GLASGOW CALEDONIAN UNIVERSITY

School of Engineering & Built Environment

ENGINEERING DESIGN & ANALYSIS 2 (M2H721926)

Tutorial: Thin Cylinders and Shells

1. Determine the hoop and longitudinal stresses set-up in a thin boiler shell of circular cross-section, 5 m long, 25 mm wall thickness and 1.3 m internal diameter when the internal pressure reaches a value of 240 kN/m^2. What will be the change in internal diameter and length given that E = 210 GN/m^2 and $\nu = 0.3$.?

2. Determine the change in volume of a thin cylinder of original volume 65.5 x 10^{-3} m^3 and length 1.3 m if its wall thickness is 6 mm and the internal pressure is 1.4 MN/m^2. For the cylinder material: E = 210 GN/m^2 and $\nu = 0.3$.

3. What must be the wall thickness of a thin spherical vessel of diameter 1 m if it is to withstand an internal pressure of 7MN/m^2 and the hoop stresses are limited to 270 MN/m^2.

4. A closed cylindrical vessel with plane ends is made from steel plate 3 mm thick. The internal length is 600 mm and the internal diameter is 250 mm. For the cylinder material, E = 208 GN/m^2 and $\nu = 0.3$. When an internal pressure of 2.4 MN/m^2 is applied, determine:

   i) the hoop and axial stresses in the shell;

   ii) the change in length and diameter;

   iii) the change in volume.

5. A closed steel cylinder is to be designed for an internal pressure of 5 MN/m^2. The internal diameter is 250 mm and the increase in the internal diameter is not to exceed 0.1 mm. For the cylinder material, E = 210 GN/m^2 and $\nu = 0.3$. Determine:

   i) the maximum wall thickness required;

   ii) the maximum value of tensile stress developed.

6. A thin cylinder 75 mm internal diameter, 250 mm long with walls 2.5 mm thick is subjected to an internal pressure of 7 MN/m^2. The cylinder material has a value E = 200 GN/m^2 and $\nu = 0.3$.

   (a) Determine the change in internal diameter and the change in length.

   (b) If, in addition to the internal pressure, the cylinder is subjected to a torque of 200 Nm, find the magnitude and nature of the principal stresses set up in the cylinder.

7. A rotating ring of mean radius 260 mm is used in a food processing plant. The maximum allowable hoop stress in the ring material is limited to 40 MN/m^2 with a factor of safety of 2 employed. Determine the maximum speed of rotation of the ring. The density of the ring material is 7800 kg/m^3.

Tutorial : Thin Cylinders and Shells - Answers

1. i) 6.24 MN/m^2; 3.12 MN/m^2; 0.033 mm; 0.03 mm
2. 17.6×10^3 mm^3
3. 6.48 mm
4. i) 100 MN/m^2; 50 MN/m^2; ii) 0.0577 mm; 0.1022 m; iii) 27×10^3 mm^3
5. i) 6.38 mm; ii) 98 MN/m^2
6. (a) 0.0334 mm; 0.0262 mm (b) 105.4 MN/m^2; 52.15 MN/m^2
7. 3800 rev/min