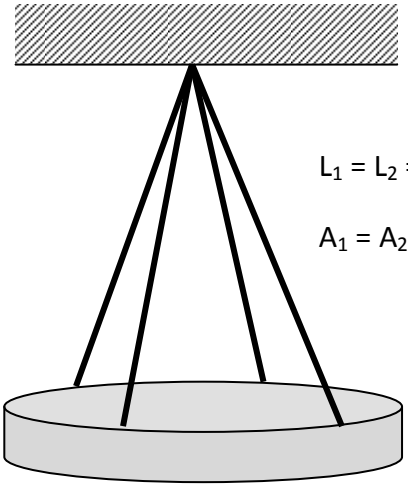
Problem 1a

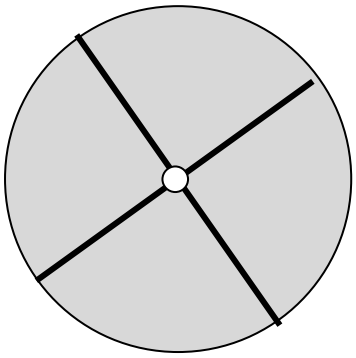
A cylinder of mass 10 kgs is suspended by four wires as shown. All wires are spaced apart equally along the circumference. Is the system statically determinate? If yes, why? If no, what assumption(s) can you make to find the stress in each wire? Find the stress in each wire.



$L_1 = L_2 = L_3 = L_4 = 0.8$ m

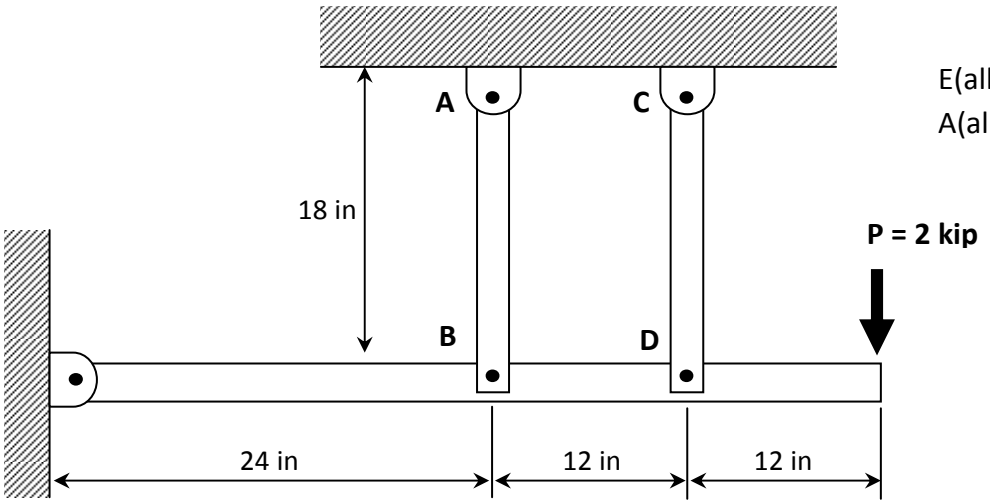
$A_1 = A_2 = A_3 = A_4 = 4$ mm^2

Top view



Problem 1b

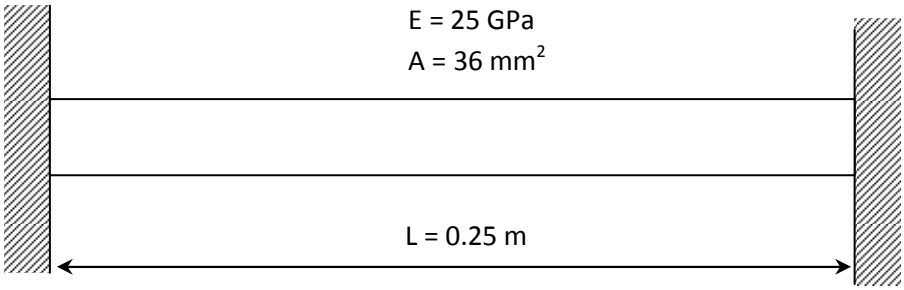
For the assembly shown below, what is the compatibility condition necessary to determine the reactions at the supports? What is the relationship between the elongations of bar AB (δ_{AB}) and CD (δ_{CD})? Assume small displacements and elongations, and that all bars remain straight.



E(all bars) = 25(10^3) ksi
A(all bars) = 1.5 in^2

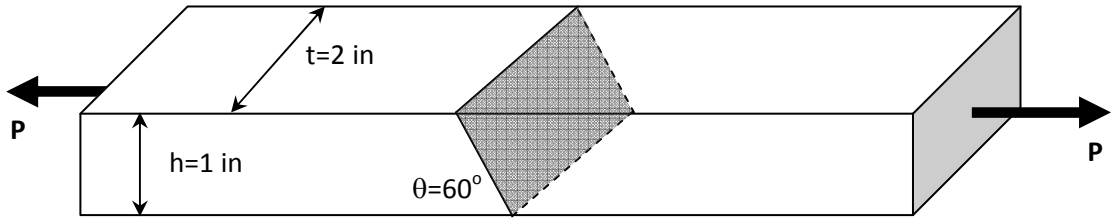
Problem 1c

The temperature of the bar shown is raised by 30 K. Hence find the internal axial loading that develops in the bar. Hence find the reaction forces the walls exert on the ends of the bar. Coefficient of thermal expansion $\alpha = 23 \times 10^{-6}\ K^{-1}$.



Problem 1d

For the given joint, find the average normal stress and shear stress acting on the glued plane. The load P = 2 kip. Thickness t = 2 in, and height h = 1 in.



Problem 2

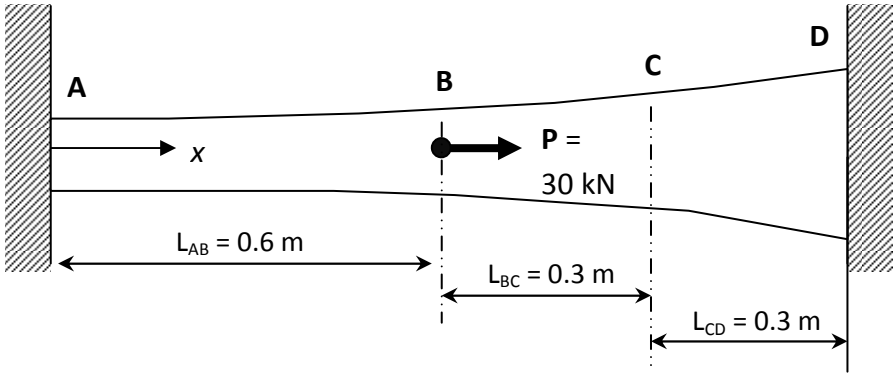
A bar AD with circular cross-section is anchored at both ends to walls. The radius of the bar varies as:

$$r(x) = r_A \exp\left(0.7\frac{x}{L}\right)$$

where r_A = 3 cm is the radius at end A, and x is the axial length measured from A. The load P = 30 kN acts on at the midpoint of the bar at B. Furthermore, the temperature of the bar is raised by 40 K.

(a) Show that this is a statically indeterminate configuration.
(b) What compatibility condition(s) do you need to use to find the end reactions at the walls?
(c) Find the end reactions that the walls at A and D exert on the bar.
(d) Find the average axial stress and displacement at C.

Given, coefficient of thermal expansion α = 38x10^{-6} K^{-1}, Young's modulus E = 210 GPa.



Problem 3

The machine component shown consists of a steel rod which is partially covered by an aluminum tube. The steel and aluminum is firmly bound at the interface. The end A is rigidly fixed to a wall. Torque loadings are present at B and C. The lengths $\mathbf{L_{AB}}$ = 100 mm, $\mathbf{L_{BC}}$ = 100 mm.

(a) Is the component statically determinate or indeterminate? Justify your answer.
(b) Using neat free body diagrams, report the torque the wall exerts on the component at A, the internal torque between AB, and the internal torque between BC.
(c) What fraction of the torque along AB is carried by the aluminum tube? Sketch the shear stress distribution at a section midway between A and B. Indicate the minimum and maximum shear stress values in each material.
(d) Find the angle of rotation at B and C.