[1.5절]

1.84 m = 1,200 kg, l = 0.20 m, b = 0.12 m, J = 12 kg · m^2,
steel E = 200 GPa = 200×10^9 N/m^2 , G = 80 GPa = 80×10^9 N/m^2

$$A = b^2 = (0.12\text{ m})^2 = 0.0144\text{ m}^2$$

$$J_p = \frac{1}{6}b^4 = \frac{1}{6}(0.12\text{ m})^4 = 34.56\times10^{-6}\text{ m}^4$$

longitudinal vibration

$$k = \frac{EA}{l} = \frac{(200\times10^9\text{ N/m}^2)(0.0144\text{ m}^2)}{0.20\text{ m}} = 14.40\times10^9\text{ N/m}$$

$$\omega_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{14.40\times10^9\text{ N/m}}{1{,}200\text{ kg}}} = 3{,}464\text{ rad/s} \quad \Rightarrow \quad (\omega_n)_{longitudinal} = 3{,}460\text{ rad/s}$$

torsional vibration

$$k_t = \frac{GJ_p}{l} = \frac{(80\times10^9\text{ N/m}^2)(34.56\times10^{-6}\text{ m}^4)}{0.20\text{ m}} = 13.824\times10^6\text{ N · m/rad}$$

$$\omega_n = \sqrt{\frac{k_t}{J}} = \sqrt{\frac{13.824\times10^6\text{ N · m/rad}}{12\text{ kg · m}^2}} = 1{,}073.3\text{ rad/s} \quad \Rightarrow \quad (\omega_n) = 1{,}073\text{ rad/s}$$

Longitudinal frequency is larger.