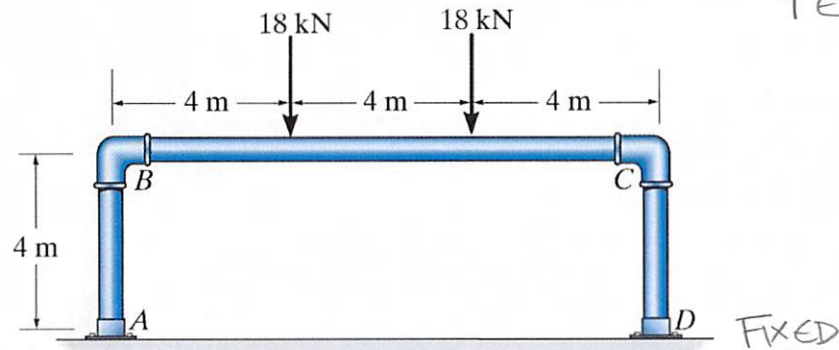


Problem 10-15 – The frame is made from a pipe that is fixed-connected. If it supports the loading shown, determine the moments developed at each of the joints and supports. EI is constant.



$$FEM_{BC} = FEM_{CB} = \pm \frac{ZPL}{9} = \frac{2(18\text{ kN})(12\text{ m})}{9} = \pm 48\text{ kNm}$$

FIXED

$$M_{AB} = \frac{ZEI}{4\text{ m}} [\theta_B] \quad (1)$$

$$M_{BA} = \frac{ZEI}{4\text{ m}} [2\theta_B] \quad (2)$$

$$M_{BC} = \frac{ZEI}{12\text{ m}} [2\theta_B + \theta_C] - 48\text{ kNm} \quad (3)$$

$$M_{CB} = \frac{ZEI}{12\text{ m}} [2\theta_C + \theta_B] + 48\text{ kNm} \quad (4)$$

$$M_{CD} = \frac{ZEI}{4\text{ m}} [2\theta_C] \quad (5)$$

$$M_{DC} = \frac{ZEI}{4\text{ m}} [\theta_C] \quad (6)$$

JOINT B

$$\sum M_B = 0$$

Free body diagram of joint B showing moments M_{BA} (counter-clockwise) and M_{BC} (clockwise).

$$= -M_{BC} - M_{BA}$$

$$M_{BA} + M_{BC} = 0 \quad (7)$$

JOINT C

$$\sum M_C = 0$$

Free body diagram of joint C showing moments M_{CB} (counter-clockwise) and M_{CD} (clockwise).

$$= -M_{CB} - M_{CD}$$

$$M_{CB} + M_{CD} = 0 \quad (8)$$

2/3

Problem 10-15 – The frame is made from a pipe that is fixed-connected. If it supports the loading shown, determine the moments developed at each of the joints and supports. EI is constant.

$$\textcircled{7} \quad M_{BA} + M_{BC} = 0 = \frac{2EI}{4m} [2\theta_B] + \frac{2EI}{12m} [2\theta_B + \theta_C] - 48 \text{ kNm}$$
$$\Rightarrow \frac{4}{3} \theta_B + \frac{1}{6} \theta_C = \frac{48 \text{ kNm}^2}{EI} \quad \textcircled{7a}$$

$$\textcircled{8} \quad M_{CB} + M_{CD} = 0 = \frac{2EI}{12m} [2\theta_C + \theta_B] + 48 \text{ kNm} + \frac{2EI}{4m} [2\theta_C]$$
$$\Rightarrow \frac{1}{6} \theta_B + \frac{4}{3} \theta_C = -\frac{48 \text{ kNm}^2}{EI} \quad \textcircled{8a}$$

$$8 \times \textcircled{7a} - \textcircled{8a} \Rightarrow \frac{21}{2} \theta_B = \frac{432 \text{ kNm}^2}{EI} \quad \theta_B = \frac{864 \text{ kNm}^2}{21EI}$$
$$\theta_C = -\frac{864 \text{ kNm}^2}{21EI}$$

Problem 10-15 – The frame is made from a pipe that is fixed-connected. If it supports the loading shown, determine the moments developed at each of the joints and supports. EI is constant.

$$M_{AB} = \frac{2EI}{4m} [\theta_B] = \underline{20.57 \text{ kNm}}$$

$$M_{BA} = \frac{2EI}{4m} [2\theta_B] = \underline{41.14 \text{ kNm}}$$

$$M_{BC} = \frac{2EI}{12m} [2\theta_B + \theta_C] - 48 \text{ kNm} = \underline{-41.14 \text{ kNm}}$$

$$M_{CB} = \frac{2EI}{12m} [2\theta_C + \theta_B] + 48 \text{ kNm} = \underline{41.14 \text{ kNm}}$$

$$M_{CD} = \frac{2EI}{4m} [2\theta_C] = \underline{-41.14 \text{ kNm}}$$

$$M_{DC} = \frac{2EI}{4m} [\theta_C] = \underline{-20.57 \text{ kNm}}$$

$$M_{BA} + M_{BC} = 0 \quad \checkmark$$

$$M_{CB} + M_{CD} = 0 \quad \checkmark$$