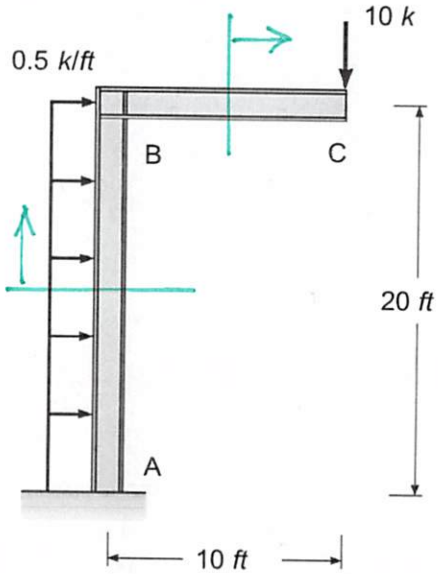
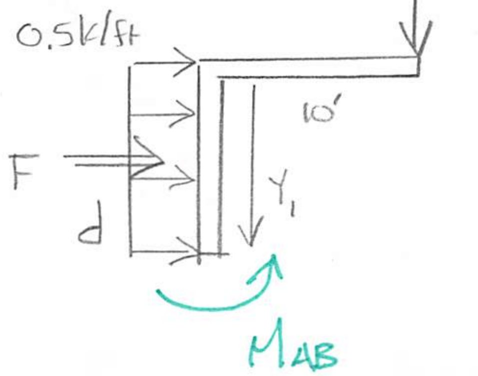
Example 8c-1: Compute the vertical deflection and rotation at point C on the frame shown. Include only the effects of the bending moment in your virtual work equations. Assume E = 29,000 *ksi* and I = 1,000 in^4.

Real loads



SECTION AB

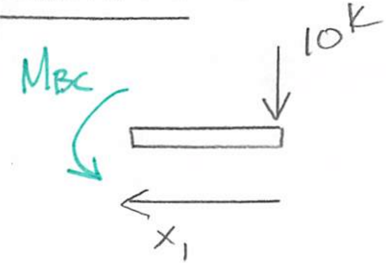


$F = \frac{1}{2}(Y_1) \quad d = \frac{1}{2}(Y_1)$

$\circlearrowleft + \; \Sigma M_{CUT} = 0 = M_{AB} - \frac{1}{2}(Y_1)\frac{1}{2}(Y_1) - 10^k(10')$

$M_{AB} = \left[\frac{Y_1^2}{4} + 100\right] k\,ft$

SECTION BC



$\circlearrowleft + \; \Sigma M_{CUT} = 0 = M_{BC} - 10^k(x_1)$

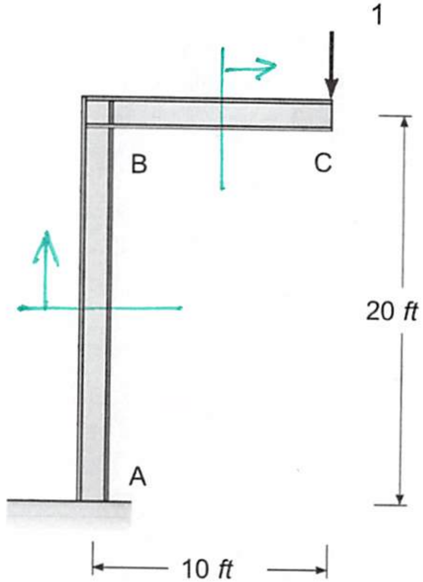
$M_{BC} = [10x_1]\, k\,ft$

✓

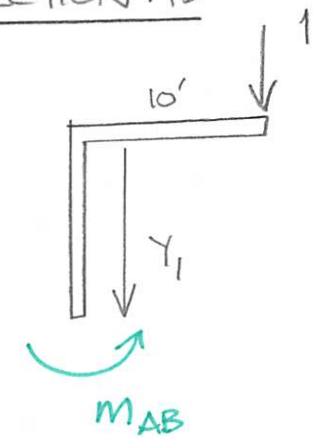
$M_{BC}(x_1 = 0) = 0$

Example 8c-1: Compute the vertical deflection and rotation at point C on the frame shown. Include only the effects of the bending moment in your virtual work equations. Assume E = 29,000 *ksi* and I = 1,000 in^4.

Virtual load



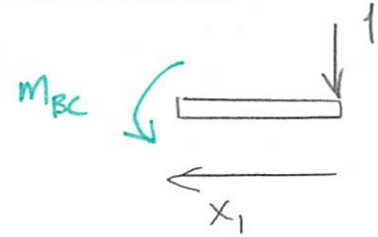
SECTION AB



$$\overset{+}{\circlearrowleft} \sum M_{CUT} = 0 = m_{AB} - 1(10')$$

$$\underline{m_{AB} = [10]\ \text{ft}}$$

SECTION BC



$$\overset{+}{\circlearrowleft} \sum M_{CUT} = 0 = m_{BC} - 1x_1$$

$$\underline{m_{BC} = [x_1]\ \text{ft}}$$

$$Y_C = \frac{1}{EI}\left[\int_0^{20} M_{AB}\, m_{AB}\, dY_1 + \int_0^{10} M_{BC}\, m_{BC}\, dx_1\right] = \frac{1}{EI}\left[\int_0^{20}\left(\frac{Y_1^2}{4} + 100\right)(10)\, dY_1 + \int_0^{10}(10x_1)(x_1)\, dx_1\right]$$

$$= \frac{1}{EI}\left[\left(\frac{5Y(Y^2+100)}{6}\right)\Bigg|_0^{20} + \frac{10x_1^3}{3}\Bigg|_0^{10}\right]$$

$$= \frac{30{,}000\ \text{k ft}^3}{EI} = \underline{\underline{1.788\ \text{IN}}}$$

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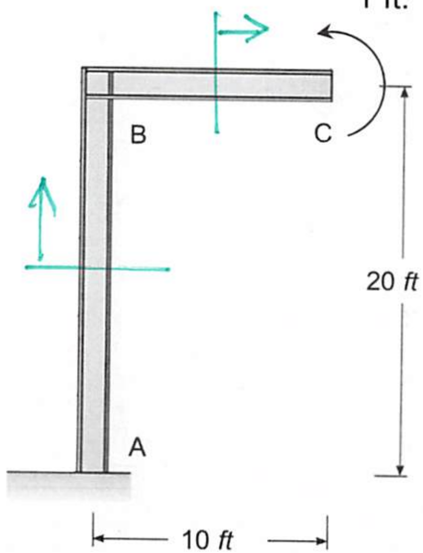
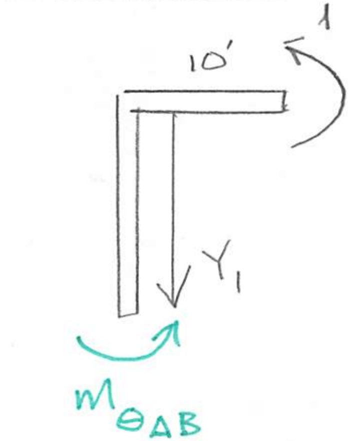
Virtual load



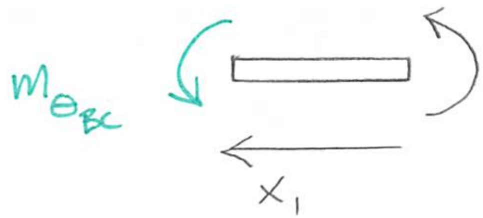
SECTION AB



$$\circlearrowleft + \sum M_{CUT} = 0 = M_{\theta_{AB}} + 1$$

$$M_{\theta_{AB}} = -1$$

SECTION BC



$$\circlearrowleft + \sum M_{CUT} = 0 = M_{\theta_{BC}} + 1$$

$$M_{\theta_{BC}} = -1$$

$$\theta_C = \frac{1}{EI}\left[\int_0^{20}\left(\frac{Y_1^2}{4}+100\right)(-1)\,dY_1 + \int_0^{10}(10x_1)(-1)\,dx_1\right] = \frac{1}{EI}\left[-\frac{Y_1(Y_1^2+1200)}{12}\Bigg|_0^{20} - \frac{5x_1^2}{2}\Bigg|_0^{10}\right]$$

$$= -\frac{9{,}500\,k\,ft^2}{3EI} = -0.0157 \text{ RADIANS}$$