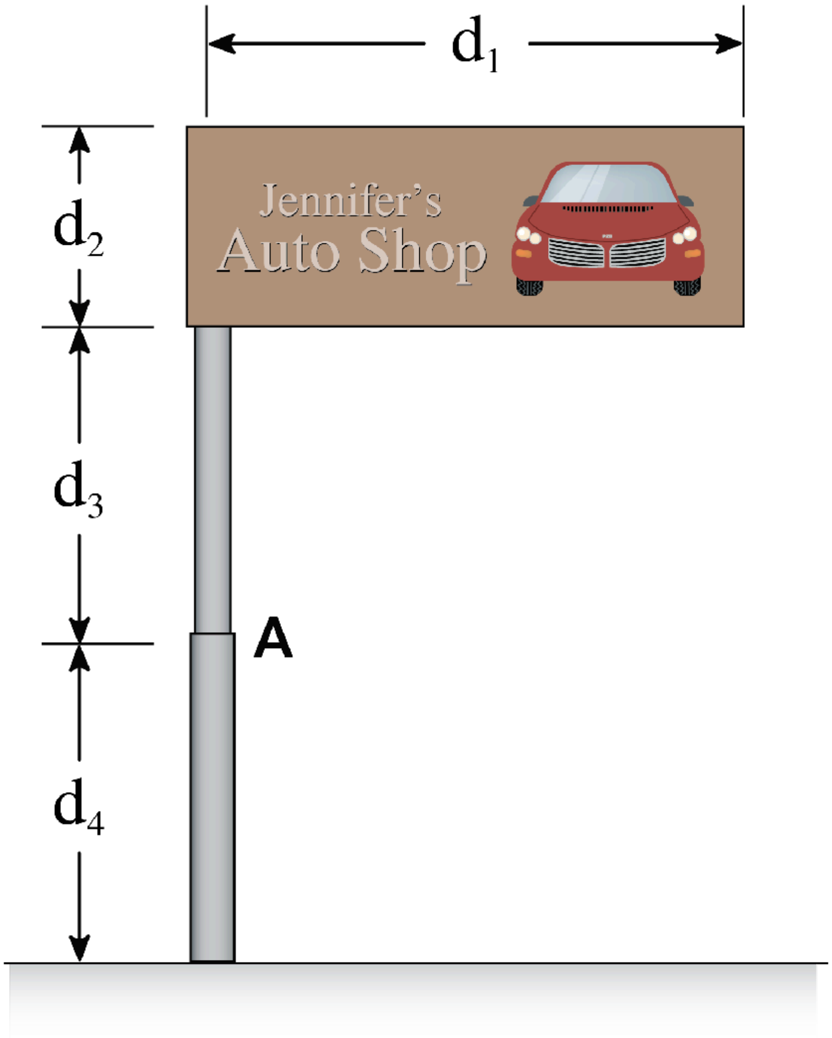
21-S-7.1-RP-04



A billboard sign has a uniform mass density of $\rho\ \mathrm{kg/m^3}$ and a thickness of $t\ \mathrm{m}$. The sign was designed with a maximum expected uniform wind loading of $P\ \mathrm{Pa}$ that would travel into the broad side of the sign. Assuming negligible mass in the pole and $g = 9.81\ \mathrm{N/kg}$, find the magnitudes of the internal loadings in the pole at A.

Calculate the total mass of the sign.

$m = \rho \cdot t \cdot d_1 \cdot d_2$

Calculate the magnitude of the force due to the wind.

$F_W = P \cdot d_1 \cdot d_2$

Find the magnitude of the internal normal force, shear force, and bending moment in the pole at A.

Looking at the section above A and assuming y is the horizontal axis, z is the vertical axis, and x is the axis orthogonal to both:

$$+\uparrow \Sigma F_z = 0 \rightarrow -N_A - m \cdot g = 0$$
$$\Rightarrow N_A = -m \cdot g$$

$$+\rightarrow \Sigma F_y = 0$$
$$\Rightarrow V_{Ay} = 0$$

$$+\cdot \Sigma F_x = 0 \rightarrow V_{Ax} - F_W = 0$$
$$\Rightarrow V_{Ax} = F_W$$

$$\Rightarrow V_A = \sqrt{{V_{Ax}}^2 + {V_{Ay}}^2} = F_W$$

$$\Sigma(M_x)_A = 0 \rightarrow (M_A)_x - \frac{d_1}{2} \cdot m \cdot g = 0$$
$$\Rightarrow (M_A)_x = \frac{d_1}{2} \cdot m \cdot g$$

$$\Sigma(M_y)_A = 0 \rightarrow (M_A)_y - (d_3 + \frac{d_2}{2}) \cdot F_W = 0$$
$$\Rightarrow (M_A)_y = (d_3 + \frac{d_2}{2}) \cdot F_W$$

Since bending moment only considers the moment vectors perpendicular to the axis of the member, $(M_A)_z$ is ignored.

$$\Rightarrow M_A = \sqrt{{(M_A)_x}^2 + {(M_A)_y}^2}$$