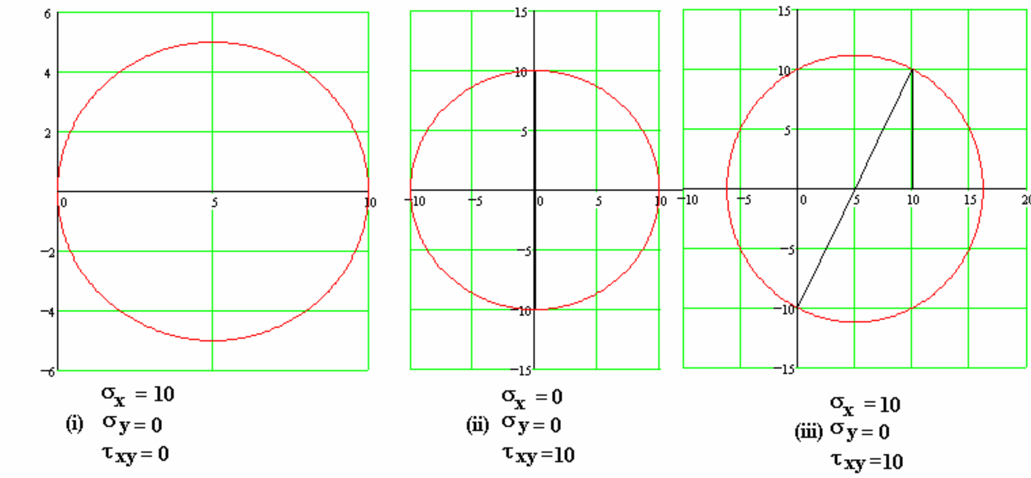
SOLUTIONS D209 2001

1.a Sketch Mohr's circle for a dimensional stress system in which:

(i) $\sigma_x = 10$ $\sigma_y = 0$ $\tau_{xy} = 0$
(ii) $\sigma_x = 10$ $\sigma_y = 0$ $\tau_{xy} = 10$
(iii) $\sigma_x = 10$ $\sigma_y = 0$ $\tau_{xy} = 10$



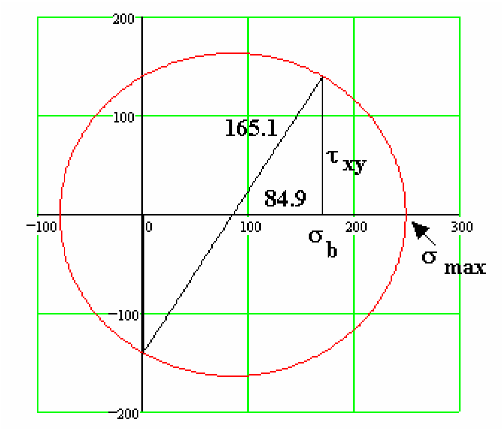
1.b A hollow shaft is 40mm outer diameter and 20 mm inner diameter. It is subjected to a bending moment of 1 000 Nm. It also transmits a torque. Calculate the maximum torque allowed if
(i) the maximum direct stress is 250 MPa.
(ii) the maximum shear stress is 125 MPa.

D = 0.04 m d = 0.02 m $I := \frac{\pi \cdot (D^4 - d^4)}{64}$ $I = 117.9 \times 10^{-9}$ m^4

BENDING STRESS M = 1000 kNm $\sigma_b = \pm My/I$ y = D/2 = 0.02 m $\sigma_b = \pm 169.8$ MPa

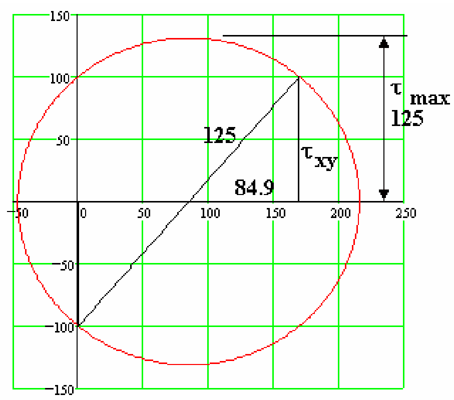
For torsion $J := \frac{\pi \cdot (D^4 - d^4)}{32}$ $J = 235.6 \times 10^{-9}$ m^4

(i) At a point on the surface where the bending stress is 169.8 MPa with a maximum direct stress of 250 MPa Mohr's circle is as shown. From this the shear stress is $\tau_{xy} = \sqrt{(165.1^2 - 84.9^2)} = 141.6$ MPa MPa



From the torsion equation Torque = T = τ J/R R =D/2 = 0.02 m
T = $(141.6 \times 10^6 \times 235.6 \times 10^{-9})/0.02 = 1.668$ kN m

(ii) The radius of the circle is the max shear stress so drawing the circle we get the following.



$\tau_{xy} = \sqrt{(125^2 - 84.9^2)} = 91.74$ MPa
From the torsion equation Torque = T = τ J/R R =D/2 R= 0.02 m

T = $(91.74 \times 10^6 \times 235.6 \times 10^{-9})/0.02 = 1.08$ kN m