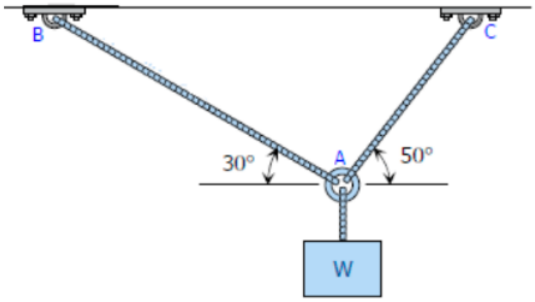
# Tutorial 8: Extension and torsion of cylinders

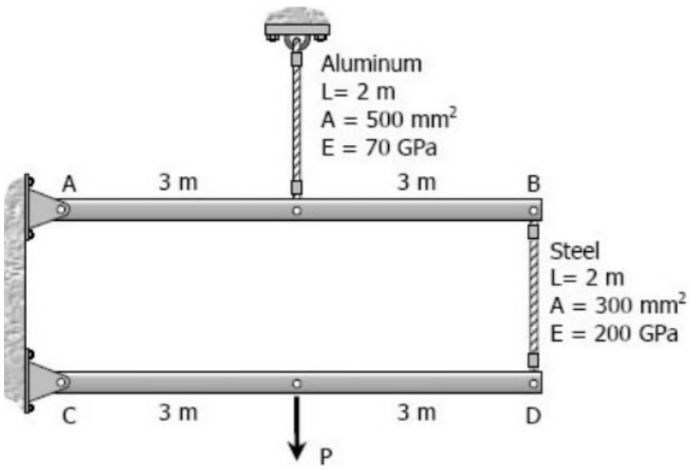
APL 104 - 2022 (Solid Mechanics)

1. Determine the largest weight W that can be supported by two wires shown in figure shown below. The stress in either wire is not to exceed 207N/mm$^2$. The cross-sectional areas of wires AB and AC are 258mm$^2$ and 323mm$^2$, respectively.



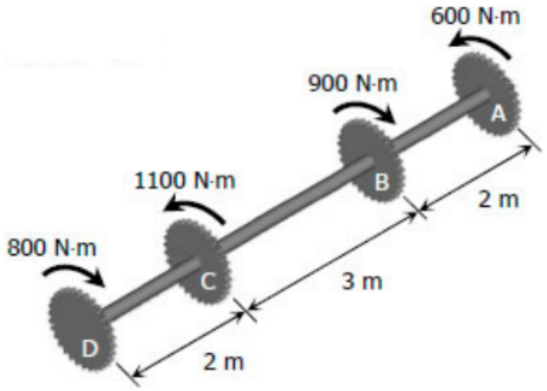

2. A round bar of length $L$, which tapers uniformly from a diameter $D$ at one end to a smaller diameter $d$ at the other, is suspended vertically from the large end. If $w$ is the weight per unit volume, find the elongation of $\omega$ the rod caused by its own weight. Use this result to determine the elongation of a cone suspended from its base.

3. The rigid bars AB and CD shown in figure below are supported by pins at A and C and the two rods. Determine the maximum force P that can be applied as shown if its vertical movement is limited to 5mm. Neglect the weights of all members.



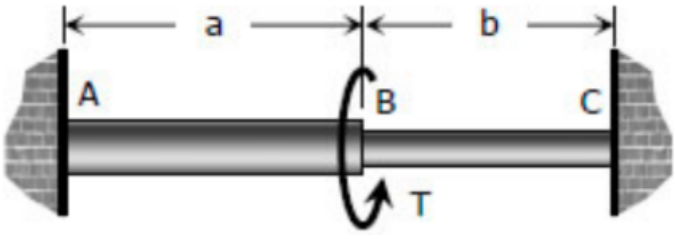
4. A 50.8mm diameter steel tube with a wall thickness of 1.27mm just fits in a rigid hole. Find the tangential stress if an axial compressive load of 1424kg is applied. Assume $\nu$ = 0.30 and neglect the possibility of buckling.

5. An aluminum shaft with a constant diameter of 50mm is loaded by torques applied to gears attached to it as shown in Fig. Using G = 28GPa, determine the relative angle of twist of gear D relative to gear A.




6. A hollow bronze shaft of 76.2mm outer diameter and 50.8mm inner diameter is slipped over a solid steel shaft 50.8mm in diameter and of the same length as the hollow shaft. The two shafts are then fastened rigidly together at their ends. For bronze, G = 7kN/mm$^2$, and for steel, G = 12kN/mm$^2$. What torque can be applied to the composite shaft without exceeding a shearing stress of 55N/mm$^2$ in the bronze or 82N/mm$^2$ in the steel?

7. The compound shaft shown in figure below is attached to rigid supports. For the bronze segment AB, the diameter is 75mm, $\tau \leq$ 60MPa, and G = 35GPa. For the steel segment BC, the diameter is 50mm, $\tau \leq$ 80MPa, and G = 83GPa. If a = 2m and b = 1.5m, compute the maximum torque T that can be applied.



8. A composite shaft is clamped at both its ends. It is composed of three sub-shafts as shown in figure below. The first part is made up of bronze (shear modulus $G_B$) and has length $L_B$ and radius $R_B$. The second part is made up of aluminium (shear modulus $G_A$) and has length $L_A$ and radius $R_A$. The third part is made up of steel (shear modulus $G_S$) and has length $L_S$ and radius $R_S$. There is a torque $T_1$ acting at the interface of aluminium and bronze parts and a torque $T_2$ acts at the interface of aluminium and steel parts. Both $T_1$ and $T_2$ act along $+\underline{e}_1$ direction. What is the maximum shear component of traction in each of the three shafts?