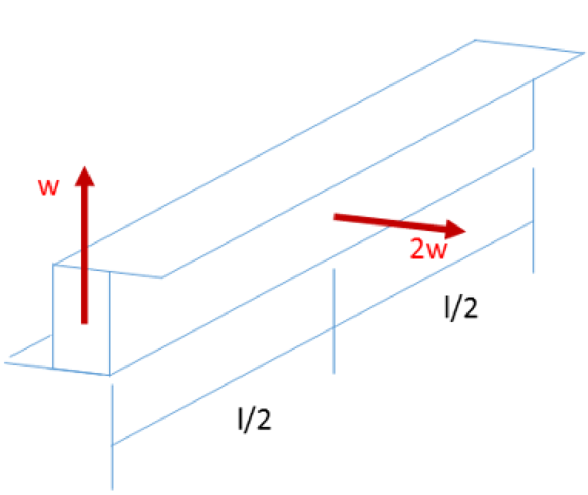
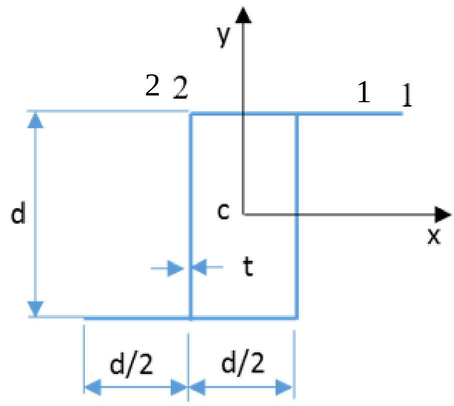
EXERCISES

2.1. A thin-walled cantilever beam is clamped at one end, the opposite tip is subjected to a vertical force W, a force 2W is applied at the mid-section, both forces acting through the shear centre. The cross-section is composed by thin walls of constant thickness as shown in the figure. Determine the distribution of normal stresses along the length of the beam for the points 1 and 2 of the cross-section.

The wall thickness t can be considered as very small in comparison with d.





Ans. $\sigma_{z,1\,max} = -1.85 \cdot w \cdot L/(t \cdot d^2)$, $\sigma_{z,2\,max} = -0.63 \cdot w \cdot L/(t \cdot d^2)$

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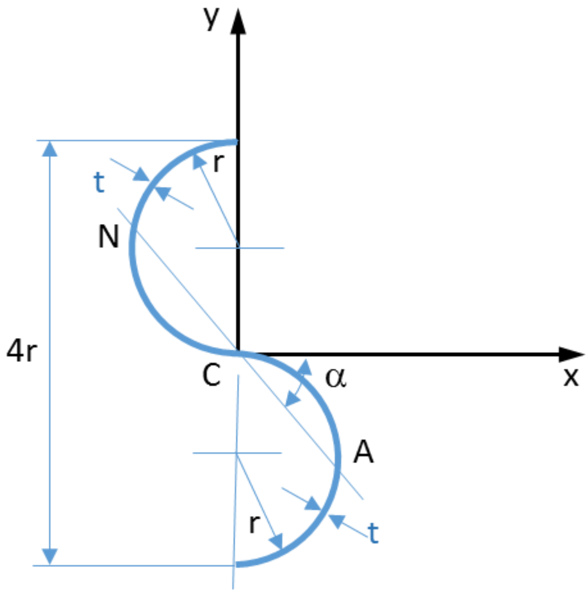
2.2. A cross-section of a beam is shown in the figure. The cross-section is composed by thin walls of constant thickness t as shown in the figure. Find the position of the neutral axis and calculate the maximum normal stress for a bending moment Mx = 3.5N·m applied about the horizontal axis Cx.
Take r =5 mm, t =0.64 mm.

The wall thickness t can be considered as very small in comparison with r.



Ans. $\sigma_{z\,max}$ = 101 MPa

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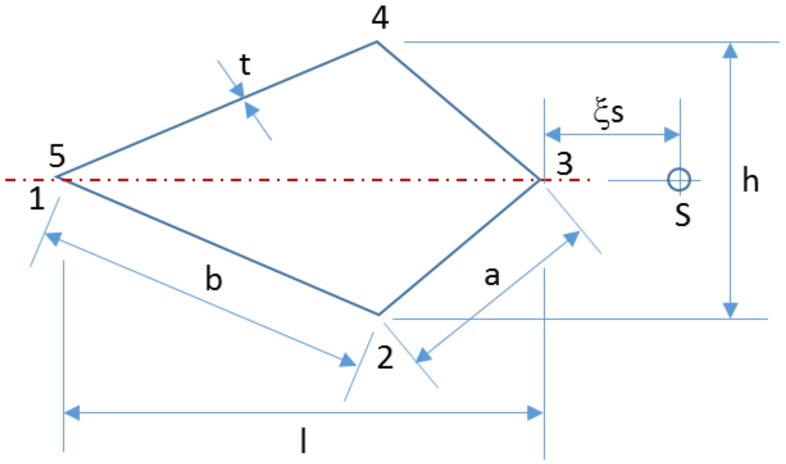
2.3. The next figure shows the singly symmetrical cross-section of a thin-walled open section beam of constant wall thickness t, which has a narrow longitudinal slit at the corner 1-5.

Calculate and sketch the distribution of shear flow due to a vertical shear force Sy acting through the shear centre S and note the principal values.

Show also that the distance ξ_S of the shear centre from the nose of the section is

$$\xi_S = \frac{l}{2\left(1+{}^{a}\!/_{b}\right)}$$



Ans. $q_{max} = 3 \cdot Q_y/(2 \cdot h)$

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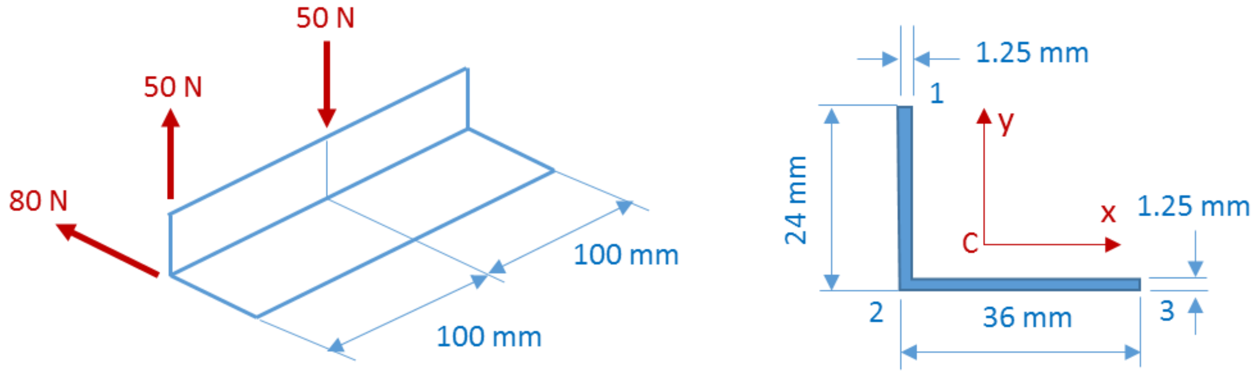
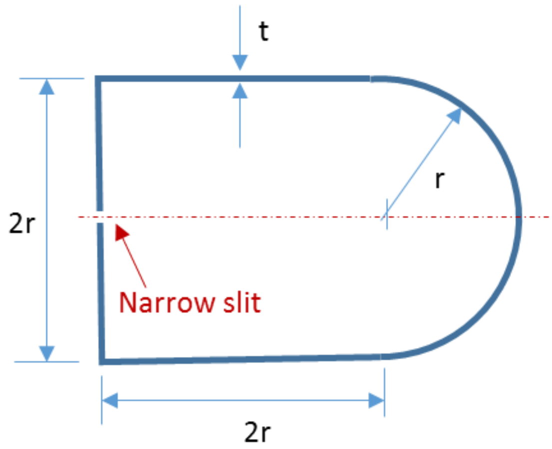
2.4. A thin-walled cantilever beam is clamped at one end, the opposite tip is subjected to a horizontal force of 80N and a vertical force of 50N, a force of 50 N is applied at the mid-section. The cross-section is composed by thin walls of constant thickness as shown in the figure. Calculate the normal stresses along the length of the beam at the points 1, 2 and 3 of the cross-section.

The wall thickness can be considered as very small in comparison with the other cross-sectional dimensions.



Ans. At built-in end, $\sigma z(1) = -11.4$ N/mm², $\sigma z(2) = -18.9$ N/mm², $\sigma z(3) = 39.1$ N/mm²
Half-way, $\sigma z(1) = -20.3$ N/mm², $\sigma z(2) = -1.1$ N/mm2, $\sigma z(3) = 15.4$ N/mm2.

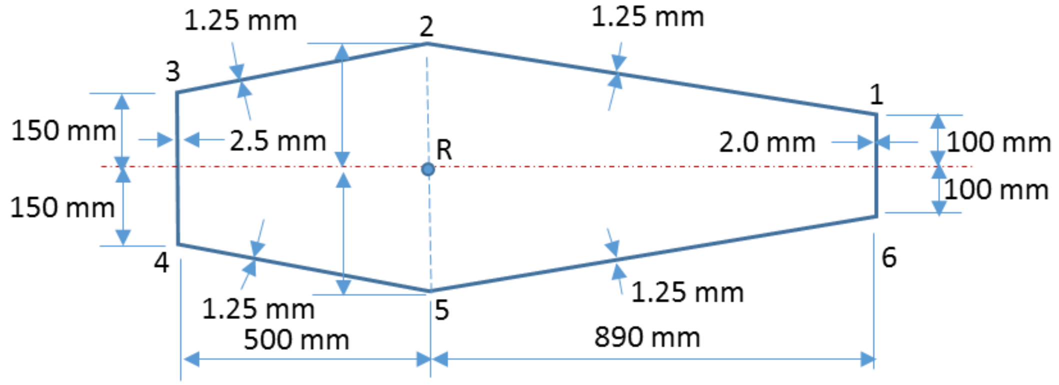
2.5. Define the term 'shear centre' of a thin-walled open section and determine the position of the shear centre of the thin-walled open section shown in the figure



Ans. 2.66r from centre of semicircular wall

2.6. A cross-section of a beam is shown in the figure. The closed cross-section is composed by thin walls. The section is subjected to a torque of 90500 Nm. Calculate the torsion rotation of the section and the maximum shear stress.

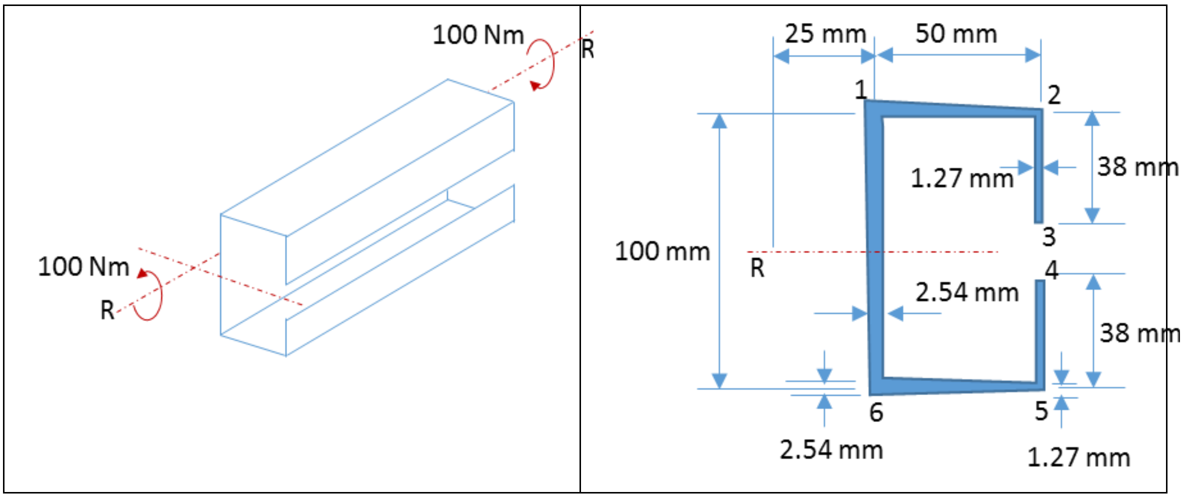
Take G = 27500 N/mm².



Ans. τ_{max} = 0.42/(r·t²)

2.7 The next figure shows the cross-section of a thin-walled beam. The thicknesses of walls are shown in the figure. The beam has an enforced axis of twist RR' and it carries a torque of 100Nm. Calculate the maximum shear stress (stress concentrations at the corner can be ignored).

Take G = 26700 N/mm².



Ans. τ_{max} = 297.36 MPa

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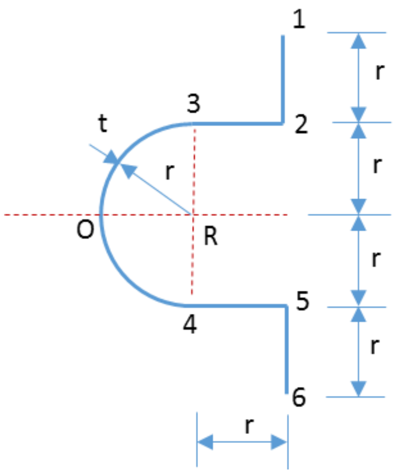
2.8. A cross-section of a beam is shown in the figure. The cross-section is composed by thin walls of constant thickness t as shown in the figure. The cross-section is subjected to a torque about an axis through R (the centre of the semicircular wall). Calculate the maximum shear stress.

The wall thickness t can be considered as very small in comparison with r.



Ans. $\tau_{max}=\pm\ 0.42/rt^2$

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