Assignment : Force method

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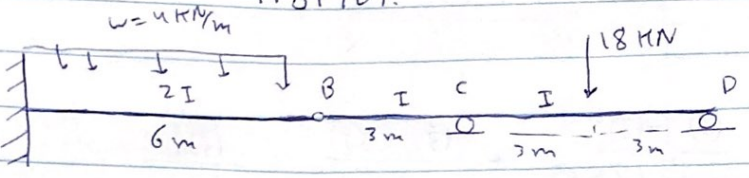
1181401.

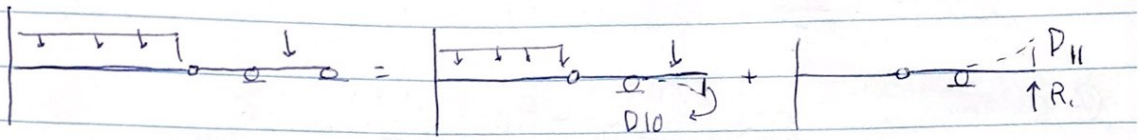
(1)

unknowns = 7

> Hoteq.

$R_1 = d_y$



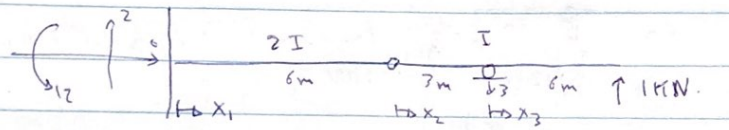


C. eq. : $0 = D_{10} + R_1 d_{11}$

Vertical def. of D

→ find D_{10} , d_{11} :

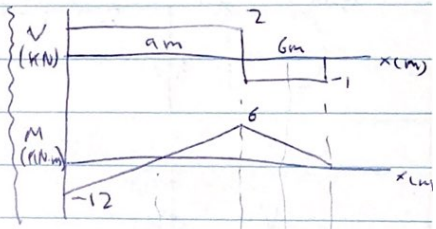
Primary virtual :

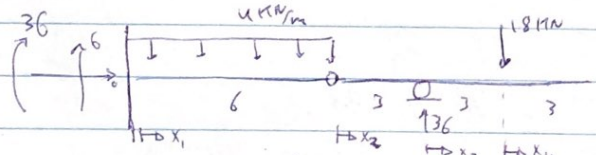


$0 < X_1 < 6m$: $m(X_1) = 2X_1 - 12$

$0 < X_2 < 3m$: $m(X_2) = 2X_2$

$0 < X_3 < 6m$: $m(X_3) = 6 - X_3$



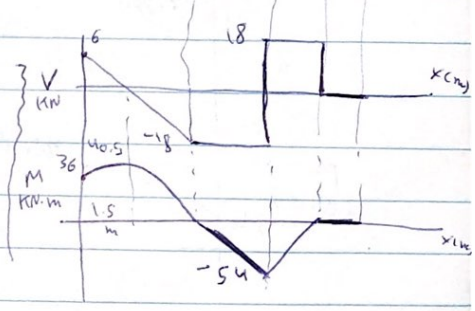


$0 < X_1 < 6m$: $V(X_1) = 6 - 4X_1$

$M(X_1) = 36 + 6X_1 - 2X_1^2$

$0 < X_2 < 3$: $M(X_2) = -18X$

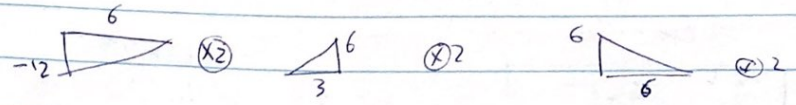
$0 < X_3 < 3$: $M(X_3) = 18X_3$ $0 < X_4 < 3$: $M = 0$.



$$1.\ D_{10} = \int_0^6 \frac{m(x_1)\,M(x_1)\,dx}{2EI} + \int_0^3 \frac{m(x_2)\,M(x_2)\,dx_2}{EI} + \int_0^3 \frac{m(x_3)\,M(x_3)\,dx_3}{EI}$$

$$= \frac{1}{EI}\left[\frac{-1296}{2} + \frac{-324}{1} + \frac{324}{1}\right] = \frac{-648}{EI}$$

$$1 \cdot d_{11} = \int \frac{m_1^2}{2EI} + \int \frac{m^2}{EI}$$



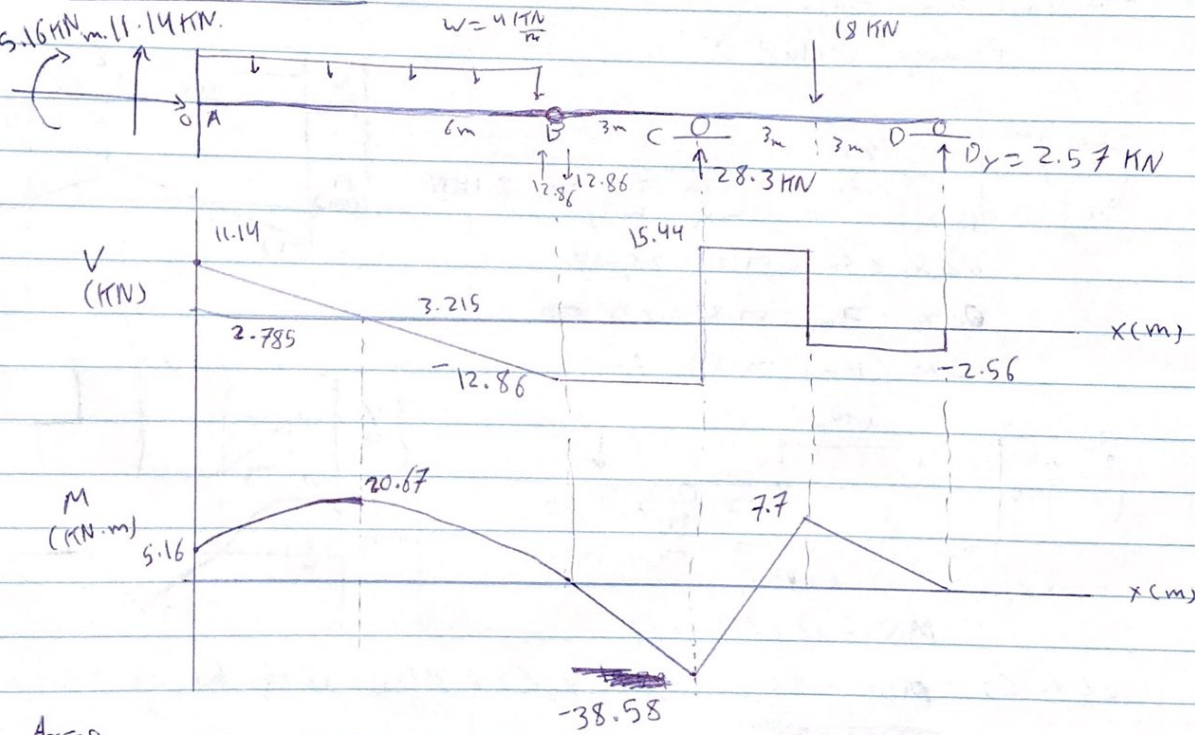
$$d_{11} = \frac{(6)(-12)^2}{3(2EI)} + \frac{(3)(6)^2}{3EI} + \frac{(6)^3}{3EI}$$

$$= \frac{252}{EI}$$

(*) C. eq. : $0 = \frac{-648}{EI} + R_1\left(\frac{252}{EI}\right)$

$\Rightarrow R_1 = 2.57$ KN ↑ $\Rightarrow$ $D_y = 2.57$ KN ↑

Real structure



$A_x = 0$

$A_y = 11.14$ KN ↑

$M_A = 5.16$ KN.m C.W.

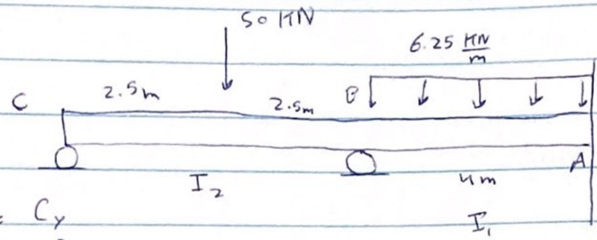
$B_x = 0$

$B_y = 12.86$ KN (↑ for AB)

$C_y = 28.3$ KN ↑

$D_y = 2.57$ KN ↑

2

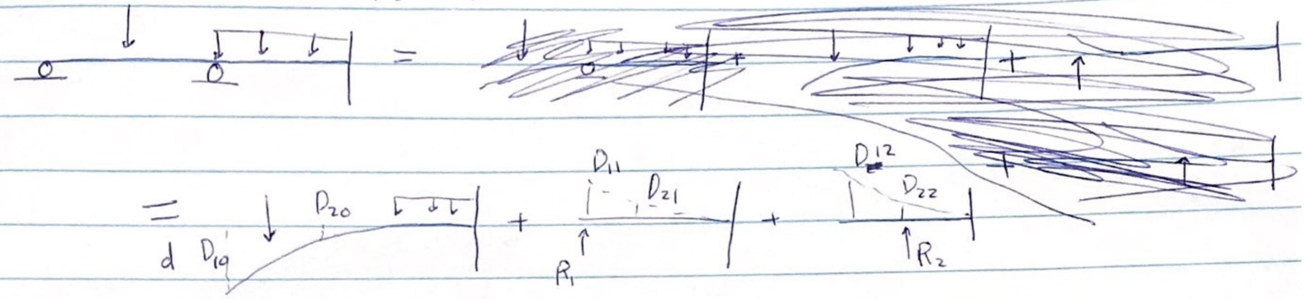


5 unknowns > 3 eq.s

2 degree ind.

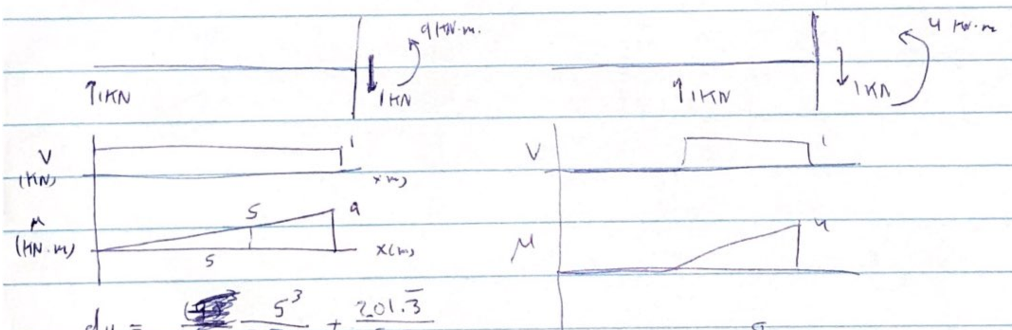
$R_1 = C_y$

$R_2 = B_x$



C. eq. at C: $0 = D_{10} + D_{11} + D_{12} = D_{10} + R_1 d_{11} + R_2 d_{12}$

C. eq. at B: $-0.01 = D_{20} + D_{21} + D_{22} = D_{20} + R_1 d_{21} + R_2 d_{22}$



$d_{11} = \frac{5^3}{3EI_2} + \frac{201.\overline{3}}{EI_1}$

~~$d_{11} = \frac{1}{E}[499600 + 1609374]$~~

$d_{11} = 0.0133$ m

$d_{21} = \frac{61.\overline{3}}{EI_1} = 0.003553$ m

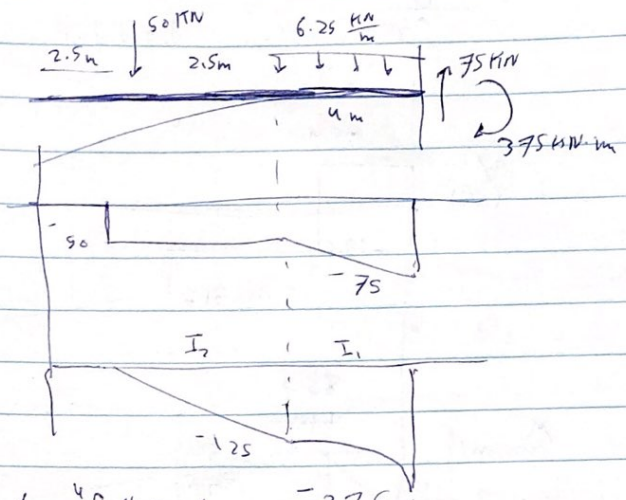
$d_{22} = \frac{8}{EI_1}$

~~$d_{22} = 0.0003089$ m~~

$d_{22} = 0.0004634$ m

$d_{12} = 0.003553$ m

find D_{10} , D_{20} ?



$V_2 = -50$ kN

$M_2 = -50x$ kN

$V_1 = -50 - 6.25x$

$M_1 = -125 - 50x - 3.125x^2$ M

$$1 * D_{10} = \int_0^{2.5} \frac{m_2 M_2}{E I_2}\,dx + \int_0^{4} \frac{M_1 m_1}{E I_1}\,dx$$

$$= \frac{-651}{E I_2} + \frac{-7100}{E I_1} = -0.4364 \text{ m}$$

$$1 * D_{20} = \int_0^{4} \frac{m_1 M_1}{E I_1}\,dx \qquad (m_2 = 0)$$

$$= \frac{-2266.7}{E I_1} = -0.1313 \text{ m}$$

C. eq's: ① $0 = -0.4364 + R_1 (0.0133) + R_2 (0.003553)$

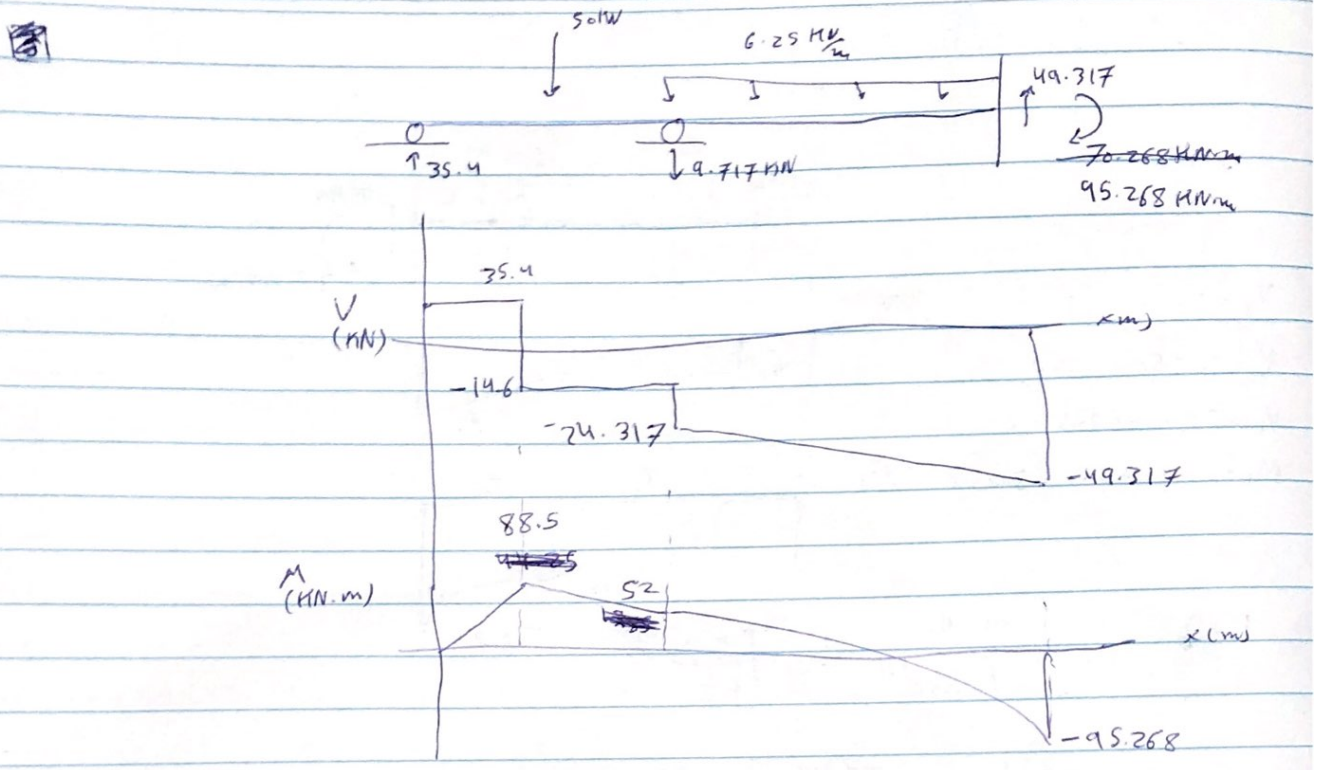
② $-0.01 = -0.1313 + R_1 (0.003553) + R_2 (0.0004634)$

① − ② $0 = -0.11658 + R_1 (0.003553) + R_2 (0.000949161)$

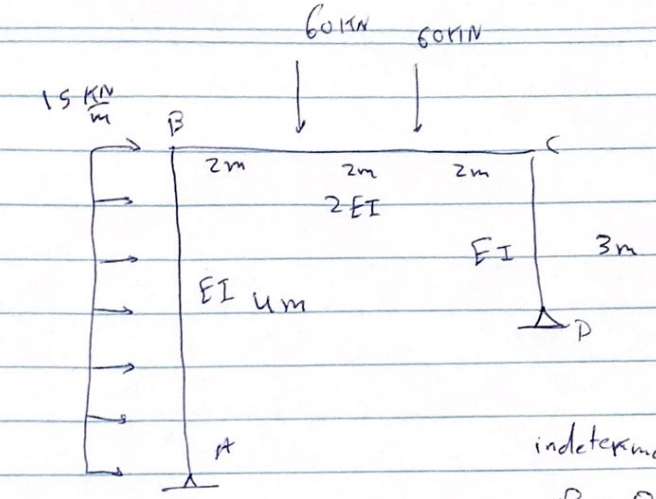
$\Rightarrow 0.01 = 0.01472 + 0 + R_2 (0.000485758514)$

$R_2 = -9.717$ kN. $\rightarrow$ $B_y = 9.717$ kN ↓

$R_1 = 35.4$ kN $\rightarrow$ $C_y = 35.4$ kN ↑

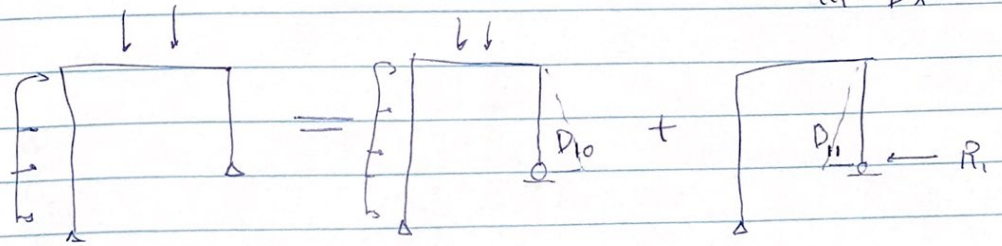

50 kN
6.25 kN/m
49.317
35.4
9.717 kN
95.268 kN.m
35.4
V
(kN)
x(m)
-14.6
-24.317
-49.317
88.5
M
(kN.m)
52
x(m)
-95.268

3



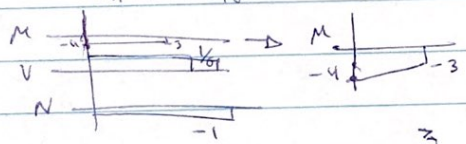
indeterminate 1st degree.

$R_1 = D_x$

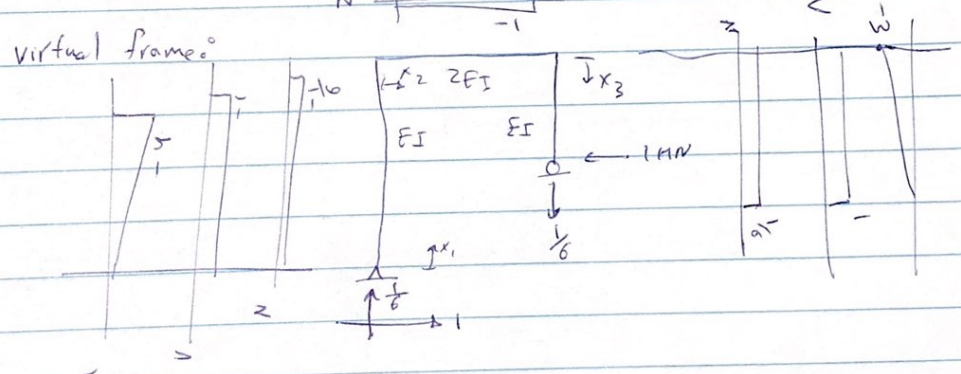


C. eq. ∘ $\delta = D_{10} + D_{11} = D_{10} + R_1 d_{11}$

Horizontal def. at D ∘

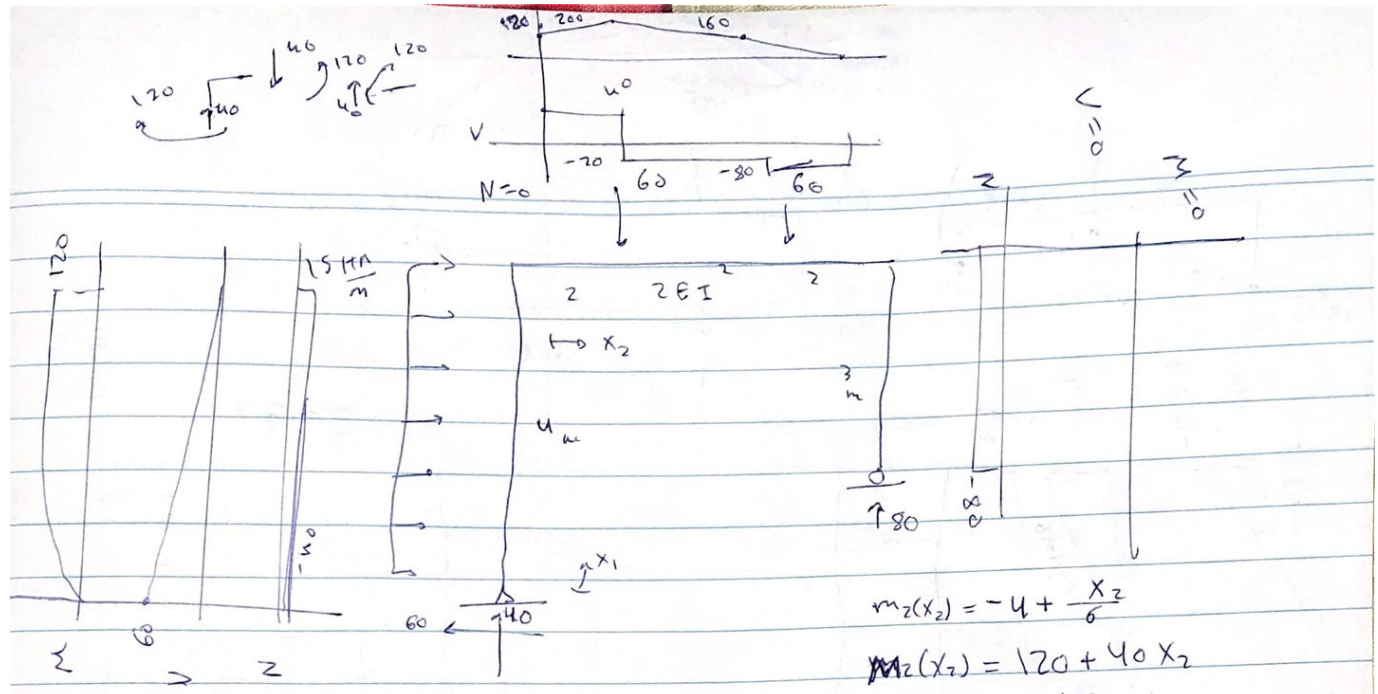


virtual frame ∘



$$1 \cdot d_{11} = \int \frac{m_1^2}{EI} + \int \frac{m_2^2}{2EI} + \int \frac{m_3^2}{EI}$$

$$d_{11} = \frac{21.\bar{3}}{EI} + \frac{37}{EI} + \frac{9}{EI} = \frac{67.\bar{3}}{EI}$$



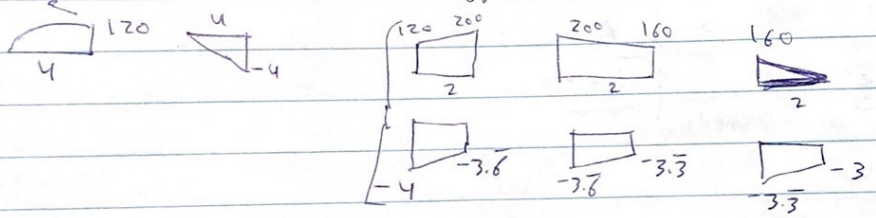
$$m_2(x_2) = -4 + \frac{x_2}{6}$$

$$M_2(x_2) = 120 + 40x_2$$

$$0 < x_2 < 2$$

$$1 \cdot D_{10} = \int_0^4 \frac{M_1 m_1}{EI}\,dx + \int_0^6 \frac{m_2 M_2}{2EI}\,dx_2 + 0$$

slope = 0



$$D_{10} = \frac{-800}{EI} + \frac{1}{2EI}\left[-1222.2 - 1262.2 - 515.5\right]$$

$$D_{10} = \frac{-2300}{EI}$$

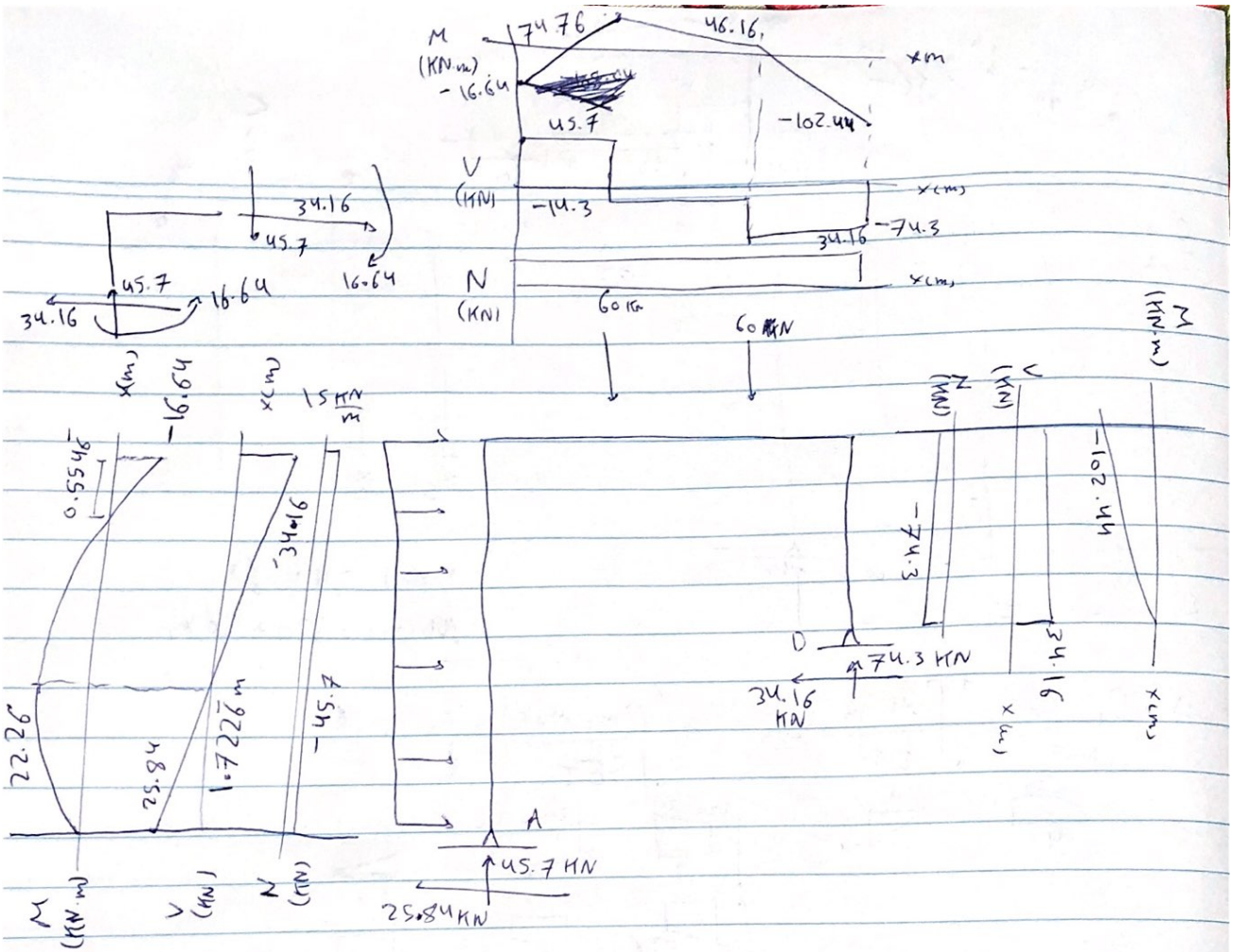
C. eq.°

$$0 = \frac{-2300}{EI} + R_1\left(\frac{67.3}{EI}\right)$$

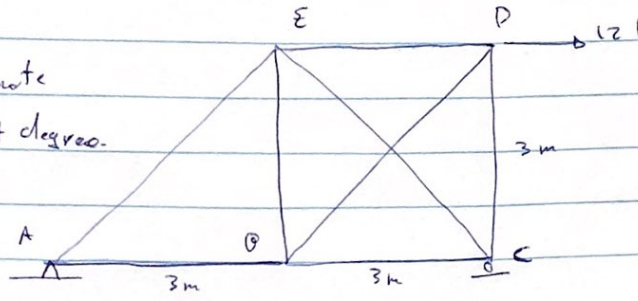
$$R_1 = 34.16\ KN \longrightarrow D_x = 34.16\ KN \leftarrow$$

$A_x = 25.84\ KN \leftarrow$ $\quad D_x = 34.16\ KN \leftarrow$

$A_y = 45.7\ KN \uparrow$ $\quad D_y = 74.3\ KN \uparrow$


M (KN.m)
74.76
46.16
xm
-16.64
45.7
-102.44
V (KN)
-14.3
-74.3
34.16
N (KN)
60 KN
60 KN
34.16
45.7
16.64
16.64
15 KN/m
0.5546
-16.64
-34.16
-45.7
22.26
25.84
1.7226
45.7 KN
25.84 KN
74.3 KN
34.16 KN
-74.3
-102.44
34.16

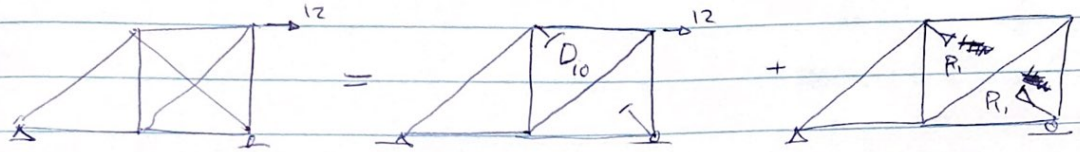
4 EA = Constant.



externally determinate

int. indeter. 1st degree.

$R_1 = CE$



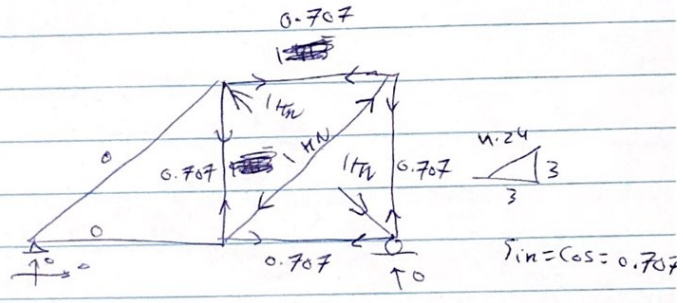
virtual truss

C. eq

for relative d.sp. at cut edges of member (CE)

$0 = D_{10} + D_{11}$

$0 = D_{10} + R_1 d_{11}$



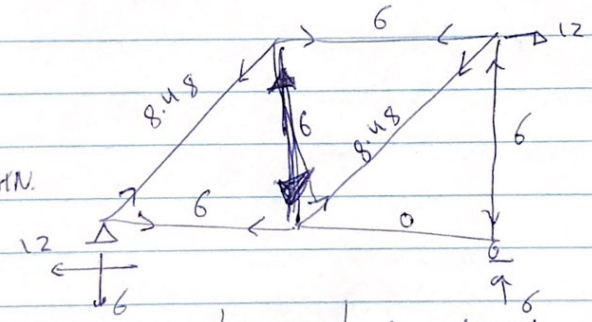
$$0 = \sum \frac{nNL}{EA} + \left(\sum \frac{Ln^2}{EA}\right) R_1$$

$$0 = \sum nNL + \left(\sum Ln^2\right) R_1$$

$$R_1 = \frac{-\sum nNL}{\sum Ln^2}$$

$$\boxed{R_1 = 5.57 \text{ KN}} \rightarrow f_{CE} = -5.57 \text{ KN}$$

Primary



$f_{ab} = N_{ab} + R_1 (n_1)_{ab}$

$F_{ab} = 6 + 0 = 6$ KN

$f_{bc} = 0 + 3.94 = 3.94$ KN

$f_{AE} = 8.48 + 0 = 8.48$ KN

$f_{BE} = -6 + 4 = -2$ KN

$f_{BD} = 8.48 + -5.57 = 2.91$ KN

$f_{ED} = -6 + 4 = -2$ KN

$f_{ED} = 6 + 4 = 10$ KN.

	n (KN)	N (KN)	L (m)	nNL	n^2L
BE	0.707	−6	3		
BD	−1	8.48	4.24		
ED	0.707	6	3		
CD	0.707	−6	3		
				$\sum nNL$	$\sum n^2L$
				$= -48.6812$	$= 8.74$