ME2110 Mechanics of solids

(Assignment 1)

August 22, 2022

Deadline : August 29,2022, 23:59:59.

Question 1.

If a load of 60 kN is applied to a rigid bar suspended by 3 wires as shown in Fig. 1. What force will be resisted by each wire. The outside wire are of Aluminium, cross sectional area 600 mm^2 and length 6m. The central wire is Steel with area 400 mm^2 and length 12m. Initially there is no slack in the wire. $E = 2 \times 10^5 \ \frac{N}{mm^2}$ for steel, $E = 0.667 \times 10^5 \ \frac{N}{mm^2}$ for aluminium.

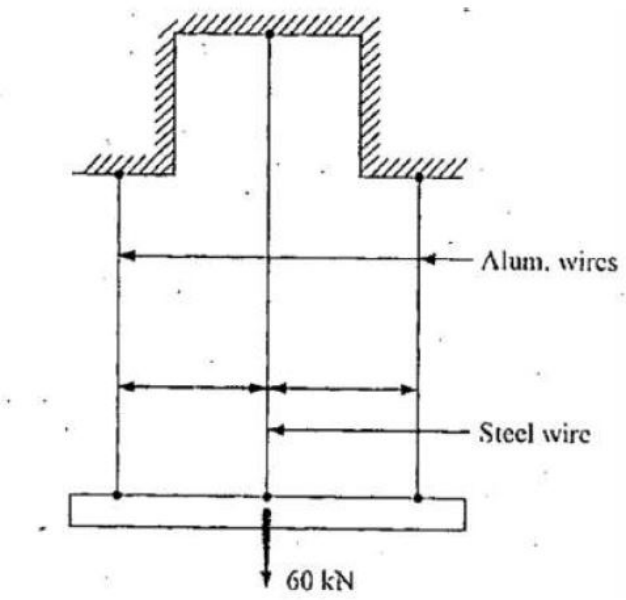

Figure 1: Question 1.

Question 2.

Assume a person's mass is 65 kg and each of person shoes has an area of 180 cm^2.
(a) What is the compressive stress $\frac{F}{A}$ on person feet if person weight is spread out evenly over both soles of person shoes?
(b) By what factor f does the compressive stress change if only 90 cm^2 of each shoe is in contact with the floor.

Question 3.

A hollow circular brass circular pipe ABC(as shown in Fig. 2) is loaded as $P_1 = 120$ kN acting at the top surface. Another load $P_2 = 100$ kN is uniformly distributed around the cap plate at B. The diameters and thicknesses of the upper and lower parts of the pipe are $d_{AB} = 32$ mm, $t_{AB} = 9$ mm, $d_{BC} = 60$ mm, and $t_{BC} = 10$ mm.

- Find the normal stress acting in AB and BC.
- The modulus of elasticity of brass is 97 GPa. When both the loads are applied, the wall thickness of BC increases by 6×10^{-3} mm. Find the increase in the inner diameter of the pipe segment BC.
- Find the bulk modulus of elasticity for the brass.
- Also find the increase in wall thickness of pipe segment AB and the increase in the diameter of AB.

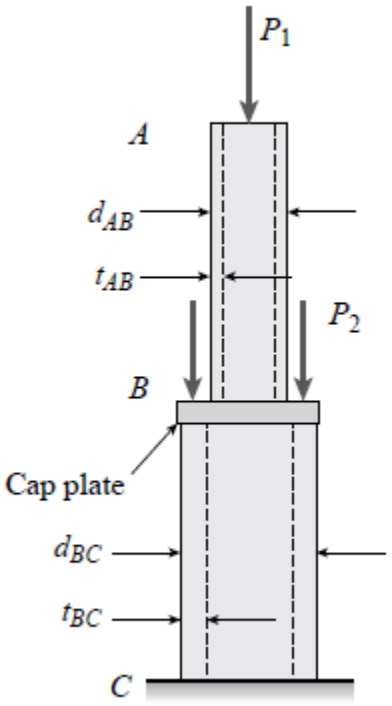

Figure 2: Question 3.

Question 4.

A specimen of steel 20 mm diameter with a gauge length of 200 mm is tested to destruction. It has an extension of 0.25 mm under a load of 80 kN and the load at elastic limit is 102 kN. The maximum load is 130 kN. The total extension at fracture is 56 mm and diameter at neck is 15 mm.
Find (a) The stress at elastic limit (b) Young's modulus (c) Percentage elongation (d) Percentage reduction in area (e) Ultimate tensile stress.

Question 5.

A steel bar of rectangular cross-section of 10 mm×40 mm carries a tensile load P and is attached to a support by means of round pin of diameter 15 mm as shown in Fig. 3. The allowable stresses for the bar in tension and pin in shear are $\sigma_{allow} = 120$ MPa and $\tau_{allow} = 60$ MPa respectively. What is the maximum permissible value of load P?

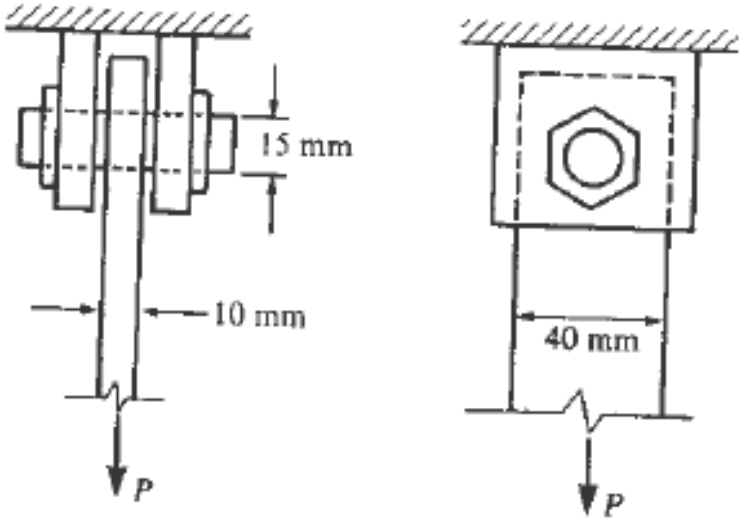

Figure 3: Question 5.

Question 6.

A wood pile,driven into the earth, supports a load P entirely by friction along its sides (as shown in Fig. 4). The friction force f per unit length of pile is assumed to be uniformly distributed over the surface of the pile. The pile has length L, cross-section A, and modulus of elasticity E. (a) Derive a formula for the shortening of the pile in terms of P, L, E and A (b) Draw a diagram showing how the compressive stress σ, varies throughout the length of the pile.

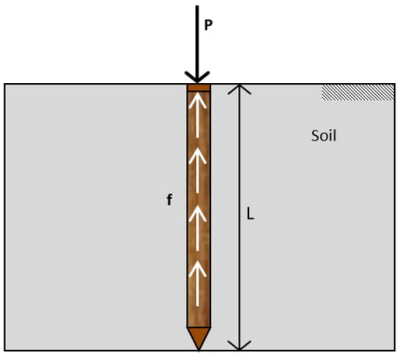

Figure 4: Question 6.

Question 7.

A round bar 15 mm diameter is made of aluminum alloy 7075-T6 ($E = 72$ GPa, $\nu = 0.33$). When the bar is stretched by axial force P, its diameter decreases by 0.010 mm. Find the magnitude of the load P.

Question 8.

A rigid bar ACDB is hinged at A and supported in a horizontal position by two identical steel wires as shown in Fig. 5 A vertical load of 30 kN is applied at B. Find the tensile forces T_1 and T_2 induced in these wires by the vertical load.

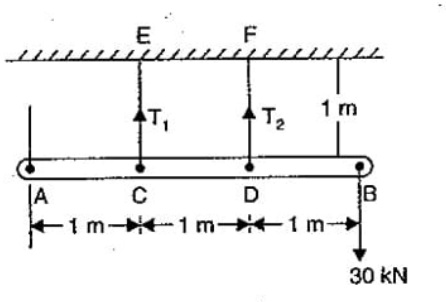

Figure 5: Question 8.

Question 9.

The cross section of a concrete corner column that is loaded uniformly in compression is shown in the Fig. 6 (a) Determine the average compressive stress σ_c in the concrete if the load is equal to 14234.3 kN. (b) Determine the coordinates

x_c and y_c of the point where the resultant load must act in order to produce uniform normal stress in the column.

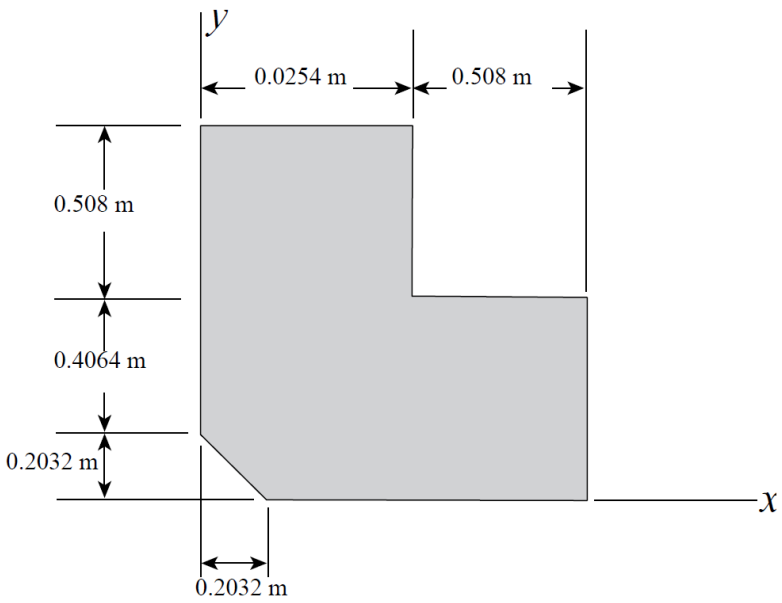

Figure 6: Question 9.