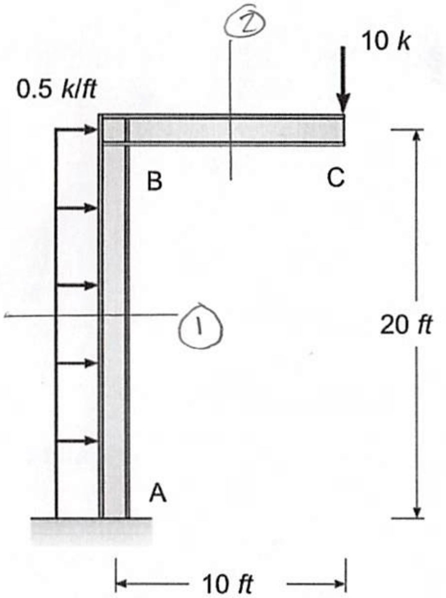
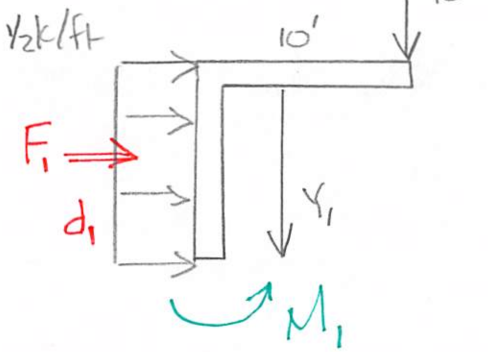
Example 8c-1: Compute the vertical deflection and rotation at point C on the frame shown. Include only the effects of the bending moment in your virtual work equations. Assume E = 29,000 *ksi* and I = 1,000 in^4.

Real loads



SECTION ①

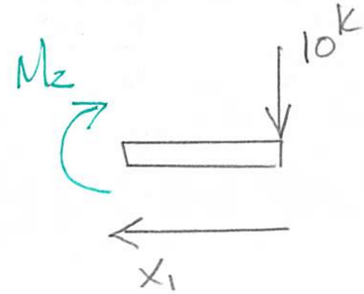


$F_1 = \frac{y_1}{2} \quad d_1 = \frac{y_1}{2}$

$$\circlearrowleft + \sum M_{CUT} = 0 = M_1 - \frac{y_1}{2}\left(\frac{y_1}{2}\right) - 10^k(10')$$

$$M_1 = \left[\frac{y_1^2}{4} + 100\right] \text{k ft}$$

SECTION ②

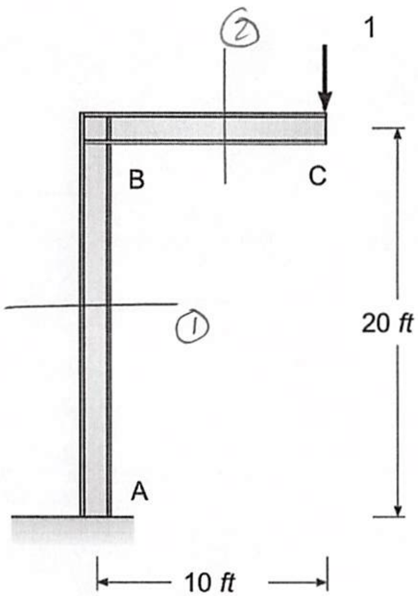


$$\circlearrowleft + \sum M_{CUT} = 0 = -M_2 - 10^k x_1$$

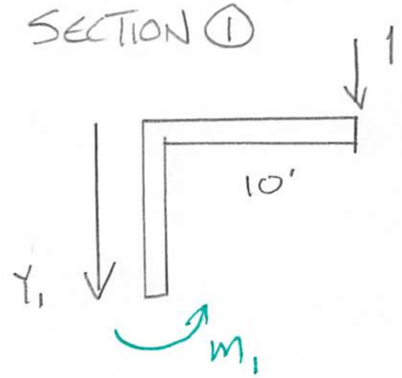
$$M_2 = \left[-10x_1\right] \text{k ft}$$

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



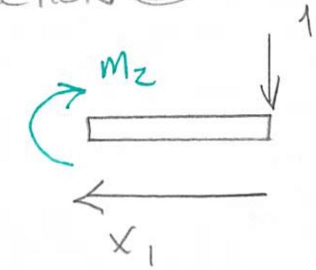
SECTION ①



$$\circlearrowleft^{+} \sum M_{CUT} = 0 = m_1 - 1(10')$$

$$m_1 = 10$$

SECTION ②



$$\circlearrowleft^{+} \sum M_{CUT} = 0 = -m_2 - 1x_1$$

$$m_2 = -x_1$$

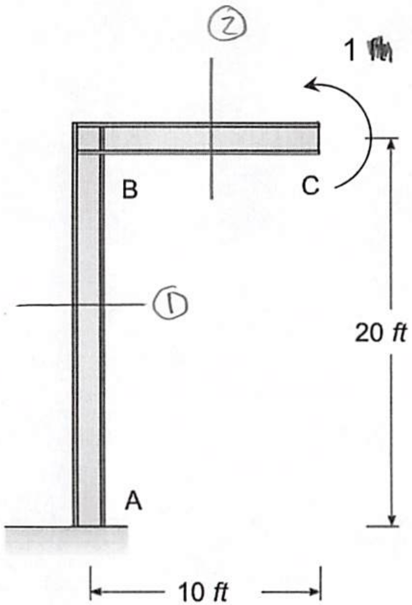
$$Y_c = \frac{1}{EI}\left[\int_0^{20}\left(\frac{Y_1^2}{4}+100\right)(10)\,dY_1 + \int_0^{10}(-10x_1)(-x_1)\,dx_1\right]$$

$$= \frac{1}{EI}\left[\frac{80{,}000}{3} + \frac{10{,}000}{3}\right] = \frac{30{,}000\ k\,ft^3}{EI}$$

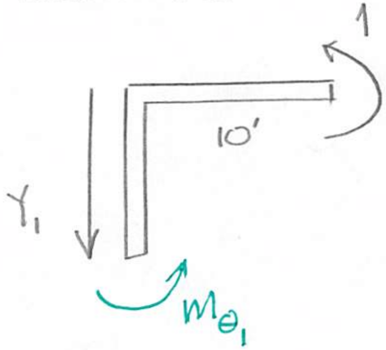
$$= \frac{30{,}000\ k\,ft^3}{} \left|\frac{IN^2}{29{,}000\ k}\right|\frac{}{1{,}000\ IN^4}\left|\frac{(12\,in)^3}{ft^3}\right. = \underline{\underline{1.79\ IN}}$$

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



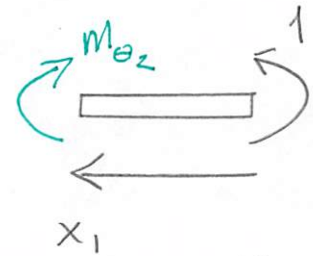
SECTION ①



$$\circlearrowleft + \sum M_{CUT} = 0 = m_{\theta_1} + 1$$

$$\underline{m_{\theta_1} = -1}$$

SECTION ②



$$\circlearrowleft + \sum M_{CUT} = 0 = -m_{\theta_2} + 1$$

$$\underline{m_{\theta_2} = 1}$$

$$\theta_C = \frac{1}{EI}\left[\int_0^{20}\left(\frac{Y_1^2}{4} + 100\right)(-1)\,dY_1 + \int_0^{10}(-10X_1)(1)\,dX_1\right] = -\left[\frac{Y_1^3}{12} + 100Y_1\right]_0^{20} - 5X_1^2\Big|_0^{10}$$

$$= -\frac{9{,}500\ k\,ft^3}{3EI} = -\frac{9{,}500\ k\,ft^2 \cdot IN^2 \cdot (12\,in)^2}{29{,}000\ k \cdot 1{,}000\ IN^4 \cdot ft^2}$$

$$= \underline{\underline{-0.0472\ \text{RADIANS}}}$$