Carleton University

Department of
Civil & Environmental
Engineering

CIVE3203
Introductory Structural Analysis

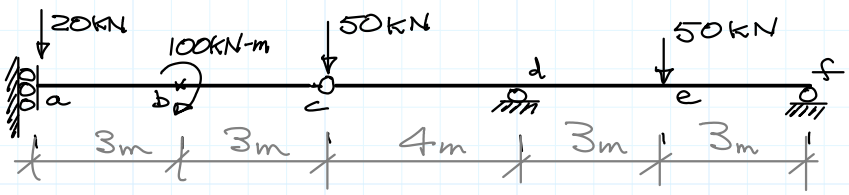
Assignment HW#1
Oct. 4, 2019
Solution

#pages: 10+ cover

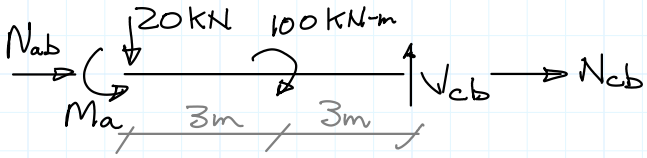
N. M. Hoff

Oct 7/2019

Problem 1



FBD abc



$\Sigma M_c = 0 \quad +\circlearrowleft$

$-20 \times 6 + 100 - M_a = 0 \qquad [kN, m]$

$M_a = -20\,kN\text{-}m \quad (\therefore \circlearrowright)$

$\Sigma F_y = 0 \quad +\uparrow$

$-20\,kN + V_{cb} = 0$

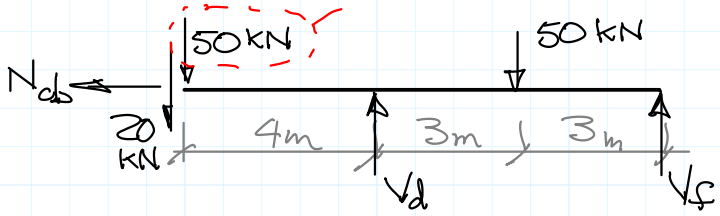
$V_{cb} = 20\,kN \quad (\therefore \uparrow)$

$\Sigma F_x = 0 \quad +\rightarrow$

$N_{ab} = -N_{cb}$

Note: this 50kN load must appear on this FBD or on one above. Not both.

FBD cdef



$\Sigma F_x = 0 \quad +\rightarrow$

$N_{cb} = 0 \quad \therefore \quad N_{ab} = 0$

$\Sigma M_f = 0 \quad +\circlearrowleft$

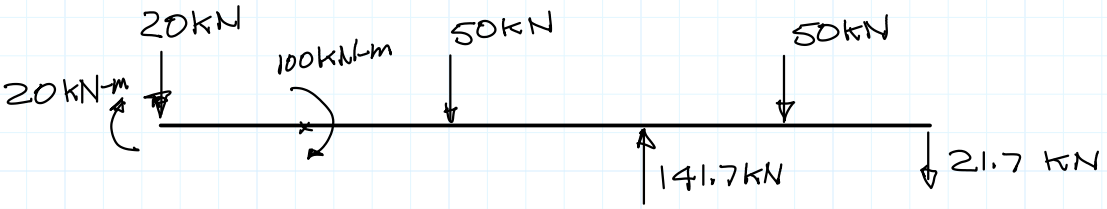
$-20 \times 10 - 50 \times 10 + V_d \times 6 - 50 \times 3 = 0$

$V_d = 141.7\,kN \quad (\therefore \uparrow)$

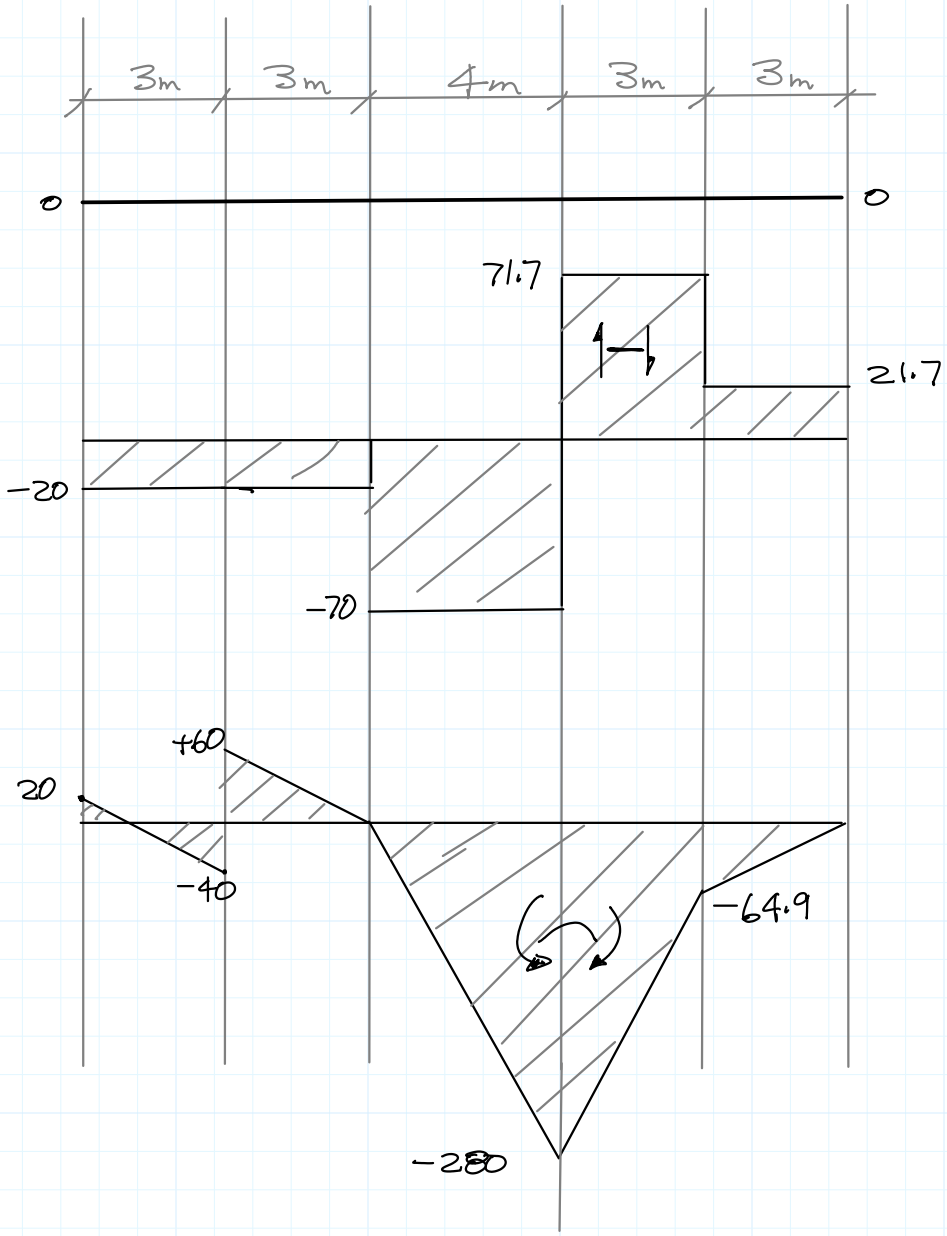
$\Sigma F_y = 0 \quad +\uparrow$

$-20 - 50 - 50 + 141.7 + V_f = 0$

$V_f = -21.7\,kN \quad (\therefore \downarrow)$



FBD



N

V [kN]

M [kN-m]

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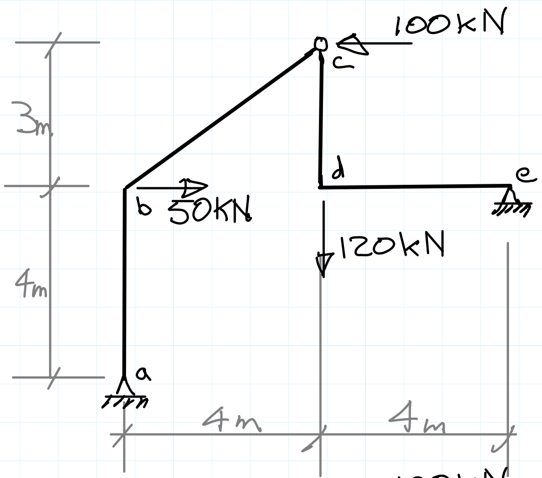
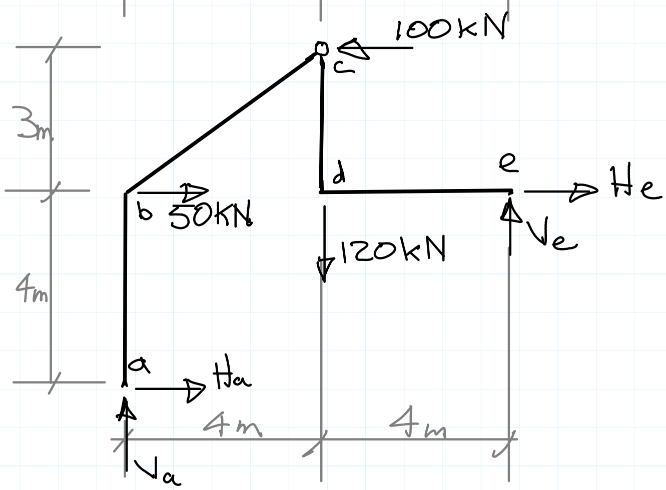
Problem 2



FBD 1

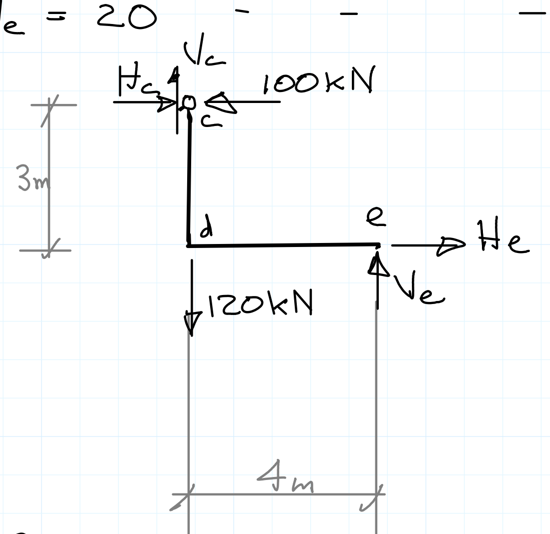


$\Sigma M_a = 0$ (+)

$50 \times 4 - 100 \times 7 + 120 \times 4 + H_e \times 4 - V_e \times 8 = 0$

$4H_e - 8V_e = 20$ — — — — — — — 1)

FBD 2



$\Sigma M_c = 0$ (+)

$-3H_e - 4V_e = 0$

$V_e = -\frac{3}{4} H_e$

from eq.1)

$$4H_e - 8\left(-\frac{3}{4}H_e\right) = 20$$

$$10H_e = 20$$

$$\underline{H_e = 2\ kN} \quad (\therefore \rightarrow)$$

$$V_e = -\frac{3}{4}H_e$$

$$V_e = -\frac{3}{4} \times 2$$

$$V_e = -1.5\ kN \quad (\therefore \downarrow)$$

From FBD 1:

$$\Sigma F_x = 0 \ \pm\rightarrow$$

$$H_a + 50 - 100 + H_e = 0$$

$$H_a = 100 - 50 - 2$$

$$\underline{H_a = 48\ kN} \quad (\therefore \rightarrow)$$

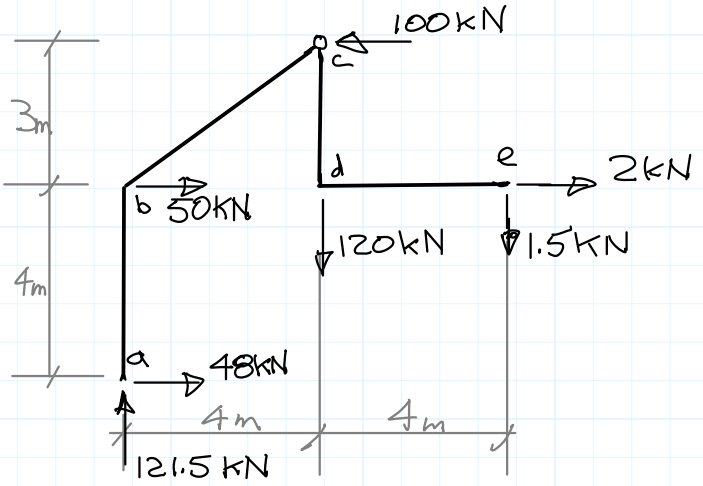
$$\Sigma F_y = 0 \ +\uparrow$$

$$V_a - 120 + V_e = 0$$

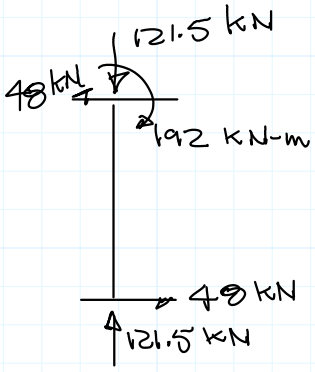
$$V_a = 120 + 1.5$$

$$\underline{V_a = 121.5\ kN} \quad (\therefore \uparrow)$$

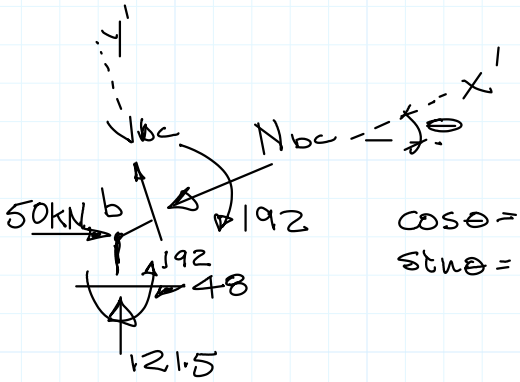
FBD:



member a-b



joint b



$\cos\theta = 0.8$

$\sin\theta = 0.6$

$\Sigma F_{x'} = 0$ $\nearrow +$

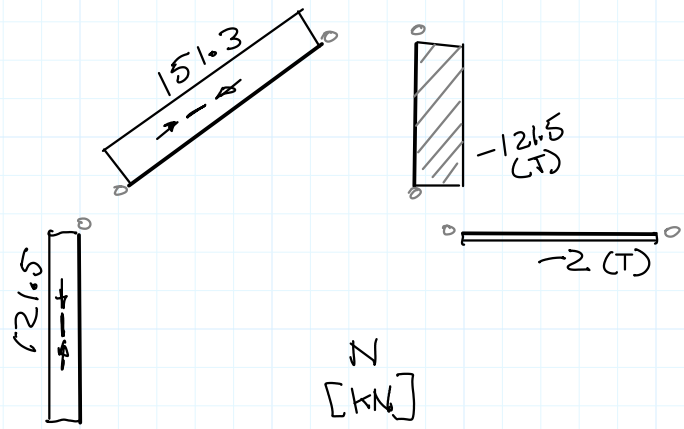
$-N_{bc} + 48\times0.8 + 121.5\times0.6 + 50\times0.8$

$N_{bc} = 151.3$ (C ←)

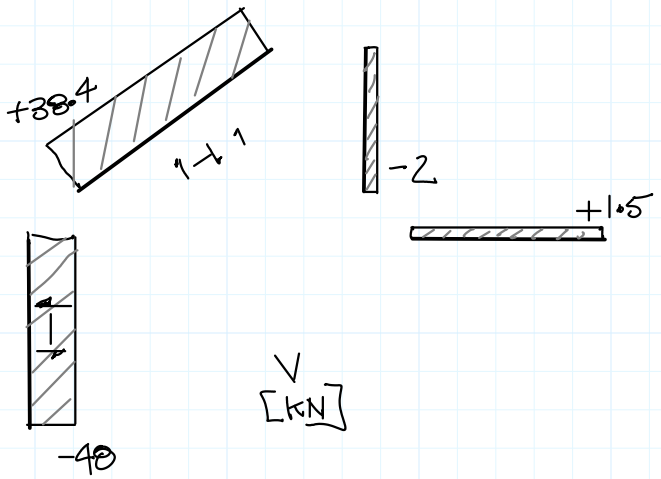
$\Sigma F_{y'} = 0$ $+\nwarrow$

$V_{bc} - 48\times0.6 + 121.5\times0.8 - 50\times0.6 = 0$

$V_{bc} = -38.4$ kN (C ↘)

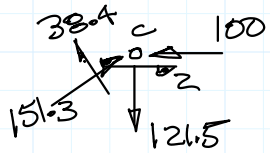


N [kN]



V [kN]

check joint c

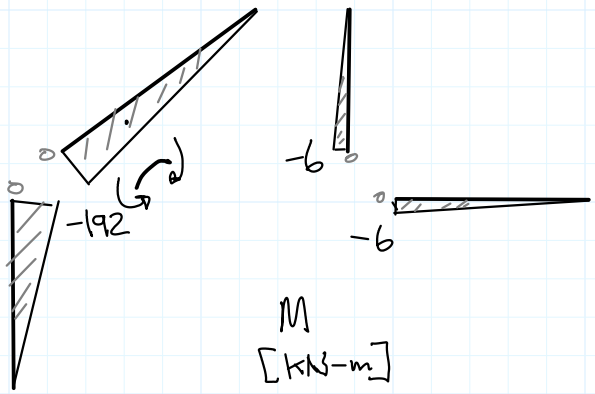


$\Sigma F_x = -100 + 2 + 151.3\times0.8 - 38.4\times0.6$

$= 0$ O.K.

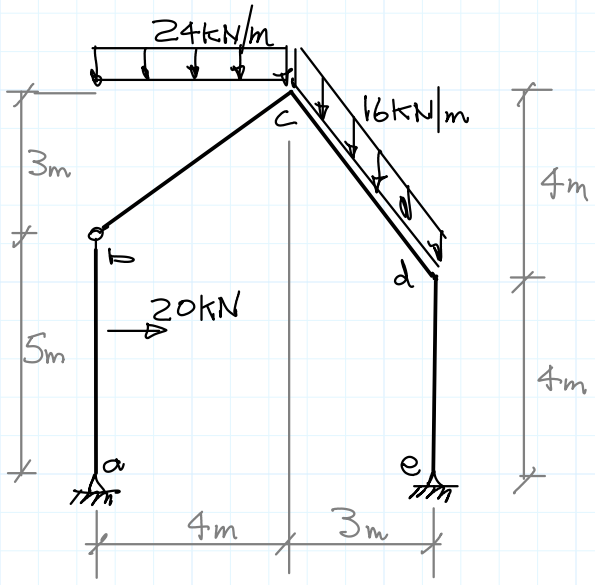
$\Sigma F_y = -121.5 + 38.4\times0.8 + 151.3\times0.6$

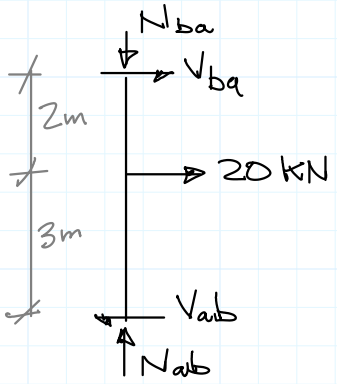
$= 0$ O.K.



M [kN-m]

Problem 3





FBD a-b

$\sum M_b = 0 \ (+)$

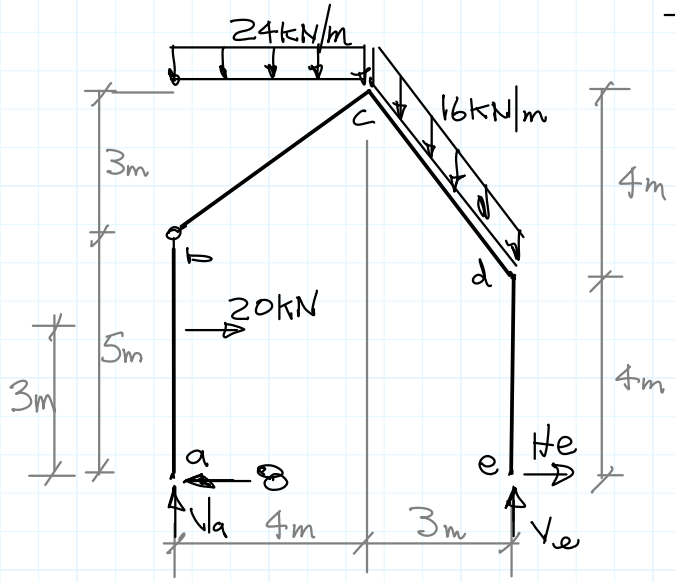
$-20 \times 2 + V_{ab} \times 5 = 0$

$V_{ab} = 8\ kN \ (\therefore \leftarrow)$

$\sum F_x = 0 \ \rightarrow +$

$V_{ba} + 20 - 8 = 0$

$V_{ba} = -12 \ (\therefore \leftarrow)$



$\sum M_e = 0 \ (+)$

$20 \times 3 - 24 \times 4 \times 5 - 16 \times 5 \times 1.5 + V_a \times 7 = 0$

$V_a = 77.14\ kN \ (\therefore \uparrow)$

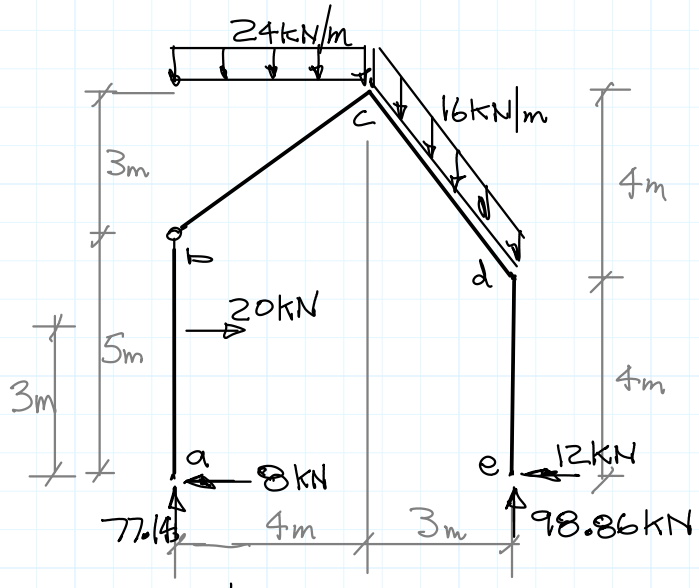
$\sum F_y = 0 \ +\uparrow$

$77.14 - 24 \times 4 - 16 \times 5 + V_e = 0$

$V_e = 98.86$

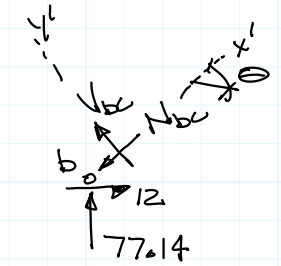
$\sum F_x = 0 \ \rightarrow +$

$H_e = -12 \ (\therefore \leftarrow)$



FBD Summary

joint b



$\cos\theta = 0.8$

$\sin\theta = 0.6$

$\Sigma F_{x'} = 0$ +↗

$-N_{bc} + 12 \times 0.8 + 77.14 \times 0.6 = 0$

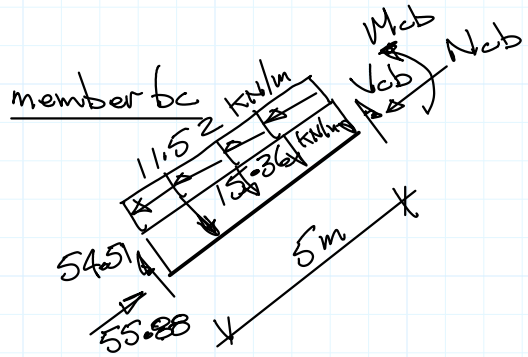
$N_{bc} = 55.88$ (∴ C)

$\Sigma F_{y'} = 0$ +↖

$V_{bc} + 77.14 \times 0.8 - 12 \times 0.6 = 0$

$V_{bc} = -54.51$ kN (∴ ↓)

member bc



$\perp$ comp = $24\frac{kN}{m} \times 4m \times 0.8 = 15.36\frac{kN}{m}$

$\parallel$ comp = $24\frac{kN}{m} \times 4m \times 0.6 = 11.52\frac{kN}{m}$

$V_{cb} = 15.36 \times 5 - 54.51 = 22.29$ kN

$\Sigma F_{x'} = 0$ +↗

$55.88 - 11.52 \times 5 - N_{cb} = 0$

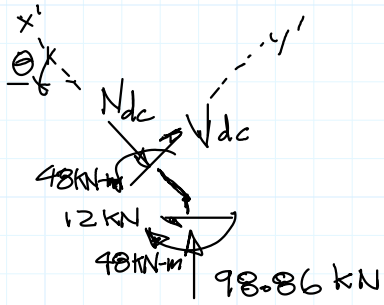
$N_{cb} = -1.72$ (∴ T)

$\Sigma M_c = 0$ +↻

$54.51 \times 5 - 15.36 \times 5 \times 2.5 - M_{cb} = 0$

$M_{cb} = 80.55$ kN-m (∴ ↻)

joint d



$\cos\theta = 0.6$
$\sin\theta = 0.8$

$\Sigma F_{x'} = 0 \quad +\nearrow$

$-N_{dc} + 12 \times 0.6 + 98.86 \times 0.8 = 0$

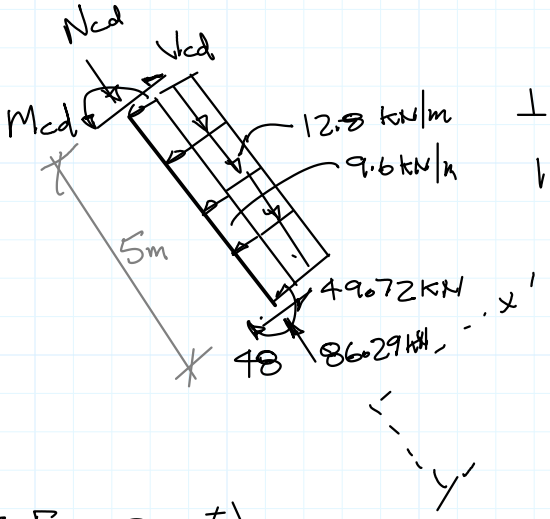
$N_{dc} = 86.29 \text{ kN} \quad (\therefore C)$

$\Sigma F_{y'} = 0 \quad +\nearrow$

$V_{dc} - 12 \times 0.8 + 98.86 \times 0.6 = 0$

$V_{dc} = -49.72 \text{ kN} \quad (\therefore \swarrow)$

member cd



$\perp \text{comp} = 16 \times \frac{5}{5} \times 0.6 = 9.6 \text{ kN/m}$

$\parallel \text{comp} = 16 \times \frac{5}{5} \times 0.8 = 12.8 \text{ kN/m}$

$\Sigma F_{y'} = 0 \quad +\searrow$

$-86.29 + 12.8 \times 5 + N_{cd} = 0$

$N_{cd} = 22.29 \quad (\therefore C)$

$\Sigma F_{x'} = 0 \quad +\nearrow$

$49.72 - 9.6 \times 5 + V_{cd} = 0$

$V_{cd} = -1.72 \quad (\therefore \nwarrow)$

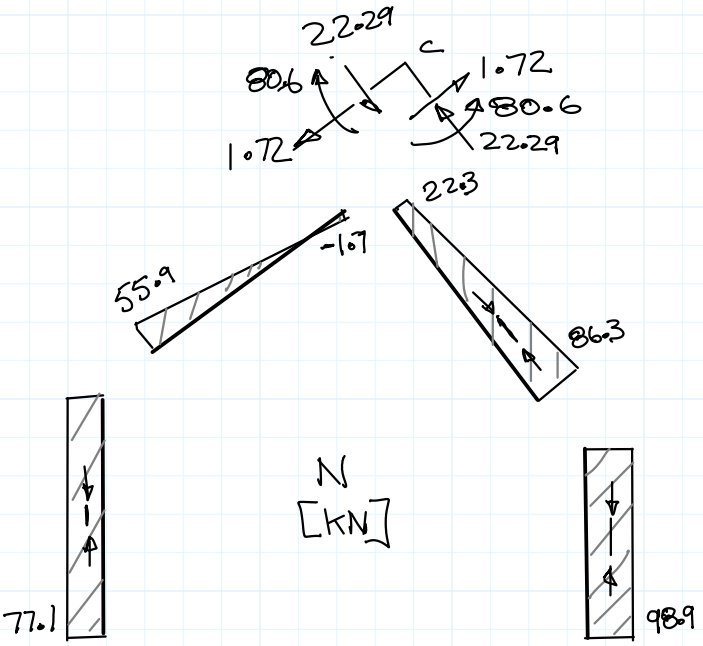
$\Sigma M_c = 0 \quad +\circlearrowleft$

$-M_{cd} + 9.6 \times 5 \times 2.5 - 49.72 \times 5 + 48 = 0$

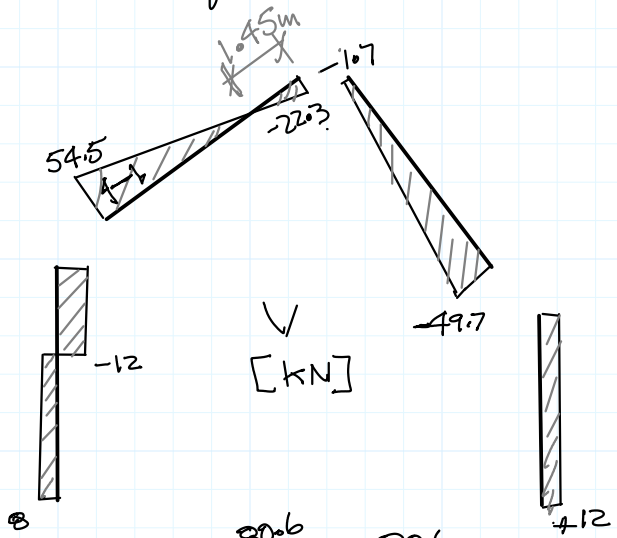
$M_{cd} = -80.6 \text{ kN-m}$

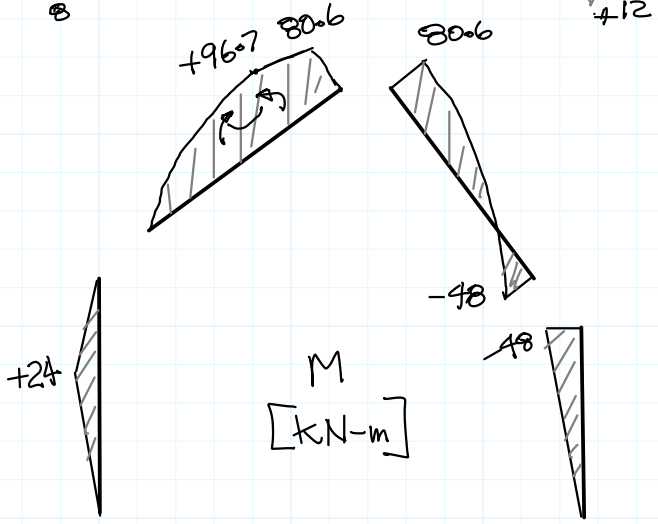
$(\therefore \circlearrowright)$

Check joint C



angle @ C is 90°
by inspection, this is in equilibrium OK.





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Marking Scheme

	Reactions + Overall FBD Summary	N diag.	V diag.	M diag.	
Q1	3	1	3	3	= 10
Q2	4	2	2	2	= 10
Q3	5	3	3	4	= 15

Notes to marker:

1. for full marks, each N, V, M diagram must have correct shape & correct values.
2. it is Ok to penalize more than once for incorrect values. For example, incorrect reactions in Q1 can lead to 0 to 2 marks for FBD portion + 1 to 2 marks for each V, M diag if the shape is ok.
3. Shape of V, M means constant values where they should be constant, linear where they should be linear & curved with correct concavity for 2° moments.

Overall Mark Deductions:

up to -10/35 for untidy, disorganized, hard to read work

-5/35 no cover page

-5/35 improper paper (i.e. not quad paper with titleblock each page)