Solids Questions

Correct answers are given in **bold**

1. Calculate the minimum force required to move a block of weight 10N up a slope of 30° inclination, where the coefficient of friction between the block and the slope is 0.3:

(a) 3.0N
(b) 2.6N
(c) 1.5N
(d) 0.3N

2. A tapered steel bar with Young' Modulus of 208GPa is subjected to an axial load of 200kN. The cross-sectional area of the bar increases linearly from 400 to 1600mm^2 along its length of 1m. Calculate the strain at the midpoint of the bar.

(a) 0.096%
(b) 0.96%
(c) 9.6%
(d) 96%

3. A torque, having a moment of 8.5 kNm is transmitted between two flanged shafts by means of four 20 mm diameter bolts. What is the average shear stress in each bolt if the diameter, d, of the bolt circle is 150 mm?

(a) 30.1 MPa
(b) 90.2 MPa
(c) 301 MPa
(d) 902 MPa

4. A square reinforced concrete pier, 300 mm × 300 mm in cross-section and 2.5 m high, has eight steel reinforcing bars, each 20 mm square, placed symmetrically about the vertical axis of the column and running the full vertical height. If concrete has a Young's modulus 1/12th of that of steel, determine the stress in the concrete due to a downward axial load on the column of 400 kN.

(a) 38.3 MPa
(b) 27.3 MPa
(c) 6.38 MPa
(d) 3.19 MPa

5. A steel rod, 12 mm in diameter, has threaded ends and passes through a copper tube of 15 mm internal diameter, 25 mm external diameter and 1.2 m long. The ends of the tube are closed by rigid washers which are secured by nuts on the threaded ends of the steel rod. At room temperature, the nuts are tightened until the copper tube is reduced in length by 0.24 mm. The whole assembly is then raised in temperature by 50°C. Calculate the stress in the steel rod after the temperature rise. Assume E=207 GPa and α=11.10-6 $°C^{-1}$ for steel; and E=103 GPa and α=17.5.10-6 $°C^{-1}$ for copper.

(a) 96.2 MPa
(b) 57.2 MPa
(c) 34.7 MPa
(d) 24.6 MPa

6. An I-section girder, 250 mm deep overall, has a web 10 mm thick. The top flange is 160 mm × 15 mm and the bottom flange is 190 mm × 15 mm. If the girder is simply supported at its ends, determine the maximum span which can be used if the total distributed load per metre is 6 kN and the maximum stress is limited to 70 MPa.

(a) 4.32m
(b) 5.72m
(c) 6.41m
(d) 7.57 m

7. A tank, 1.5 m x 1.5 m and 1.3 m deep, is supported symmetrically by a pair of steel cantilevers, 1.5 m long which it completely covers. The cantilevers are of T-section of 130 mm x 130 mm overall section and thickness 12 mm. If the maximum tensile stress is not to exceed 70 MPa, determine the maximum safe depth to which the tank may be filled with oil of density 900 kgm^{-3}.

(a) 0.12 m
(b) 1.22 m
(c) 2.44 m
(d) 4.88 m

8. At a point in an elastic material, normal stresses of 50 MPa tension and 30 MPa compression are applied on planes at right angles to one another. If the maximum principal stress is not to exceed 60 MPa, determine the maximum shear stress that may be added to the given planes

(a) - 50 MPa
(b) ± 20 MPa
(c) ± 30 MPa
(d) 60 MPa

9. A stepped shaft, 0.6 m long is 75 mm in diameter for 0.25 m of its length and 120 mm diameter for the remainder of its length. The shaft is fixed at both ends and a torque of 700 Nm is applied at right angles to its longitudinal axis at the change of section. Determine the maximum shear stress in the shaft.

(a) 0.6 MPa
(b) 1.7 MPa
(c) 3.4 MPa
(d) 17 MPa

10. A stepped shaft, 2.5 m long has a diameter of 75 mm for half of its length and 60 mm over the remainder of its length. It transmits power under a uniform torque while rotating at 300 rev/min. Calculate the maximum power that can be transmitted by the shaft, satisfying the following two conditions:

(i) the shear stress must not exceed 70 MPa in any part of the shaft; and

(ii) the total angle of twist over the whole length of the shaft must not exceed 2°. Assume E = 80 GPa.

(a) 63.3 kW
(b) 12.6 kW
(c) 24.7 kW
(d) 1.2 GW