

Chapter 4

- 4-1** For a torsion bar, $k_T = T/\theta = Fl/\theta$, and so $\theta = Fl/k_T$. For a cantilever, $k_L = F/\delta$, $\delta = F/k_L$. For the assembly, $k = F/y$, or, $y = F/k = \theta + \delta$. Thus

$$y = \frac{F}{k} = \frac{Fl^2}{k_T} + \frac{F}{k_L}$$

Solving for k

$$k = \frac{1}{\frac{l^2}{k_T} + \frac{1}{k_L}} = \frac{k_T k_L}{k_T l^2 + k_L} \quad \text{Ans.}$$

- 4-2** For a torsion bar, $k_T = T/\theta = Fl/\theta$, and so $\theta = Fl/k_T$. For each cantilever, $k_L = F/\delta_1$, $\delta_1 = F/k_L$, and, $\delta_L = F/k_L$. For the assembly, $k = F/y$, or, $y = F/k = \theta + \delta_1 + \delta_L$. Thus

$$y = \frac{F}{k} = \frac{Fl^2}{k_T} + \frac{F}{k_L} + \frac{F}{k_L}$$

Solving for k

$$k = \frac{1}{\frac{l^2}{k_T} + \frac{1}{k_L} + \frac{1}{k_L}} = \frac{k_T k_L k_L}{k_T k_L l^2 + k_T k_L + k_T k_L} \quad \text{Ans.}$$

- 4-3 (a)** For a torsion bar, $k = T/\theta = GJ/l$.

Two springs in parallel, with $J = \pi d^4/32$, and $d_1 = d_2 = d$,

$$\begin{aligned} k &= \frac{J_1 G}{x} + \frac{J_2 G}{l-x} = \frac{\pi}{32} G \left(\frac{d_1^4}{x} + \frac{d_2^4}{l-x} \right) \\ &= \frac{\pi}{32} G d^4 \left(\frac{1}{x} + \frac{1}{l-x} \right) \quad \text{Ans. (1)} \end{aligned}$$

Deflection equation,

$$\theta = \frac{T_1 x}{JG} = \frac{T_2 (l-x)}{JG}$$

results in $T_1 = \frac{T_2 (l-x)}{x}$ (2)

From statics, $T_1 + T_2 = T = 1500$. Substitute Eq. (2)



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[Chemical Engineering Catalog](#) ,1918 [Friction, Wear, and Erosion Atlas](#) Kenneth G. Budinski,2013-11-06 Friction wear and erosion are major issues in mechanical engineering and materials science resulting in major costs to businesses operating in the automotive biomedical petroleum oil gas and structural engineering industries The good news is by understanding what friction wear or erosion mode predominates in a mechanism or device you can [Mechanical Engineering](#) ,1985

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Maintenance Engineering Handbook, Ninth Edition Keith Mobley,2025-08-22 The most complete and current guide to every aspect of maintenance engineering updated to reflect the latest advances in the industry The most comprehensive resource of its kind Maintenance Engineering Handbook has long been a staple for engineers managers and technicians seeking current advice on everything from tools and techniques to planning and scheduling Since the last edition was published there have been exponential technology advancements that directly affect maintenance and maintenance engineering function Recent changes in technology especially those of predictive analytics wireless cloud base data acquisition and smart sensors have radically changed the landscape of both engineering and maintenance management This updated edition integrates these advances into a comprehensive approach to maintenance management with proven

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