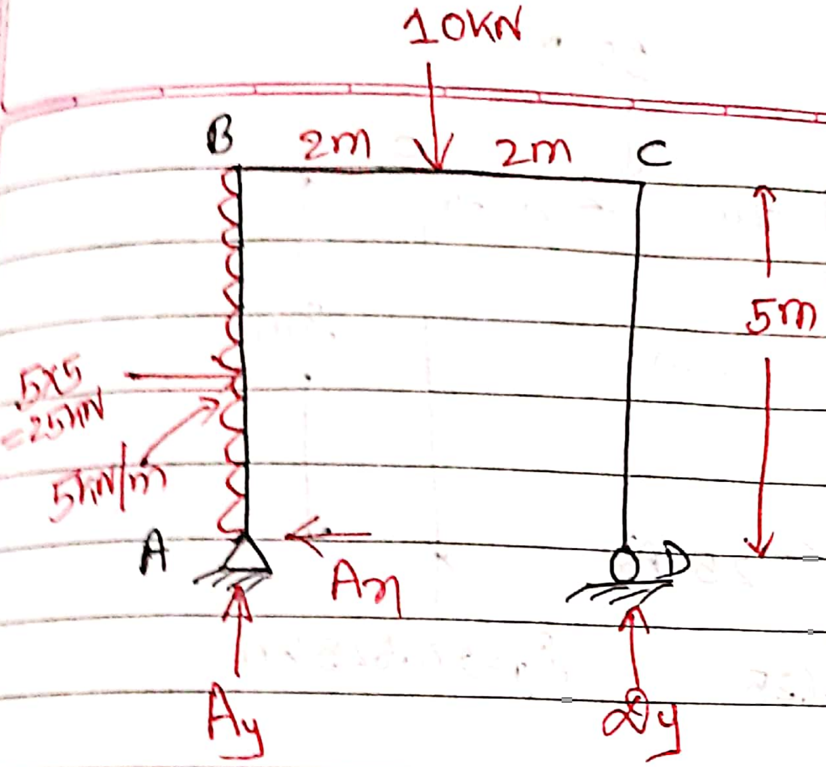
8



Step 1:→ calculating the Reactions

$\Sigma F_y = 0$ ($\uparrow$ +ve)

$\Rightarrow A_y + D_y - 10 = 0$ — (1)

$\Sigma F_x = 0$ ($\rightarrow$ +ve)

$-A_x + 25 = 0$

$\Rightarrow \boxed{A_x = 25 KN}$

$\Sigma M_A = 0$ (+ve) (clockwise +ve)

$\Rightarrow 25 \times 2.5 + 10 \times 2 - D_y \times 4 = 0$

$\Rightarrow 4 D_y = 62.5 + 20$

$\Rightarrow \boxed{D_y = 20.625 KN}$

From eqn (1)

$\Rightarrow A_y + 20.625 - 10 = 0$

$\Rightarrow \boxed{A_y = -10.625 KN}$

-ve sign represents that our assumed direction is not correct and now we have to change it.

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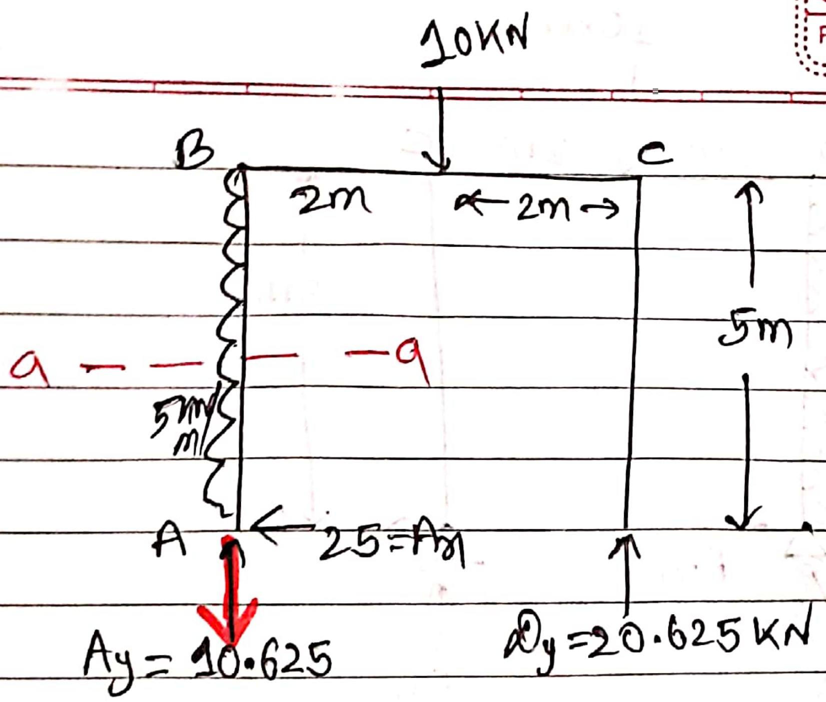
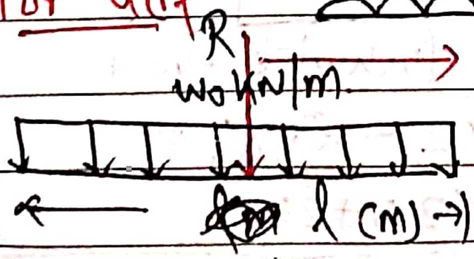


Step 2:- Analysing shear force and Bending moment of given frame.

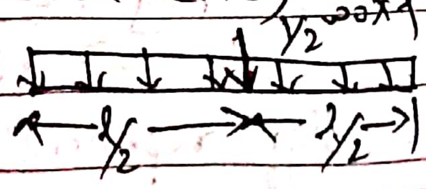
For this isolate each member and find shear force, Bending moment, Axial force seperately.

Note

For udl



Reaction of loading intensity is given by the area under the loading diagram. ie $R = \frac{1}{2} w_0 \times l$ and passes through CG of that rectangle (ie from $l/2$ from each end)



continued, Step2

For member (AB) → passing section a-a such that ($0 \le x \le 5m$)

Let $V_x \rightarrow$ represent the shear force equation

and $M_x \rightarrow$ represent the bending moment equation.

$V_x = 25 - 5x$

~~$V_x = 25 kN$~~

- @ $x = 0 \rightarrow V_A = 25 kN$
- @ $x = 5 \rightarrow V_{B,L} = 0 kN$

⇒ while moving from left to right → clockwise (+ve)

$$M_x = 25x - 5x \times \frac{x}{2} = 25x - 2.5x^2$$

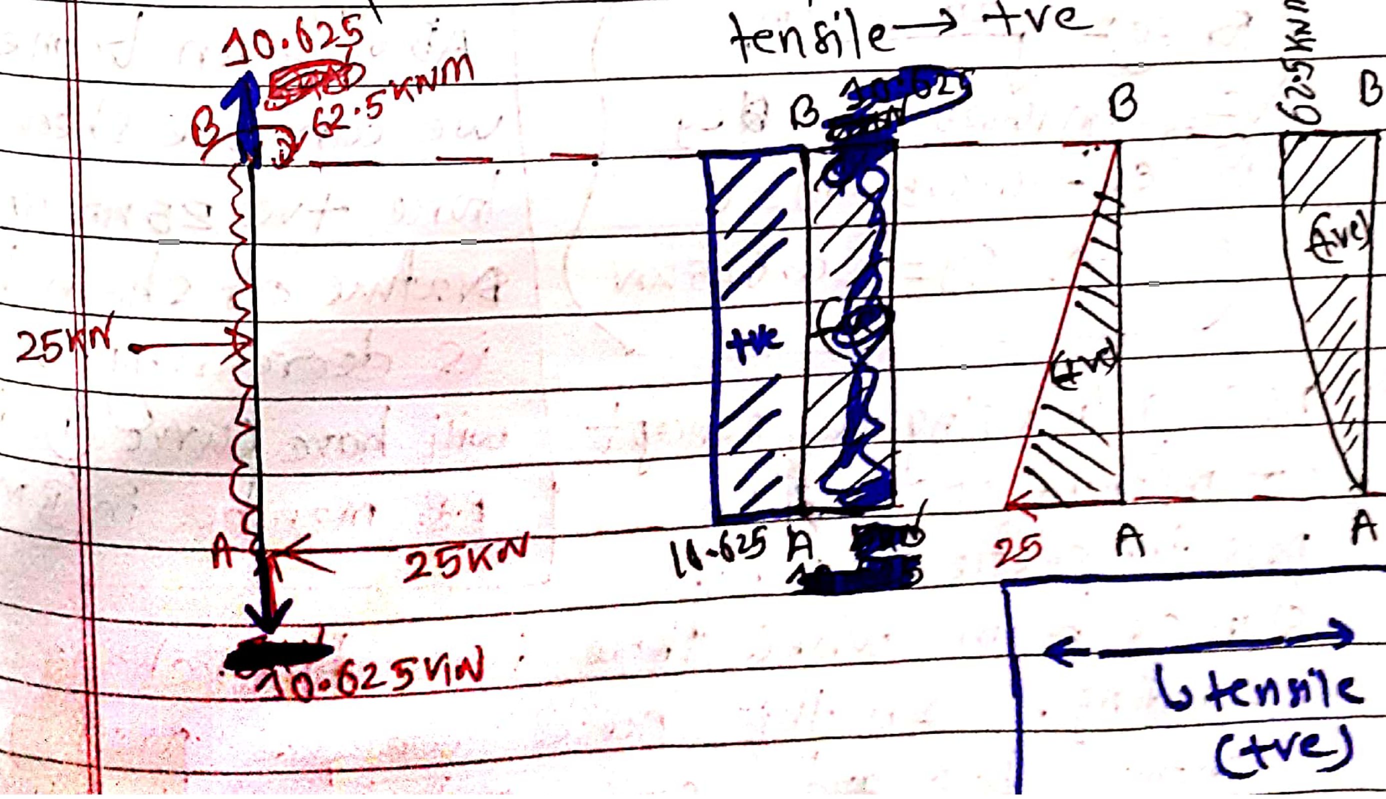
$$\Rightarrow M_x = 25x - 2.5x^2$$

- @ $x = 0 \rightarrow M_A = 0$
- @ $x = 5 \rightarrow M_{B,L} = 125 - 62.5$

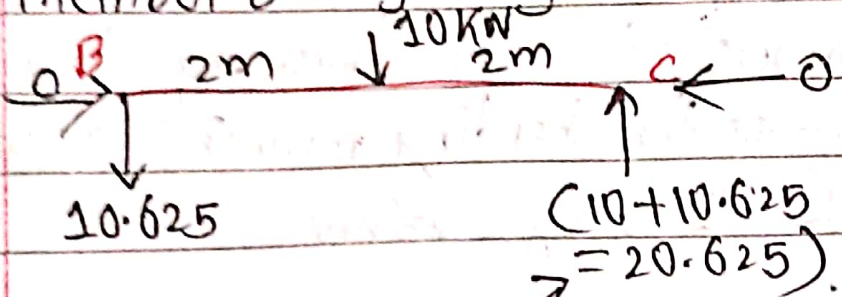
$\Rightarrow M_{B,L} = 62.5 kNm$

For Axial force ⇒ compression → −ve

tensile → +ve

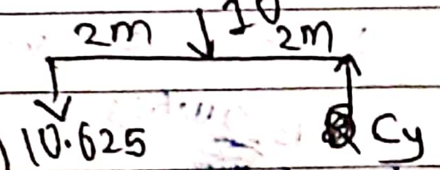


Member BC (Balance the member BC by seeing the force in



Balance the forces at joint c in member(AB) by simply providing the net force (vertical) required to make it in equilibrium or simply consider member BC as beam and find the reaction at c.

For Eg:-

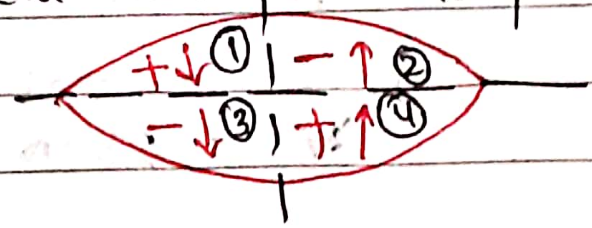


$(\Sigma F_y = 0 \uparrow)$

$C_y - 10.625 - 10 = 0$

$\Rightarrow C_y = 20.625 \text{ KN}$

Trick: (Always see the shear force diagram to draw curve for UDL/UVL

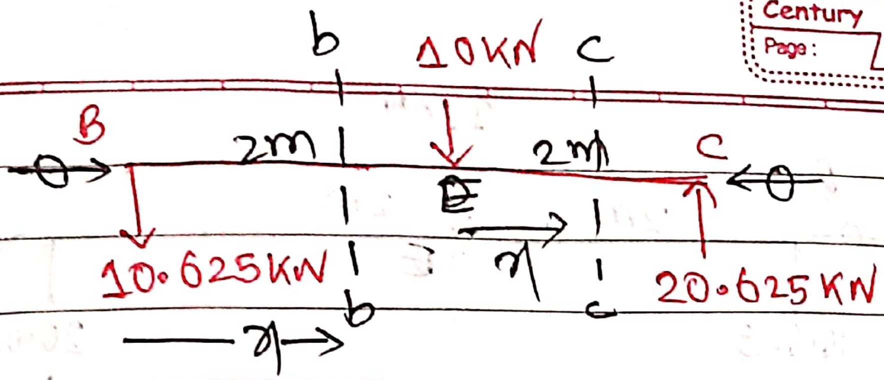


+ ⇒ Represents the value of shear force.

↑ or ↓ ⇒ increasing or decreasing represents the nature of shear force diagram.

For Eg:- In member AB of given frame we can see shear force +ve 25 kN and nature of shear force is decreasing, so we will have curve ① in AB member in (BMD)

Now again using the concept of method of section pass the section along the span of beam where there is sudden change in loading. In this case we are passing section b-b and c-c and formulating the shear force and bending moment equation in term of x.

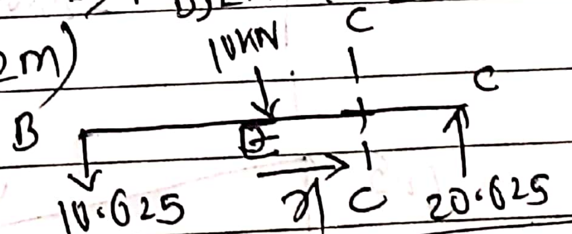


For span BD $(0 \le x \le 2m)$

$V_x = -10.625$
- @ $x=0$ → $V_{B,R} = -10.625$
- @ $x=2$ → $V_{D,L} = -10.625$

$M_x = -10.625x + 62.5$
- @ $x=0$ → $M_{B,R} = 0 + 62.5 = 62.5$ KNm
- @ $x=2$ → $M_{D,L} = -21.25 + 62.5$ ⇒ $M_{D,L} = 41.25$ KNm

For span DC $(0 \le x \le 2m)$

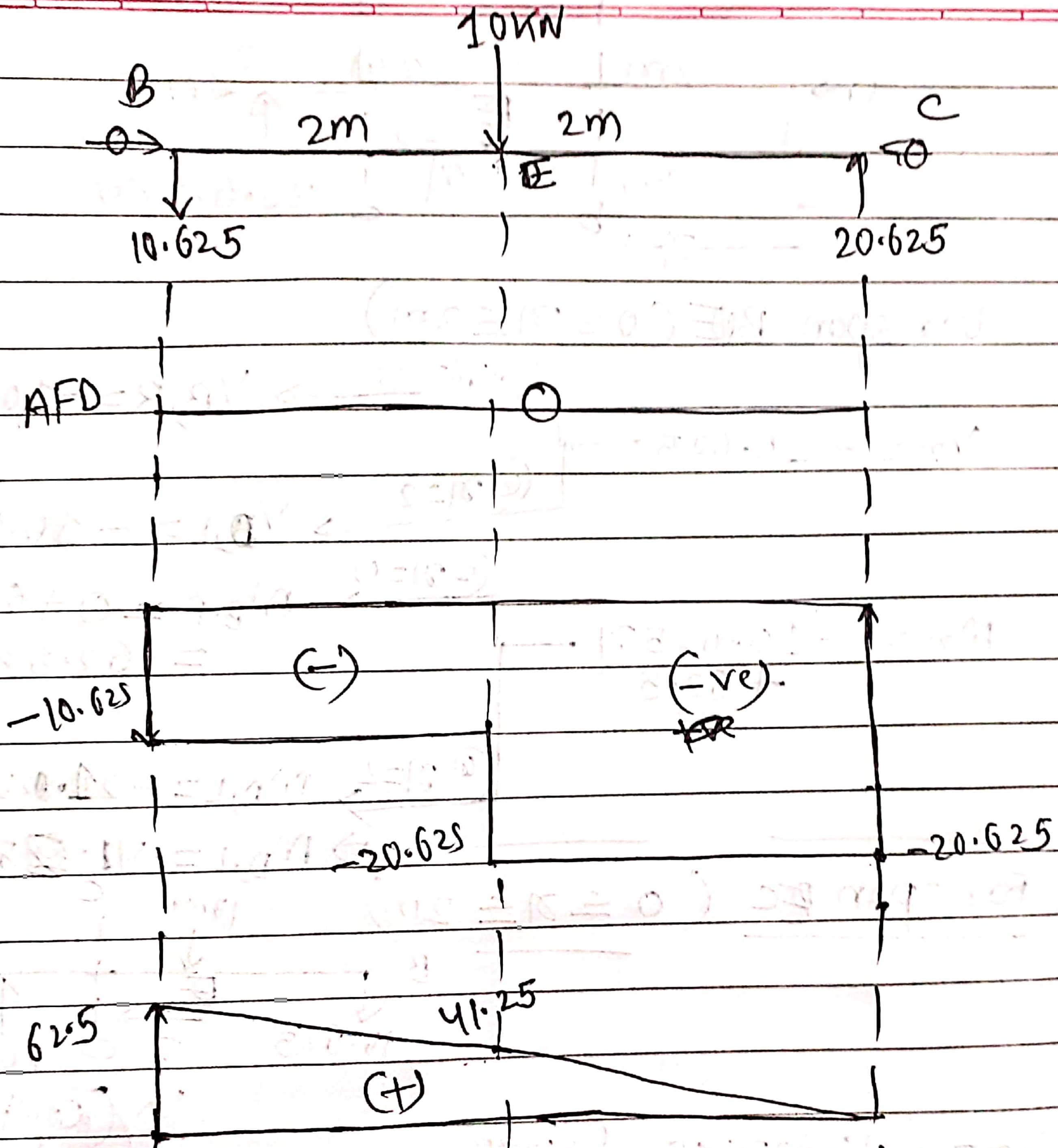


↳ (Don't take x from B in this case)

Always take x from the considered span.

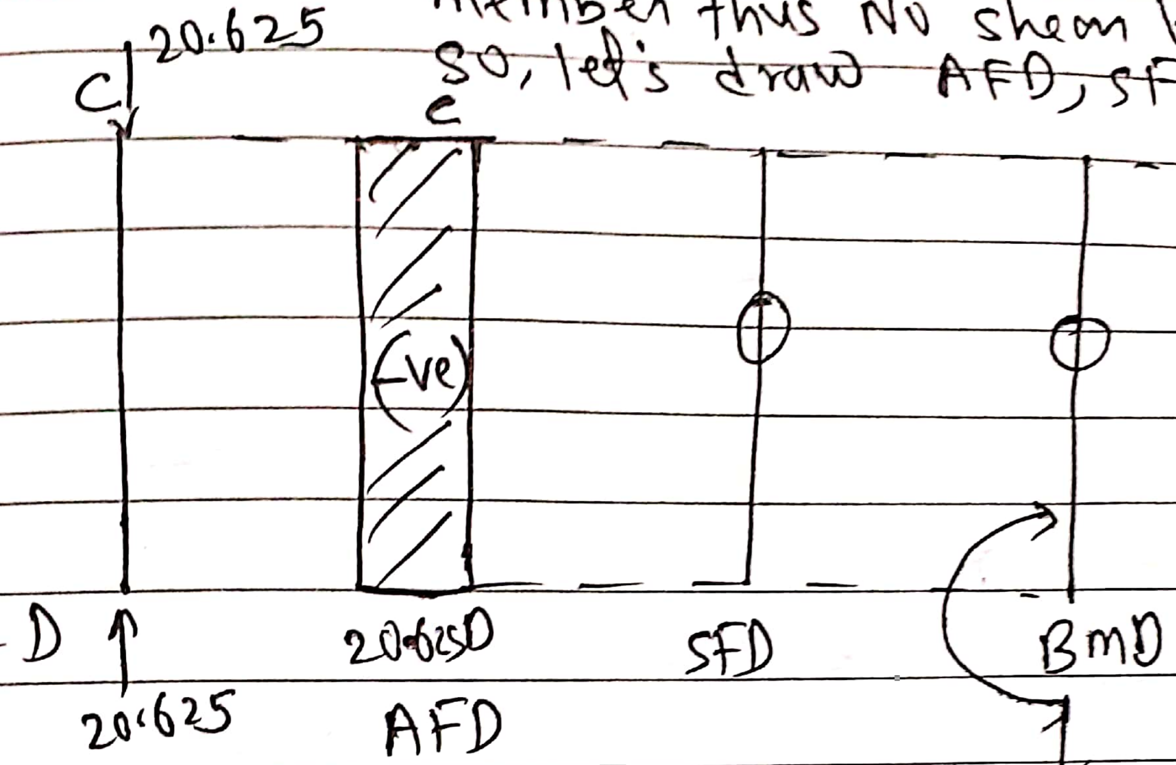
$V_x = -10.625 - 10 = -20.625$
- @ $x=0$ → $V_{D,R} = -20.625$
- @ $x=2$ → $V_{C,L} = -20.625$

$M_x = -10.625(2+x) - 10x + 62.5$
$= -21.25 - 10.625x - 10x + 62.5$
$= -21.25 - 20.625x + 62.5$
- @ $x=0$ → $M_{D,R} = -21.25$
- $x=2$ → $M_{C,L} = -41.25 - 21.25 + 62.5 = 0$


10KN
B
2m
2m
C
E
10.625
20.625
AFD
0
(-)
(-ve)
-10.625
-20.625
-20.625
62.5
41.25
(+)

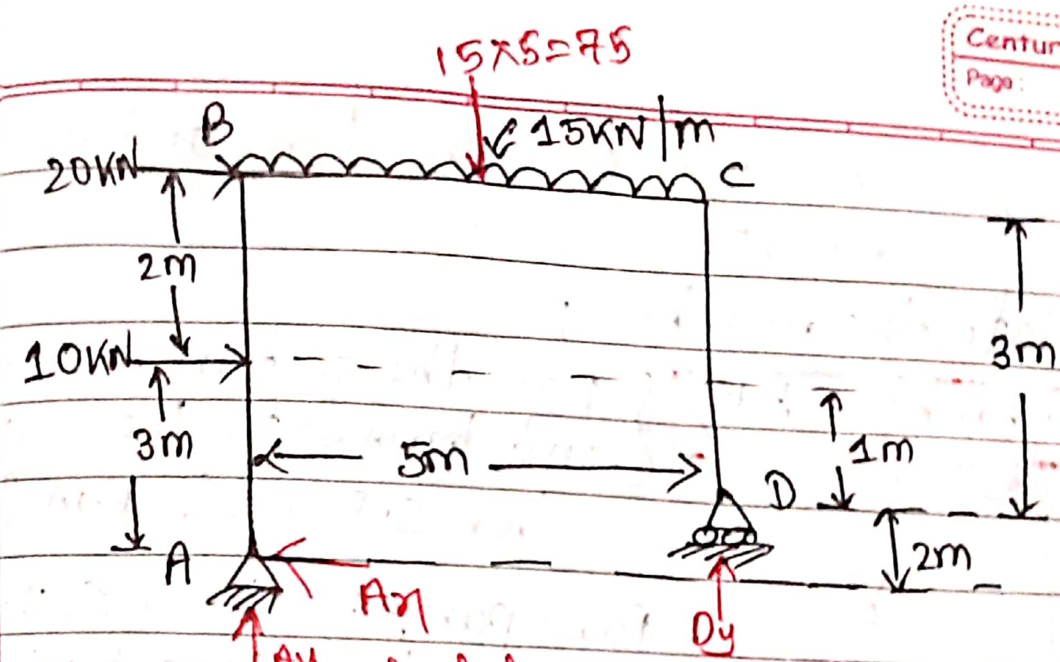
Member CD

(No forces perpendicular to member thus no shear force so, let's draw AFD, SFD and BMD



Bcz no moment at C and D being Roller there will be no moment so NO BMD.

8

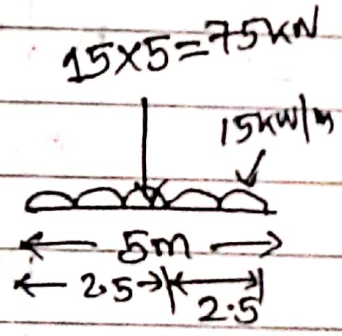


Step 1:→ Calculating the Reactions

$\Sigma F_x = 0$ ($\rightarrow$ +ve)

$-A_x + 10 + 20 = 0$

$\Rightarrow \boxed{A_x = 30\,KN\ (\leftarrow)}$



$\Sigma F_y = 0$ ($\uparrow$ +ve)

$A_y + D_y - 75 = 0$ — (1)

$\Sigma M_A = 0$ (+ve) {Clockwise +ve}

$\Rightarrow 10\times3 + 20\times5 + 75\times2.5 - D_y\times5 = 0$

$\Rightarrow 30 + 100 + 187.5 - 5D_y = 0$

$\Rightarrow \boxed{D_y = 63.5\ KN\ (\uparrow)}$

From eqn (1)

$\Rightarrow A_y + 63.5 - 75 = 0$

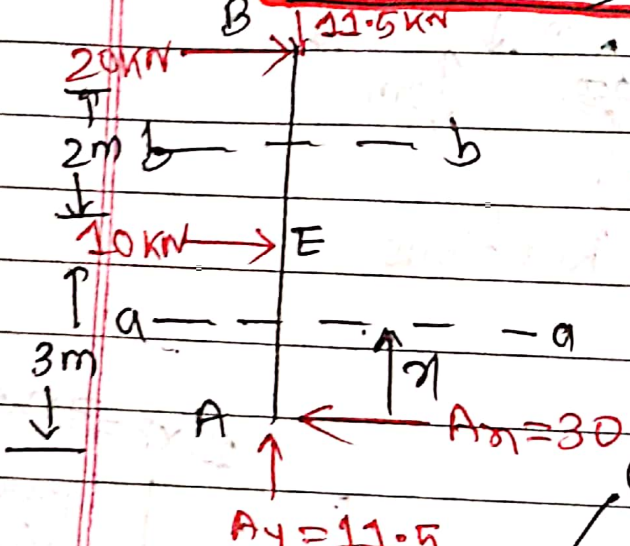
$\Rightarrow A_y - 11.5 = 0$

$\Rightarrow \boxed{A_y = 11.5\,KN\ (\uparrow)}$

Step 2:→ Analysis of shear force and Bending moment

Isolate the member;

$\boxed{\text{Member AB}}$; { pass the section a-a and b-b and formulate the equation for S.F and B.M }



For span AE $(0 \le x \le 3m)$
(Move from left to right)

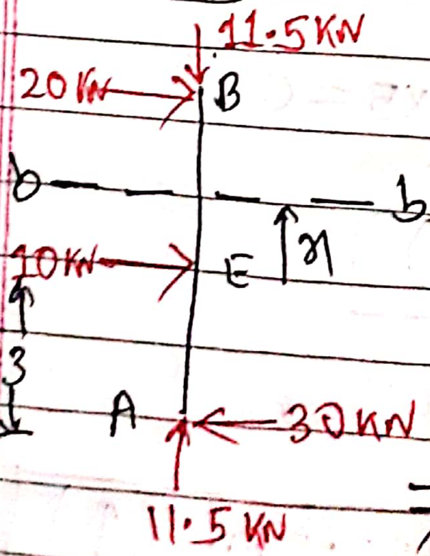
$V_x = 30$ — @x=0 → $V_A = 30$ KN; @x=3m → $V_{E,L} = 30$ KN

(Clockwise +ve) ← Always take this ~~Mx = 30x~~ . while moving from left to right)

Bending moment equation

$\Rightarrow M_x = 30x$ — @x=0 → $M_A = 0$; @x=3m → $M_{E,L} = 90$ KNm

Similarly for span b-b $(0 \le x \le 2m)$



$V_x = 30 - 10 = 20$ — @x=0 → $V_{E,R} = 20$; @x=2 → $V_{B,L} = 20$

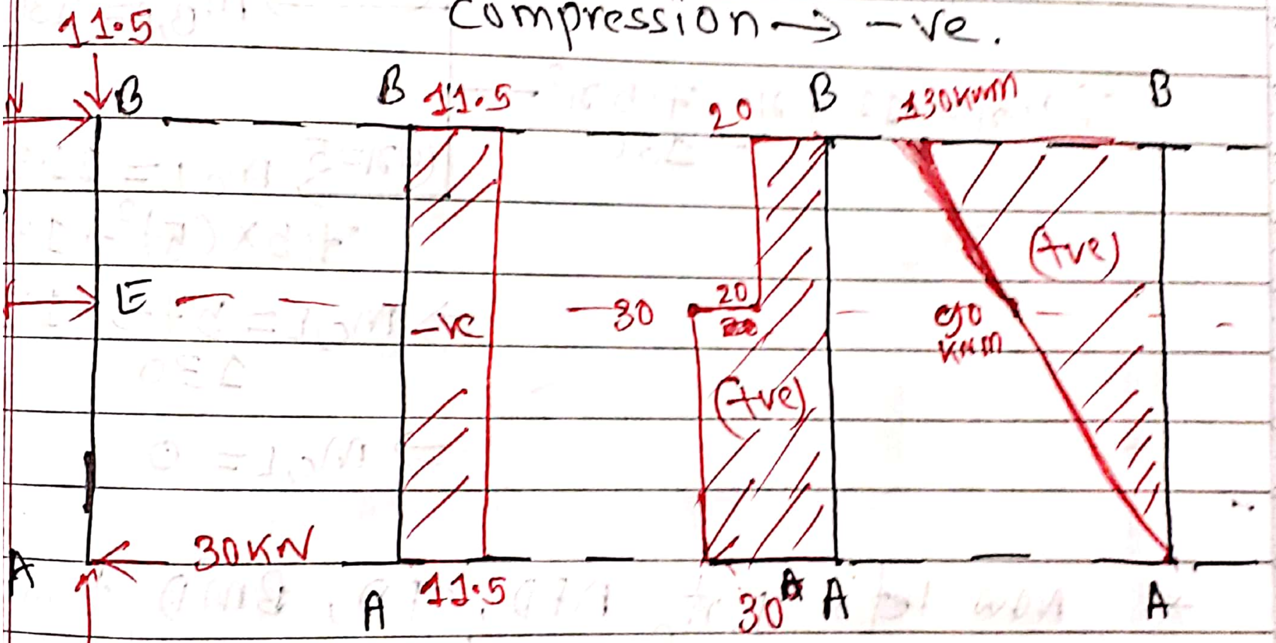
$M_x = 30(3+x) - 10x$

$\Rightarrow M_x = 90 + 30x - 10x = 90 + 20x$

$$M_x = 90 + 20x \begin{cases} @\,x=0 \rightarrow M_{E,R} = 90\text{ kNm} \\ @\,x=2,\ M_{B,L} = 90+40 \\ \qquad\qquad = 130\text{ kNm} \end{cases}$$

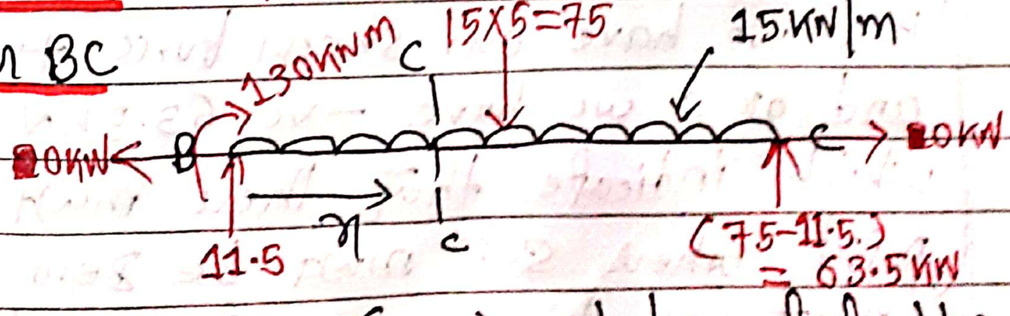
Let's plot AFD, SFD and BMD for member AB.

For AFD → tensile → +ve
compression → −ve.



AFD
(Compression −ve)

Member BC



Pass the section (C−C) and formulate the equation for shear force and Bending moment.

Note in member AB for ~~axial~~ which will be axial in member BC is already balanced.

$$V_x = 11.5 - 15x \begin{cases} @x=0 \rightarrow V_{B,R} = 11.5\,KN \\ @x=5 \rightarrow V_{C,L} = 11.5 - 15\times 5 \\ \Rightarrow V_{C,L} = -63.5\,KN \end{cases}$$

✓ moment at B that we found

$$M_x = 11.5x - 15\times x\times x/2 + 130$$

$$\Rightarrow M_x = 11.5x - 7.5x^2 + 130 \begin{cases} @x=0 \rightarrow M_{B,R} = 130\,KNm \\ @x=5 \rightarrow M_{C,L} = 11.5\times 5 - 7.5\times(5)^2 + 130 \\ \Rightarrow M_{C,L} = 57.5 - 187.5 + 130 \\ \Rightarrow M_{C,L} = 0 \end{cases}$$

Now let's plot AFD, SFD, BMD taking our sign convention into consideration.

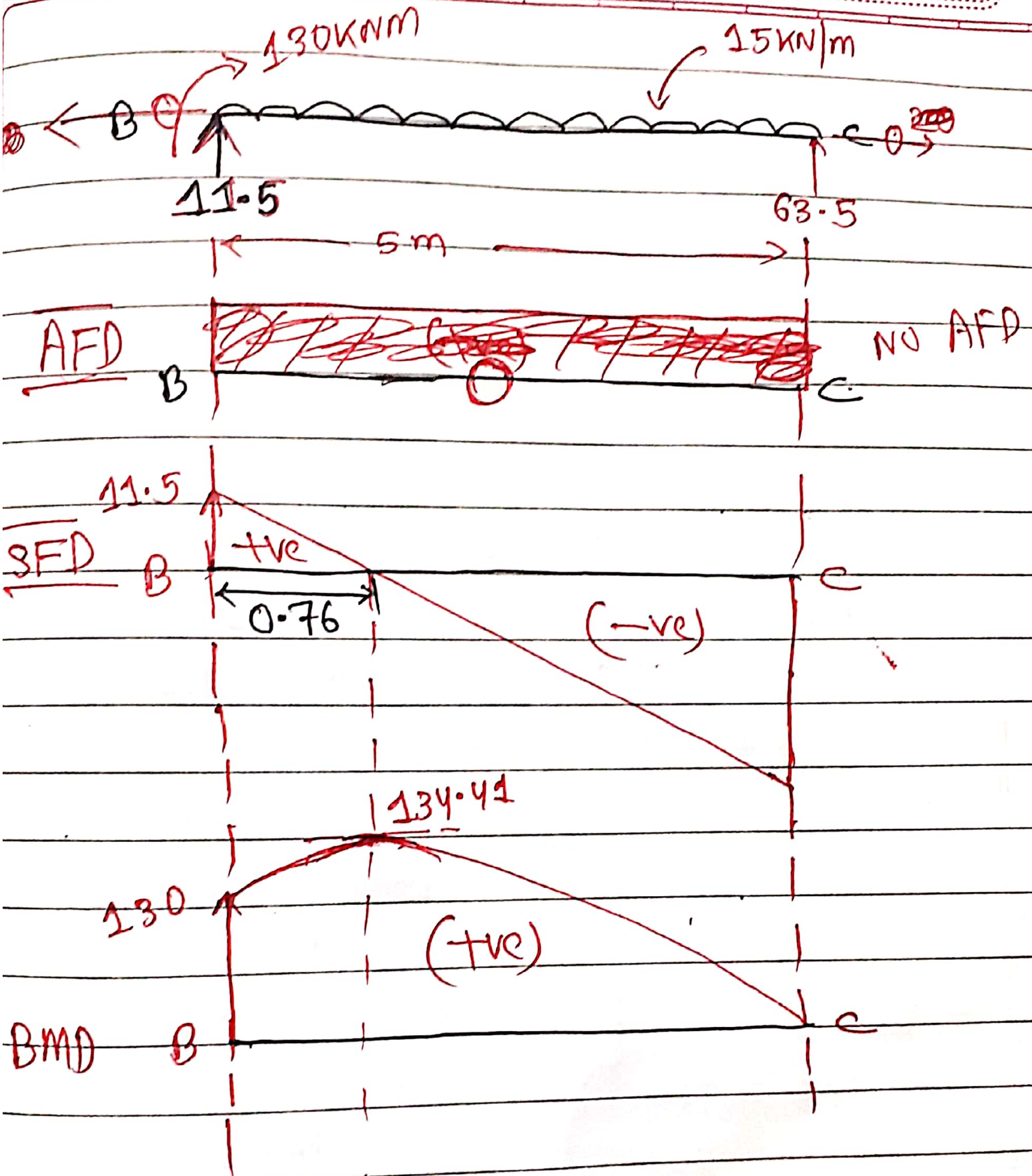
But before that see in the S.F value
Here we have our shear force +ve 11.5 at B and at C we have −ve 63.5KN shear force which indicates that there must be certain point where S.F must be zero and at that point Bending moment should be maximum

$\therefore$ point of zero shear $V_x = 11.5 - 15x = 0$

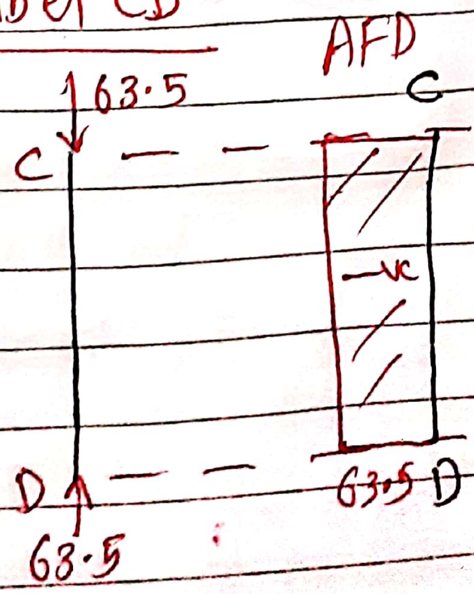
$\Rightarrow x = 11.5/15 \Rightarrow x = 0.76\,m$ from B

$\therefore (M)_{max} = 11.5(0.76) - 7.5(0.76)^2 + 130$

$\Rightarrow \boxed{(M)_{max} = 134.41\,KNm}$

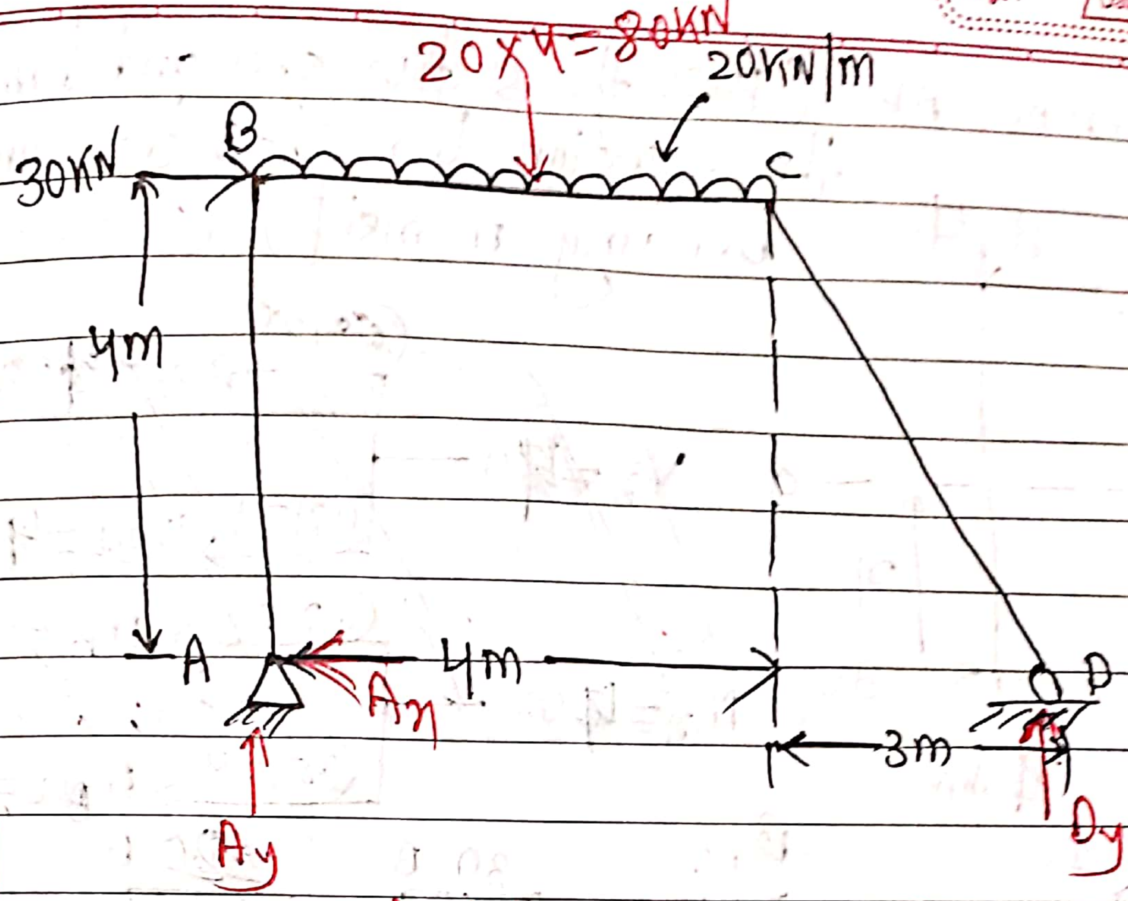


member CD



{Note:- No force in member CD to cause S.F and B.M.}

(8)



Step 1 :→ calculating the Reactions

$\Sigma F_x = 0$ (→ +ve)

$-A_x + 30 = 0$

$\Rightarrow \boxed{A_x = 30\,kN}$

$\Sigma F_y = 0$ (↑ +ve)

$A_y + D_y - 80 = 0$ —— (1)

$\Sigma M_A = 0$ (↻ +ve)

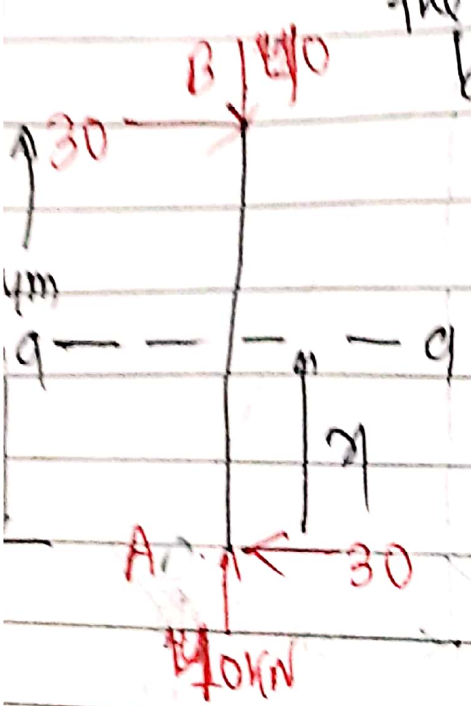
$30 \times 4 + 80 \times 2 - D_y \times 7 = 0$

$\Rightarrow \boxed{D_y = 40\,kN\,(\uparrow)}$

From eqn (1) ; $\Rightarrow A_y + 40 - 80 = 0$

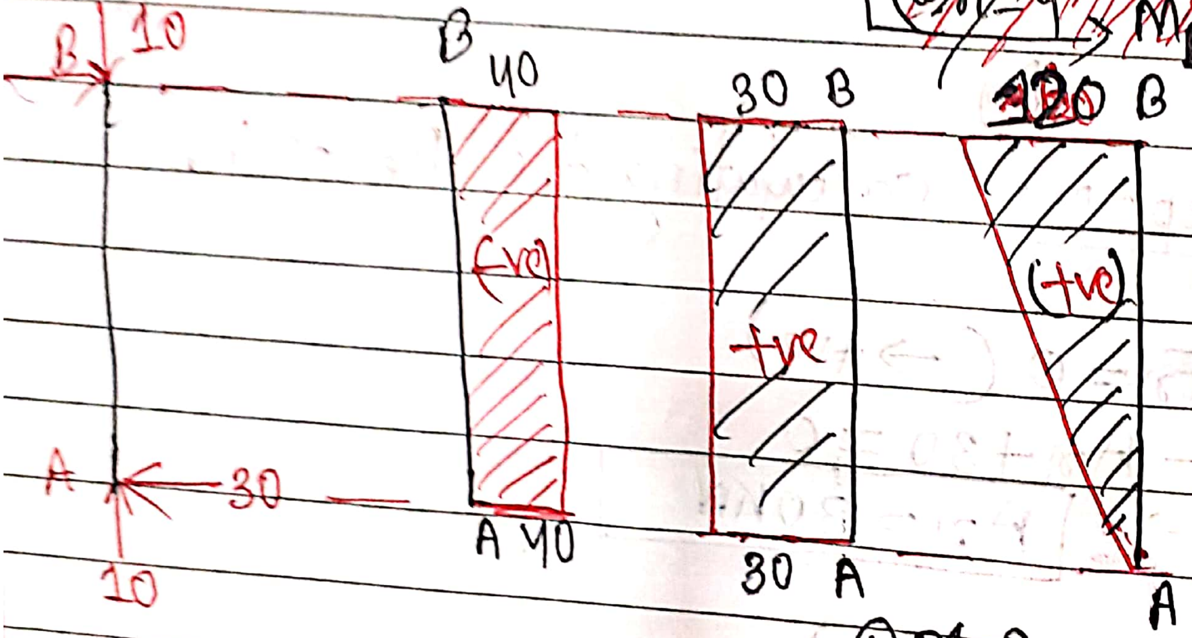
$\Rightarrow \boxed{A_y = 40\,kN}\ (\uparrow)$

Member AB (pass the section a-a and form up the equation for shear force and bending moment) $(0 \le x \le 4m)$



~~$V_x = 30$; @ $x=0$ → $V_A = 30KN$; @ $x=4$ → $V_{B,L} = 30KN$~~

~~$M_x = 30x$; @ $x=0$ → $M_A = 0$; @ $x=4$ → $M_{B,L} = 120KNm$~~

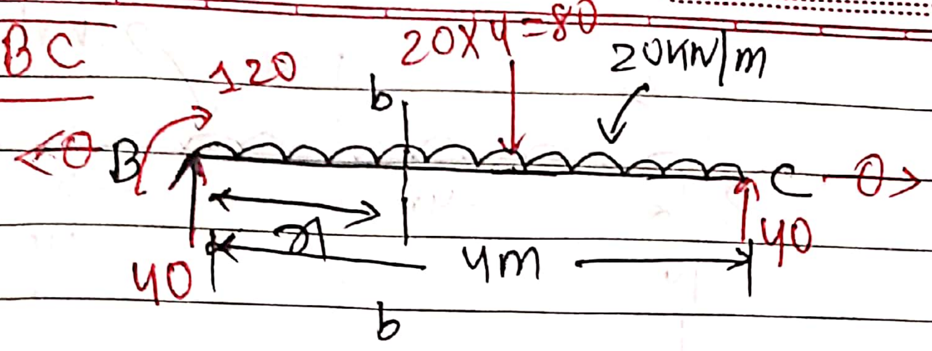


Member BC

$V_x = 30$
- @ $x=0$ → $V_A = 30KN$
- @ $x=4$ → $V_{B,L} = 30KN$

$M_x = 30x$
- @ $x=0$ → $M_A = 0$
- @ $x=4$ → $M_{B,L} = 120KNm$

Member BC



Pass the section (b-b) from B and form the equation for shear force and Bending moment interms of x.

$V_x = 40 - 20x$ → @ $x=0$ → $V_{B,R} = 40KN$; @ $x=4$ → $V_{C,L} = -40KN$

point of zero shear force

$\Rightarrow V_x = 40 - 20x = 0$

$\Rightarrow x = 2m$

$M_x = 40x - 20x \times \frac{x}{2} + 120$

$\Rightarrow M_x = 40x - 10x^2 + 120$

@ $x=0$ → $M_{B,R} = 0 + 120$

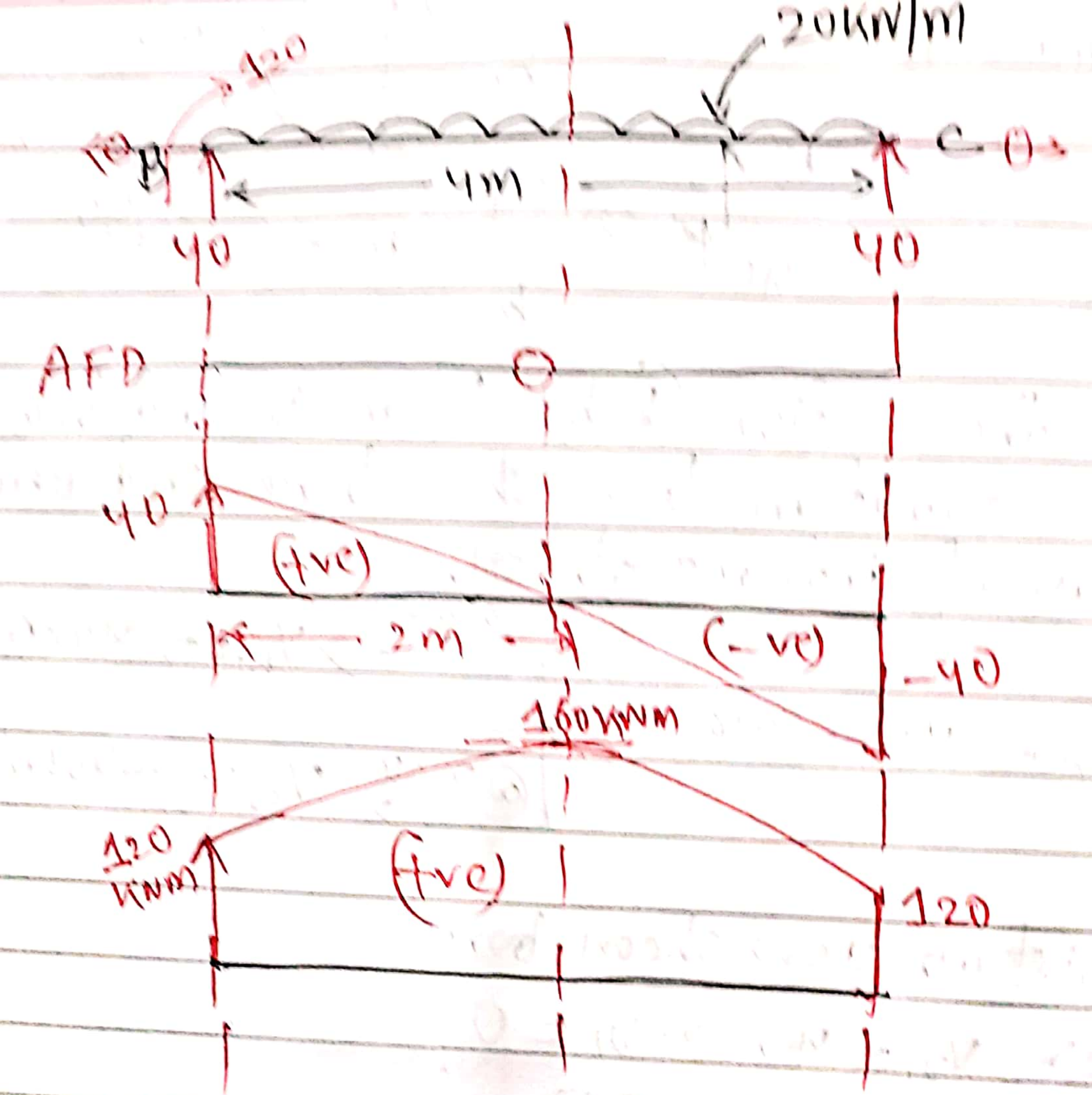
$\Rightarrow M_{B,R} = 120 KNm$

@ $x=4$ → $M_{C,L} = 40\times4 - 10(4)^2 + 120$

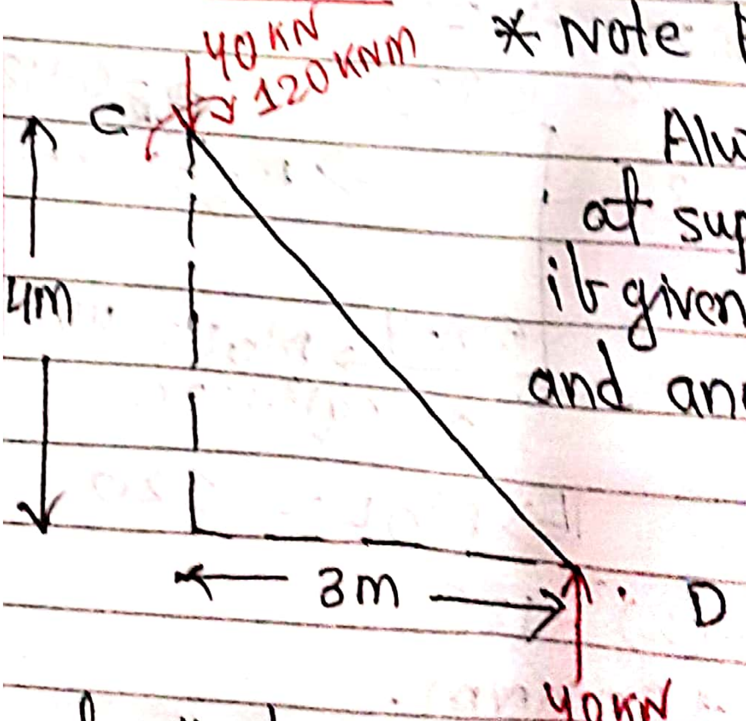
$\Rightarrow M_{C,L} = 120$

$(M)_{max} = 40\times2 - 10(2)^2 + 120$

$\Rightarrow (M)_{max} = 160 KNm.$



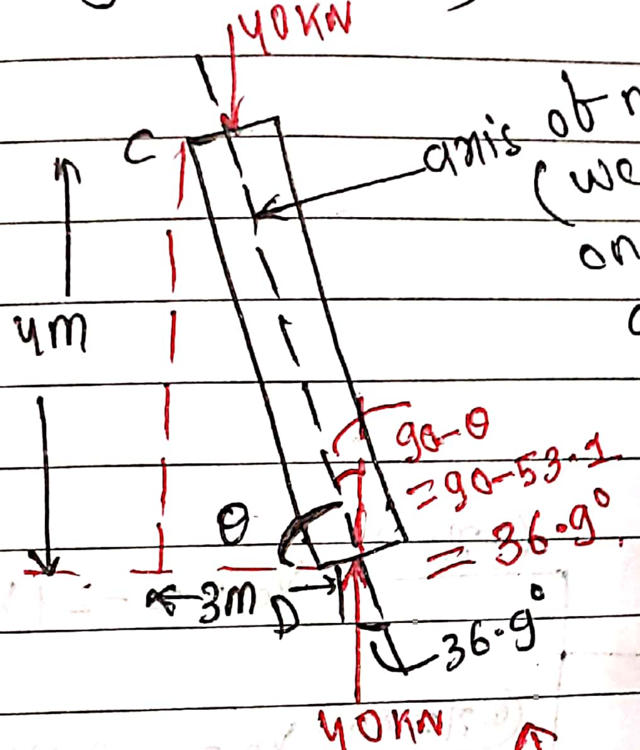
Member CD



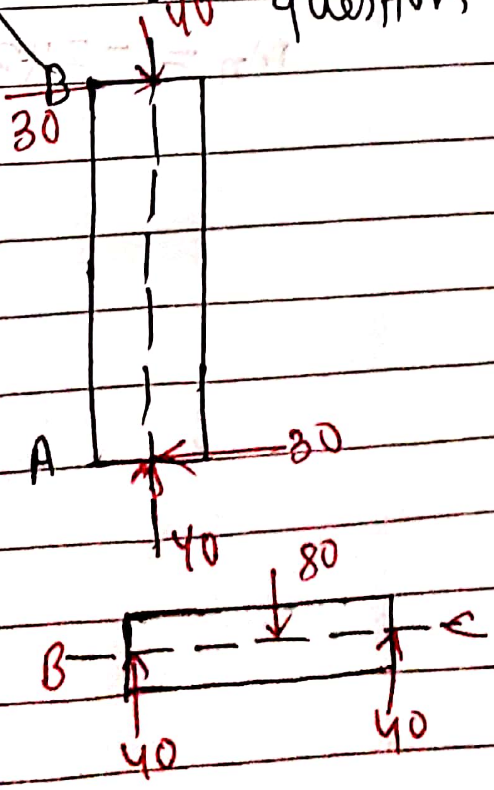
* Note for Inclined member
Always first resolved the forces at supports, ~~or~~ joints ~~or~~ and member if given along the axis of member and another perpendicular to it.
For given case we only have forces at joint (C) and support D
So we have to resolve both

length of member (CD) = $\sqrt{4^2+3^2} = 5m$

To make it more clean consider CD ~~mcb~~ member as shown in the figure below;



But for non-inclined member it's not required bcz we already have forces in such direction for Eg:- in give question



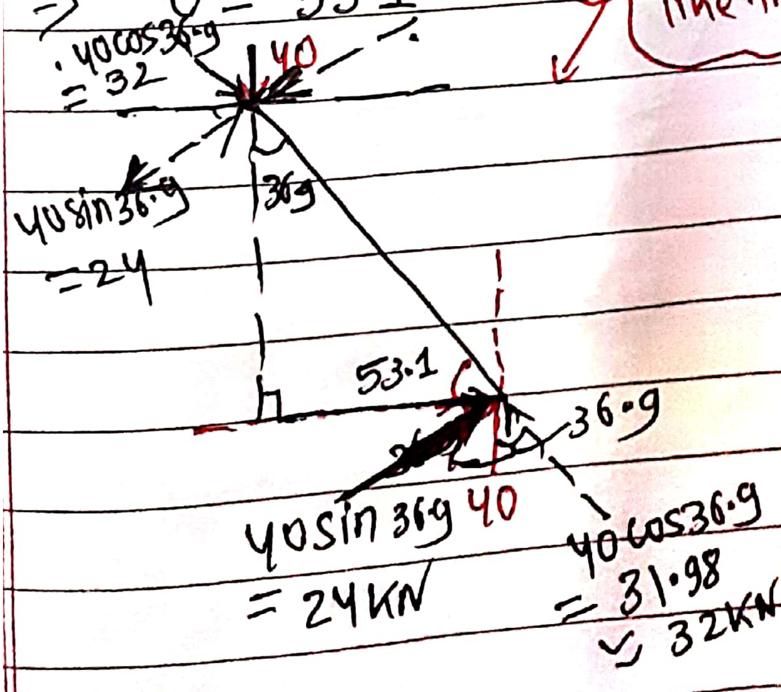
$\tan\theta = P/b = \frac{4}{3}$

$\Rightarrow \theta = \tan^{-1}(4/3)$

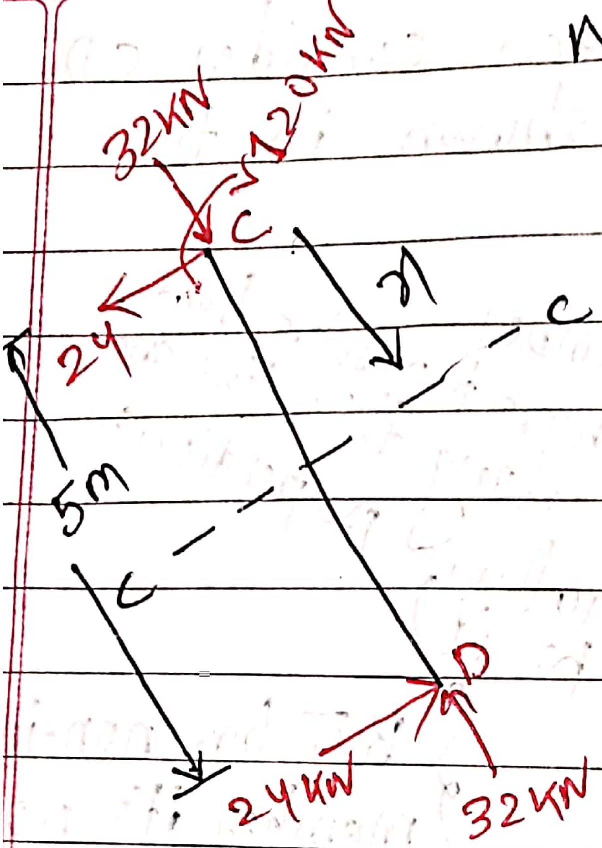
$\Rightarrow \theta = 53.1°$

This is just to explain

you show like this



Now pass the section c-c
and formulate the equation for
C – D.



$V_x = -24$
- @ $x=0$: $V_{C,R} = -24$ KN.
- @ $x=5m$: $V_D = -24$ KN

$M_x = -24x + 120$
- @ $x=0$: $M_{C,R} = 120$
- @ $x=5$: $M_D = -120 + 120 = 0$

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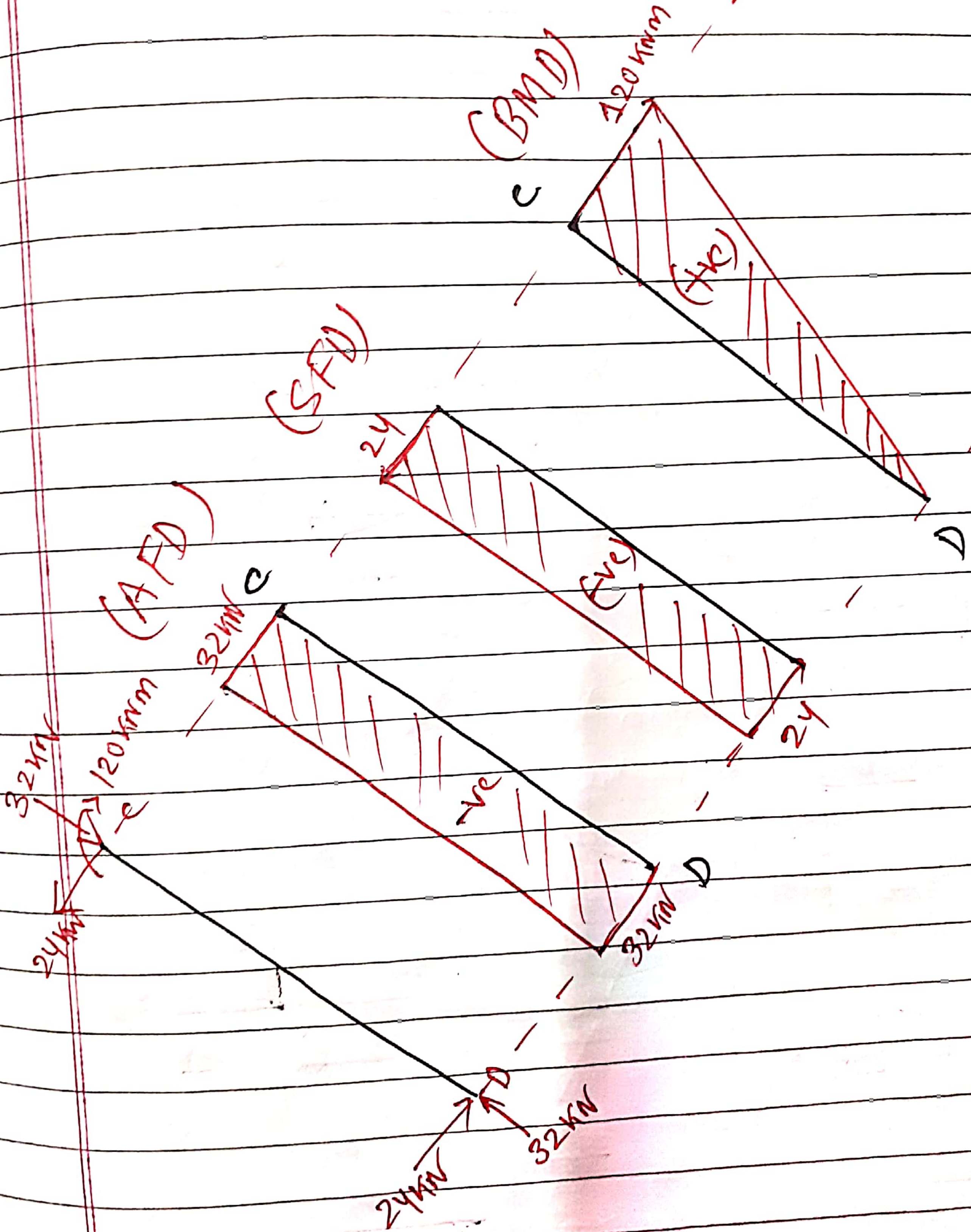
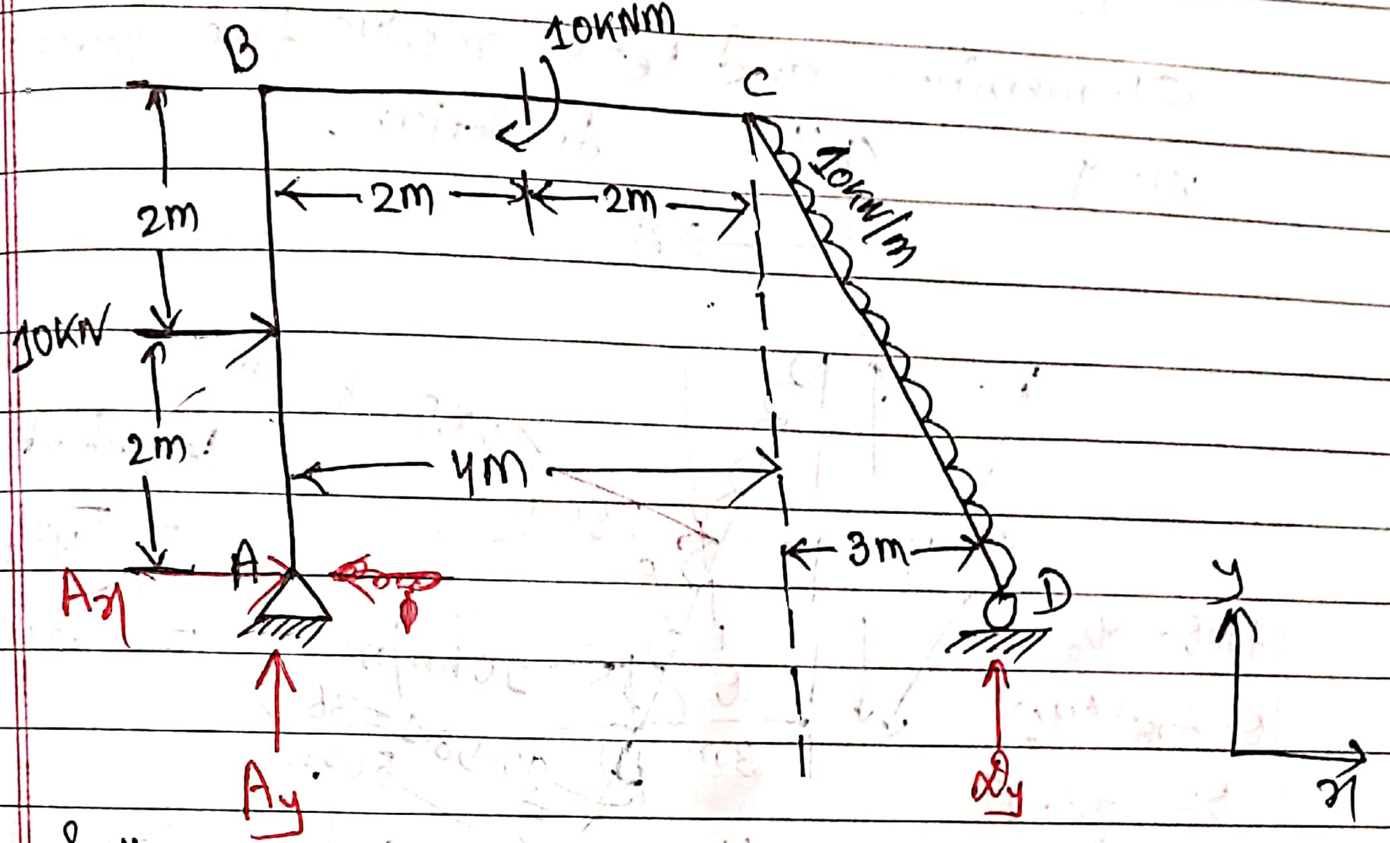

(BMD)
120 kNm
C
(+ve)
D
(SFD)
24
(-ve)
24
(AFD)
C
32 kN
-ve
D
32 kN
32 kN
120 kNm
C
24 kN
D
24 kN
32 kN

If UDL is acting on inclined member.

(8)



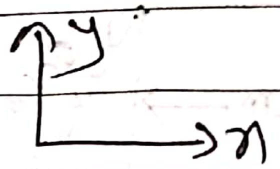
Soln

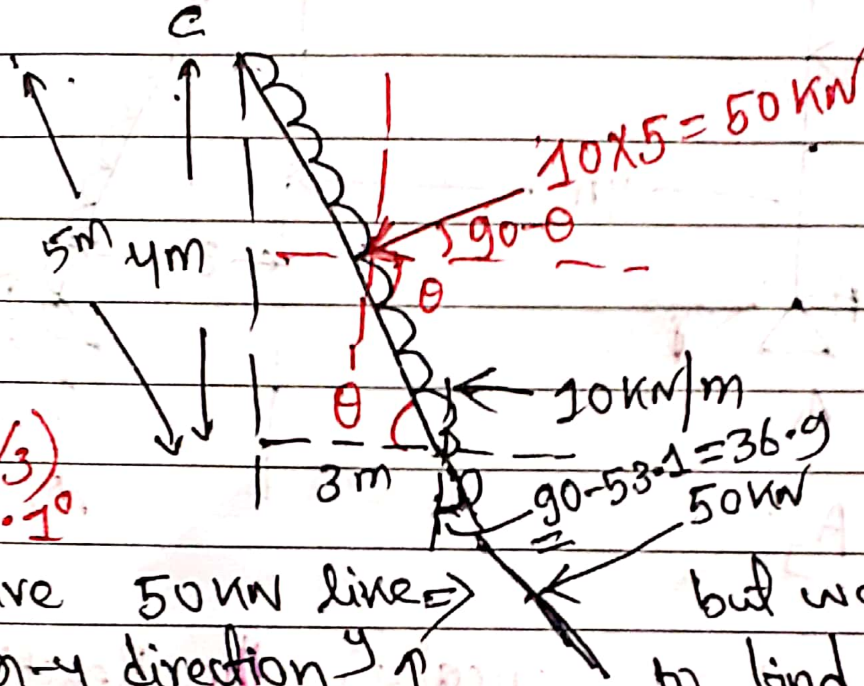
Step 1 :-> Calculating the Reactions.

This question is little tricky because here we have to resolve the Resultant of udl to horizontal and vertical components ~~bcoz~~ to find the reaction at supports because the resultant of this udl will be $\perp^r$ to the inclined member but to use the ΣF_x and ΣF_y equation we need forces parallel to A_x (ie in x-direction) and A_y, D_y (ie parallel to y-direction)

Or, you can see the Global co-ordinate system (ie $\overset{\uparrow y}{\longrightarrow x}$ and make all the forces in this direction)

To give you more insight let's just take CD member and let's resolve the forces in x-y direction.





$\tan\theta = 4/3$

$\theta = \tan^{-1}(4/3)$

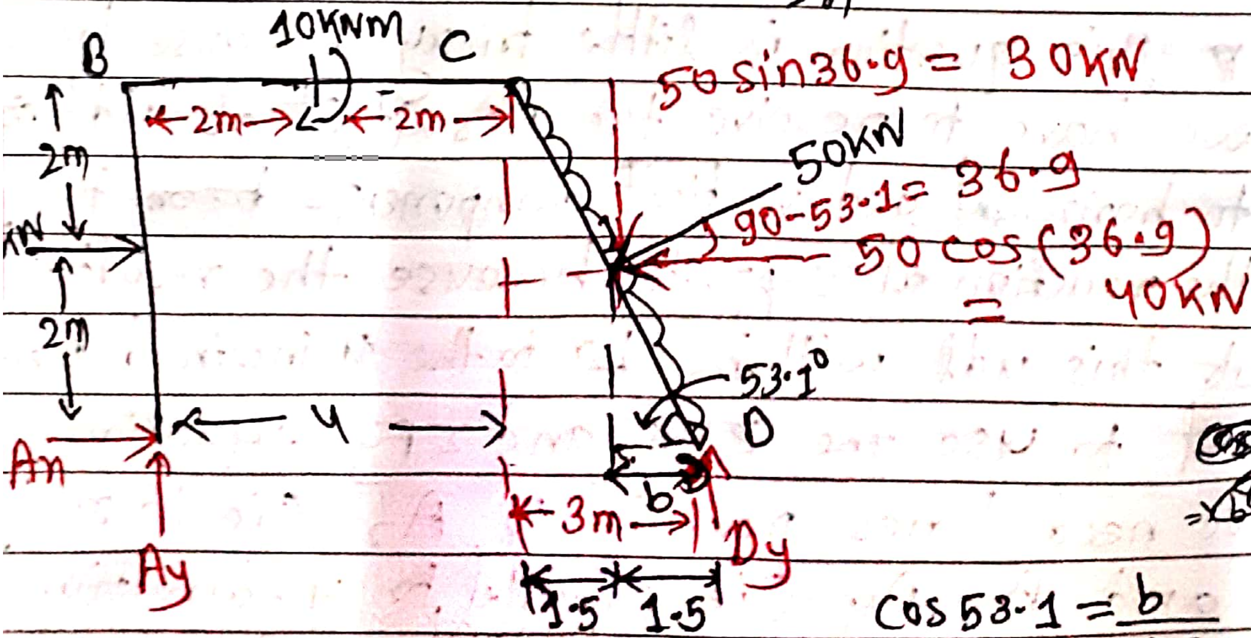
$\theta = 53.1^\circ$

length of CD

$= \sqrt{4^2+3^2}$

$= 5m.$

we have 50KN line ⇒ but we need force in x-y direction to find reactions so we have to resolve



$\cos 53.1 = \frac{b}{2.5}$

$\Rightarrow b = 2.5 \times \cos 53.1$

$\Rightarrow \boxed{b = 1.5m}$

$\Rightarrow \sum F_x = 0 \; (\rightarrow +ve)$

$A_x + 10 - 40 = 0$

$A_x - 30 = 0 \Rightarrow \boxed{A_x = 30\,kN}$

$\sum F_y = 0 \; (\uparrow +ve)$

$A_y + D_y - 30 = 0 \quad — (1)$

$\sum M_A = 0 \; \rightarrow (\text{Clockwise} +ve)$

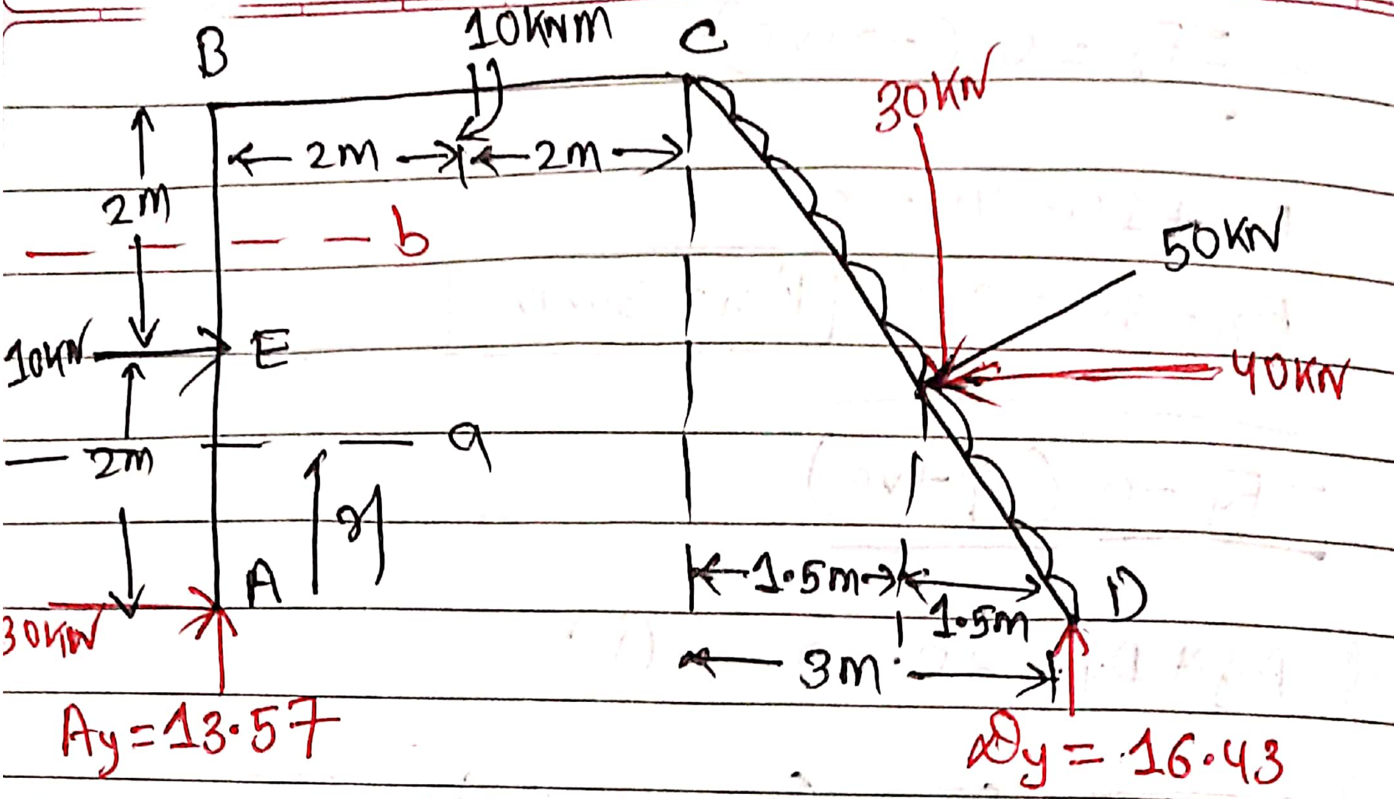
$10 \times 2 + 10 + 30(4 + 1.5) - 40 \times 2 - D_y \times 7 = 0$

$\Rightarrow \boxed{D_y = 16.43\,kN}$

From eqn (1)

$A_y + 16.43 - 30 = 0$

$\Rightarrow \boxed{A_y = 13.57\,kN}$



Step2:- Analysis of shear force and bending moment.

Member AB → pass the section (a-a) and (b-b) to form the S.F and B.m equation interms of x.

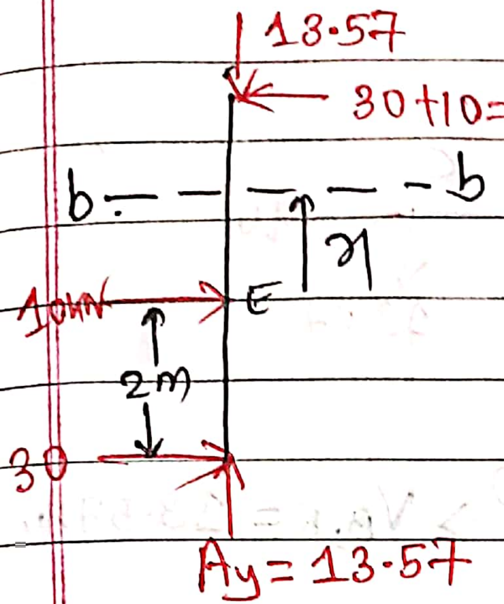
Span AE ($0 \le x \le 2m$)

$V_x = -30KN$
- @ $x=0$ → $V_A = -30KN$
- @ $x=2$ → $V_{E,L} = -30KN$

$M_x = -30x$
- @ $x=0$ → $M_A = 0$
- @ $x=2$ → $M_{E,L} = -60KN$

Scanned with CamScanner

Span (EB) $(0 \le x \le 2m)$



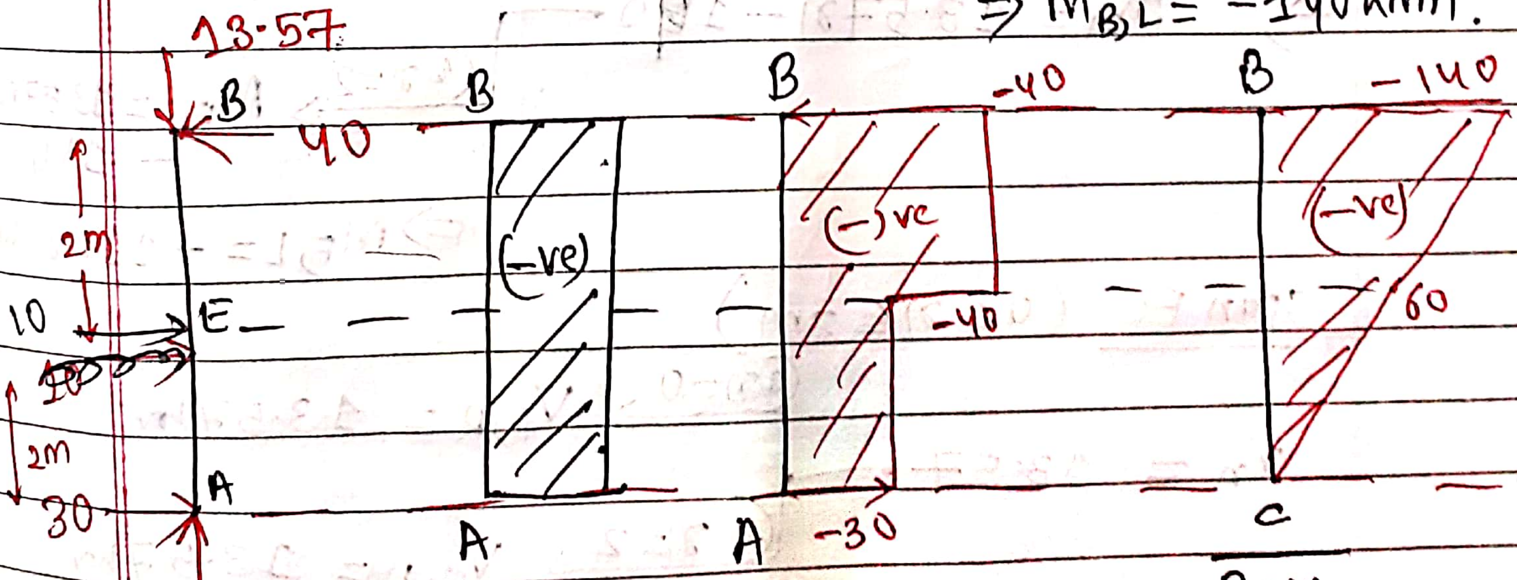
$$V_x = -30 - 10 = -40$$

$$\Rightarrow V_x = -40 \quad \begin{cases} @x=0, & V_{E,R} = -40 \\ @x=2, & V_{B,L} = -40 \end{cases}$$

$$M_x = -30(2+x) - 10x = -60 - 30x - 10x$$

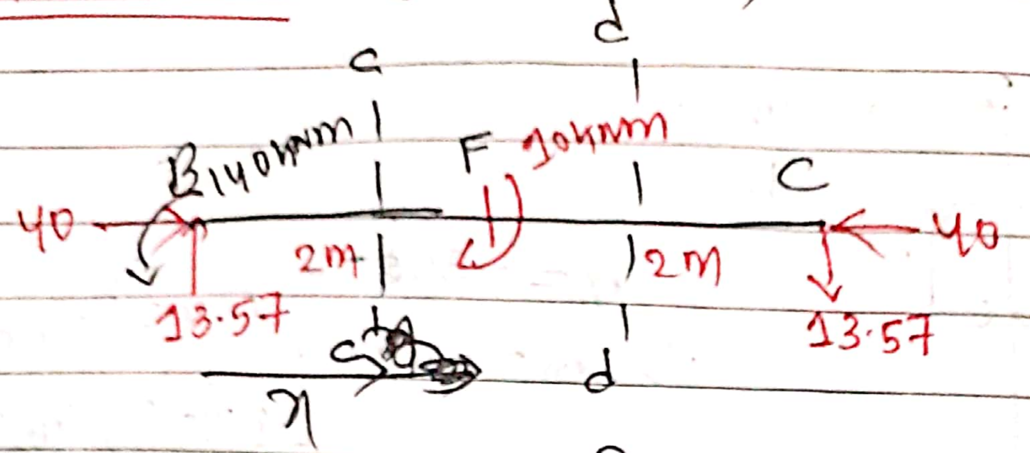
$$\Rightarrow M_x = -60 - 40x \quad \begin{cases} @x=0 \rightarrow & M_{E,R} = -60\,kNm \\ @x=2 \rightarrow & M_{B,L} = -60-80 \end{cases}$$

$$\Rightarrow M_{B,L} = -140\,kNm.$$



AFD SFD BMD

Member BC $(0 \le x \le 2) \rightarrow$ span BF



SP

$V_x = 13.57$ — @ $x=0$ $\rightarrow$ $V_{B,R} = 13.57$ kN
— @ $x=2$ $\rightarrow$ $V_{F,L} = 13.57$ kN

$M_x = 13.57x - 140$ — @ $x=0$ $\rightarrow$ $M_{B,R} = -140$

$\Rightarrow M_x = 13.57x - 140$ — @ $x=2$ $\rightarrow$ $M_{F,L} = 13.57 \times 2 - 140$

$\Rightarrow M_{F,L} = -112.86$ kNm

Span FC $(0 \le x \le 2m)$

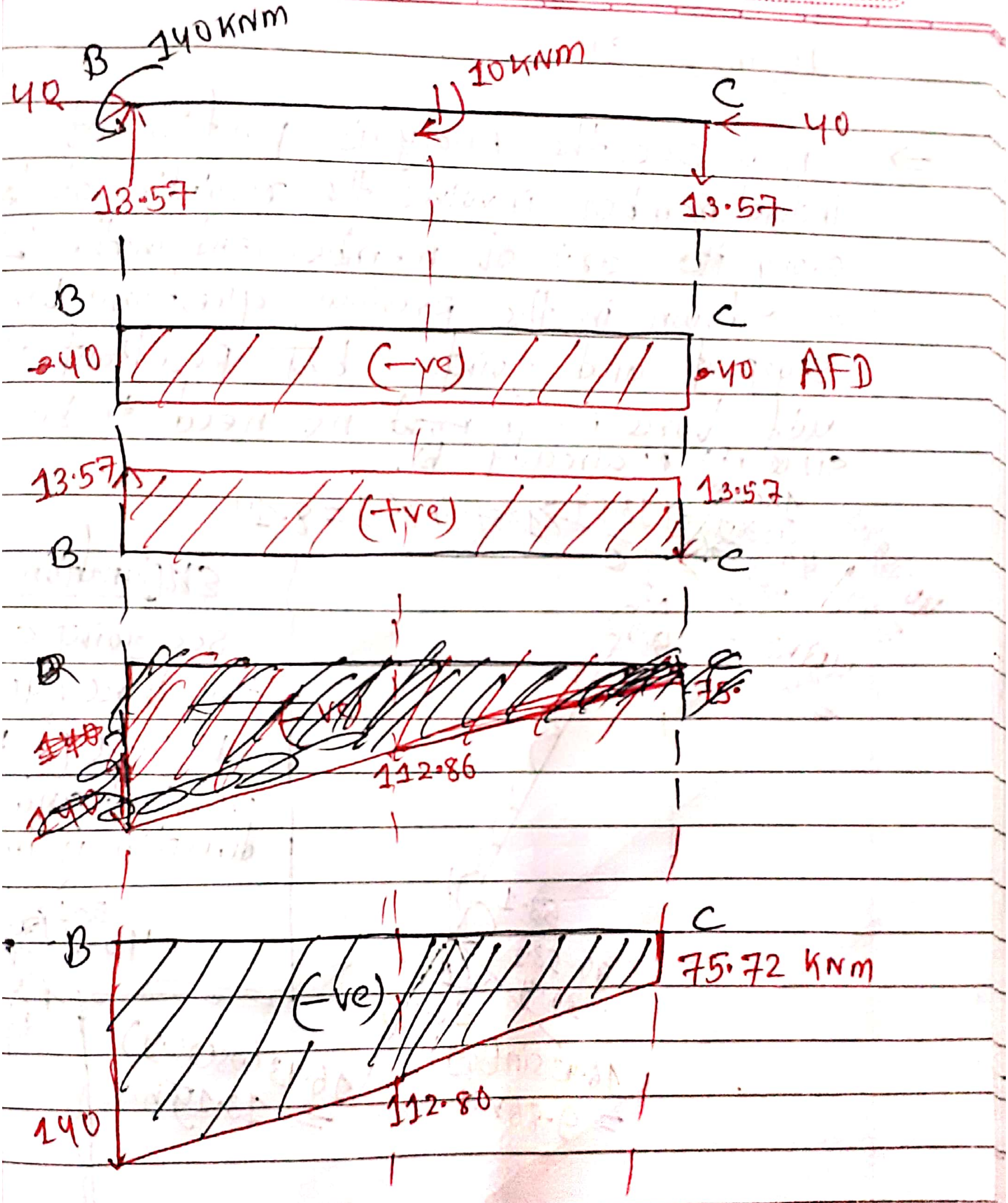
$V_x = 13.57$ — @ $x=0$ $\rightarrow$ $V_{F,R} = 13.57$ kN
— @ $x=2$ $\rightarrow$ $V_{C,L} = 13.57$ kN

$M_x = 13.57(2+x) + 10 - 140$

$= 27.14 + 13.57x - 130$

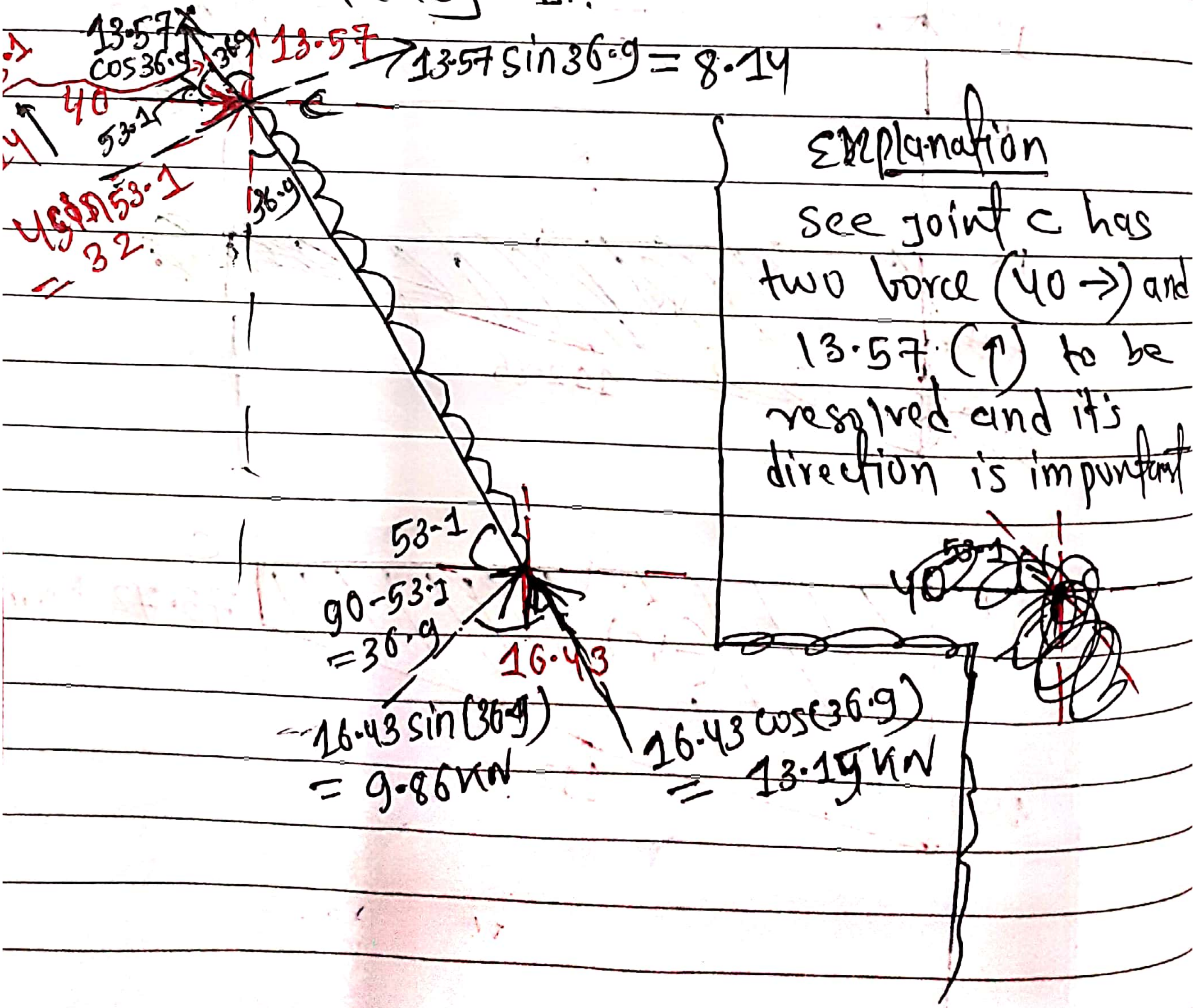
$= 13.57x - 102.86$ — @ $x=0$ $\rightarrow$ $M_{F,R} = -102.86$
— @ $x=2$ $\rightarrow$ $M_{C,L} = 13.57 \times 2 - 102.86$

$\Rightarrow M_{C,L} = -75.72$ kNm


B
140 KNm
10 KNm
40
C
40
13.57
13.57
B
C
-40
(-ve)
-40
AFD
13.57
(+ve)
13.57
B
C
140
112.86
75.
B
C
75.72 KNm
(-ve)
112.80
140

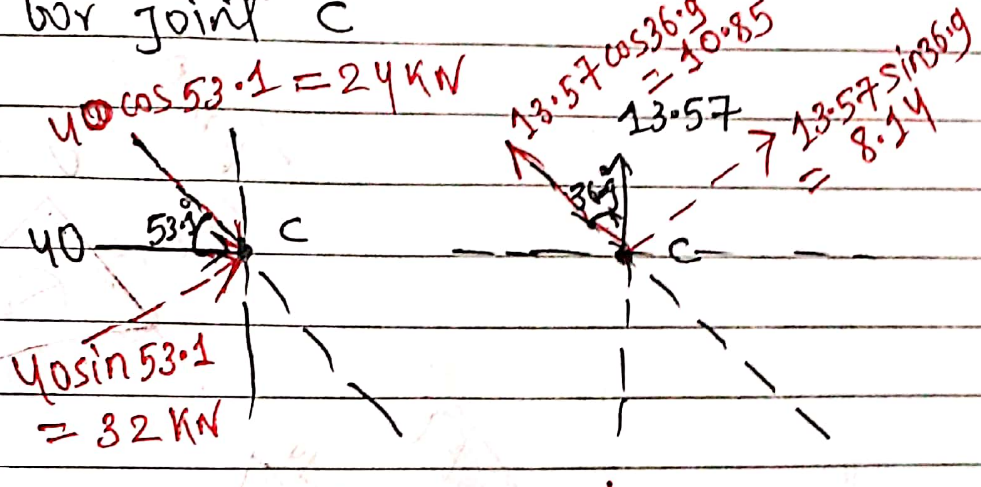
Member CD

Now see the Analysis portion of inclined member involves the resolution of forces along ~~its~~ axis of member and another br to it as down in the previous questions, bor the supports and joints but Resultant of udl force is in ~~...~~ no need to be resolved since it's already br.

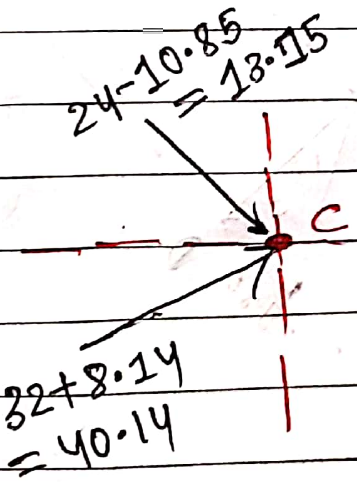


Explanation for Force Resolve

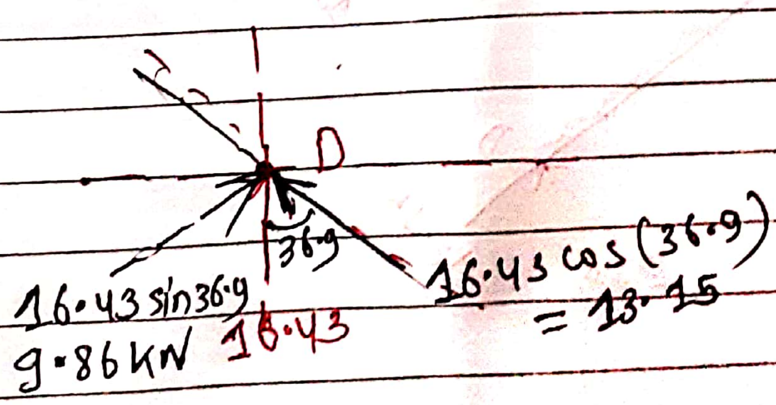
let see for joint C



we will take net of each of forces at joint C.



For ~~joint~~ support at D.



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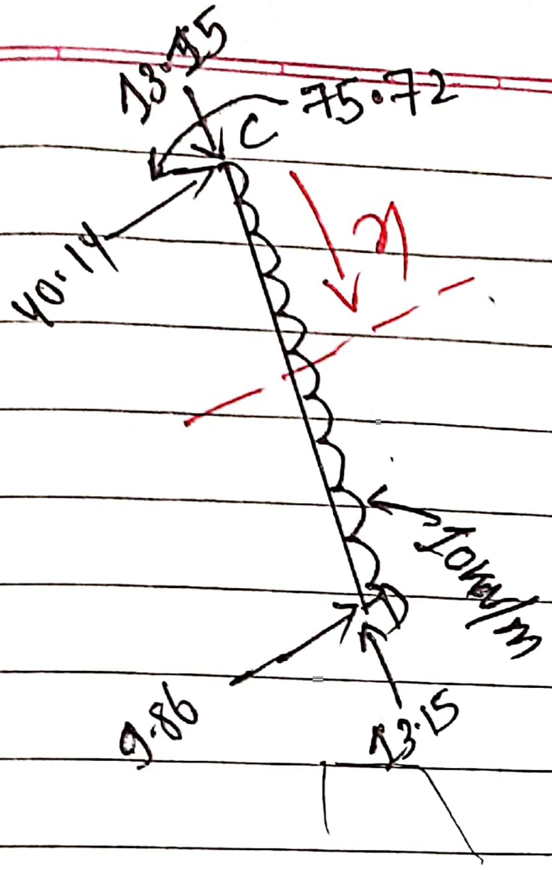


Member CD ($0 \le x \le 5m$)

$V_x = 40.14 - 10x$ ~~[illegible]~~

@ $x=0$ → $V_{C,R} = 40.14$

@ $x=5$ → $V_D = 40.14 - 50$

$\Rightarrow V_D = -9.86$

point of zero shear force

$\Rightarrow V_x = 40.14 - 10x = 0$

$\Rightarrow \boxed{x = 4.01m}$

$M_x = 40.14x - 75.72 - 10x \times x/2$

@ $x=0$ → $M_{C,R} = -75.72$

@ $x=5m$ → $M_D = 40.14 \times 5 - 75.72 - 5(5)^2$

$\Rightarrow$ ~~M_D~~

$\Rightarrow M_D = 200.7 - 75.72 - 125$

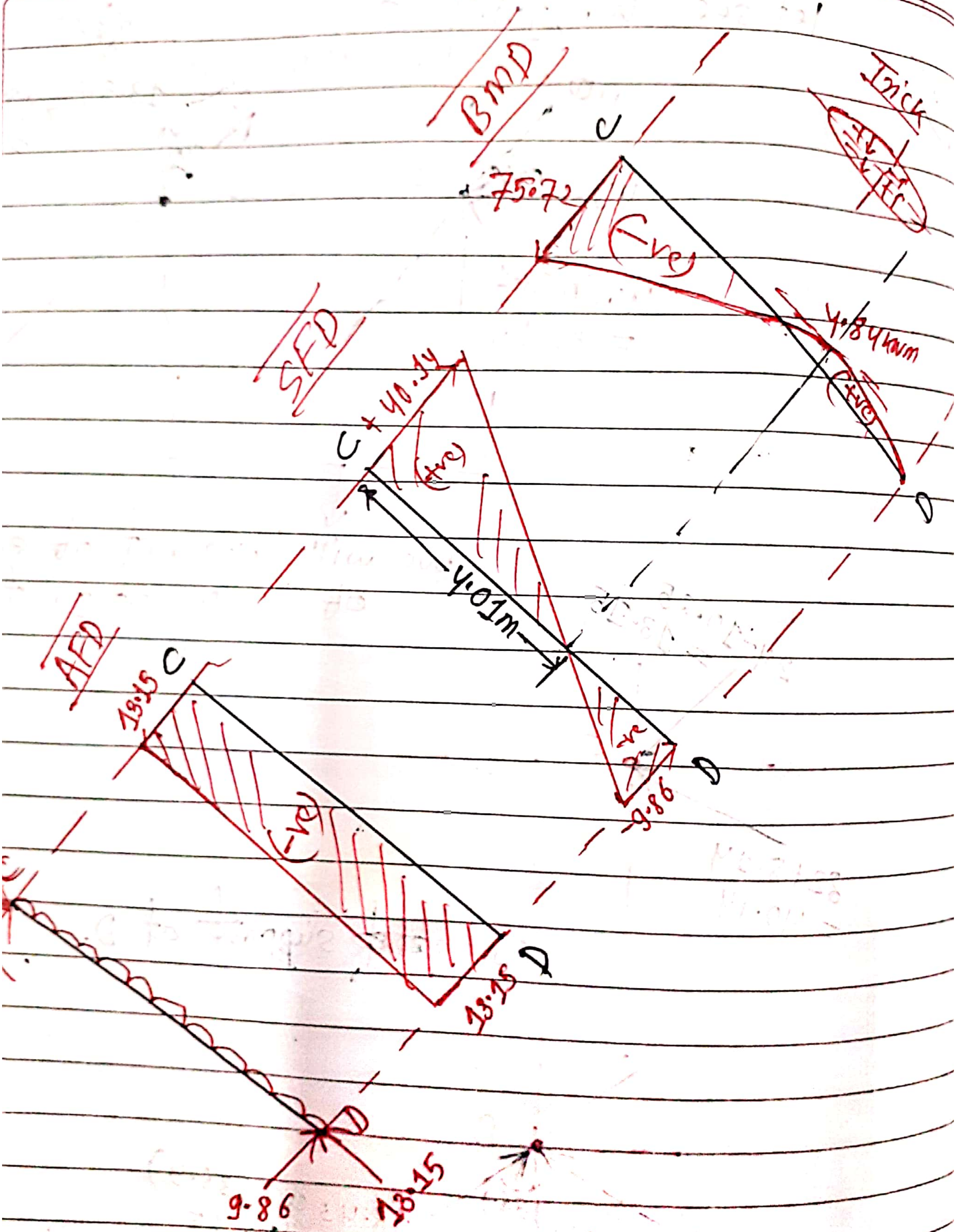
$\Rightarrow M_D =$ ~~[illegible]~~ $\simeq 0$

@ $x = 4.01$

$(M)_{max} = 40.14 \left(\cancel{4.01} \; 4.01\right) - 75.72 - 5(4.01)^2$

$\Rightarrow (M)_{max} = 161.12 - 75.72 - 80.56$

$\Rightarrow (M)_{max} = 4.84$ KNm.


BMD
C
75.72
(-ve)
4.84 kNm
(+ve)
D
Trick
SFD
C
+40.54
(+ve)
4.01m
(-ve)
-9.86
D
AFD
C
13.15
(-ve)
13.15
D
D
9.86
13.15