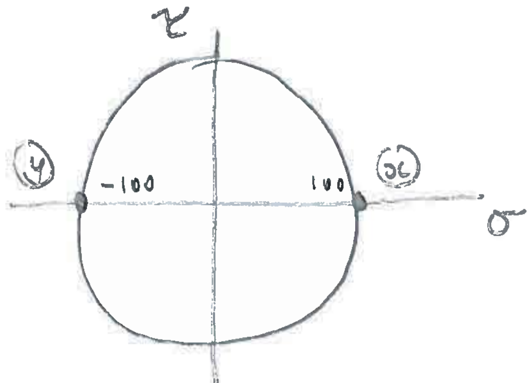
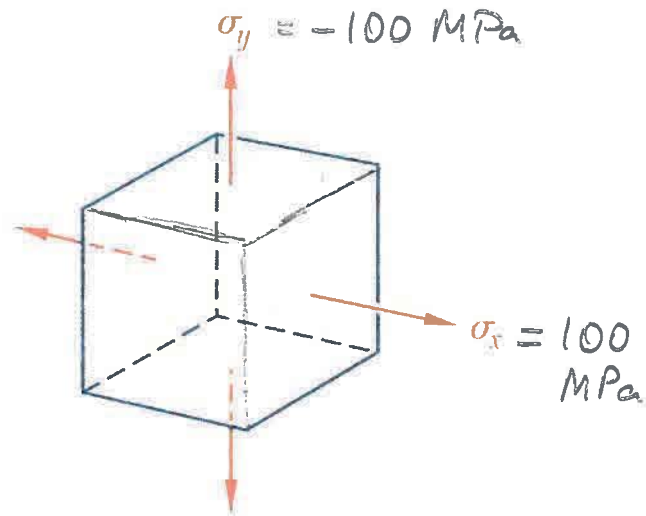
SA 4. A 150mm steel cube is loaded by stresses σ_x = 100 MPa and σ_y = −100 MPa. Draw a labeled Mohr's circle and use the Tresca criterion to determine the safety factor against yielding.





Tresca: $\max\left(|\sigma_1-\sigma_2|, |\sigma_2-\sigma_3|, |\sigma_3-\sigma_1|\right) = \frac{\sigma_Y}{SF}$

Here $\sigma_1 = 100$ MPa, $\sigma_2 = -100$ MPa, $\sigma_3 = 0$ $\quad \sigma_Y = 250$ MPa

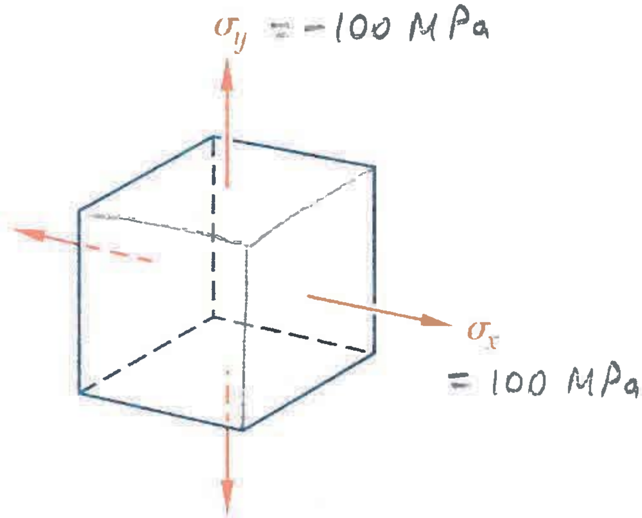
from formula sheet.

$\rightarrow \max\left(|100+100|, |-100-0|, |0-100|\right) = \frac{250}{SF}$

$= \max(200, 100, 100) = \frac{250}{SF}$

$\rightarrow SF \quad \frac{250}{200} = 1.25$

SA 5. The same 150mm steel cube as in SA4 is loaded by the same stresses σ_x = 100 MPa and σ_y = −100 MPa. Determine the change in volume caused by the applied stresses. Comment on your result.



Use multiaxial Hooke's Law to determine strains

$$\varepsilon_x = \frac{1}{E}\sigma_x - \frac{\nu}{E}\sigma_y - \frac{\nu}{E}\sigma_z$$

$$\varepsilon_y = -\frac{\nu}{E}\sigma_x + \frac{1}{E}\sigma_y - \frac{\nu}{E}\sigma_z$$

$$\varepsilon_z = -\frac{\nu}{E}\sigma_x - \frac{\nu}{E}\sigma_y + \frac{1}{E}\sigma_z$$

σ_x = 100 MPa
σ_y = −100 MPa
σ_z = 0

Volumetric strain $e = \varepsilon_x + \varepsilon_y + \varepsilon_z$

(sub. above formulas) $e = (1-2\nu)(\sigma_x + \sigma_y + \sigma_z)$

$e = (1-2\nu)(100 - 100 + 0)$

$e = 0$

→ Volume change is zero

This result is expected because Mohr's circle shows that opposite biaxial stress corresponds to a pure shear stress at ±45°. Such shearing produces only change in shape but no change in volume.