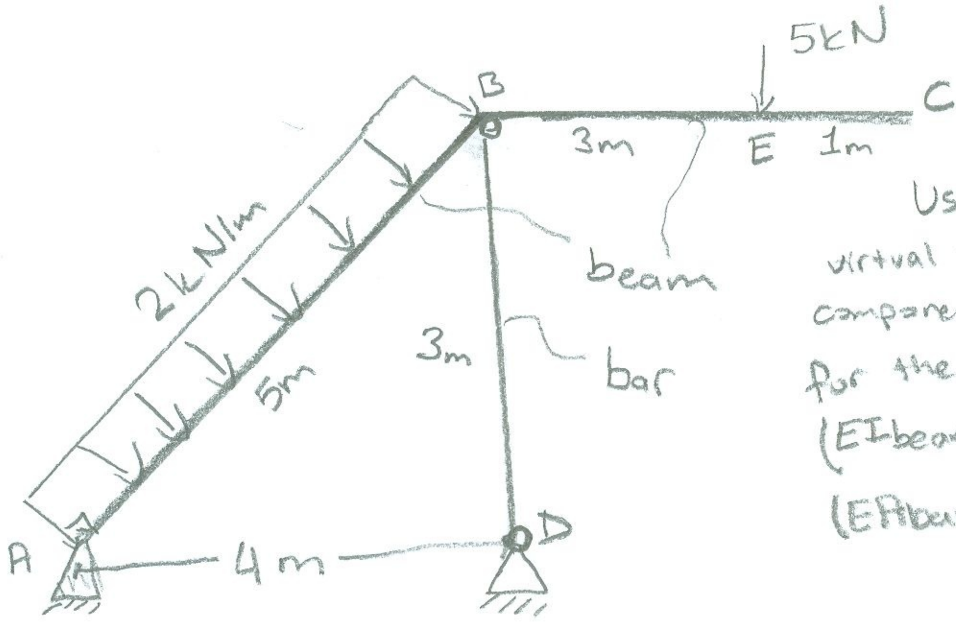
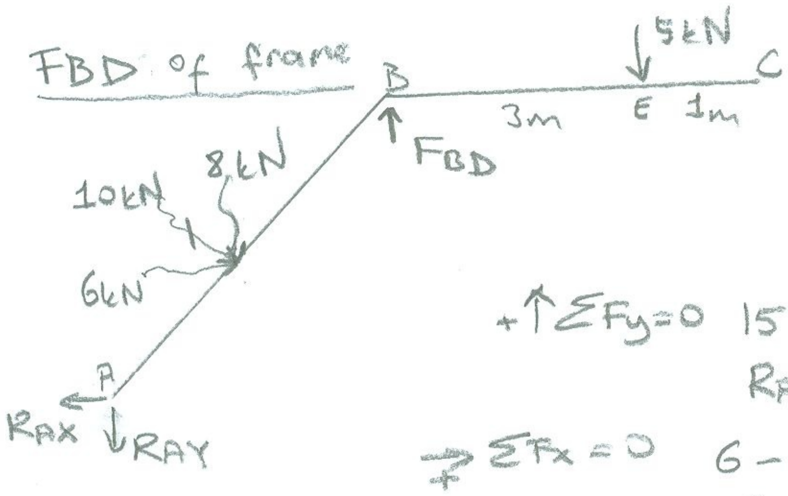


Using the principle of virtual work, calculate vertical component of the deflection at C for the frame shown.

$(EI_{beam})_{ABC} = 20000\ kNm^2$

$(EA_{bar})_{BD} = 10000\ kN$

FBD of frame



$+\circlearrowright \Sigma M_A = 0 \quad 5\times7 + 8\times2 + 6\times1.5 - 4F_{BD} = 0$

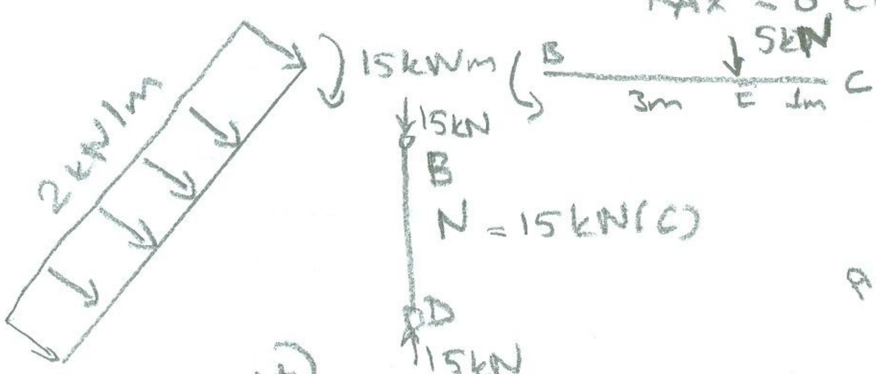
$\Rightarrow F_{BD} = 15\,kN\ (\uparrow)$

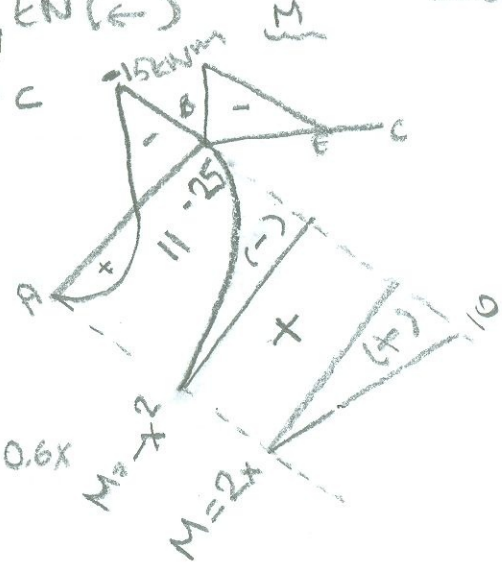
$+\uparrow \Sigma F_y = 0 \quad 15 - 5 - 8 - R_{AY} = 0$

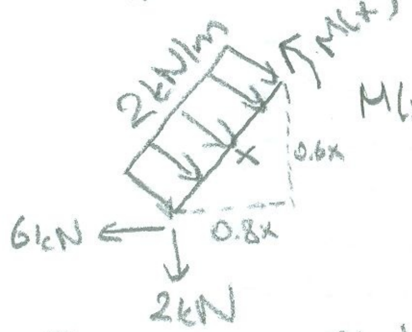
$R_{AY} = 2\,kN\ (\downarrow)$

$\xrightarrow{+} \Sigma F_x = 0 \quad 6 - R_{AX} = 0$

$R_{AX} = 6\,kN\ (\leftarrow)$



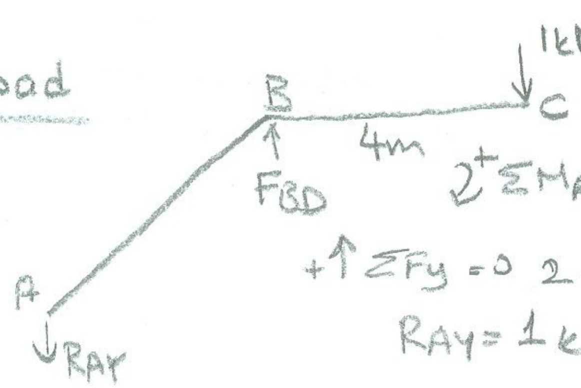




$M(x) = -2 * x * \frac{x}{2} - 2 * 0.8x + 6 * 0.6x$

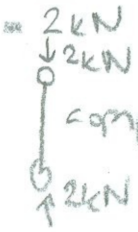
$= -x^2 + 2x$

FBD of unit load



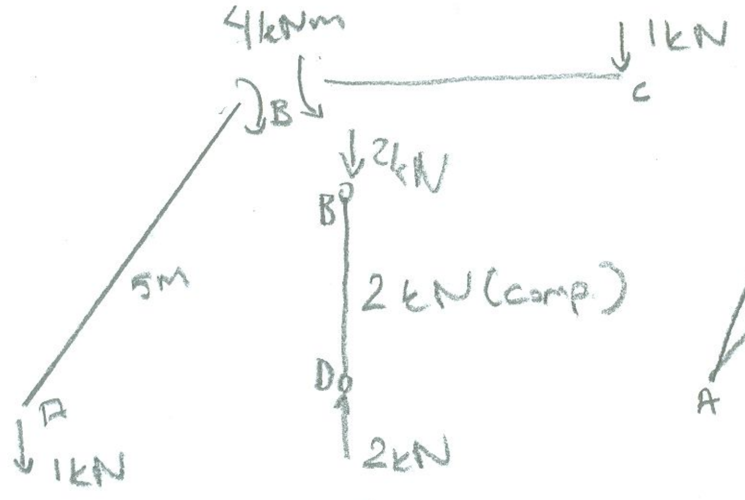
$\circlearrowright^{+} \Sigma M_A = 0 \quad 1\times8 - F_{BD}\times4 = 0$

$F_{BD} = 2\,kN\ (\uparrow)$

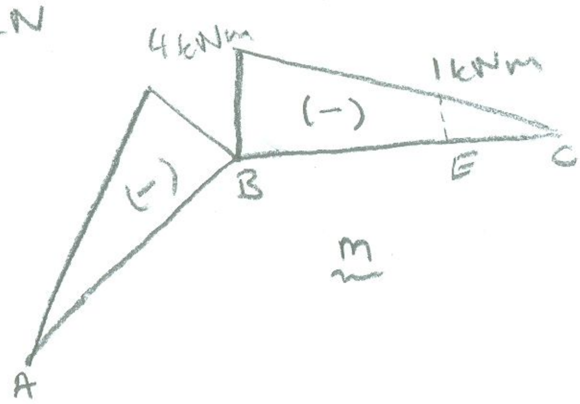


$+\uparrow \Sigma F_y = 0 \quad 2 - R_{AY} - 1 = 0$

$R_{AY} = 1\,kN\ (\downarrow)$

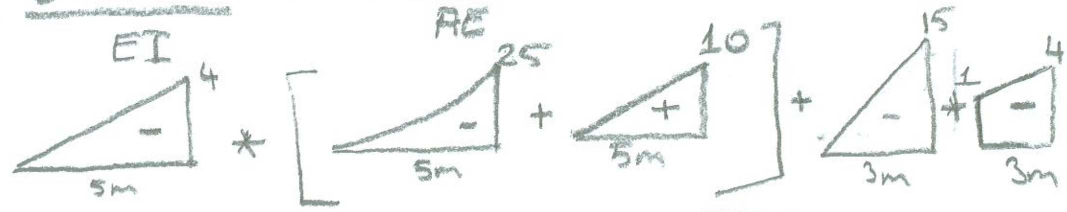


n



m

$$1 \times \Delta_{CY} = \frac{\int m M dx}{EI} + \sum \frac{nNL}{AE}$$

= 

EI

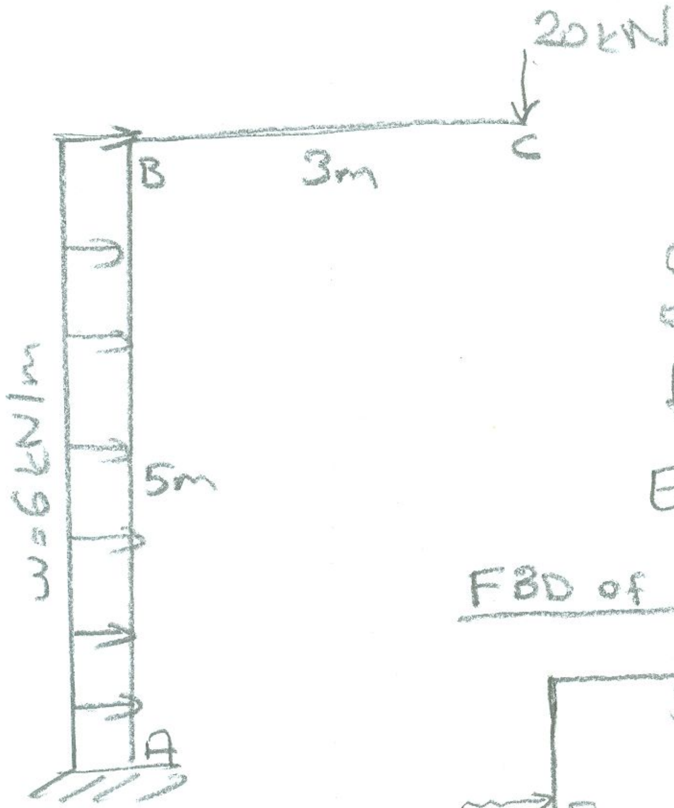
$$+ \frac{-2 * -15 * 3}{EA}$$

$$= \frac{\frac{1}{4} * 5 * 4 * 25 - \frac{1}{3} * 5 * 4 * 10 + \frac{1}{6} * 3 * 15 * (1+2*4)}{20000} + \frac{90}{10000}$$

0,00629 m

0,009 m

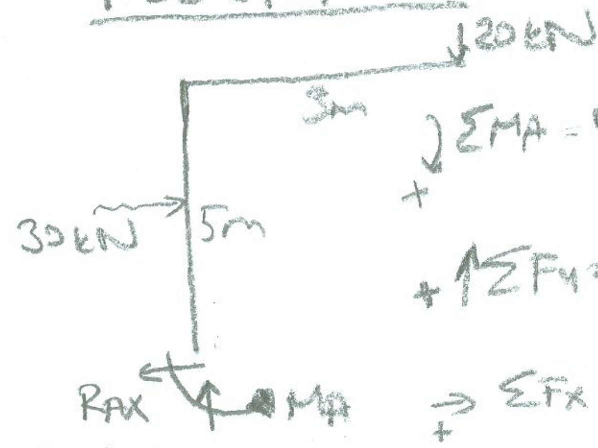
$\Delta_{CY} = 0,01529$ m



Using the principle of virtual work calculate the horizontal component of the deflection at C for the frame shown left.

$E = 200\ \text{GPa}$ $I = 240 \times 10^{6}\ \text{mm}^4$

FBD of frame



$\circlearrowright + \Sigma M_A = 0$ $20 \times 3 + 30 \times 2.5 - M_A = 0$

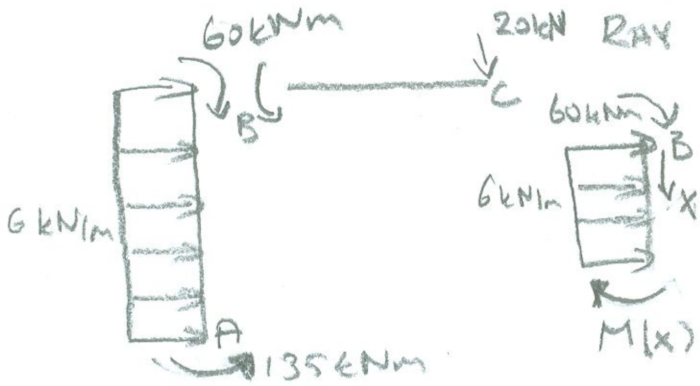
$M_A = 135\ \text{kNm}\ (\circlearrowleft)$

$+\uparrow \Sigma F_y = 0$ $R_{AY} - 20 = 0$

$R_{AY} = 20\ \text{kN}\ (\uparrow)$

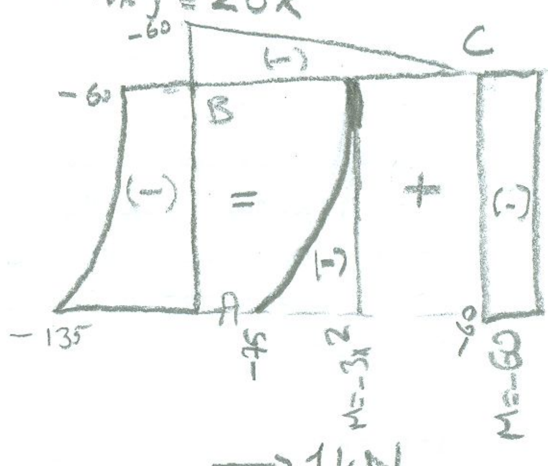
$\overset{+}{\rightarrow} \Sigma F_x = 0$ $30 - R_{AX} = 0$

$R_{AX} = 30\ \text{kN}\ (\leftarrow)$

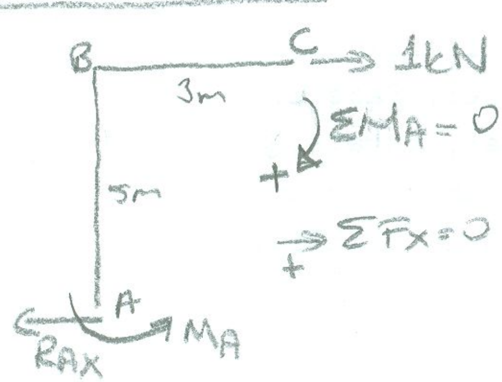


$M(x) = -60 - 3x^2$

$M(x) = -20x$



FBD of unit load

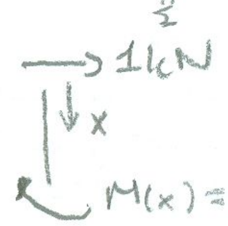


$\circlearrowright + \Sigma M_A = 0$ $1 \times 5 - M_A = 0$

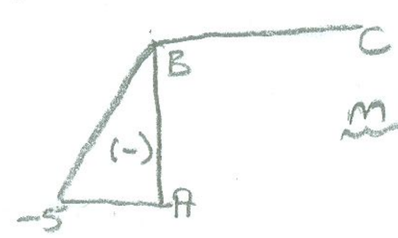
$M_A = 5\ \text{kNm}\ (\circlearrowleft)$

$\overset{+}{\rightarrow} \Sigma F_x = 0$ $1 - R_{AX} = 0$

$R_{AX} = 1\ \text{kN}\ (\leftarrow)$

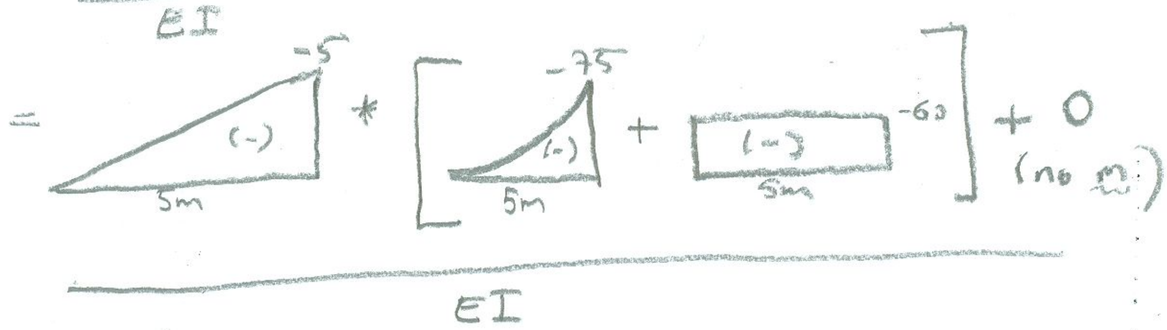


$M(x) = -x$



$\underset{\sim}{m}$ (kNm)

$$1 * \Delta_{cx} = \frac{\int mM\,dx}{EI}$$



$$1 * \Delta_{cx} = \frac{\frac{1}{4}(5)(75)(5) + \frac{1}{2}(5)(5)(60)}{EI} = \frac{1218.75}{EI}$$

$$\Delta_{cx} = 25.4 \text{ mm}$$
$(\rightarrow)$