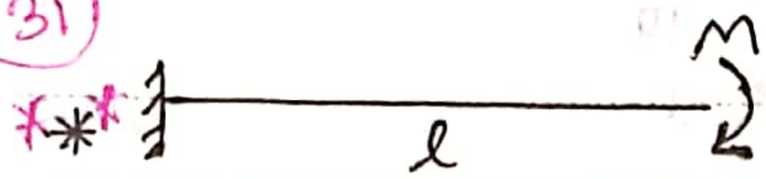
$\therefore R_B = \frac{P}{3}$

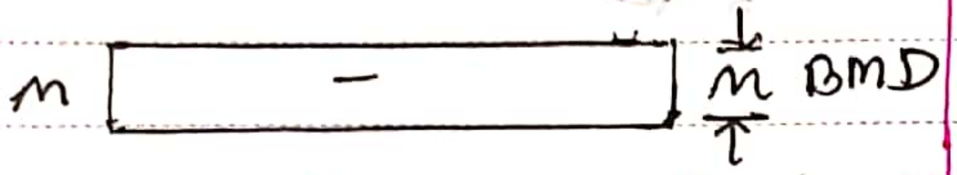
$\Sigma F_y = 0 \quad \therefore R_A + P - P + \frac{P}{3} = 0 \quad \therefore R_A = \frac{-P}{3}$



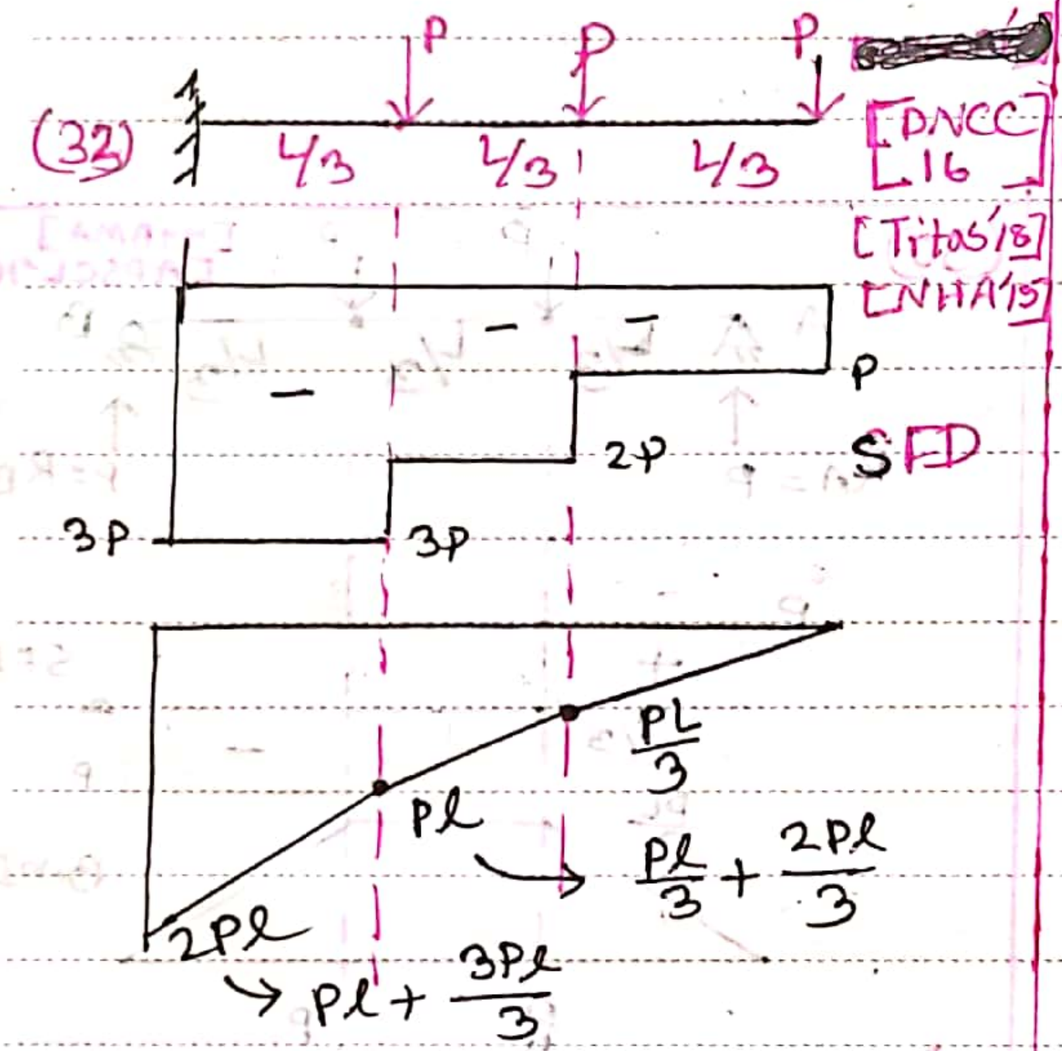
* $-\frac{PL}{9} + \frac{2P}{3} \times \frac{L}{3} = \frac{PL}{9}$ (positive)

(31) [RRI'14]



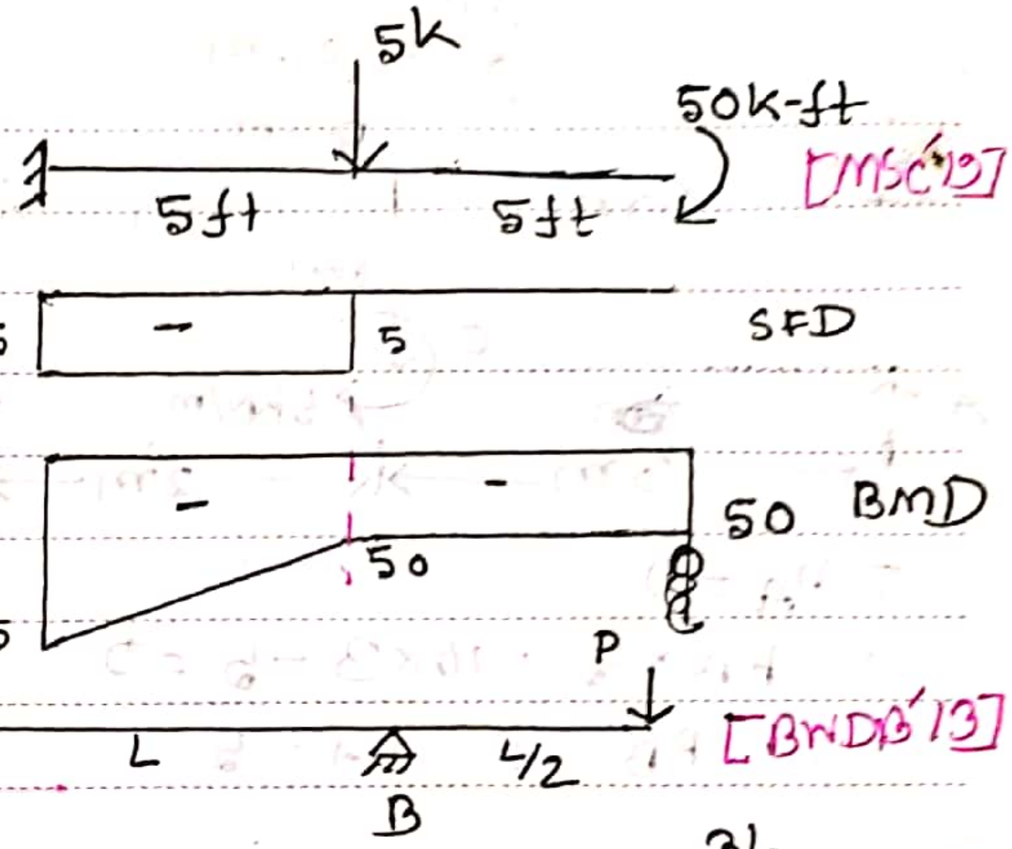


(32) [DNCC 16] [Titas'18] [NHA'15]



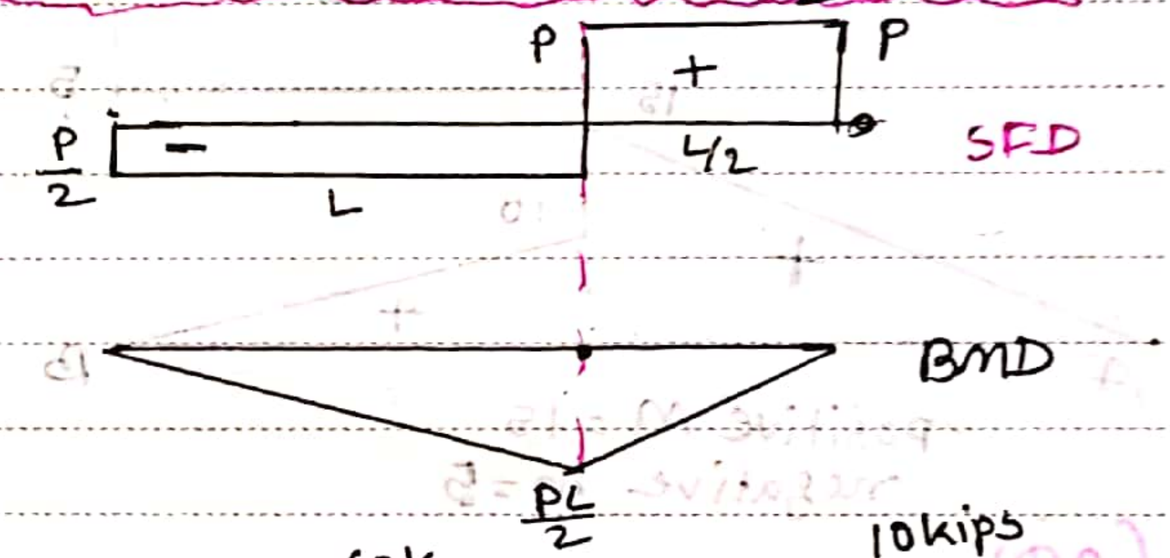
(33) [DESCO'19] [SGCL'20]

(34) [BNDB'13]



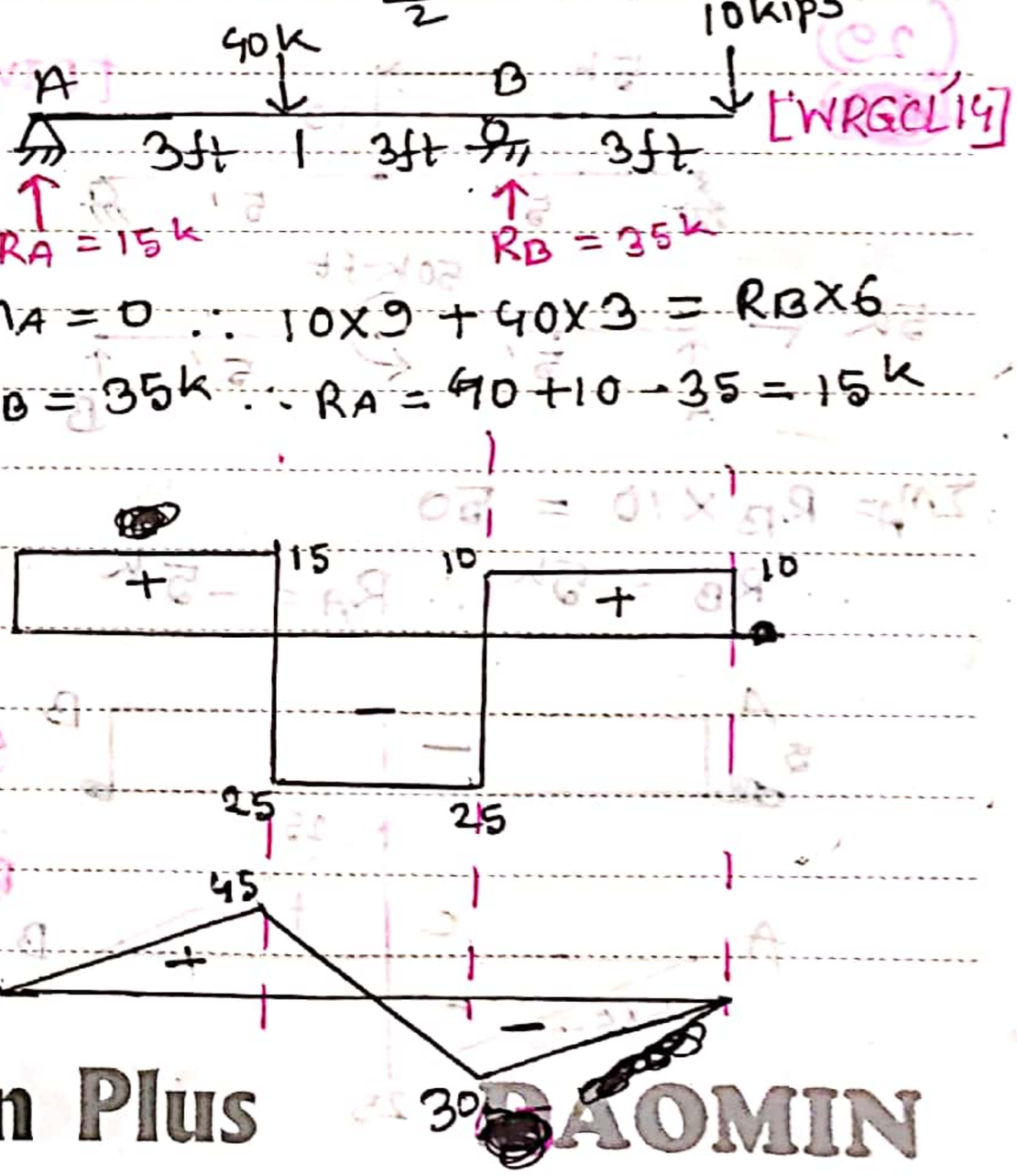
$\Sigma M_A = 0 \therefore R_B \times L = P \times \frac{3L}{2}$

$\therefore R_B = \frac{3P}{2} \quad \therefore R_A = P - \frac{3P}{2} = -\frac{P}{2}$



(35) [SGCL'20]

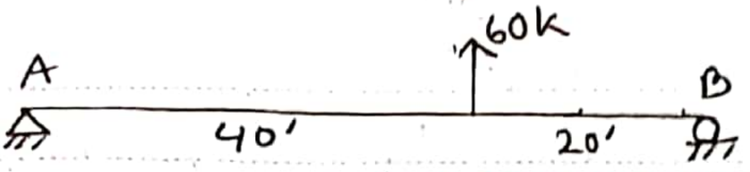
(36) [WRGCL'14]



$\Sigma M_A = 0 \therefore 10 \times 9 + 40 \times 3 = R_B \times 6$

$\therefore R_B = 35k \quad \therefore R_A = 40 + 10 - 35 = 15^k$

(37)

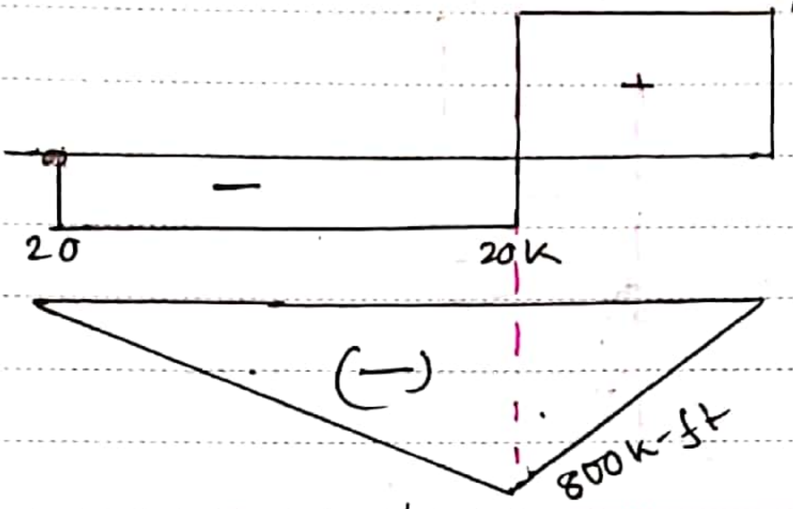


[BPDB'16] [CPGCBL'18]

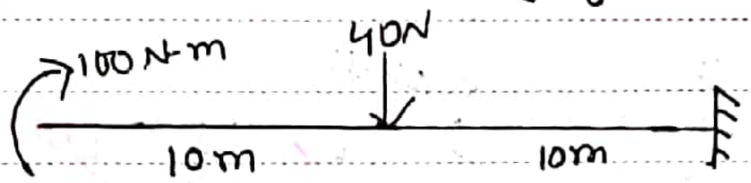
$R_B \times 60 + 60 \times 40 = 0$ $[\Sigma M_A = 0]$

$\Rightarrow R_B = -40k$

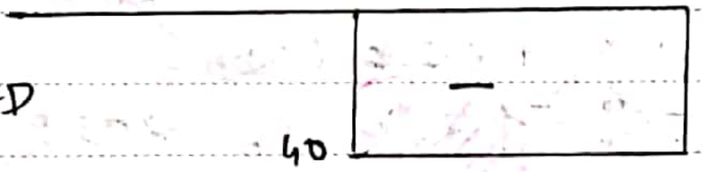
$R_A + R_B + 60 = 0 \therefore R_A = -20k$

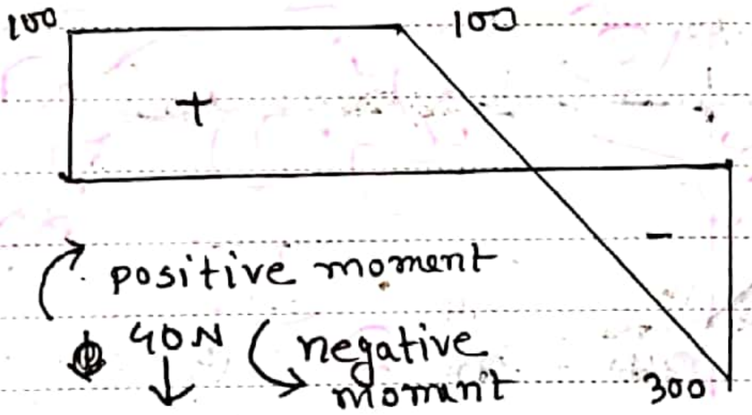


*

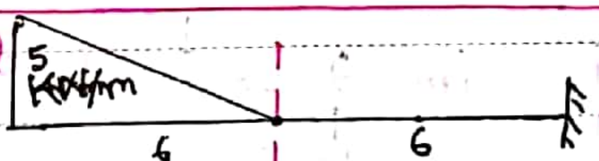


SFD

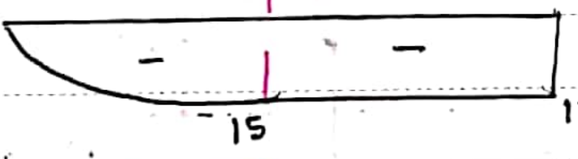




(39)



[NPCBL'17]

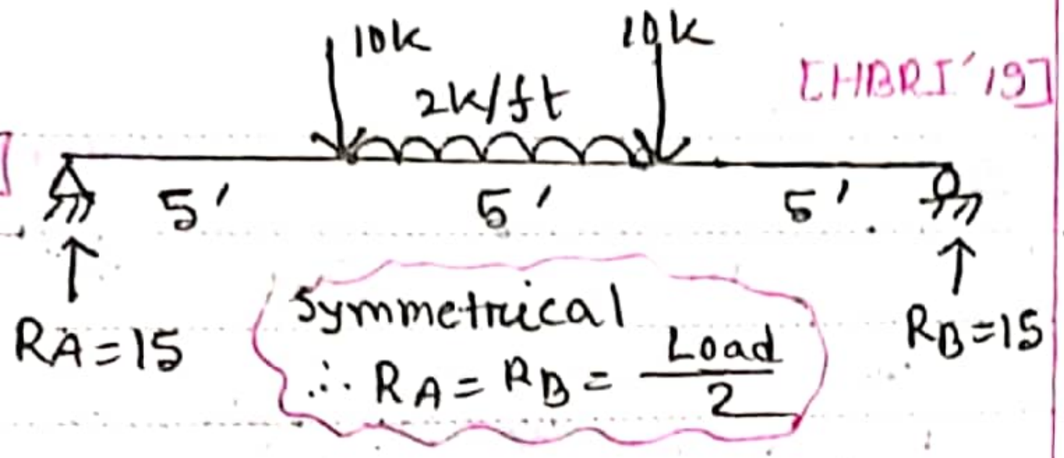


$= \frac{1}{2} \times 6 \times 15$

$60 + 6 \times 15$

$= 150$

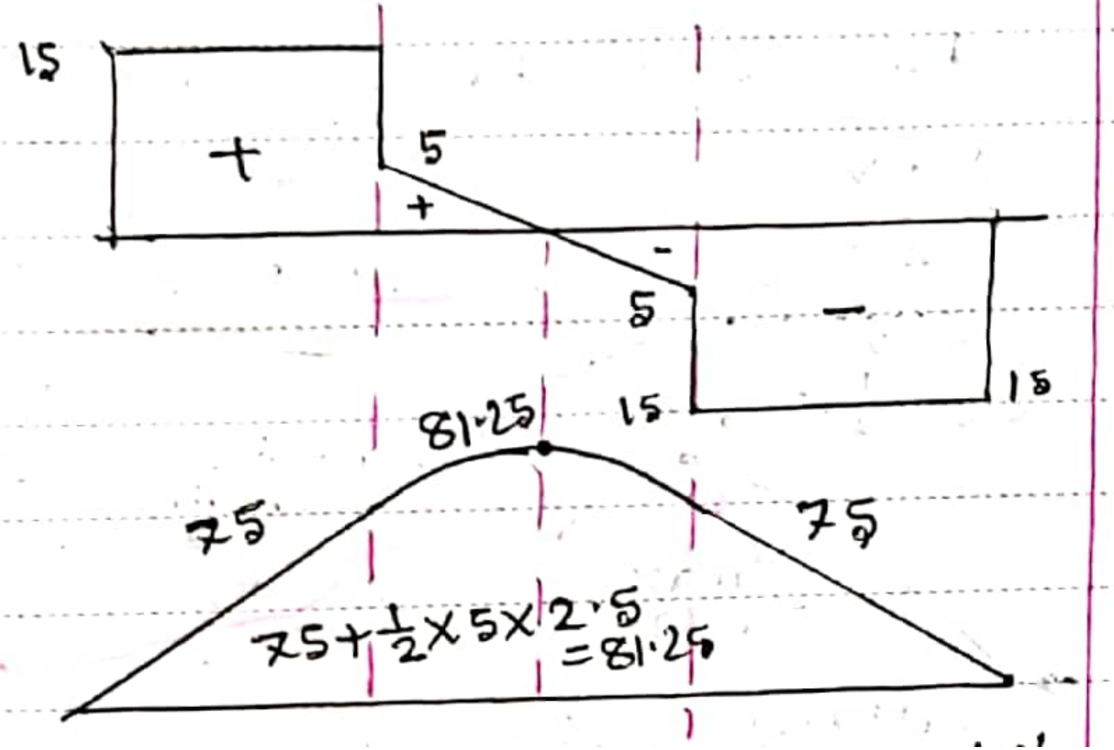
[40]



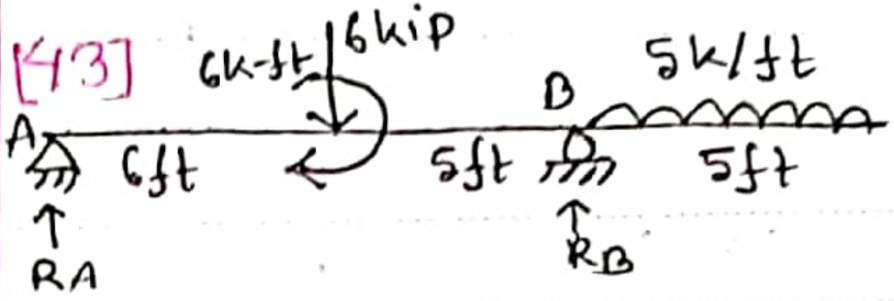
[HBRI'19]

Symmetrical

$\therefore R_A = R_B = \frac{\text{Load}}{2}$



[43]

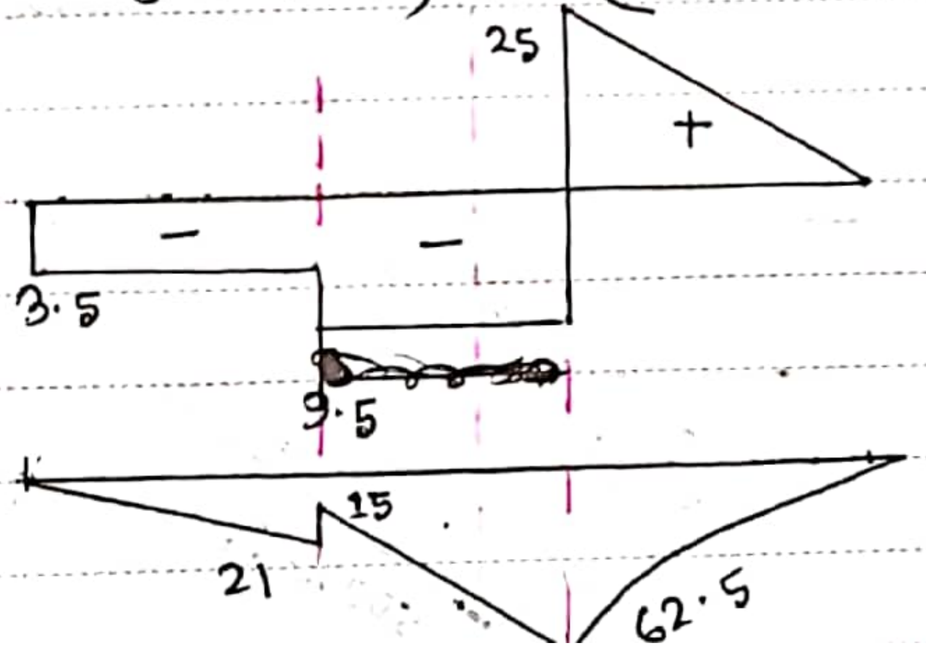


[MSC'17]
[BEPZA'19]
[BUDB'20]

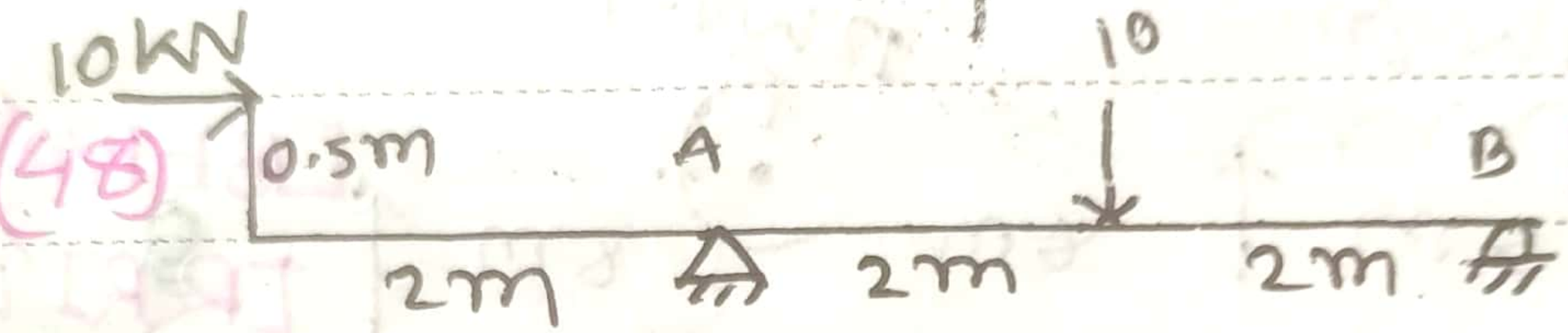
$\Sigma M_A = 0$

$\therefore 5 \times 5 \times 13.5 + 6 + 6 \times 6 = R_B \times 11$

$\therefore R_B = 34.5$; $R_A = (6 + 5 \times 5) - 34.5 = -3.5k$



(48)



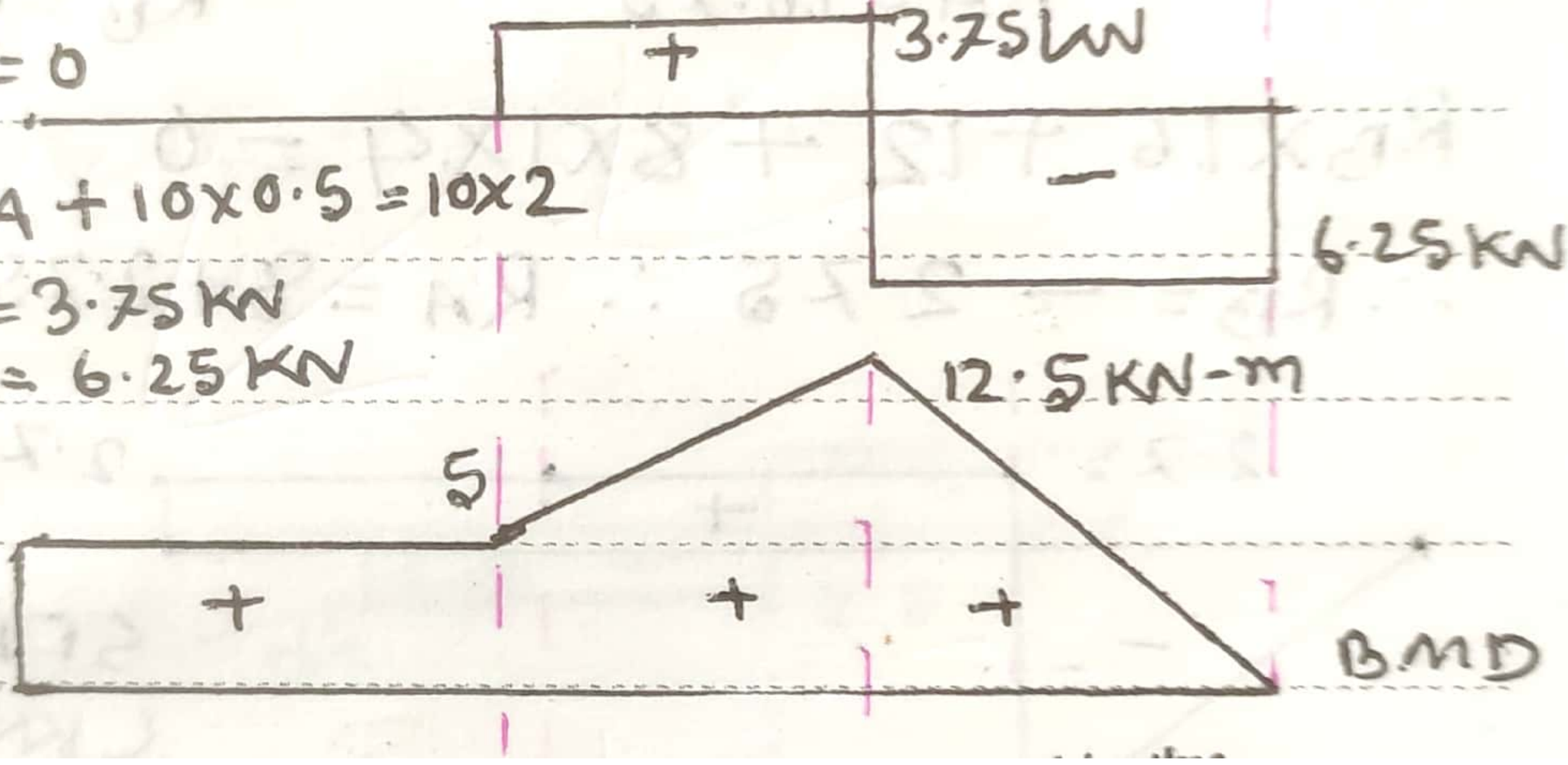
[APSCL 2020]
[BGDCL'21]

$\Sigma M_B = 0$

$\therefore 4R_A + 10 \times 0.5 = 10 \times 2$

$\therefore R_A = 3.75\,KN$

$R_B = 6.25\,KN$



ERL'22

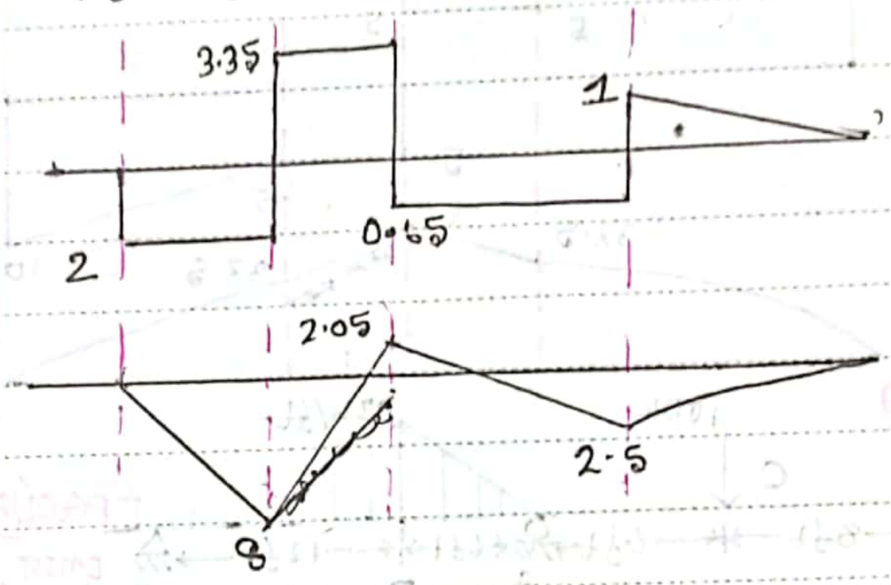
(52) 2k, 4k, A, B, 0.2k/ft

1' 4' 3' 7' 5'

[BPDB '21]

$0.2 \times 5 \times 12.5 + 4 \times 3 = R_B \times 10 + 2 \times 4$ [BGFC'21]

$\therefore R_B = 1.65 \quad \therefore R_A = 5.35$



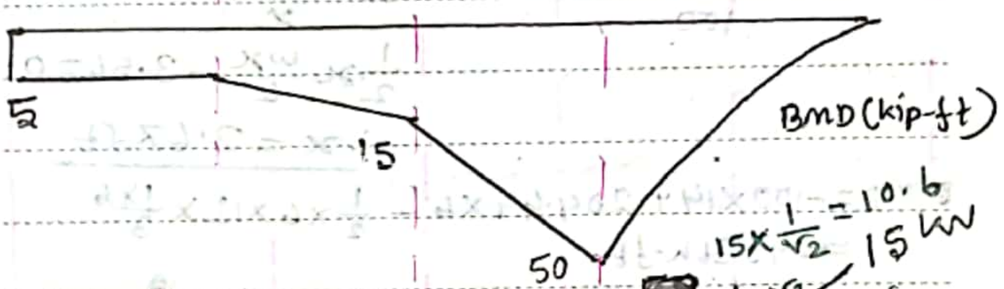
(53) 5k-ft, A, 5k, B, 4k/ft

5' 5' 5' 5' 5'

[SGFL'21]

$4 \times 5 \times 12.5 + 5 \times 5 = R_B \times 10 + 5$

$\therefore R_B = 27k \quad R_A = 25 - 27 = -2k$



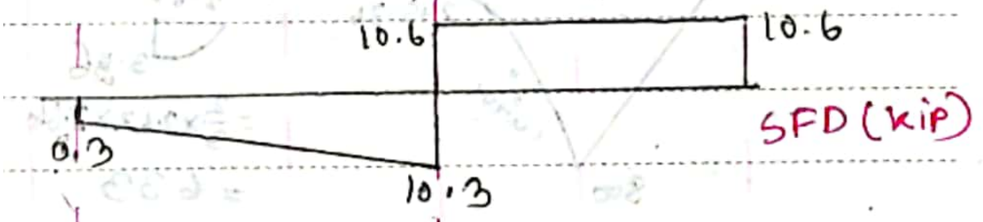
$15 \times \frac{1}{\sqrt{2}} = 10.6$

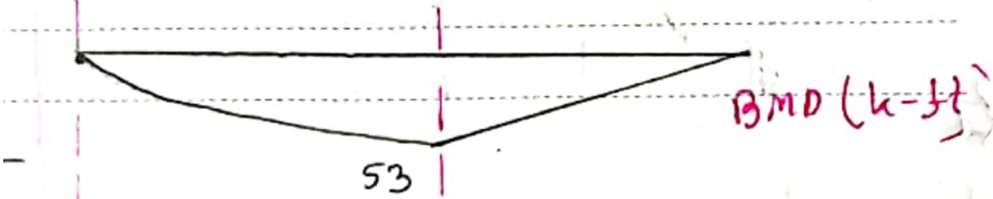
15 kN

1kip/ft

10ft 5ft

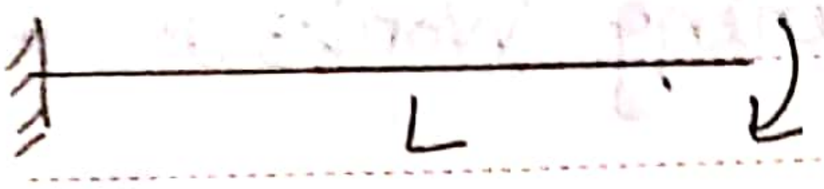
[BIFPCL'21]

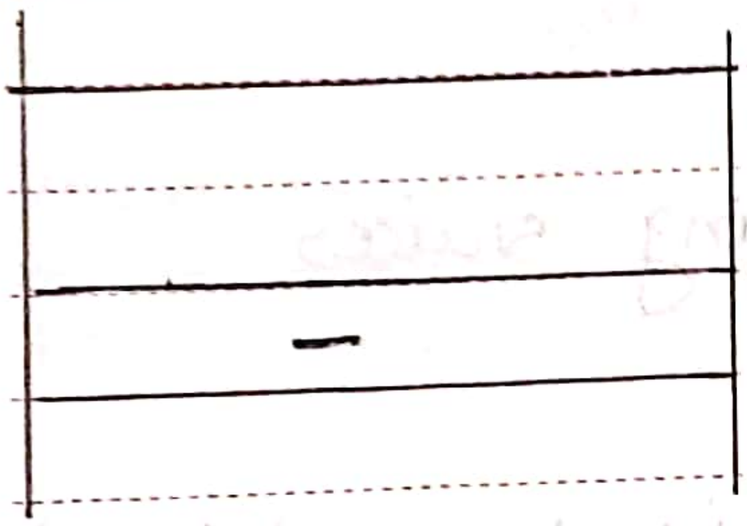




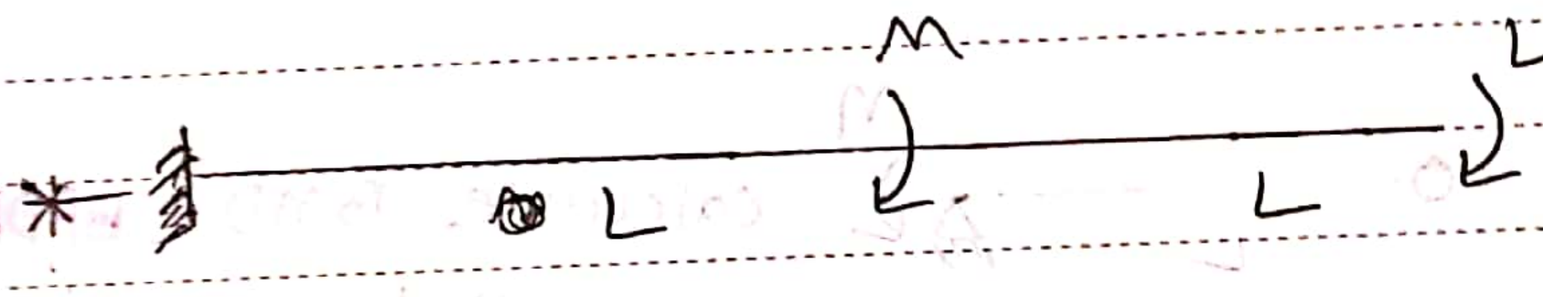
Date : / /

Sun | Mon | Tue | Wed | Thu | Fri | Sat

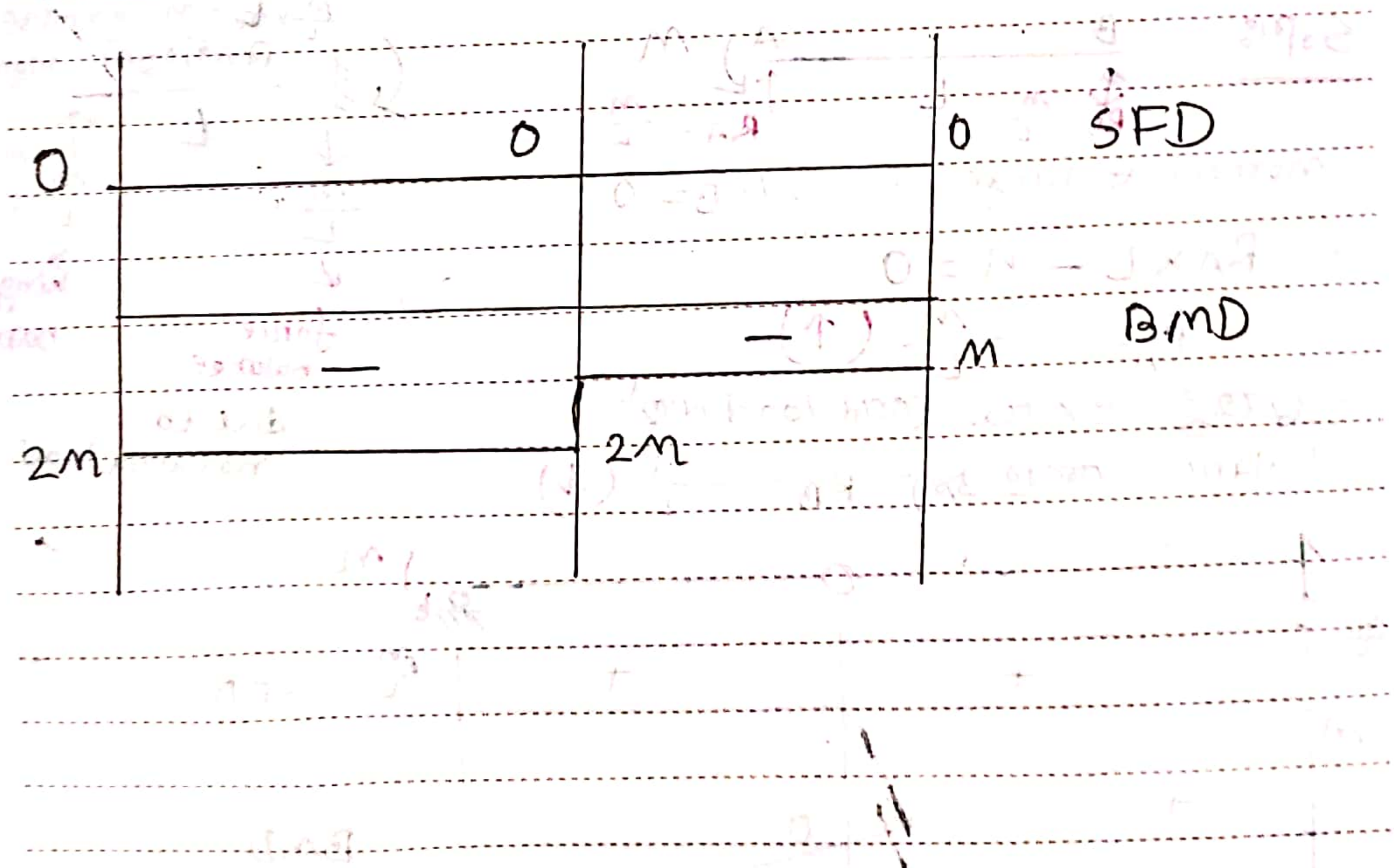




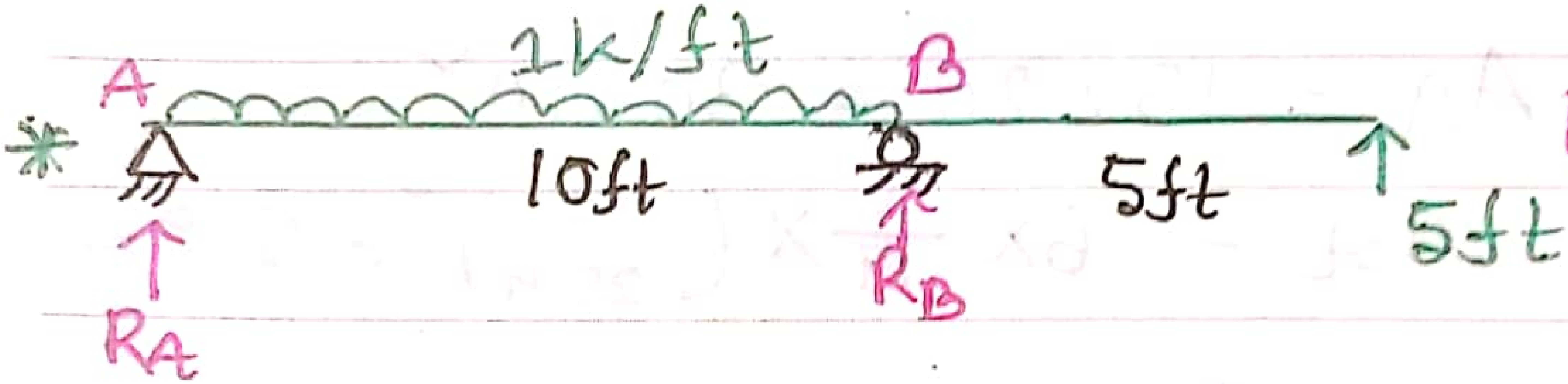
এটা propped beam এর।
এর ~~extra load~~ support 3
টা right end এ 2nm
reaction 3 টা। আর
উল্টা reaction balance
করার জন্য fixed end এ
দুটো reaction টা।



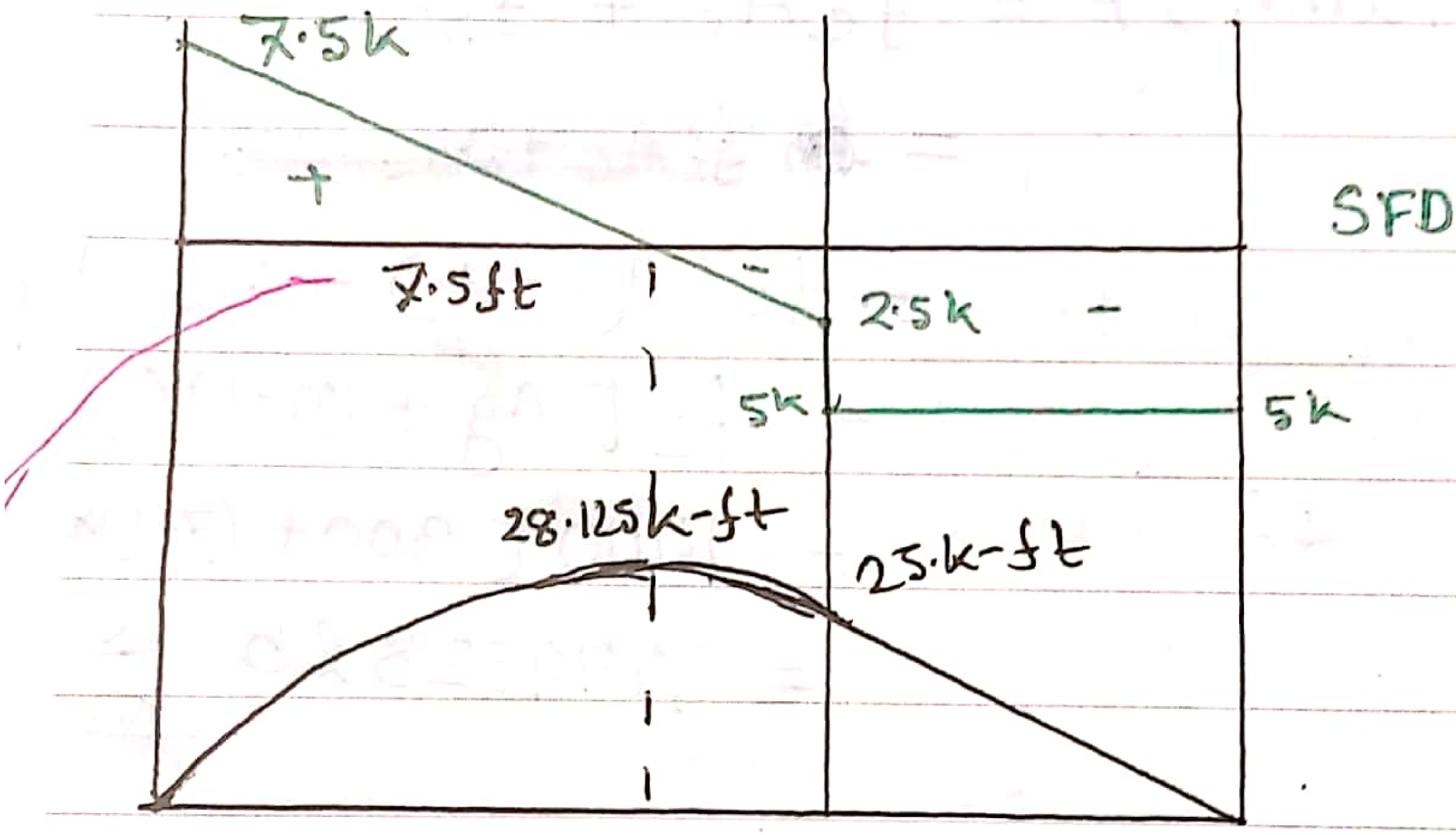
[BIWTA'23]



premiaflex
We Add value to your product

* 

[GTCL'22]



$\Sigma M_A = 0$

$5 \times 15 + R_B \times 10 = 10 \times 1 \times 5$

$\Rightarrow R_B = -2.5k$

$\Sigma F_y = 0$

$R_A - 2.5 + 5 = 10 \times 1$

$\therefore R_A = 7.5k$

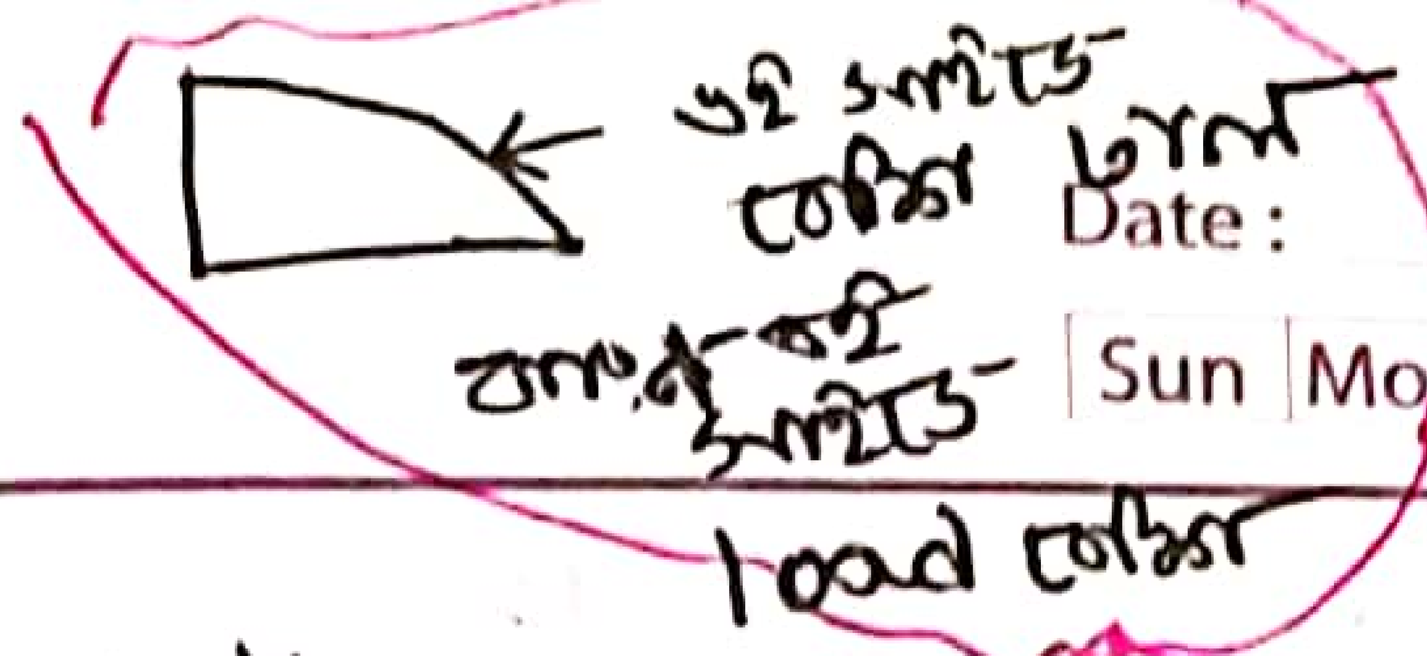
~~7.5k ...ft~~

$\frac{7.5k}{1k/ft} = 7.5 \times k \times \frac{ft}{k} = 7.5ft$ এখানে $\frac{R_A}{UDL}$ করলাম

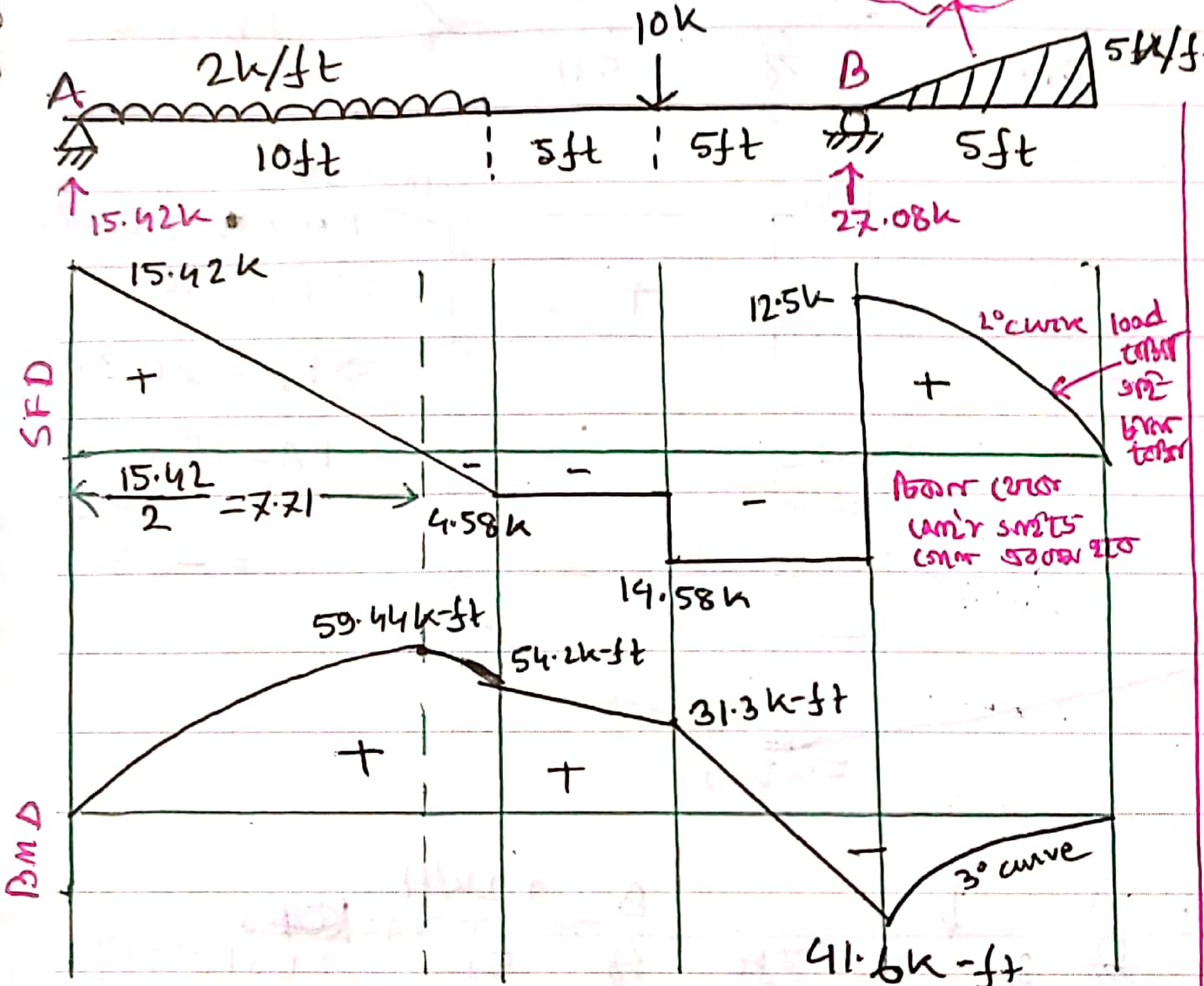
~~[illegible]~~ [illegible]

Date :

Sun | Mon | Tue | Wed | Thu | Fri | Sat



[BEPZA 21]



$\frac{1}{2} \times 5 \times 5 \times \left(20 + \frac{2 \times 5}{3}\right)$

$+ 10 \times 15 + 2 \times 10 \times 5$

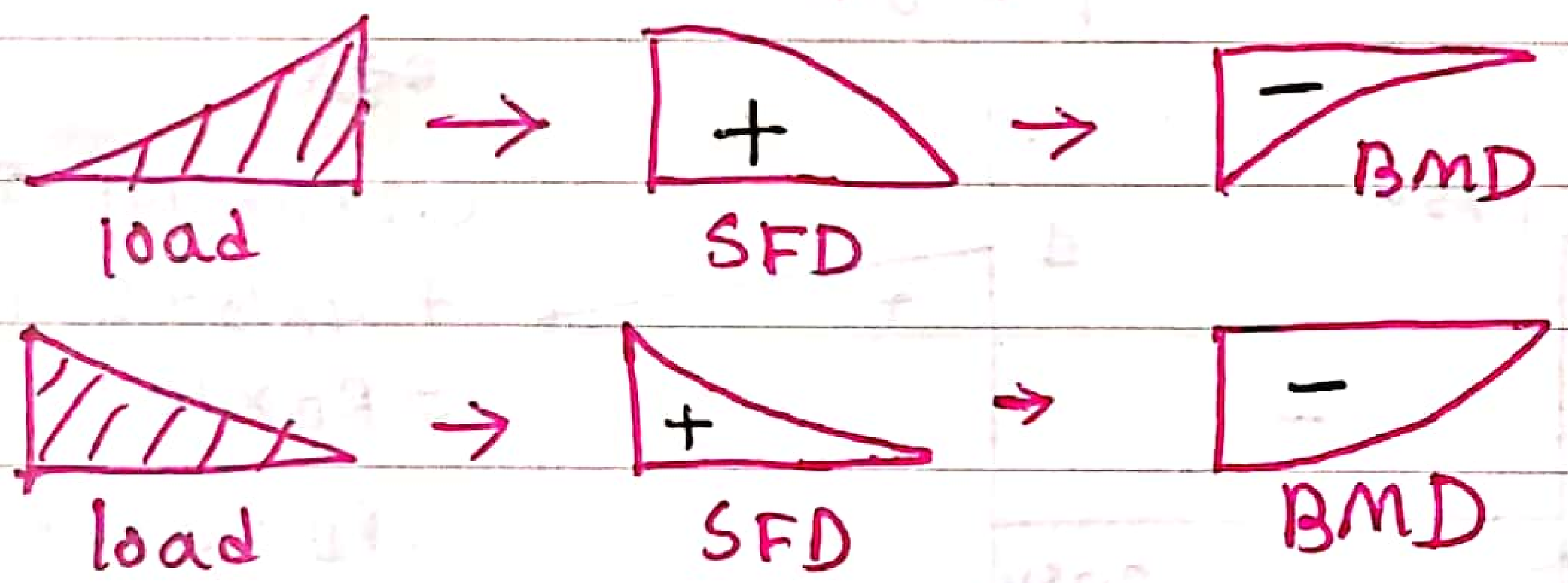
$= R_B \times 20$

$\therefore R_B = 27.08^k$

$\therefore R_A + 27.08$

$= 2 \times 10 + 10 + \frac{1}{2} \times 5 \times 5$

$\therefore R_A = 15.42k$



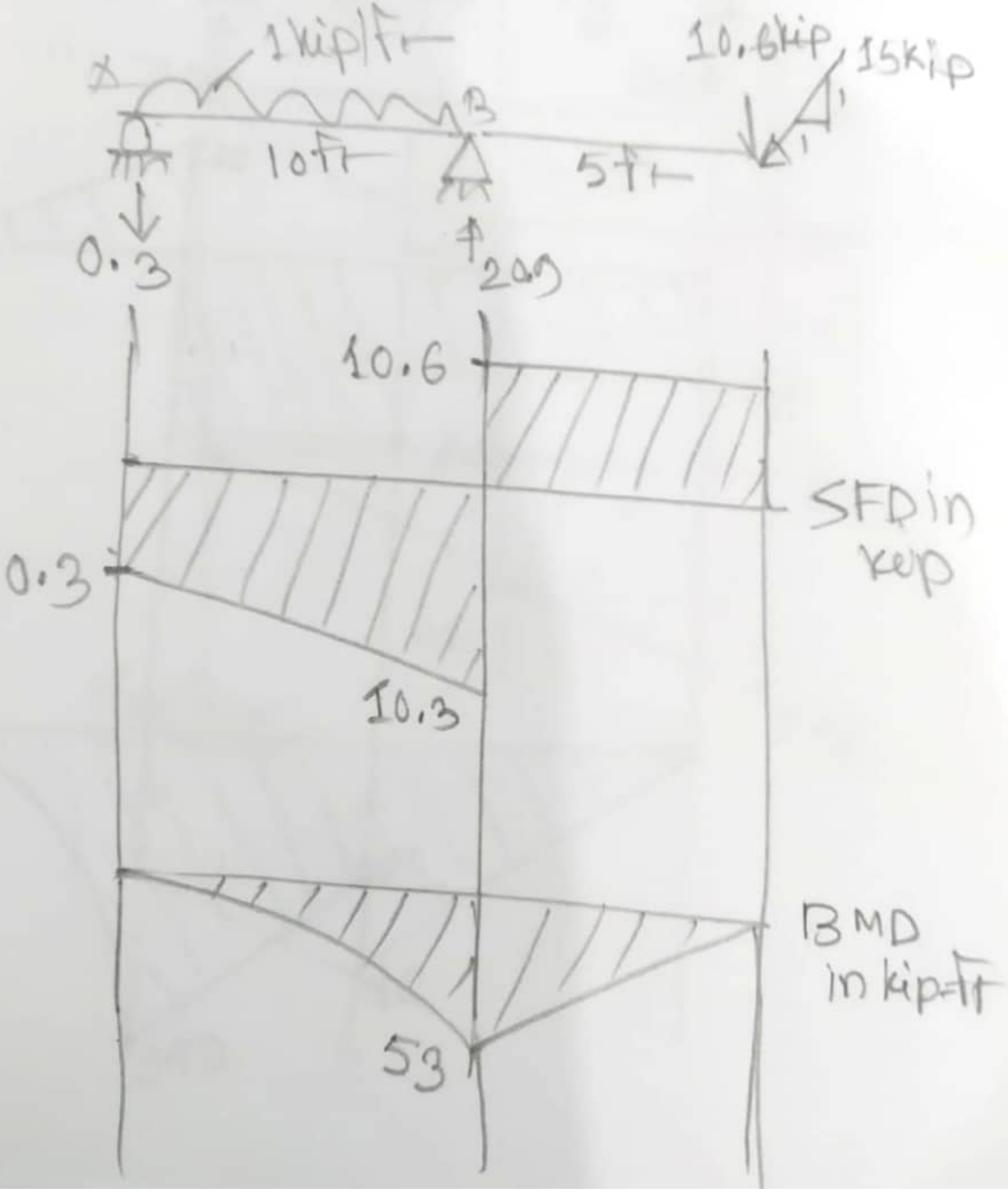
যেখানে load বেশি SFD তে সেখানে ঢাল বেশি হবে।

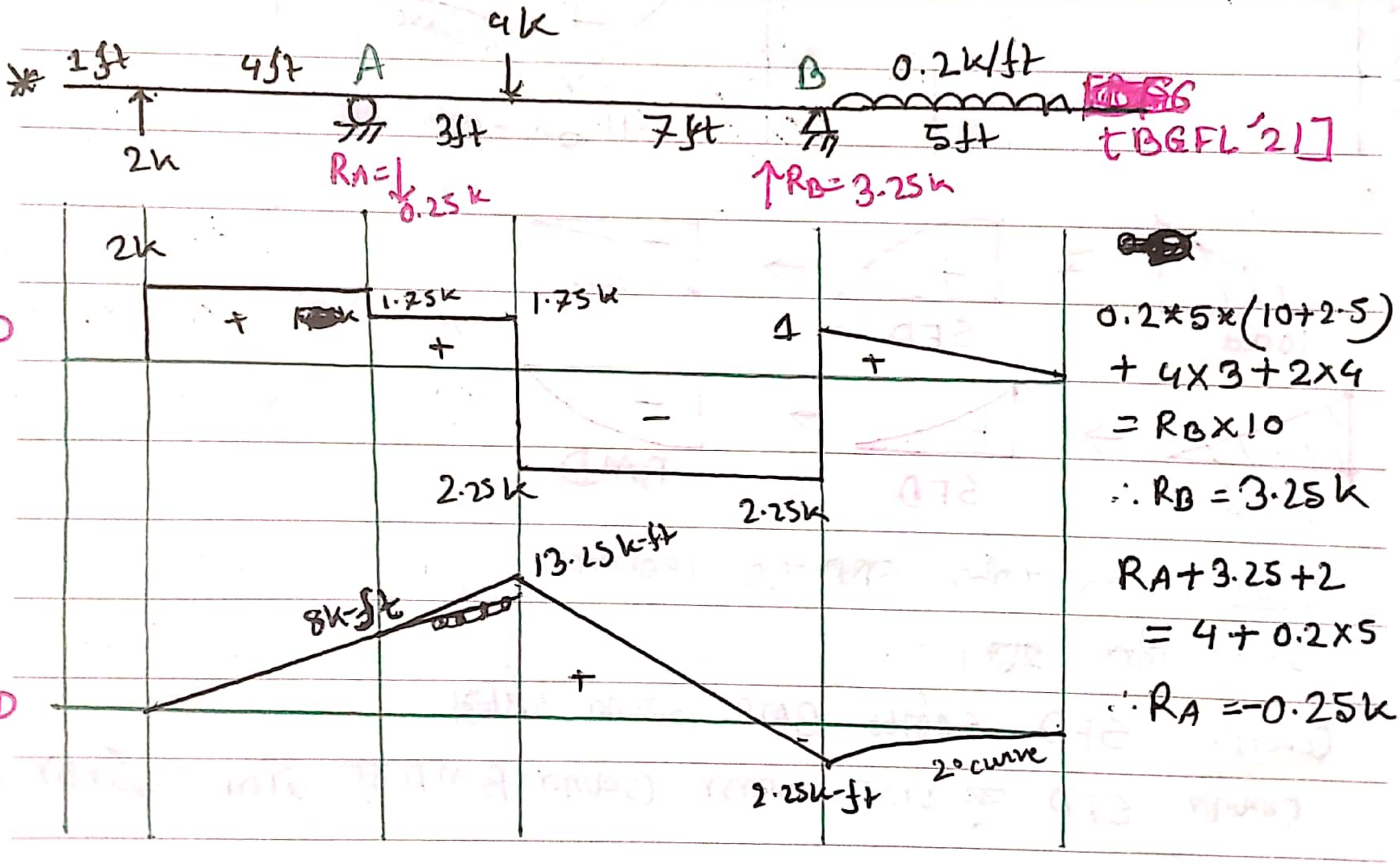
যেখানে SFD সর্বোচ্চ BMD সেখানে সর্বনিম্ন

যেখানে SFD এর ঢাল যত সেখানে BMD এর ঢাল তত।

[BITPCL'21]

29.


1 kip/ft
A
B
10 ft
5 ft
10.6 kip
15 kip
0.3
20
10.6
0.3
10.3
SFD in kip
53
BMD in kip-ft

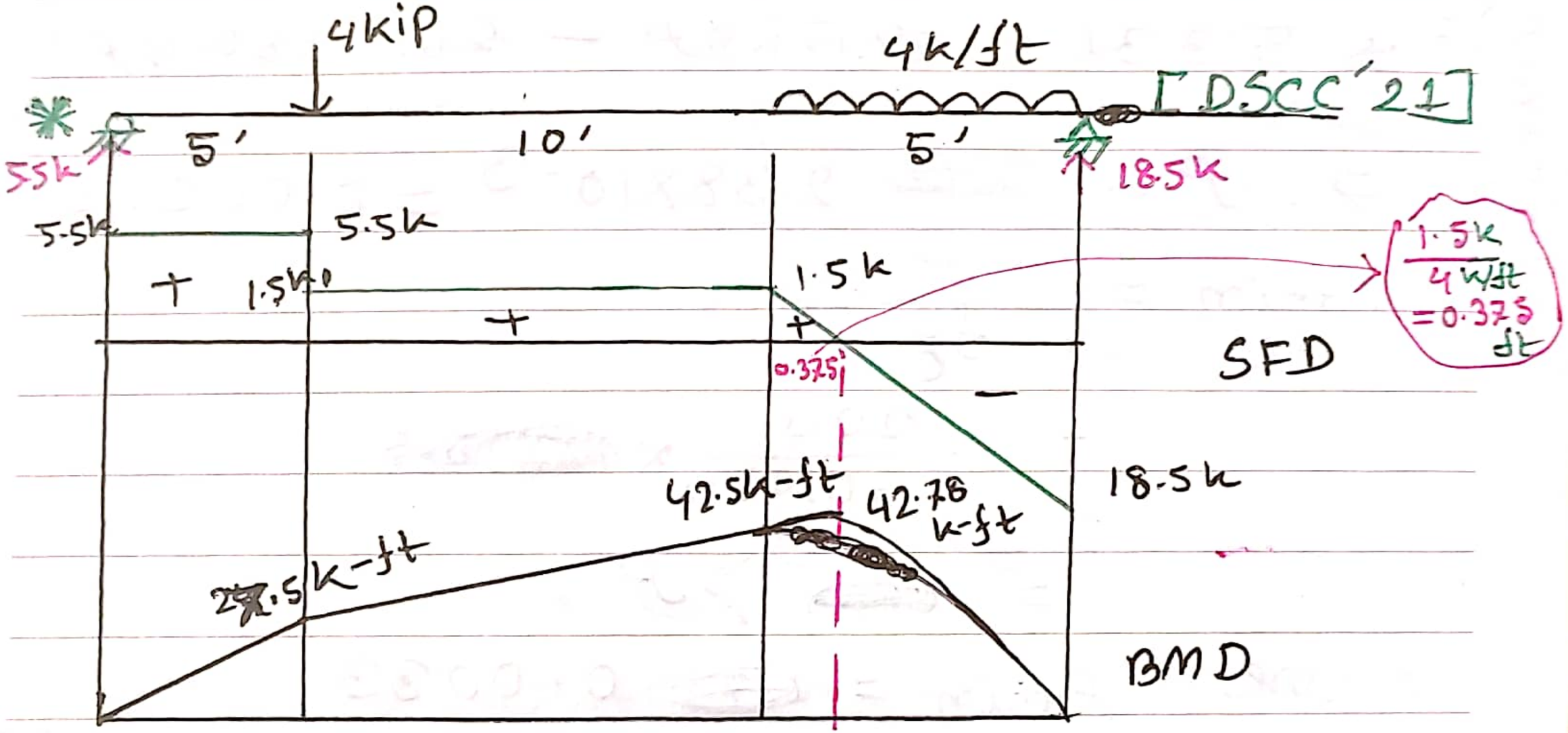


$0.2 \times 5 \times (10 + 2.5) + 4 \times 3 + 2 \times 4 = R_B \times 10$

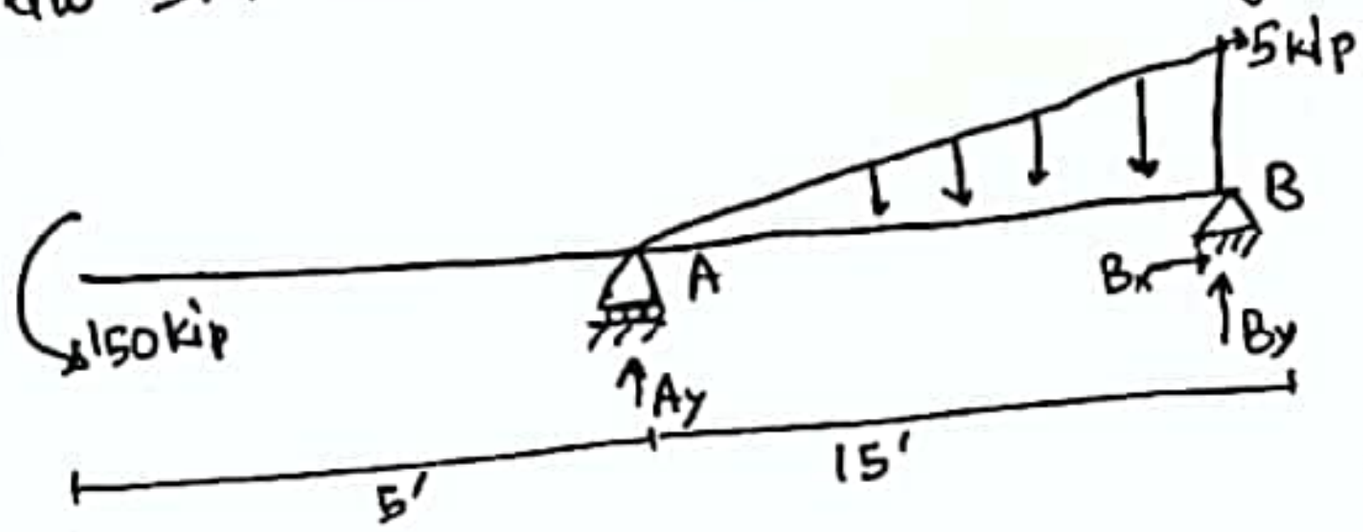
$\therefore R_B = 3.25k$

$R_A + 3.25 + 2 = 4 + 0.2 \times 5$

$\therefore R_A = -0.25k$


4kip
4k/ft
[DSCC'21]
5'
10'
5'
5.5k
18.5k
5.5k
5.5k
1.5k
1.5k
+
+
+
0.375'
−
SFD
18.5k
42.5k-ft
42.78 k-ft
25.5 k-ft
BMD
1.5k
4 k/ft
=0.375 ft

Draw SFD and BMD for the following beam.



Solution:

$\Sigma M_B = 0$ ↺ +ve

$\Rightarrow Ay \times 15 - 150 - \left(\frac{1}{2} \times 5 \times 15\right) \times \frac{1}{3} \times 15 = 0$

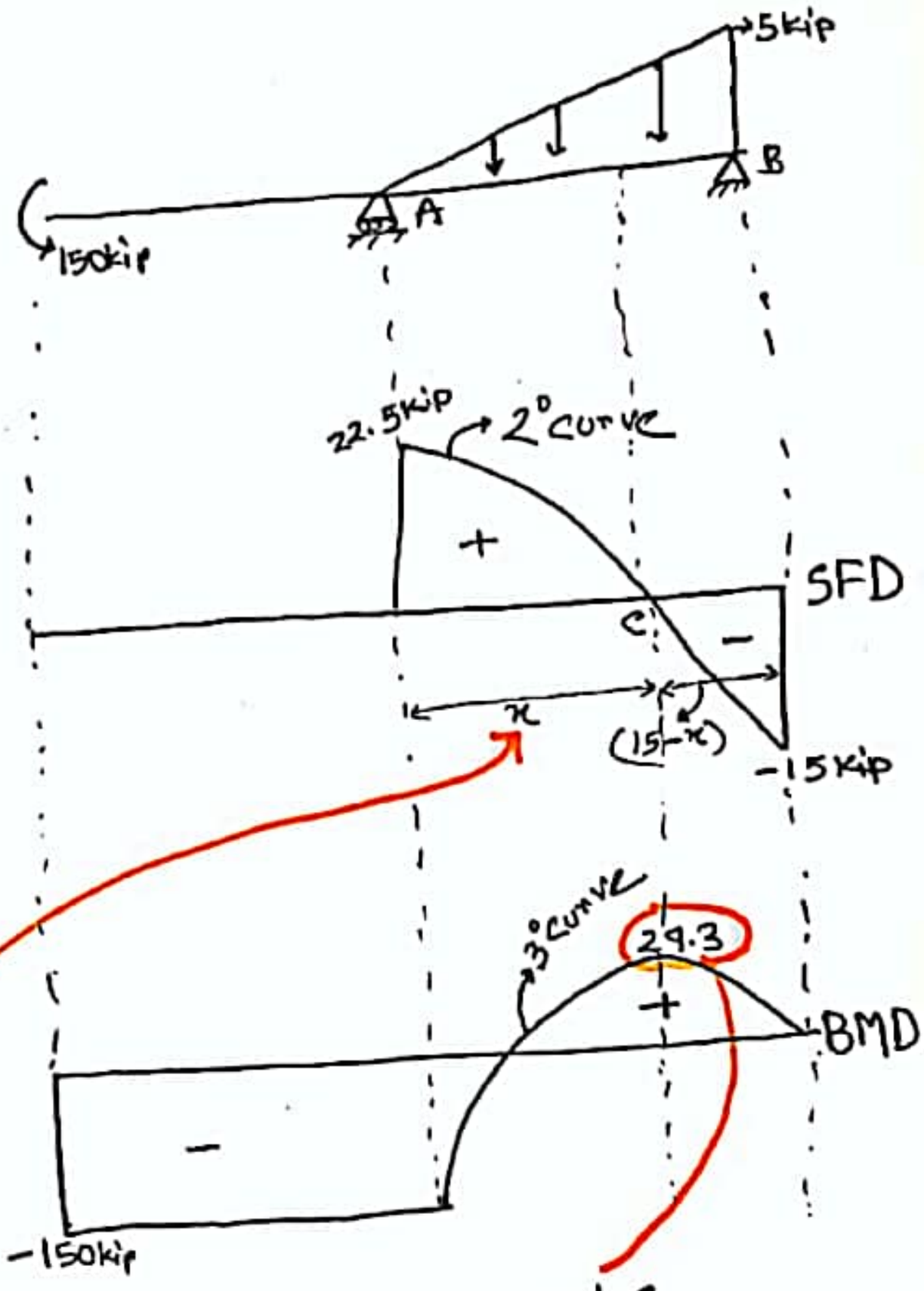
$\Rightarrow Ay = 22.5$ kip ↑

$\Sigma F_y = 0$ ↑ +ve

$\Rightarrow Ay + By = \frac{1}{2} \times 5 \times 15$

$\Rightarrow By = 37.5 - 22.5$

$\Rightarrow By = 15$ kip ↑



Here, $\frac{5}{15} = \frac{y}{x}$

$\Rightarrow y = \frac{x}{3}$

At point C, Shear is zero.

Only consider left Shear at

Point C, $\Sigma F_y = 0$ ↑ +ve

$22.5 = \frac{1}{2} \times x \times y$

$\Rightarrow 22.5 = \frac{1}{2} \times x \times \frac{x}{3}$

$\Rightarrow x = 11.62$

Moment at C,

$\frac{2}{3} \times x \times 22.5$

$\Rightarrow \frac{2}{3} \times 11.62 \times 22.5$

$= 179.3$ $\quad (179.3 - 150) = 29.3$

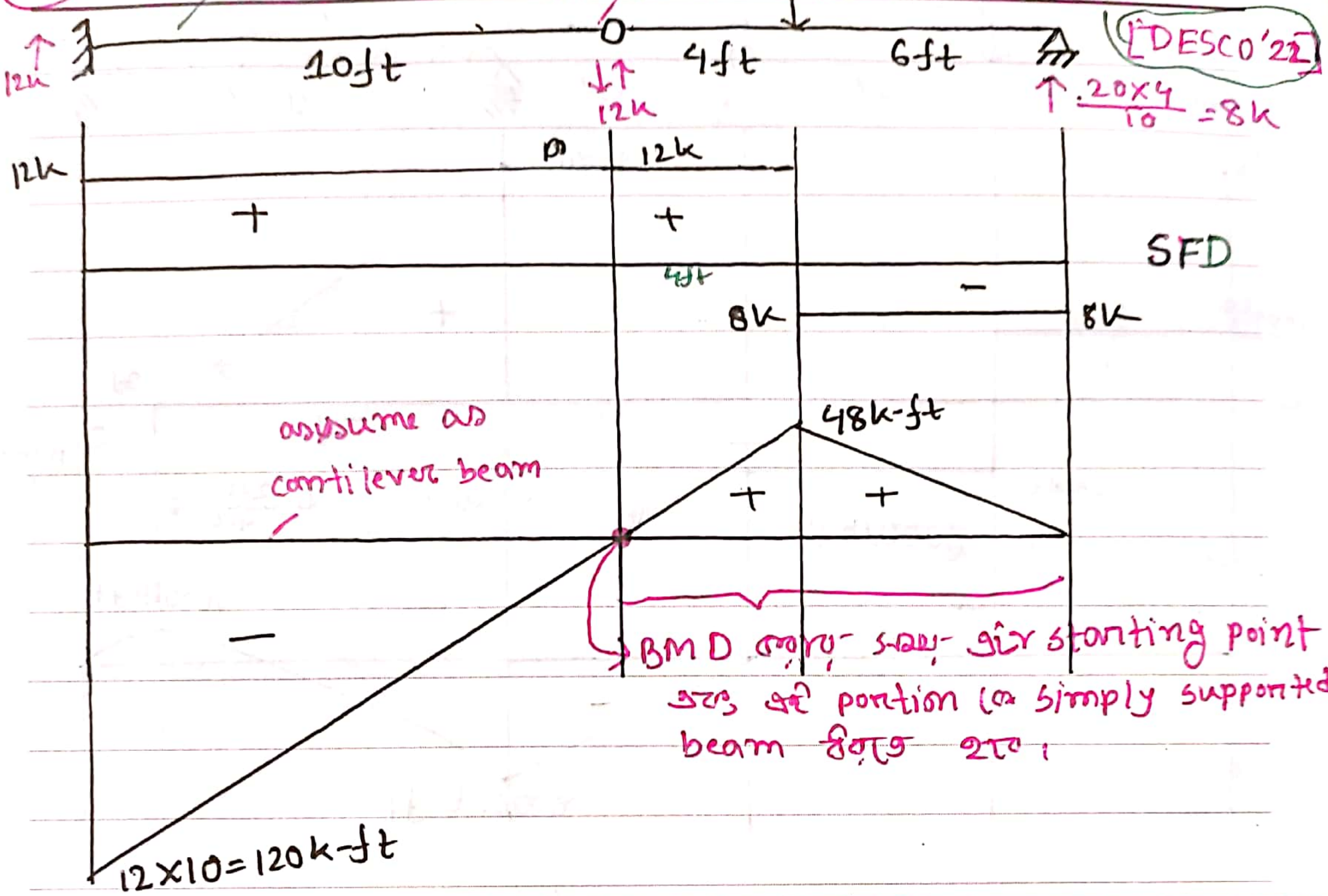
DESCO 22

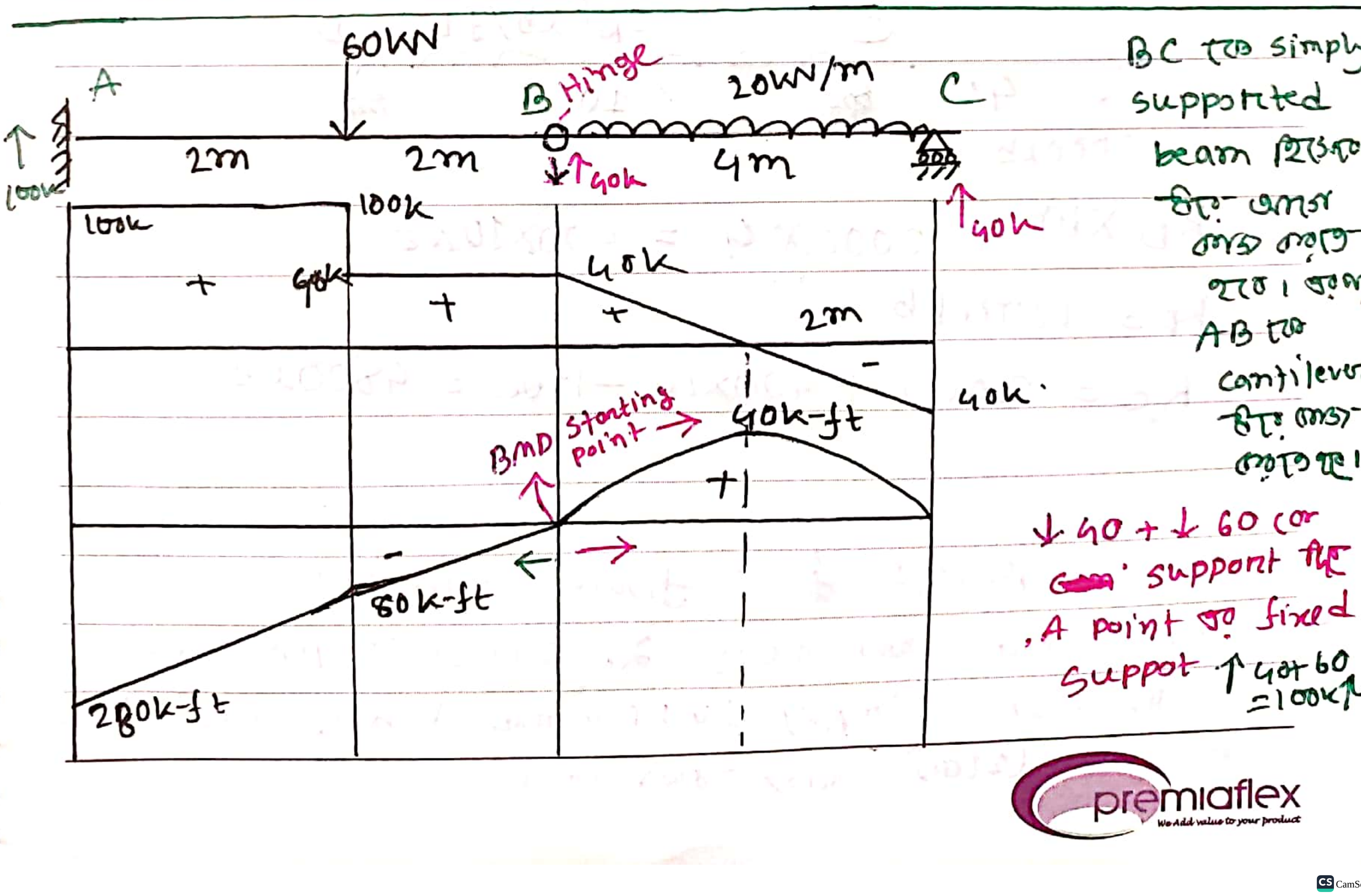
32 beam এর free end এ ↓12k load এর counter reaction ↑ fixed portion.

free end এ কোনো support নাই।

Date :

Sun | Mon | Tue | Wed | Thu | Fri | Sat





BC তে simply supported beam হিসেবে ধরে এগুতে হবে। তাহলে AB তে cantilever ধরে কাজ করতে হবে।

↓40 + ↓60 কে support দিতে, A point কে fixed support ↑40+60 =100k↑

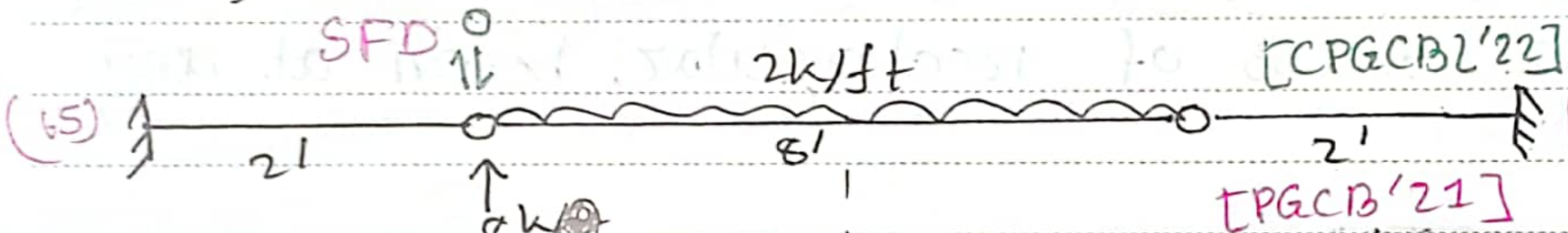
premiaflex
We Add value to your product

SFD

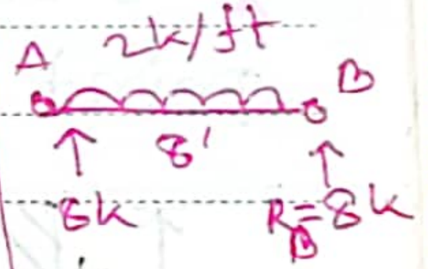
BMD

[CPGCB'22]

(b5)



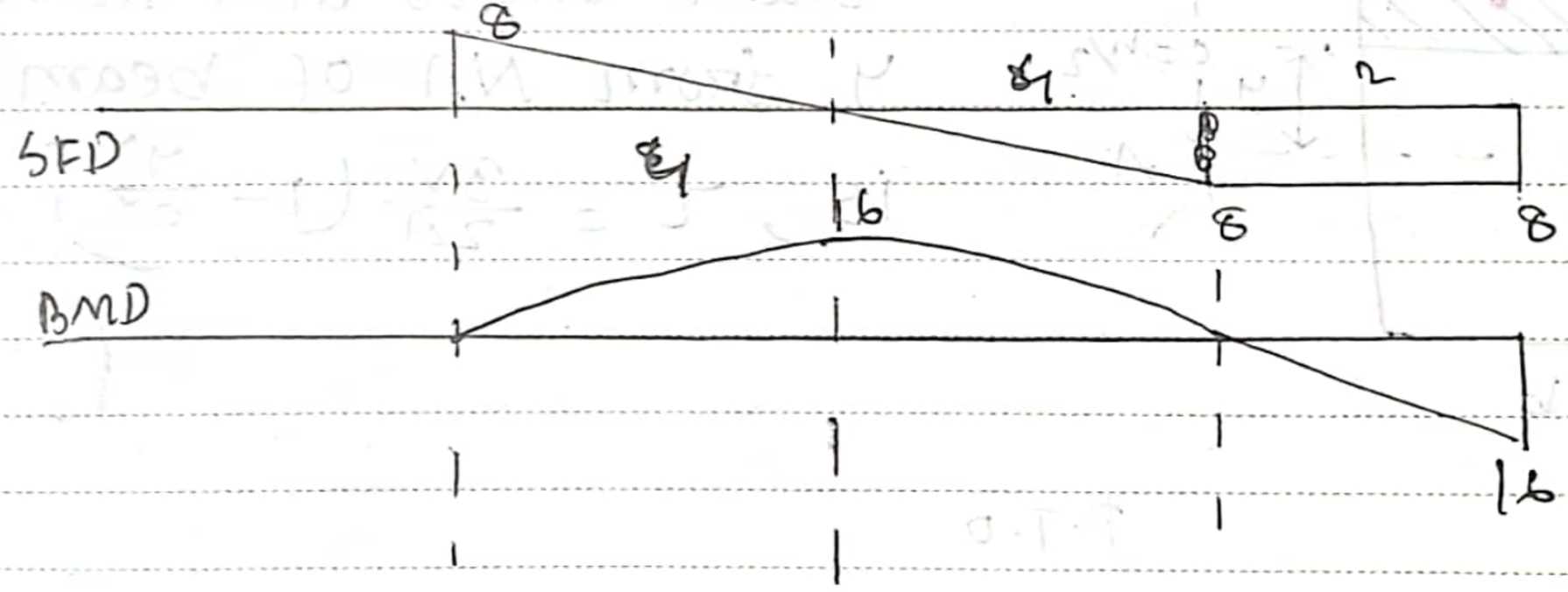
[PGCB'21]



8k নিচের দিকে।

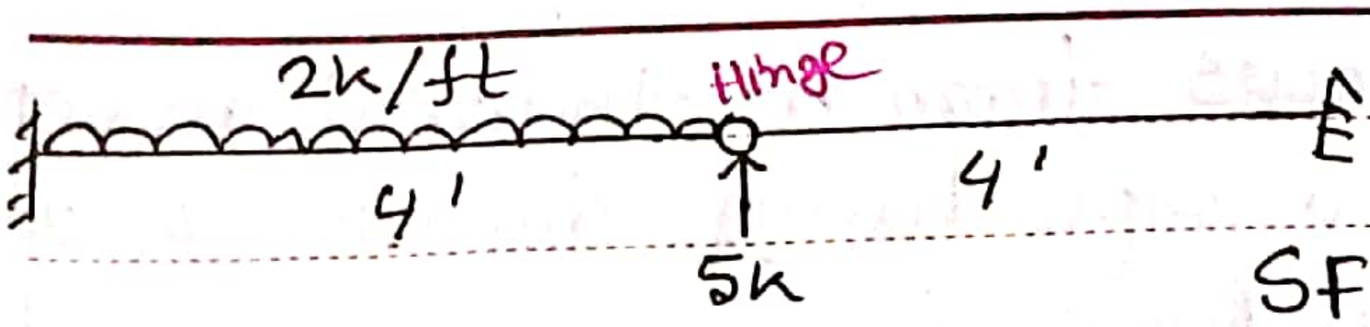
RA = 0

∴ ↓↑ at B hinge



Date : / /

Sun	Mon	Tue	Wed	Thu	Fri	Sat

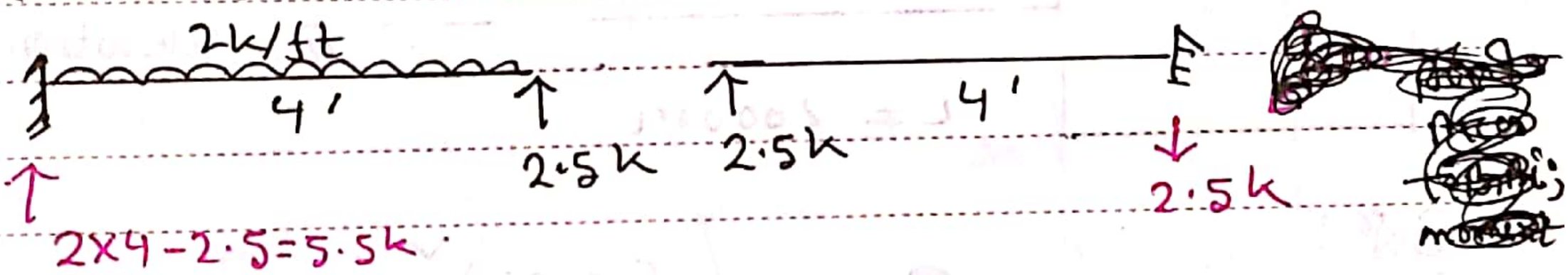


[COXDA '23 AAO BUET]

SFD, BMD

Soln:

হিঞ্জের মধ্যে load. আবার দুই পাশের fixed support. সুতরাং একপাশের ~~hinge~~ pin support আরেক পাশের fixed support হলেও hinge এর load কে fixed সহিত consider করি। কিন্তু এখন দুই পাশেই fixed support. তাই load 5k কে 2.5k, 2.5k করে দুই পাশে দিয়ে দিলাম।



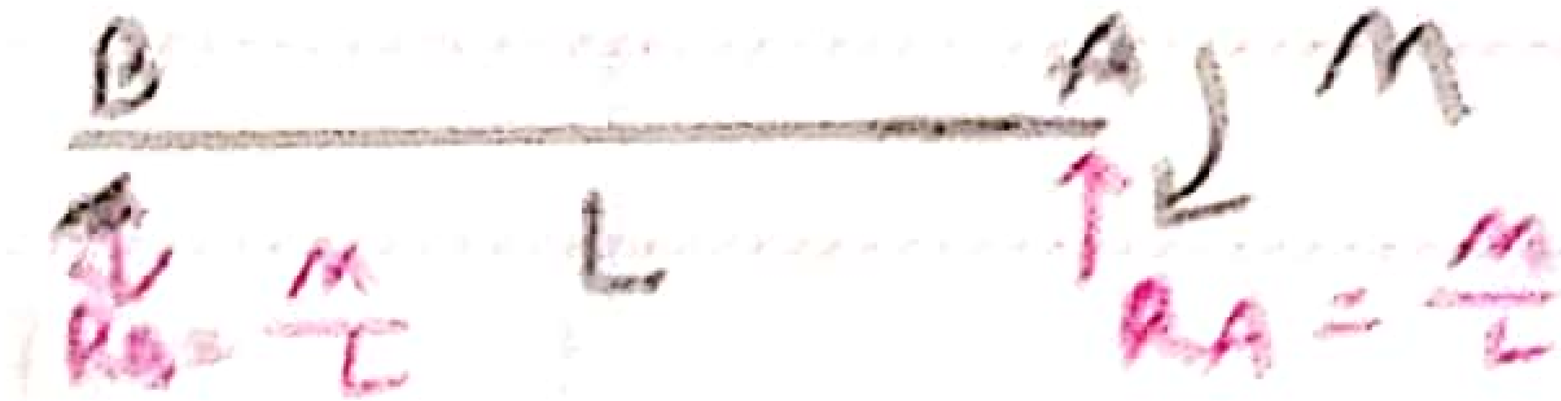
কারণ দুই প্রান্তে hinge (zero), hinge এ moment zero.

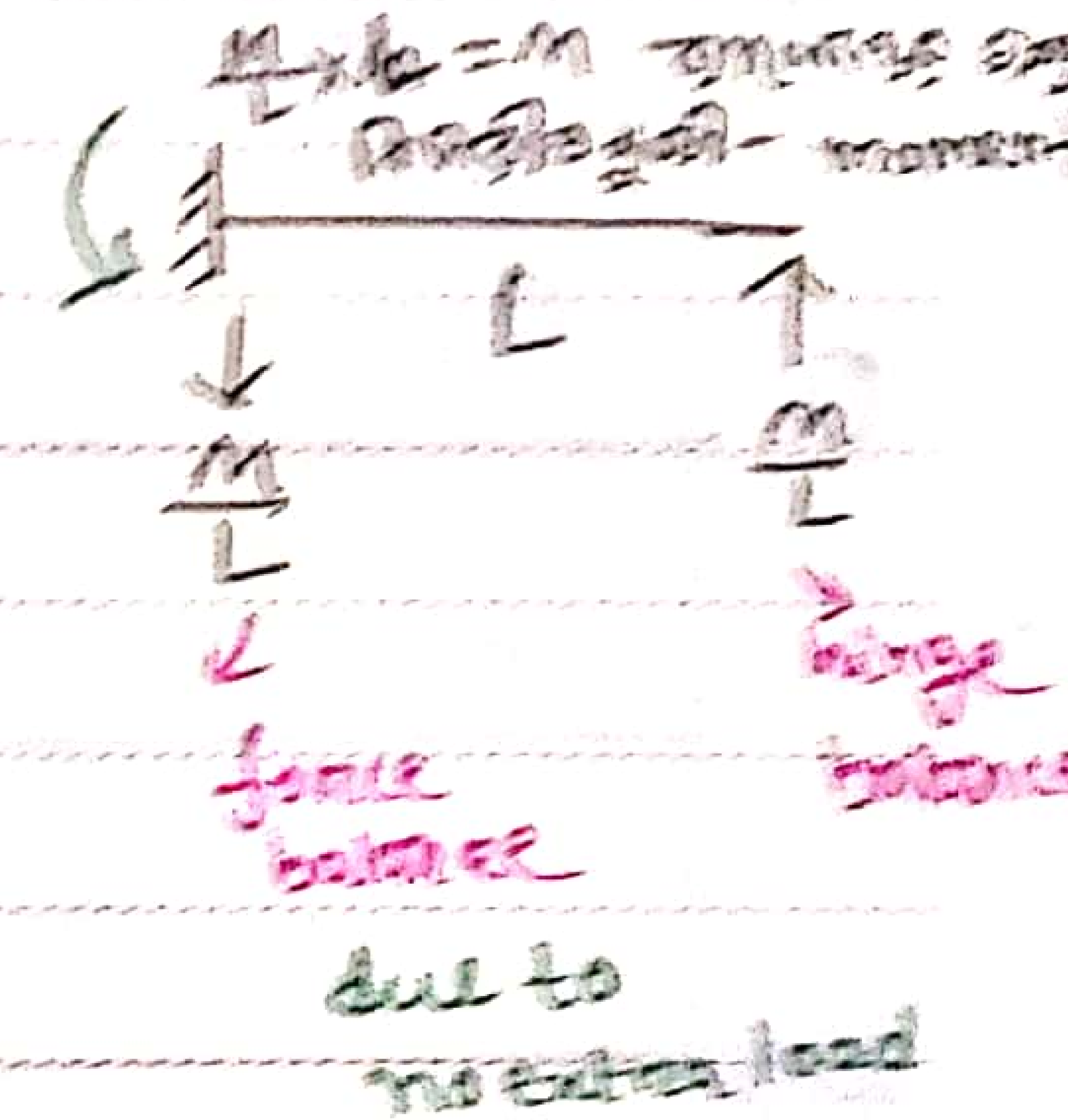
hinge এর বামে +SFD এর ক্ষেত্রে +BMD hinge এর ডানে +SFD এর ক্ষেত্রে -BMD এবং -SFD এর ক্ষেত্রে +BMD

* 

Calculate BMD [BPDB'23]

Soln:



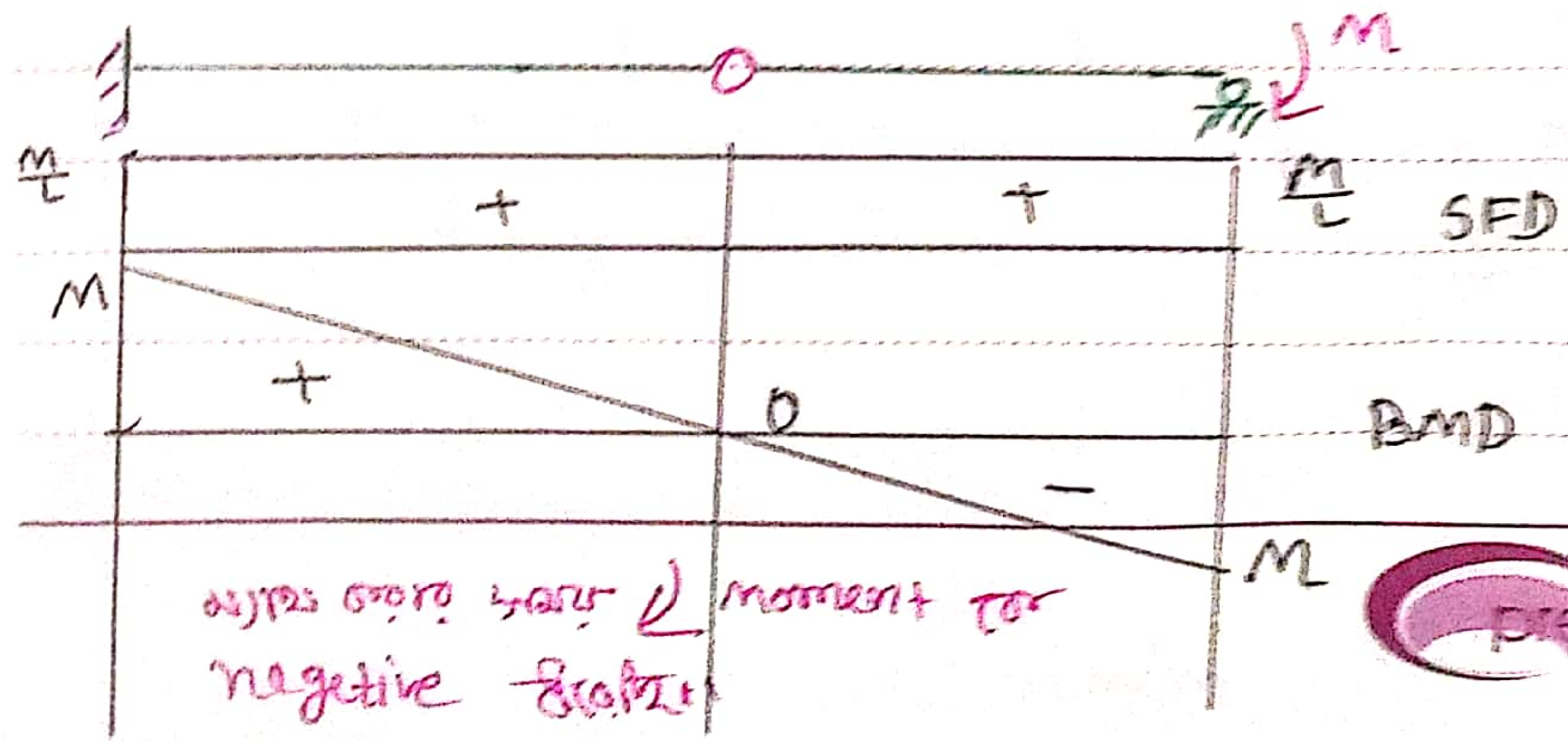


moment at hinge, i.e., $M_B = 0$

$\therefore R_A \times L - M = 0$

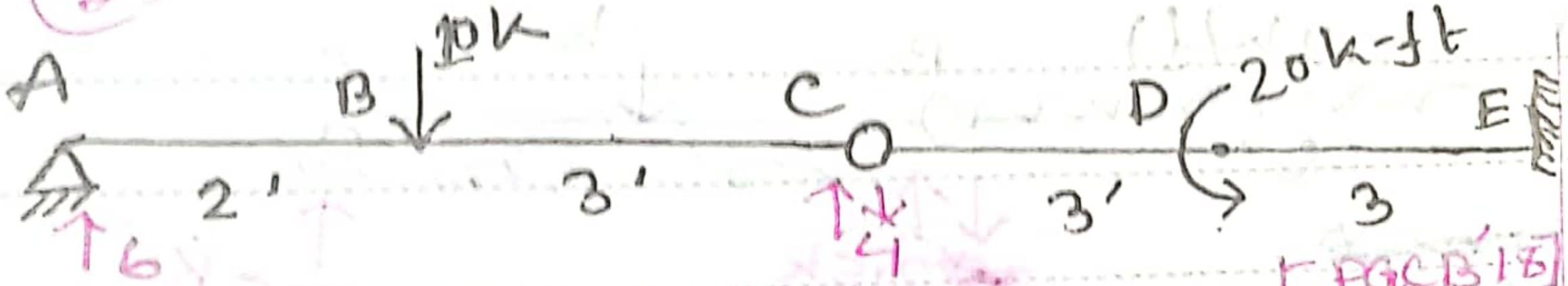
$\therefore R_A = \frac{M}{L}$ (↑)

যেহেতু extra কোন load নাই balance করার জন্য $R_B = -\frac{M}{L}$ (↓)



ডানে থেকে ঘড়ির ↙ moment তাই negative হবে।

(55)

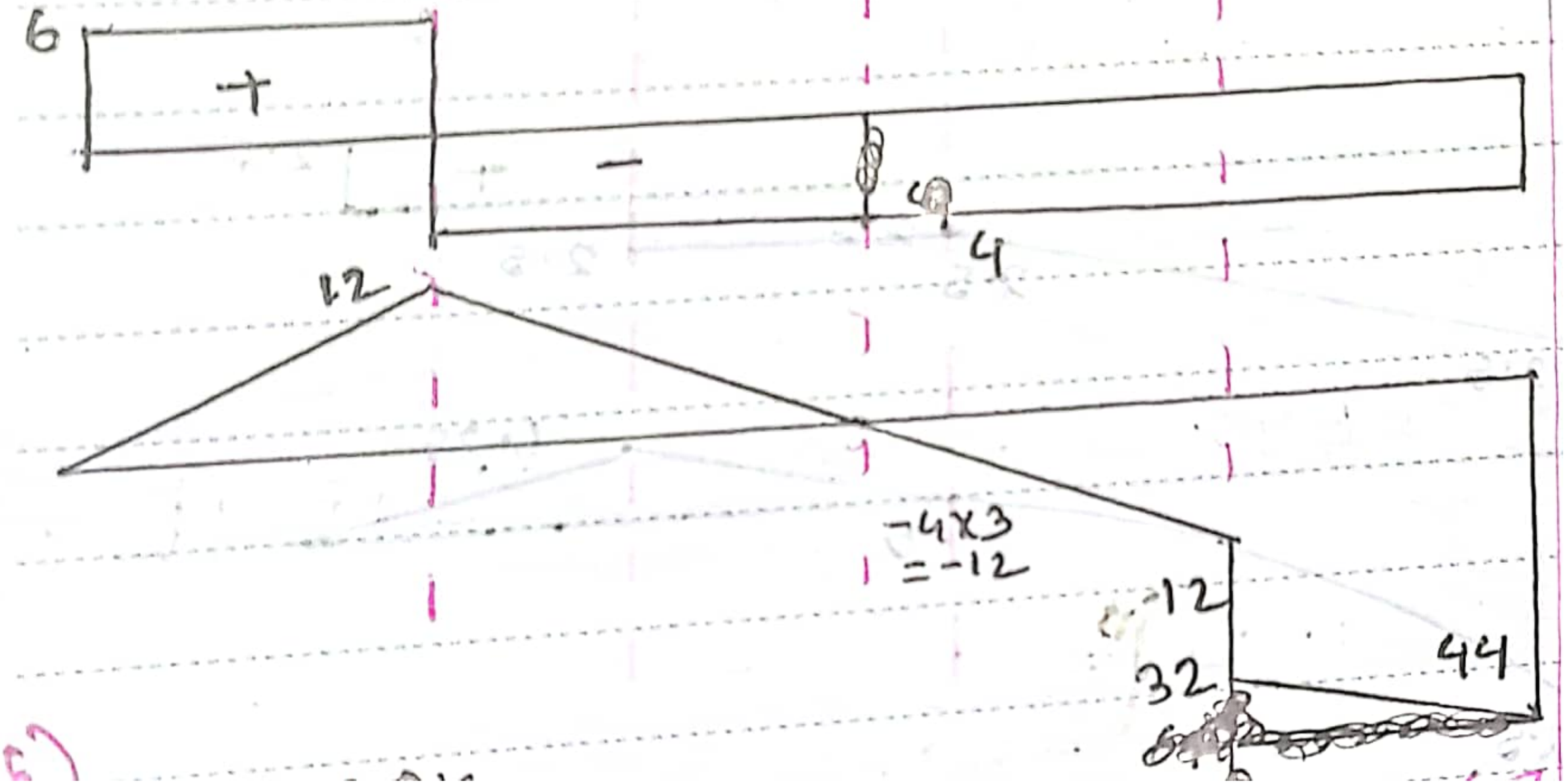


[FBDCB'A]

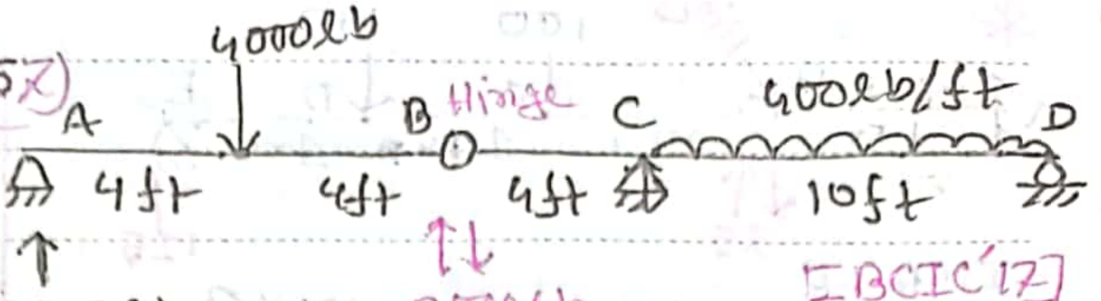
Sol^n:

$$R_A = \frac{10 \times 3}{5} = 6 \quad \therefore R_C = 4$$

$$M_E = -4 \times 6 - 20 = -44 \text{ K-ft}$$

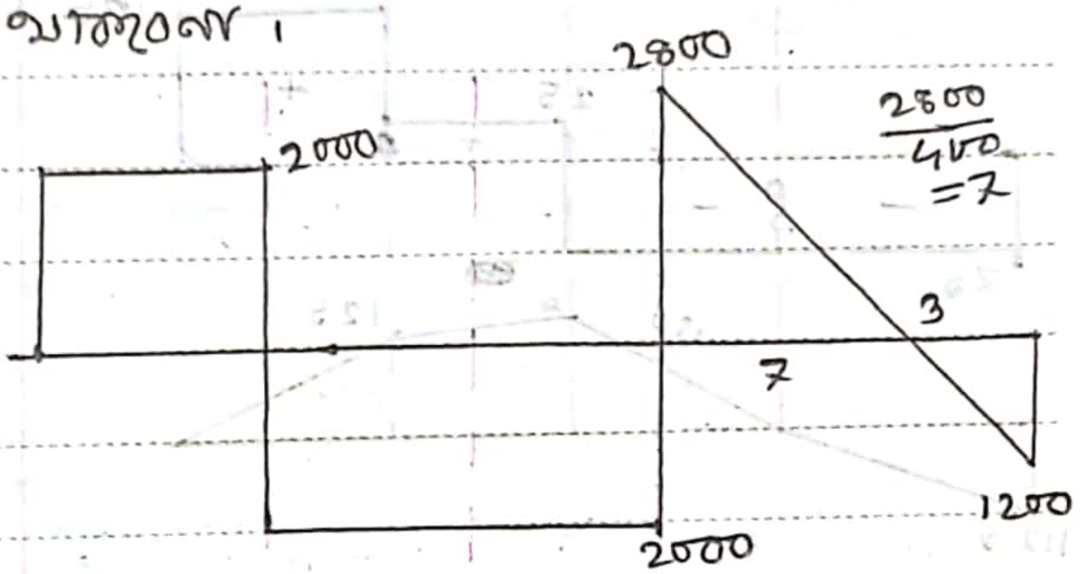


(5Z)

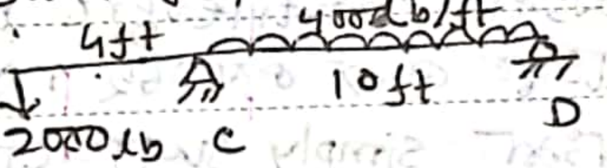


[BCIC'17]

যখন fixed support এর ক্ষেত্রে support এ কোন resisting moment থাকবে।



hinge এর ডানপাশের অংশ নিয়ে

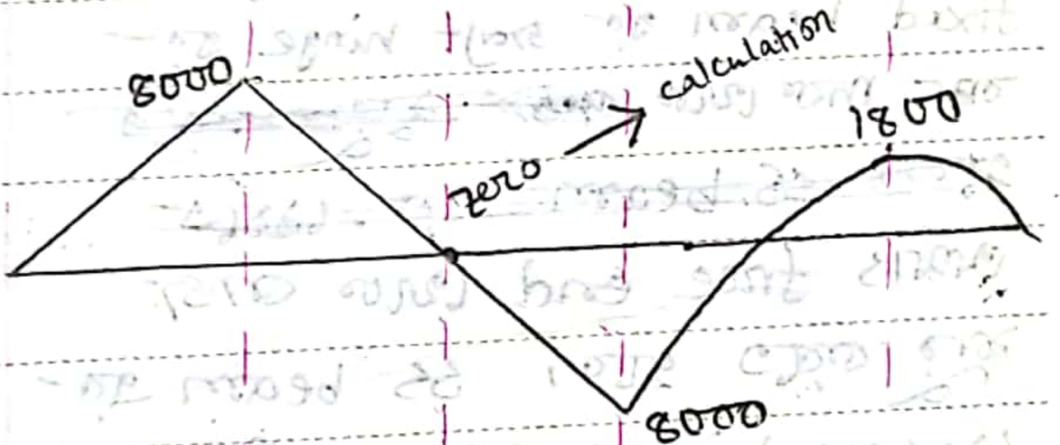


$R_D \times 10 = 400 \times 10 \times 5 - 2000 \times 4$

$\therefore R_D = 1200\,lb$

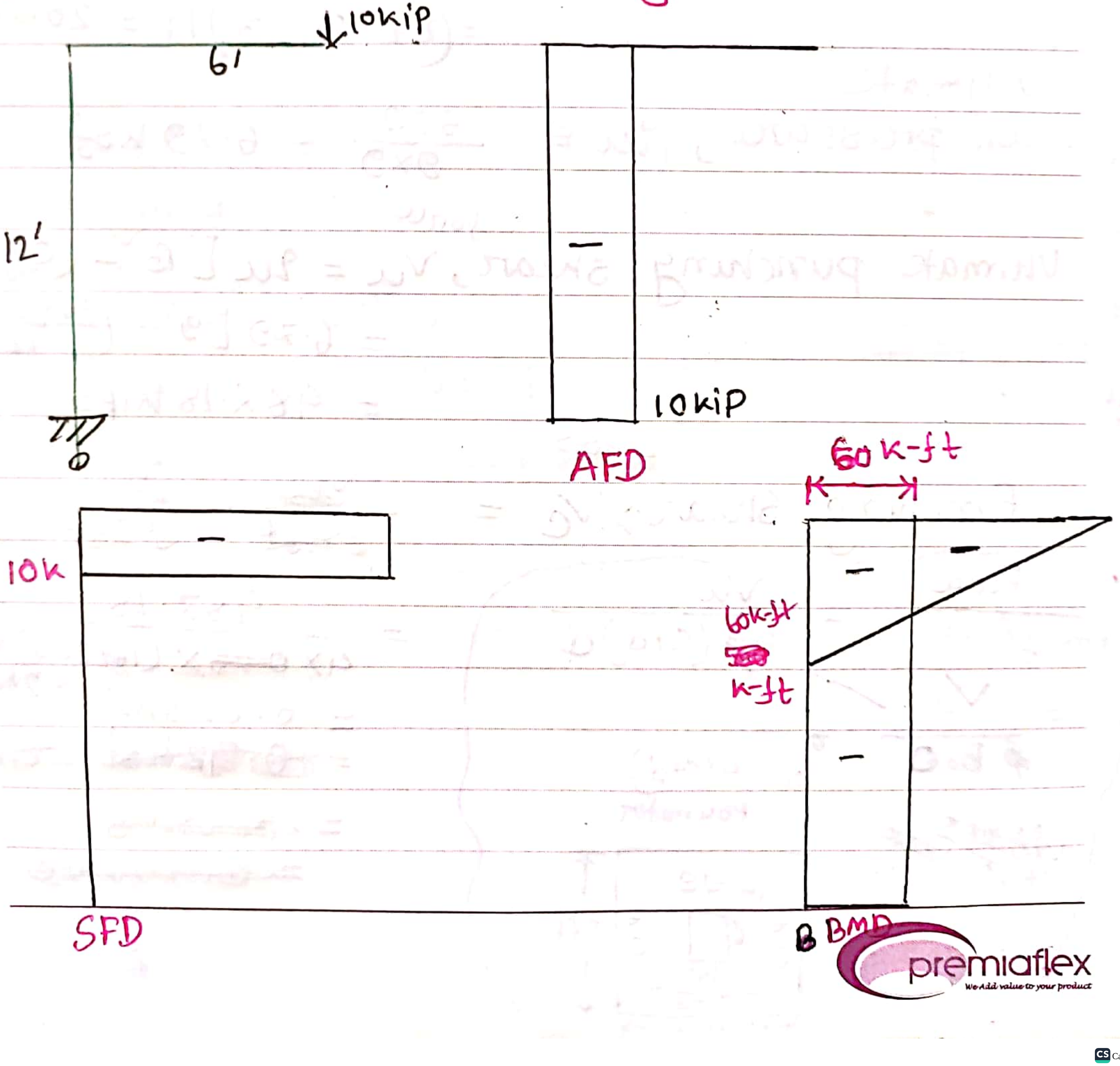
$\therefore R_C = (400 \times 10 + 2000) - 1200$

$= 4800\,lb$



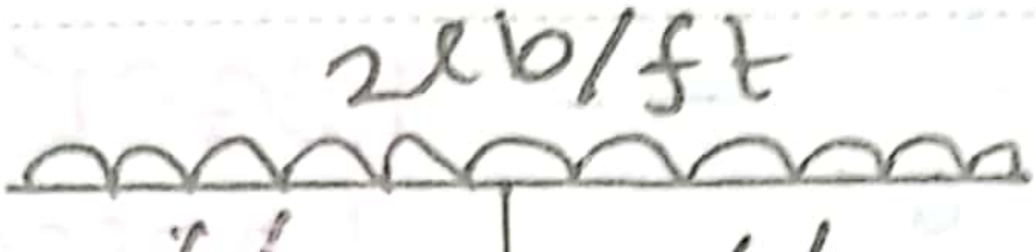
Eastern Lubricants Blenders Limited
2022

* Draw an Axial Force Diagram, SFD & BMD



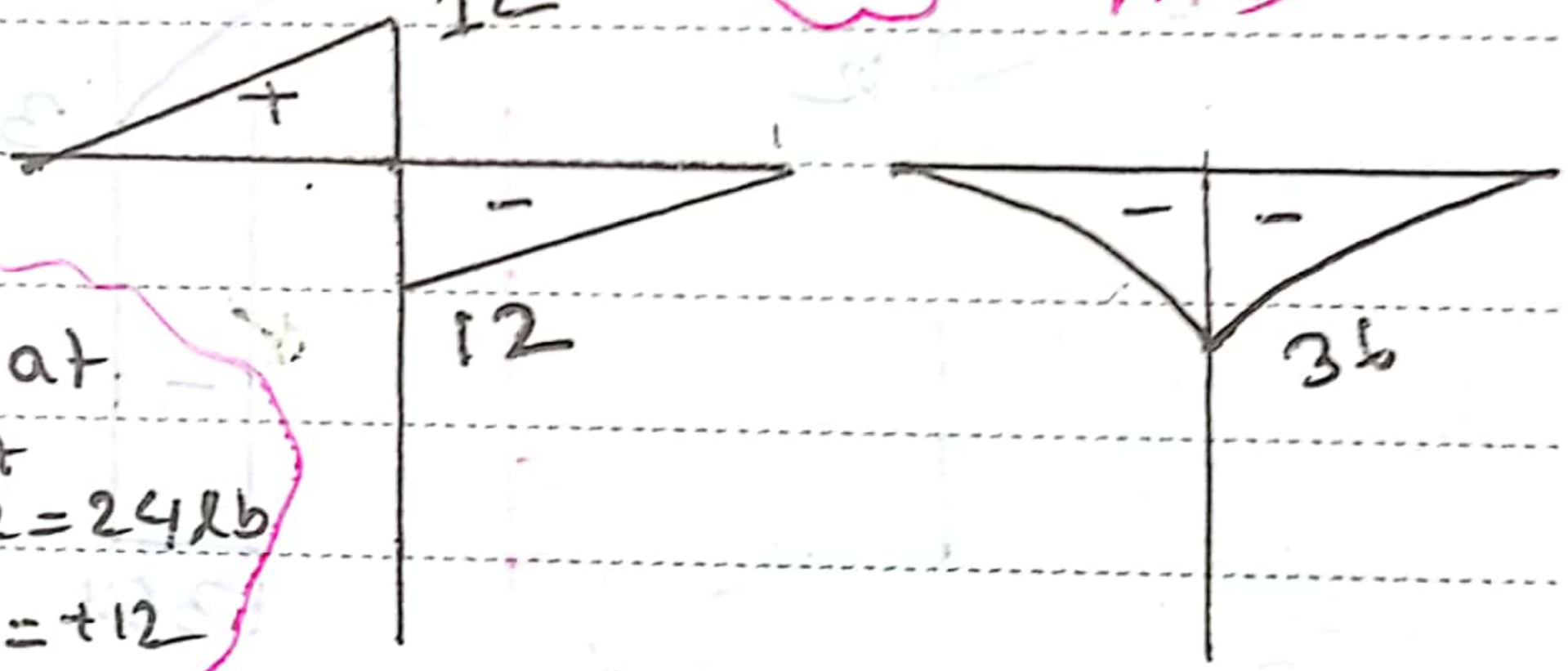
premiaflex
We Add value to your product

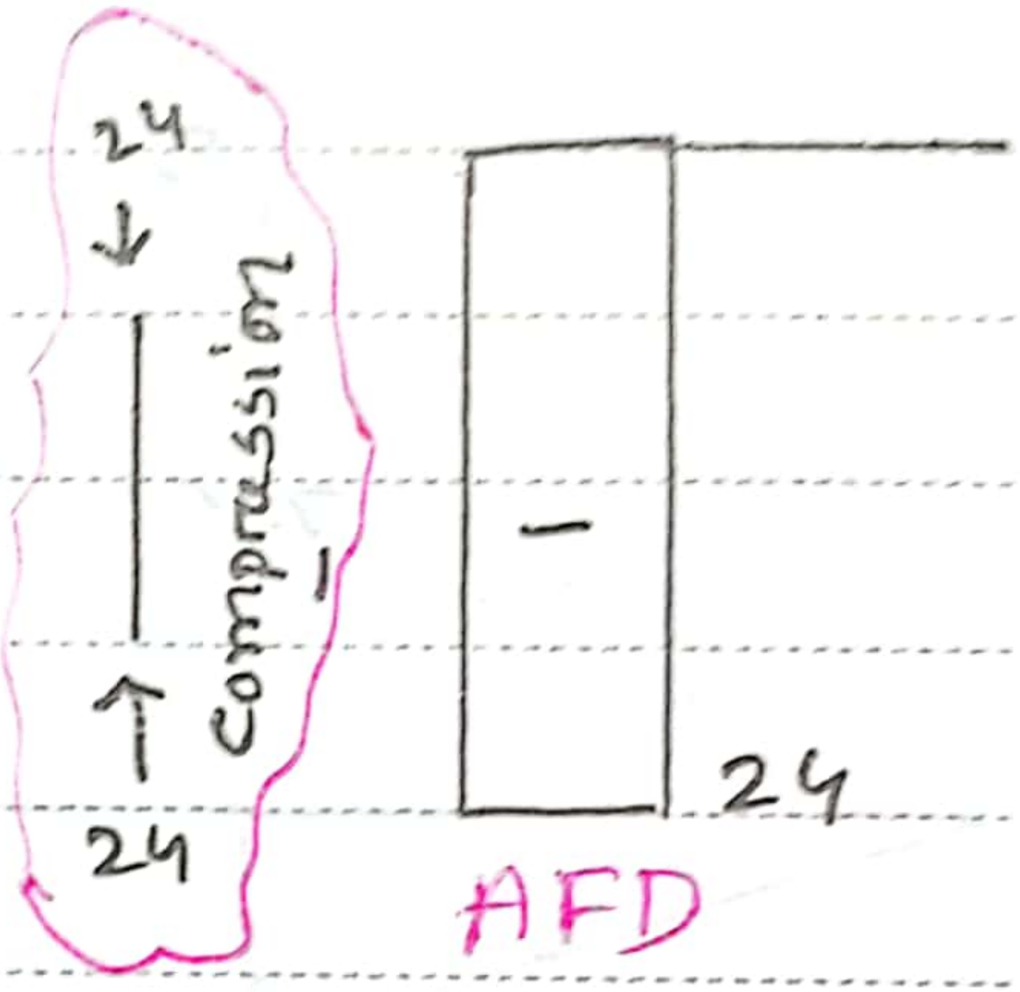
(59)



[BWDB'16]

Soln:





(61) 2k/ft

6' 6'

5'

[SGCL'17]
[DESCO'15]

36

2x6x3 = 36

12

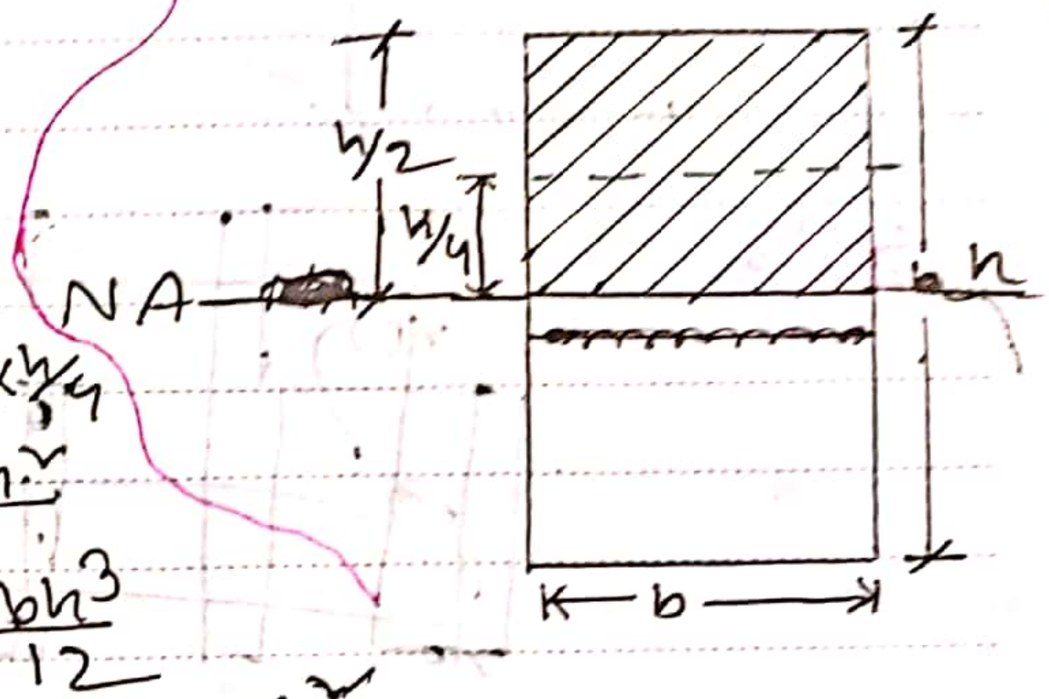
36

SFD

BMD

Shear & Bending Stresses in Beams

(65) Determine the $^{max^m}$ shear stress of a rectangular beam having shear of V & cross-sectional dimension is bXh ? [ERL'2017] [DNCC'16]



Soln: We know,

shear stress, $\delta = \frac{VQ}{I.b}$

For max^m shear stress,

First moment area, $Q = b \times \frac{h}{2} \times \frac{h}{4}$

$= \frac{bh^2}{8}$

moment of inertia $= \frac{bh^3}{12}$

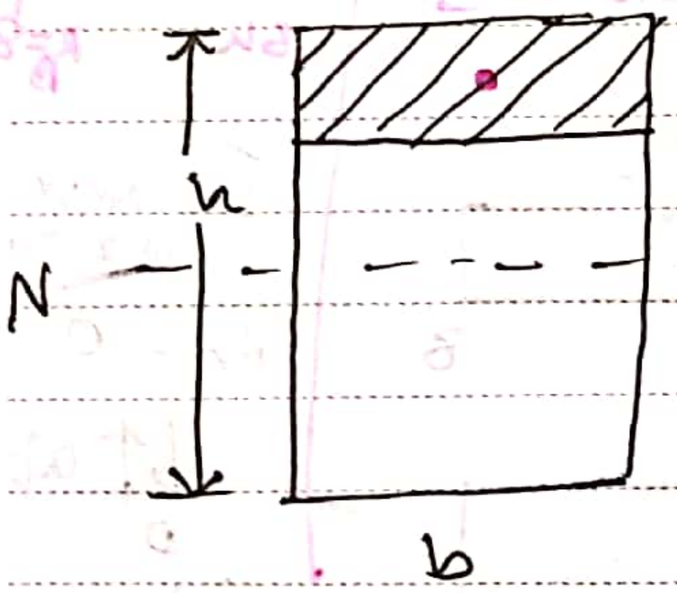
$\therefore$ Max^m shear stress, $\delta_{max} = \frac{V \times \frac{bh^2}{8}}{\frac{bh^3}{12} \times b}$

$= V \times \frac{bh^2}{8} \times \frac{12}{b^2h^3}$

$= \frac{3V}{2bh} = \boxed{\frac{3V}{2A}}$

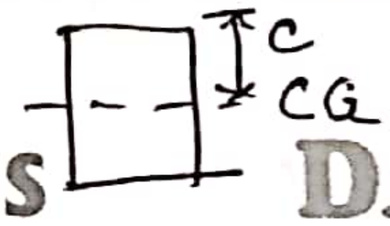
Max^m shear stress
Normal shear stress of 1.5 gt

* Shear stress of rectangular beam at any point :

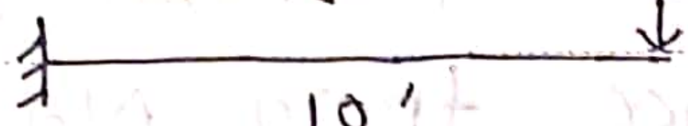


Shear stress at a distance y from NA of beam is, $\tau = \frac{3V}{2A}\left(1 - \frac{y^2}{c^2}\right)$

* Maximum bending stress of a beam, $\sigma_m = \frac{Mc}{I}$



(66) Determine the max^m flexure & shear stress of the following cantilever beam if the section is 1ft x 1ft. [Meghna' 17] [BCIC'16] [JOC'18]



Soln

Here, Shear force, F = 10k, Moment, M = 10 X 10 = 100k-ft

Max^m bending stress, $\sigma_{max} = \frac{MC}{I} = \frac{100 \times 0.5}{\frac{1}{12}}$

$= 600 ksf$

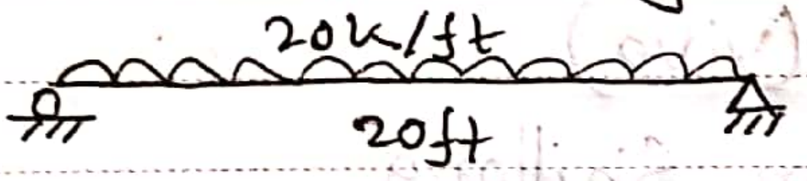
Max^m shear stress, $\tau_{max} = \frac{3F}{2A} = \frac{3 \times 10}{2 \times 1} = 15 ksf$ Ans

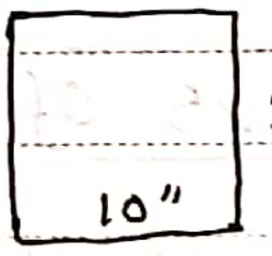
(67) Calculate the max^m shear stress of rectangular beam having dimension of (6" X 12") and vertical shear ~~stress~~ of 48 kips [PGCB'15] [BPDB'16] [BIWTC'12]

Soln: Max^m shear stress, $\tau_{max} = \frac{3F}{2A} = \frac{3 \times 48}{2 \times 6 \times 12}$

$= 1 ksi$ A

(68) Find the max^m bending & shearing stress for the following structures. [BPDB'12] [RRI'15] [BWDB'13]





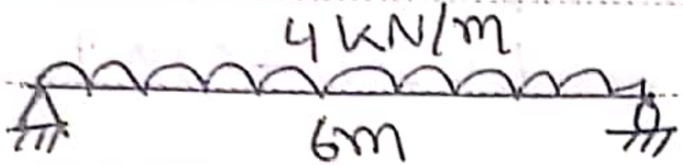
Soln: Max^m Shear, $V = \frac{wl}{2} = \frac{20 \times 20}{2} = 200k$

Max^m moment, $M = \frac{wl^2}{8} = \frac{20 \times 20^2}{8} = 1000 k\text{-ft} = 1000 \times 12 = 12000 k\text{-in}$

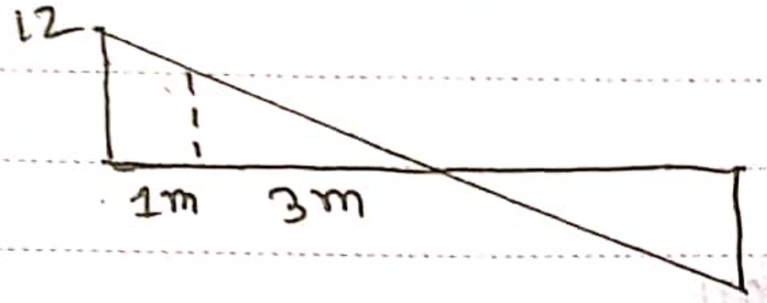
Now, $\tau_{max} = \frac{3F}{2A} = \frac{3 \times 200}{2 \times 10 \times 20} = 1.5 ksi$

$\sigma_{max} = \frac{MC}{I} = \frac{12000 \times 10}{\frac{10 \times 20^3}{12}} = 18 ksi$ ~~A~~

(69) Determine the shear stress at a distance 1m from left support for 30mm from top fiber of the beam.



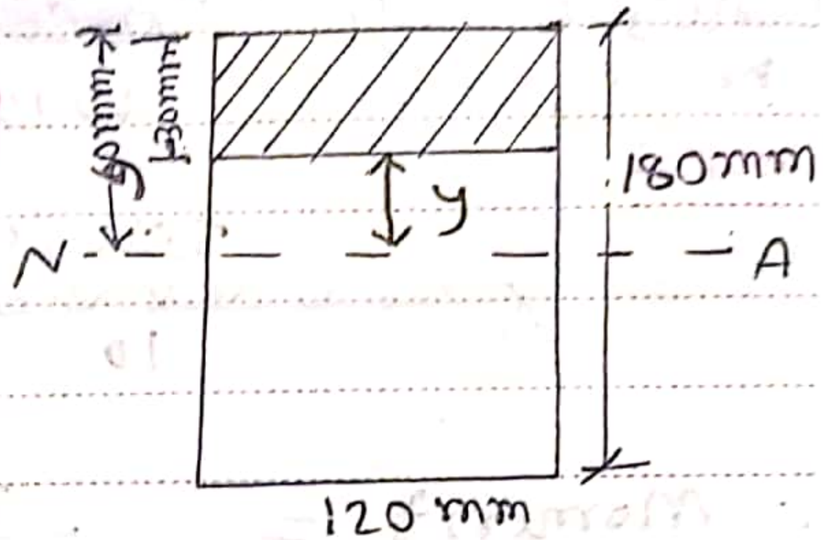
[PADMA Bridge '15]



slope

$12 - \frac{12}{3} \times 1$

$= 8 \text{ kips}$



Soln:

Shear stress at 30mm distance from top fiber

$$= \frac{3F}{2A}\left(1 - \frac{y^2}{c^2}\right)$$

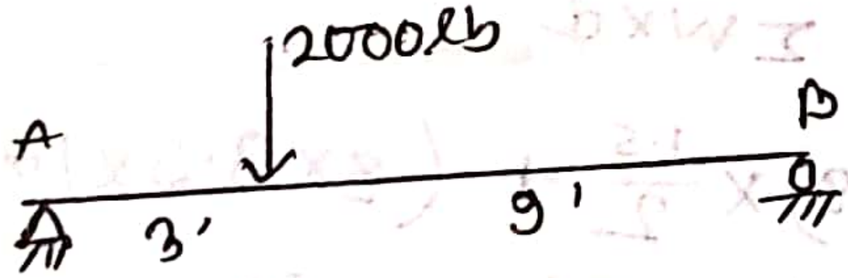
$$= \frac{3 \times 8}{2 \times 0.18 \times 0.12}\left(1 - \frac{0.06^2}{0.09^2}\right)$$

$$= 308.64 \text{ kN/m}^2$$

A simply supported beam (2"×4"), 12ft long is subjected to a concentrated load of 2000lb, at a point 3ft from the left support. Determine the maxm fiber stress and the stress in a fiber located at 0.5" from the top of the beam at mid span. [DSCC'21]

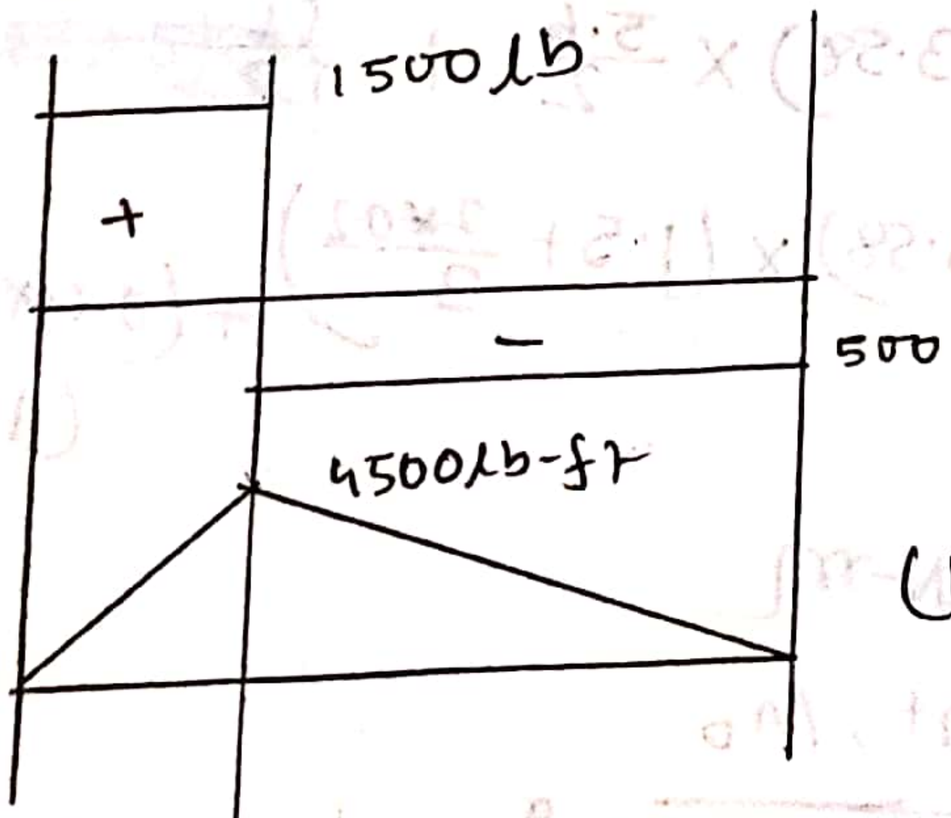
* Flexure/bending/fiber power

Soln:

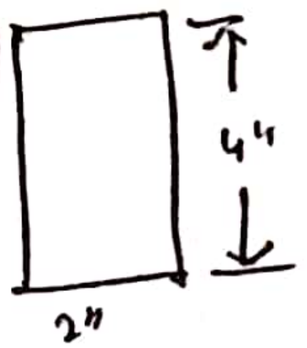


$R_A = \frac{9 \times 2000}{3+9}$

$= 1500$



SFD (lb)



(BMD)

(a) Maxm fiber stress $f_{max} = \frac{Mc}{I}$ → lb-in

$= \frac{(4500 \times 12) \times 2}{\frac{2 \times 4^3}{12}} = 10125 \text{ psi}$

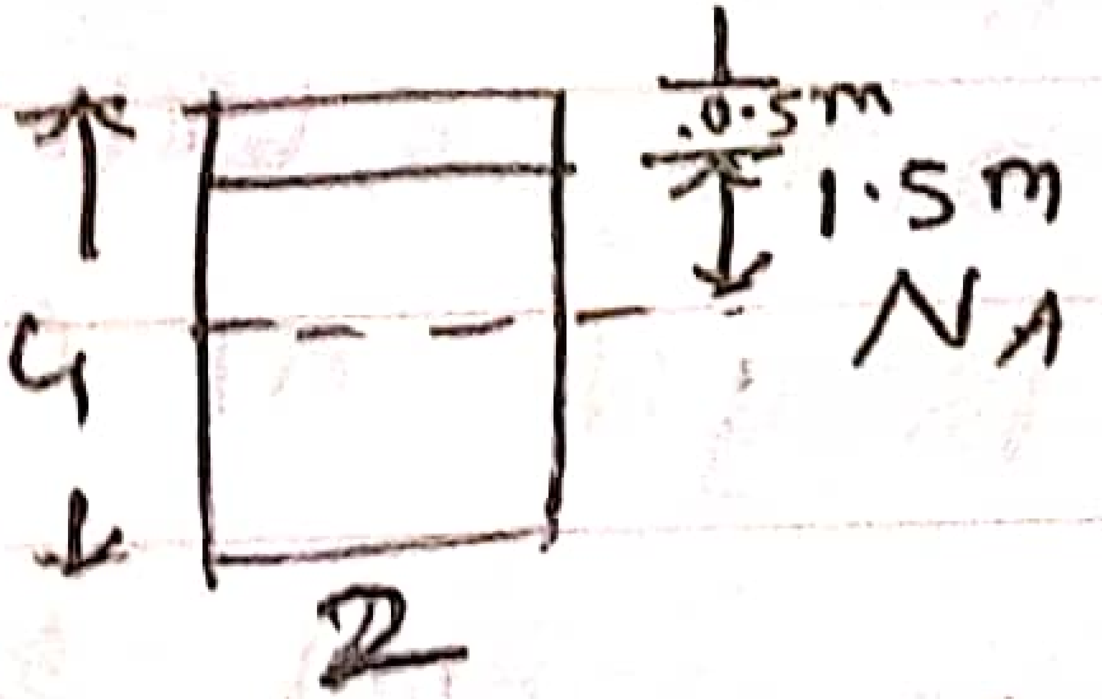
[illegible] থেকে,

৯ ft দূরে 4500 lb-ft

∴ 6 ft দূরে $\frac{4500 \times 6}{৯} = 3000$ lb-ft [mid span $\frac{12}{2} = 6$ ft]

∴ $M_{~~mid~~} = 3000$ lb-ft $= 3000 \times 12$ lb-in

(b), fiber stress located 0.5 in from the top of the beam at ~~mid span~~

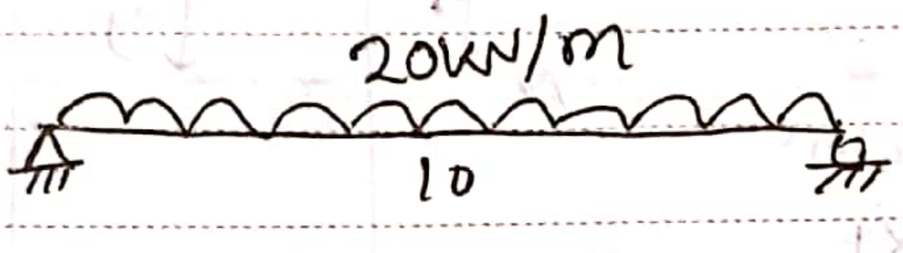


$$f_b = \frac{(3000 \times 12) \times 1.5}{\frac{2 \times 4^3}{12}}$$

$= 5062.5$ psi Ans

(Q1) Determine the section of a square beam if maximum bending stress is 200kN/m² in a ss uniformly distributed load beam with 20kN/m Beam length 10m [COXDA'19]

Sol^n:



$\therefore$ Moment $= \frac{20 \times 10^2}{8} = 250 kN\text{-}m$

$\therefore$ bending stress, $\sigma = \frac{Mc}{I}$

$\Rightarrow 200 = \frac{250 \times \frac{b}{2}}{\frac{b^4}{12}}$

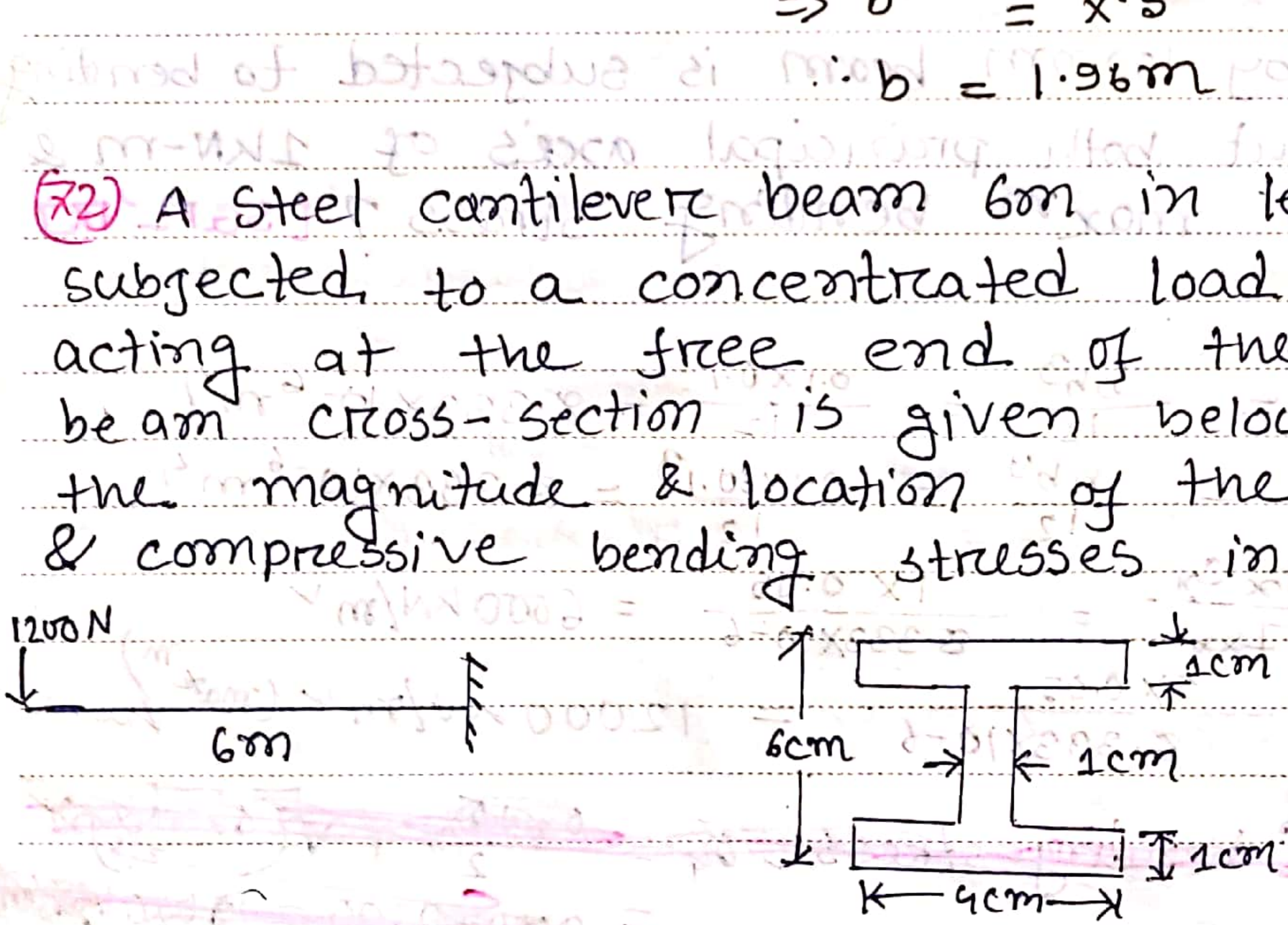
$\Rightarrow 200 = \frac{250b}{2} \times \frac{12}{b^4}$

$\Rightarrow b^3 = \frac{250 \times 12}{2 \times 200}$

$\Rightarrow b^3 = 7.5$

$\therefore b = 1.96m$

(Q2) A steel cantilever beam 6m in length is subjected to a concentrated load of 1200N acting at the free end of the bar. The beam cross-section is given below. Determine the magnitude & location of the max^m tensile & compressive bending stresses in the beam.



[DWASA'17]

$1MPa = 10^6 N/m^2 = 1N/mm^2$

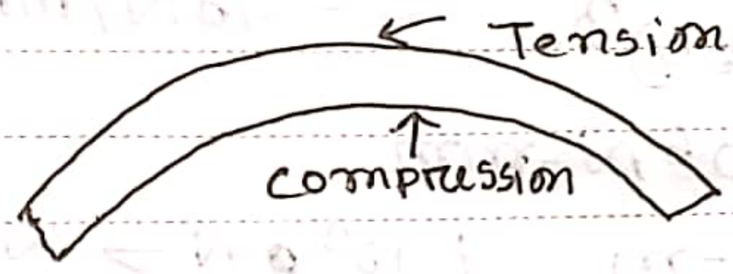
Soln: Bending moment $= 1200 \times 6 = 7200 N\text{-}m$

$$I = \frac{4 \times 6^3}{12} - \frac{3 \times 4^3}{12}$$ [ఖాళీ భాగం తీసివేయాలి]

$$= 56 cm^4$$

$$\therefore \sigma = \frac{MC}{I} = \frac{7200 \times 0.03}{56 \times 10^{-8}} = 386 \times 10^6 Pa = 386 MPa$$

$\frac{6cm}{2}$



Tension at top fiber
compression at bottom fiber
both values are same i.e. 386MPa

Long Column Buckling

radius of gyration, $r_x = \sqrt{\frac{I_x}{A}}$; $r_y = \sqrt{\frac{I_y}{A}}$

* I = moment of inertia about x-x or y-y axis

slenderness ratio, $R = \frac{\text{effective length, } L_e}{\text{least radius of gyration, } r_{min}}$

For steel column
$R \geq 100 \Rightarrow$ long column (buckling occurs)

for RCC column
$R \geq 40 \Rightarrow$ long column (buckling occurs)

* End conditions	Effective length
(1) Both end hinged/pinned	$L_e = l$
(2) fixed - free	$L_e = 2l$
(3) fixed - fixed	$L_e = 0.5l$
(4) fixed - hinged	$L_e = 0.7l$

Euler's buckling stress, $\sigma_E = \frac{\pi^2 E}{\left(\frac{L_e}{r_{min}}\right)^2}$

$[\because I = Ar^2] = \boxed{\frac{\pi^2 EI}{AL_e^2}}$ ***

Euler's buckling load, $P = \sigma A$ $[\because \sigma = \frac{P}{A}]$

$= \frac{\pi^2 EI}{L_e^2}$

* I_{xx}, I_{yy} এর মধ্যে minimum টার মান I

Shortcut formula, $P = \frac{\pi^2}{L_e^2} EI$; $\sigma = \frac{\pi^2}{L_e^2} * Er^2$

buckling stress এর পরিমাণ কম

(75)

* Determine Euler buckling stress of a 12ft long column having x-sectional properties $r_x = 4.25$ in & $r_y = 2.1$. Assume pinned-pinned end for strong axis buckling & fixed-pinned end for weak axis buckling. Given, $E = 29000$ ksi [DPDC'19]

Soln

Stress at strong axis, $\sigma_1 = \dfrac{\pi^2 E}{\left(\frac{Le}{r_{max}}\right)^2}$

$= \dfrac{\pi^2 \times 29000\ \text{ksi}}{\left(\frac{12\times12\ \text{in}}{4.25}\right)^2} = 249.31\text{ksi}$

For weak axis, $\sigma_2 = \dfrac{\pi^2 \times 29000}{\left(\frac{0.7\times12\times12}{2.1}\right)^2} = 124\ \text{ksi}$

(fixed-pinned)

*

* A steel rod 5m long and 40mm diameter is used as a column with one end free other end fixed. Determine the cripling load by Euler's formula. Take $E = 200$ GPa

Soln

$$I = \frac{\pi}{64} \times d^4 = \frac{\pi}{64} \times (40)^4 = 40000\pi\ \text{mm}^4$$

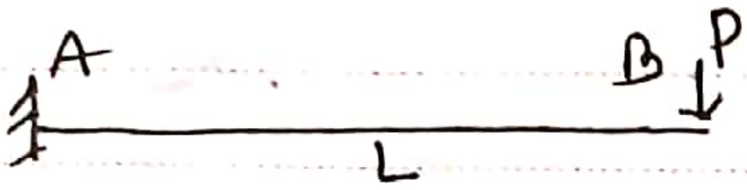
$$\therefore P = \frac{\pi^2 EI}{Le^2} = \frac{\pi^2 \times 200\times10^3 \times 40,000\pi}{(2\times5\times10^3)^2}$$

$(1\text{GPa} = 10^3\text{MPa} = 10^3\text{N/mm}^2)$

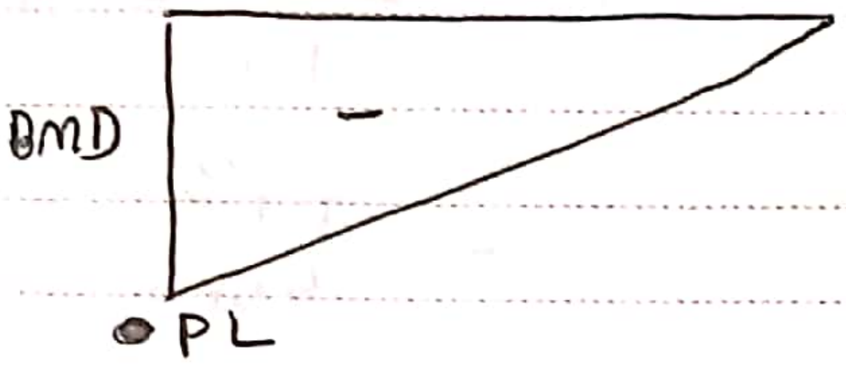
$= 2480\text{N}$

$= 2.48\text{KN}$

Deflection of Beams using Moment-Area Method

(i) 

[SGFL'20] [BWDB'20]



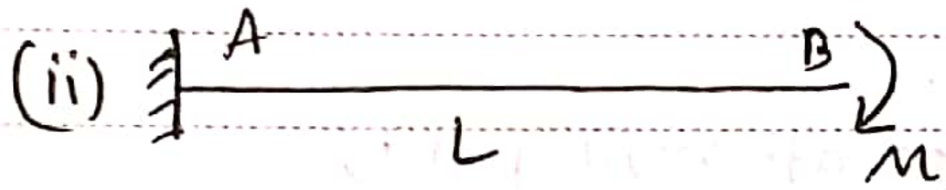
$$\text{Slope at B, } \theta_B = \frac{\text{Area of BMD}}{EI}$$

$$= \frac{\frac{1}{2} * L * PL}{EI} = \frac{PL^2}{2EI}$$

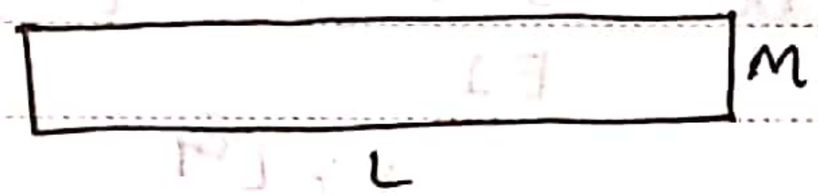
$$\text{deflection at B, } Y_B = \frac{A\bar{x}}{EI} = \frac{PL^2}{2EI} * \frac{2L}{3}$$

$\theta_B * \bar{x}$

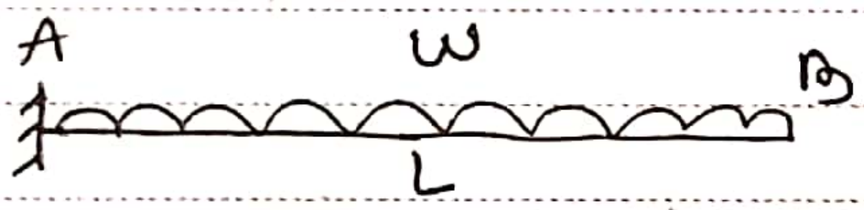
$$= \frac{PL^3}{3EI}$$

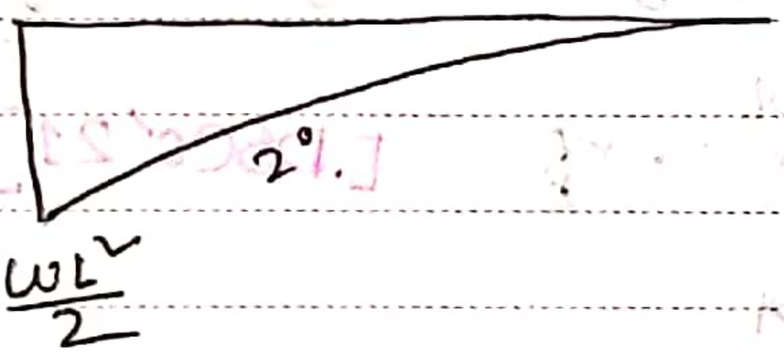
(ii) 

[DESCO'15] [APSCL'16]



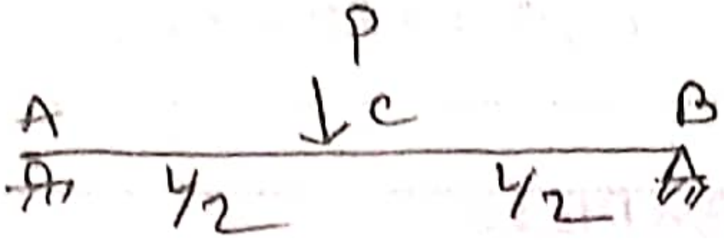
$$\text{deflection, } Y_B = \frac{A\bar{x}}{EI} = \frac{ML * \frac{L}{2}}{EI} = \frac{ML^2}{2EI}$$

(iii) 

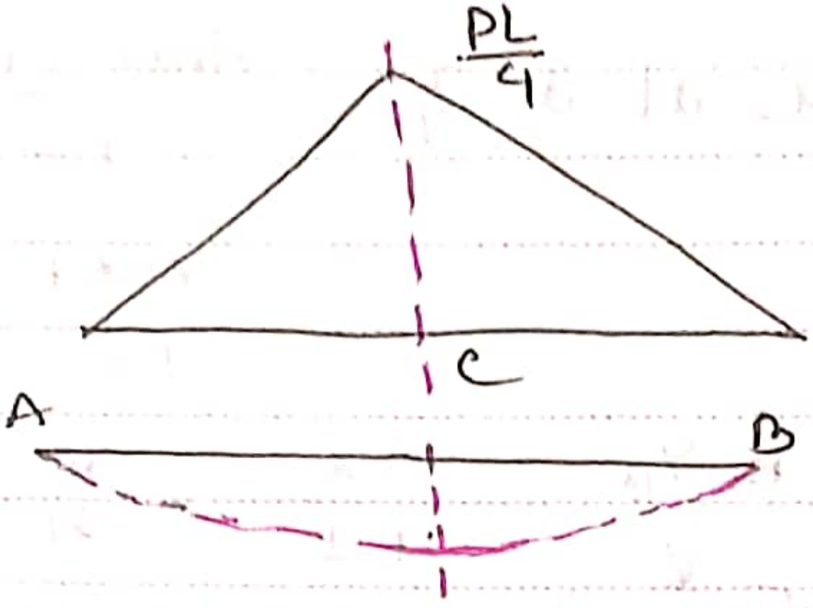


$$\text{deflection at B, } Y_{max} = \frac{\frac{1}{3} * \frac{WL^2}{2} * L * \frac{3L}{4}}{EI}$$

$$= \frac{WL^4}{8EI}$$

(iv) 

[BCPCL'16]

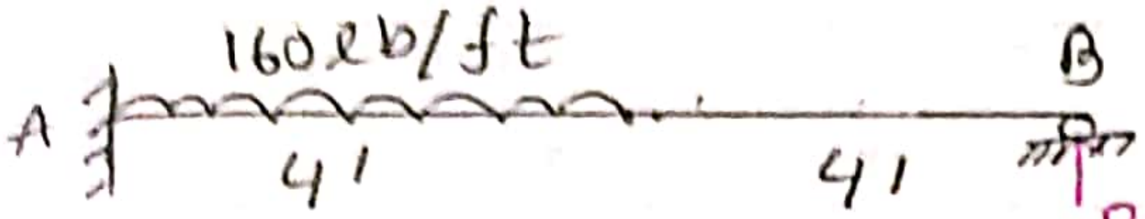


deflection at C, $y_{max} = \frac{\frac{1}{2} \times \frac{PL}{4} \times \frac{L}{2} \times \left(\frac{2}{3} \times \frac{L}{2}\right)}{EI}$

$= \frac{PL^3}{48EI}$

Slope at A = Slope at B = $\theta = \frac{PL^2}{16EI}$

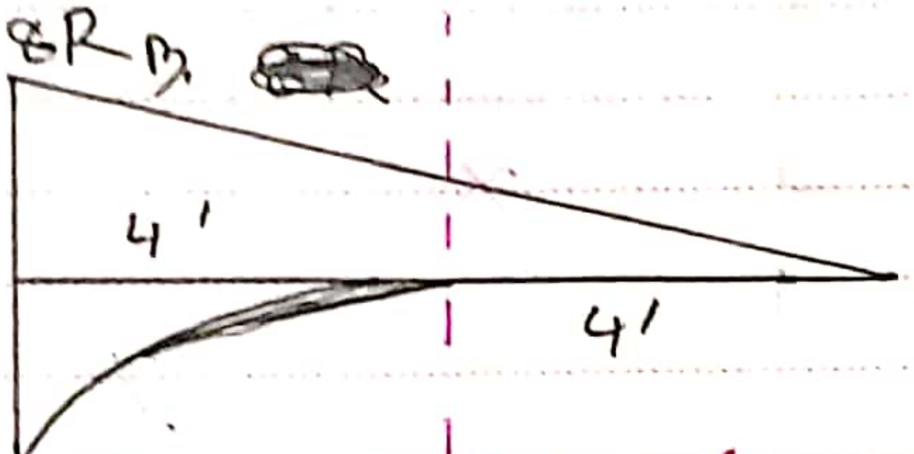
mid point ir almost flat i mid ৎ slope zero. ২২ support ৎ slope max^m



EI = constant
deflection at B, $y_B = 0$

Find the reaction at B, R_B [KGDCL'21] [MGMCL'22]

Sol^n:



$160 \times 4 \times \frac{4}{2} = 1280$ (4 ft বড় অংকের বরাবর force আসছে। Force×distance = moment)

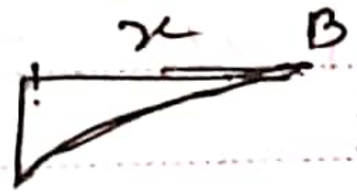
Now, $y_B = \frac{1}{EI}\left[\frac{1}{2} \times 8R_B \times 8 \times \frac{2 \times 8}{3} - \frac{1}{3} \times 1280 \times 4 \times \left(4 + \frac{3 \times 4}{4}\right)\right]$ ($\Sigma Area \times \bar{x}$)

~~$\Rightarrow 0 \times EI = 2133R - 11946.67 - 29867$~~

$\therefore \Rightarrow 0 \times EI = 170.67 R_B - 11946.67$

$\therefore R_B = 70 lb$

[CG B point থেকে হিসাব করতে হবে যেহেতু B point এ deflection y_B হিসাব করতেছি।]

[

$= \frac{3x}{4}$ from B]

y_B = deflection at B

$= \frac{A\bar{x}}{EI}$ → CG from point B

area of moment

(1)

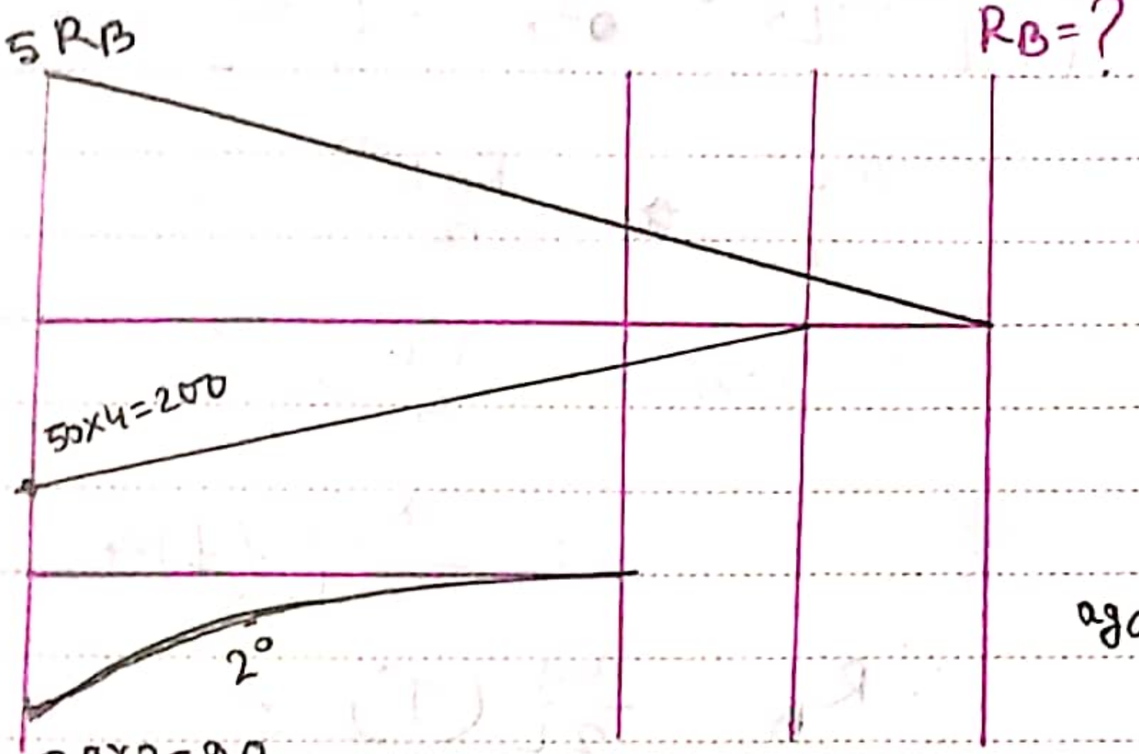
Find the reaction at B, R_B : EI = constant.

Soln:

$y_B = 0$

$\therefore \frac{1}{EI}[\text{Area} \cdot \bar{x}_B] = 0$

$\Rightarrow \frac{1}{EI}\left[\left(\frac{1}{2}\times 5\times 5R_B\right)\times\frac{2*5}{3} - \left(\frac{1}{2}\times 4\times 200\right)\times\left(1+\frac{2*4}{3}\right) - \left(\frac{1}{3}\times 90\times 3\right)\times\left(2+\frac{3*3}{4}\right)\right]=0$



$\therefore R_B = 44.38\,KN \uparrow$

again, $R_A + R_B - 50 - 20\times 3 = 0$

$\Rightarrow R_A = 50+60-44.38 = 65.62\,KN \uparrow$

$\therefore \Sigma M_A = 0$

$\therefore M_A + 44.38\times 5 - 50\times 4 - 20\times 3\times 1.5 = 0$

$\therefore M_A = 68.1\,KN\text{-}m \circlearrowleft$