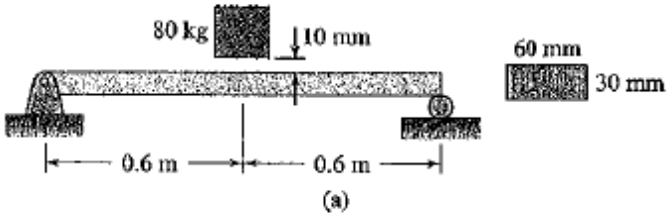
Sample Problem **12.5** Pytel, Kiusalaas "Mech of Materials"

The 80-kg block hits the simply supported beam at its midspan after a drop of 10 mm as shown in Fig. (a). Determine (1) the impact factor; and (2) the maximum dynamic bending stress in the beam. Use $E = 200$ GPa for the beam. Assume that the block and the beam stay in contact after the collision.



(a)

Solution

Part 1

The moment of inertia of the cross section of the beam abcut the neutral axis is

$$I = \frac{bh^3}{12} = \frac{60(30)^3}{12} = 135.0 \times 10^3 \text{ mm}^4 = 135.0 \times 10^{-9} \text{ m}^4$$

According to Table 6.3 on page 233, the static midspan deflection of the beam under the weight of the 80-kg mass is

$$\delta_{st} = \frac{(mg)L^3}{48EI} = \frac{(80 \times 9.81)(1.2)^3}{48(200 \times 10^9)(135.0 \times 10^{-9})} = 1.0464 \times 10^{-3} \text{ m}$$

From Eq. (12.12b), the impact factor is

$$n = 1 + \sqrt{1 + \frac{2h}{\delta_{st}}} = 1 + \sqrt{1 + \frac{2(0.010)}{1.0464 \times 10^{-3}}} = 5.485 \qquad \textit{Answer}$$

Part 2

The maximum dynamic load P_{max} at the midspan of the beam is obtained by multiplying the static load by the impact factor:

$$P_{max} = n(mg) = 5.485(80 \times 9.81) = 4305 \text{ N}$$

The maximum bending moment caused by this load occurs at the midspan, as shown in Fig. (b). Its value is

$$M_{max} = \frac{4305}{2}(0.6) = 1291.5 \text{ N} \cdot \text{m}$$

which results in the maximum dynamic bending stress

$$\sigma_{max} = \frac{M_{max}c}{I} = \frac{1291.5(0.015)}{135.0 \times 10^{-9}} = 143.5 \times 10^6 \text{ Pa} = 143.5 \text{ MPa} \qquad \textit{Answer}$$