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Mechanics of Materials-II

6th Semester---- (Session 2007)

Problem Sheet #6

Pb.1 The cylinder of a hydraulic ram is 254 mm internal diameter and 50 mm thick. Find the maximum hoop stress in the material and the radial and hoop stress at a point in the barrel 19 mm from the inner surface when the fluid pressure inside the cylinder is 9.24 MN/m2.
(Ans: 28.83 MN/m2, -4.6 MN/m2, 24.2 MN/m2)

Pb.2 Determine the radial and hoop stresses at all points in a thick-walled cylinder of internal and external radii 76 mm and 152 mm respectively, when acted upon by internal and external pressures of 124 MN/m2 and 46 MN/m2 respectively. Show by means of a diagram how each stress varies over the thickness. For your distribution you may calculate the hoop and radial stresses at radii 76, 100, 125 and 152 mm.

Ans : For $r = 76$ mm $\sigma r = -124$ MN/m2 & $\sigma h = 84$ MN/m2
For $r = 152$ mm $\sigma r = 84$ MN/m2 & $\sigma h = 6$ MN/m2

Pb.3 A thin spherical steel vessel is made up of two hemispherical portions bolted together at flanges. The inner diameter of the sphere is 300mm and the wall thickness is 6mm. Assuming that the vessel is a homogeneous sphere, what is the maximum working pressure for an allowable tensile stress in the shell of 150Mpa? If twenty bolts of 16mm diameter are used to hold the flanges together, what is the tensile stress in the bolts when the sphere is under full pressure? (Ans: 12MPa; 211MPa)

Pb.4 A compound tube is made by shrinking one tube on another, the final dimensions being:- External diameter - 254 mm, Internal diameter - 150 mm, Diameter at junction of tubes - 228 mm. If the radial pressure on the external surface of the inner tube at the common 114 mm radius is 27.58 MN/m2, determine the maximum tensile stress in the material of the outer tube. (Ans: 257 MN/m2)

Pb.5 Determine the k ratio for a thick-walled cylinder subjected to an internal pressure of 80MPa if the circumferential stress is not to exceed 140MPa. What are the maximum shear stresses at the inside and outside surfaces? (Ans: 1.915; 110MPa, 30MPa)

Pb.6 In a pressure test on a hydraulic cylinder 120mm external diameter and 60mm internal diameter the hoop and longitudinal strains are measured by means of strain gauges on the outer surface and found to be 266×10^{-6} and 69.6×10^{-6} respectively for an internal pressure of 100MPa. Determine the actual hoop stress at the outer surface and compare this result with the calculated value. Determine also the safety factor for the cylinder according to the maximum shear stress theory. The properties of the cylinder material are as: $\sigma_P = 280$MPa; E= 208 GPa; v= 0.29. (Ans: 65MPa, 66.67MPa 1.05)

Pb.7 Show the tangential and radial stress distribution caused by the internal pressure 10MPa using Lame formula. Also compare this tangential stress distribution with that obtained by the approximate formula for tin walled cylinders if (a) k=1.1 & if (b) k=4.

[Ans: (a) $(\sigma_t)_{max}$ = 105.24MPa $(\sigma_t)_{min}$ = 95.24MPa, $(\sigma_t)_{thin}$ = 100M
(b) $(\sigma_t)_{max}$ = 11.33MPa $(\sigma_t)_{min}$ = 1.33MPa, $(\sigma_t)_{thin}$ =3.33MPa;]

Pb.8 A 750mm diameter penstock has a wall thickness of 12mm & connects a reservoir at A with a generation station at B as shown.(Fig will be discussed in class). Knowing that the specific weight of water is 10^4 N/m^{3,} determine the maximum normal stress & maximum shearing stress in penstock under static conditions.

(σ_l = 18.75 N/mm^2 , σ_h = 37.5 N/mm^2 , τ_{max} = 9.37 N/mm^2

Pb.9 show that the ratio of the maximum tangential stress to the average tangential stress for a cylinder subjected to internal pressure is $(1+K^2)/(1+k)$, where $k=r_o / r_i$

Pb.10 Show that no matter how large the outside diameter of a cylinder, subjected only to internal pressure, the maximum tangential stress is not less than p_1.(Hint: let $r_o \rightarrow \infty$)

Pb.11 A steel pipe whose external diameter & thickness are respectively 318.75mm & 9.375mm carries a water pressure of 2.8MPa. Determine the maximum tensile stress induced in the pipe. By what percent this stress will reduce if the thickness of pipe is increased by 33 %.

(44.8 MPa, 26.37%)

Pb.12 A thick-walled steel cylinder having an inside diameter of 150mm is to be subjected to an internal pressure of 40MPa. Find to the nearest mm the out side diameter required if the hoop tension in the cylinder wall is not to exceed 125MPa. Find also the hoop stress at the outer surface of the cylinder. (Ans: 209mm, 85MPa)

Pb.13 The maximum stress permitted in a thick cylinder, radii 80mm and 120mm, is 20MPa. The external pressure is 6MPa what internal pressure can be applied? Plot curves showing the variation of hoop and radial stresses through the material.

Pb.14 An undersea research vehicle has a spherical pressure hull 1m radius and shell thickness of 34mm.the pressure hull is made of a certain steel having yield point of 690MPa. Determine the depth of submergence that could set up the yield point stress in the spherical shell. Density of water is 1000Kg/m^3. (Ans: 4783m)

Pb.15 A thin cylinder shell, 1.5m internal diameter, 2.4m long, plates 25mm thick, is under Internal pressure of 1MPa. Assuming the end plates are rigid, find the changes in length and diameter. E = 206GPa; v=0.267. (Ans: 0.081mm; 0.19mm)

Pb.16 A thick cylinder 200mminternal diameter is subjected to an internal pressure of 3.55MPa. If the allowable stress is 24MPa, find the thickness required.

(Ans: 16.1mm)