GX640

OLLSCOIL NA hÉIREANN
The National University of Ireland

National University of Ireland, Galway

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Third Year Mechanical and Biomedical Engineering Examination

MECHANICAL ANALYSIS & DESIGN

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Attempt *Five* Questions
Time Allowed: 3 Hrs.
Graph Paper is available and a set of Useful Formulae is provided.

1(a) Derive equations for the principal stresses and maximum shearing stresses on plane AB as shown in Figure 1(a). ***(10)***

(b) Sketch a Mohr circle for the stress state shown in Figure 1(b) and find the principal stresses, the maximum shear stress and the angular orientation of the planes upon which these stresses act. ***(10)***

σ_x = 8 MPa compressive
σ_y = 12 MPa tensile
τ_{xy} = 3 MPa (cw)
τ_{yx} = 3 MPa (ccw)

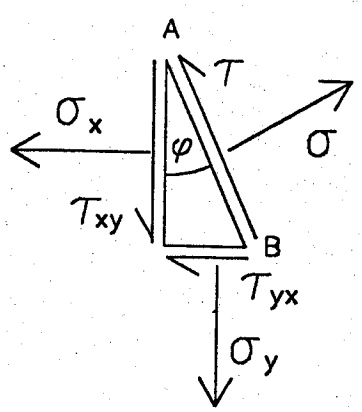

Figure 1(a)

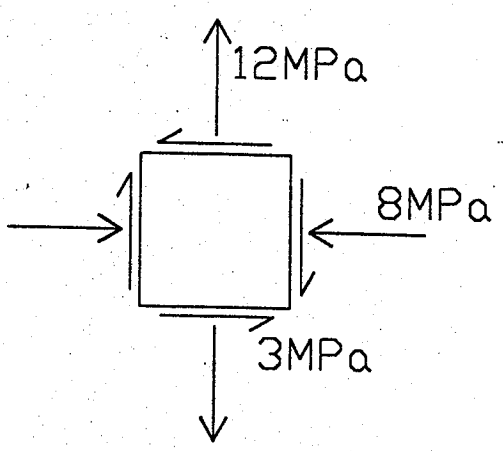

Figure 1(b)

2. The torsion bar spring below is to be loaded statically by forces **F** = 40N and by a torque **T** which varies from O to 10N. The material has a yield strength of 800 MPa, an ultimate strength of 1200MPA and the unmodified endurance limit Se^1 may be taken as 600MPa. The 2.5m long body of the spring has a hot-rolled surface finish. The geometric stress concentration factors at the shoulders are 1.68 for bending and 1.42 for torsion. Determine a suitable diameter D of the nearest millimetre using a factor of safety of 2.5

(20)

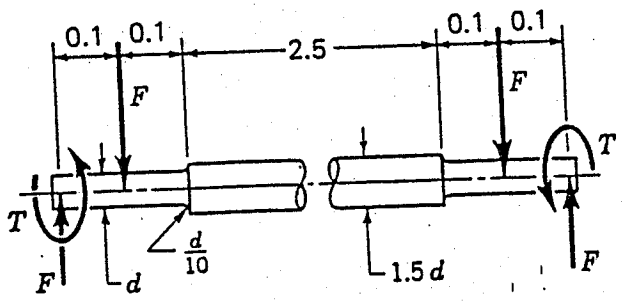

FIGURE 2

3. Figure 3 shows a hydraulic cylinder in which D = 100mm, t = 10mm, L =300mm and w = 20mm. Both end brackets as well as the cylinder are made of steel. The cylinder has been designed for a working pressure of 4MPa. Five M12 x 1.75 metric grade 5.8 bolts are used, tightened to 75 per cent of the proof load

(a) Find the stiffness of the bolts and members assuming that the entire cylinder is compressed uniformly and that the end brackets are perfectly rigid.

(4)

(b) Find the mean and alternating stresses in the bolts.

(4)

(c) Find the endurance limits of the bolts based on 50% reliability

(4)

(d) What factor of safety gurads against:

(i) static failure *(4)*

(ii) fatigue failure *(4)*

Assume Young's modulus for the bolt and cylinder steel is 207GPa.

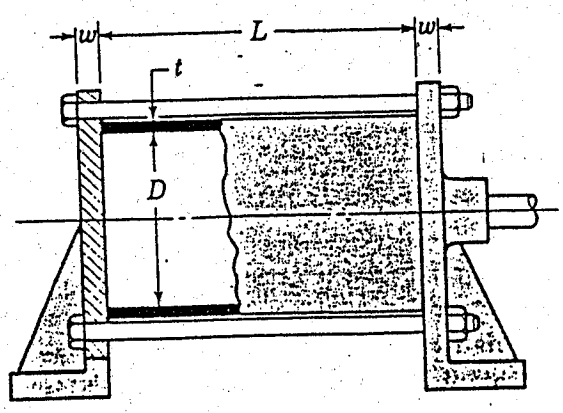

FIGURE 3

4. An unpeened extension spring is made of 0.60 mm music wire and has an outside diameter of 4.8 mm. The spring is wound with a pretension of 1.10 N and the load fluctuates between this value and 6.8 N.

Since the spring might fail statically or in fatigue, find the factor of safety for both types of failure.

5. A centrifugal pump is driven through a speed reducing gearset. The 20 tooth hobbed pinion with 20° full depth teeth rotates at 1450 rpm and meshes with a 50 tooth hobbed gear. Both gears are manufactured from steel with a Brinell hardness of 200 and an ultimate tensile strength of 600 MPa. The gears have a face width of 50 mm and module of 8 mm.

Determine the maximum power that can be safely transmitted, based on both bending and contact strengths i.e. fatigue and wear.

Use a factor of safety n = 2.5, a reliability of 95%, and an elastic coefficient, C_p, of 190×10^3 N/m. Also, assume direction of gear rotation as one-way only.

6. An internal expanding-rim-type brake is shown in Figure 6. The drum diameter is 250 mm, R is 100 mm and the shoe face width is 50 mm. The material used has a coefficient of friction of .24 and permits a maximum pressure of 1.2 MPa.

i) Calculate the actuating force. *(8)*
ii) Calculate the braking capacity. *(6)*
iii) Calculate the hinge pin reactions. *(6)*

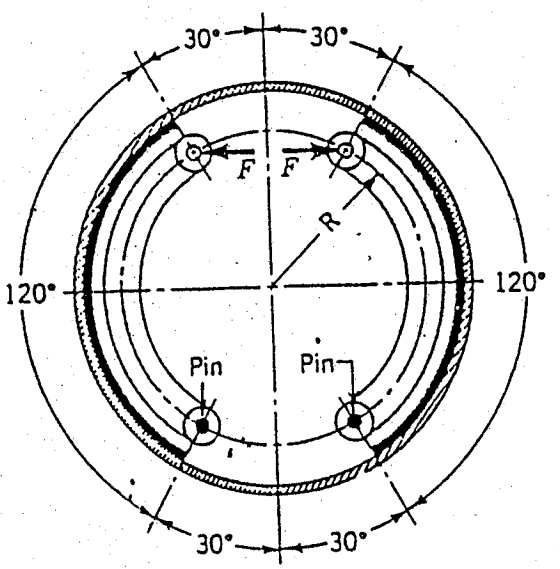

FIGURE 6

7(a) Discuss the difference between boundary lubrication and hydrodynamic lubrication in terms of stability

(5)

(b) Sketch a general assembly layout of a single impression mould for a plastic container which is spruegated and uses stripper plate ejection. Show cooling arrangements for the cavity and core. Name all mould parts.

(10)

(c) Explain, using an example, the function of the Gannt chart in project management.

(5)