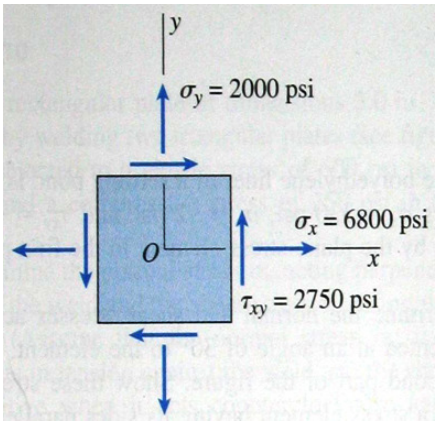
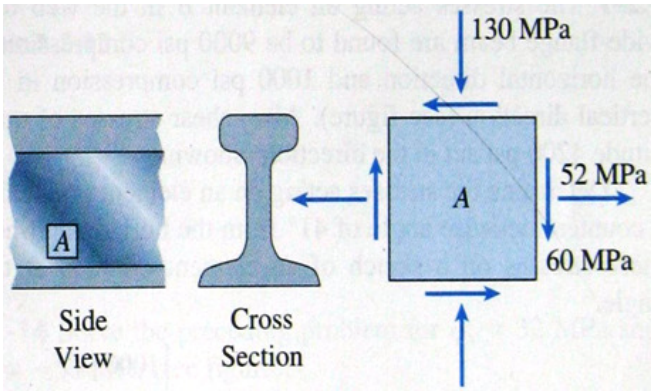
EGBE260 Homework: Week 13, Analysis of Stress and Strain

7.2-1. An element in plane stress si subjected to the stresses shown below. Determine the stress acting on an element oriented at an angle θ=60° from the x axis, where the angle θ is positive when counterclockwise. Show these stresses on a sketch of an element oriented at an angle θ.



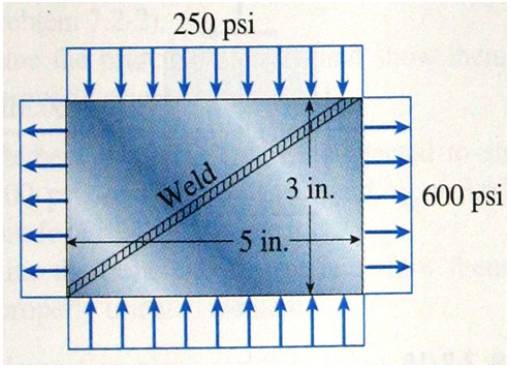
Answers: σ_{x1} = 5580 psi, τ_{x1y1} = -3450 psi.

7.2-4. The stresses acting on element A in the web of a train rail are found to be 52 MPa tension in the horizontal direction and 130 MPa compression in the vertical direction. Also, shear stresses of magnitude 60 MPa act in the direction shown. Determine the stresses acting on an element oriented at a counterclockwise angle of 48° from the horizontal. Show these stresses on a sketch of an element oriented at this angle.



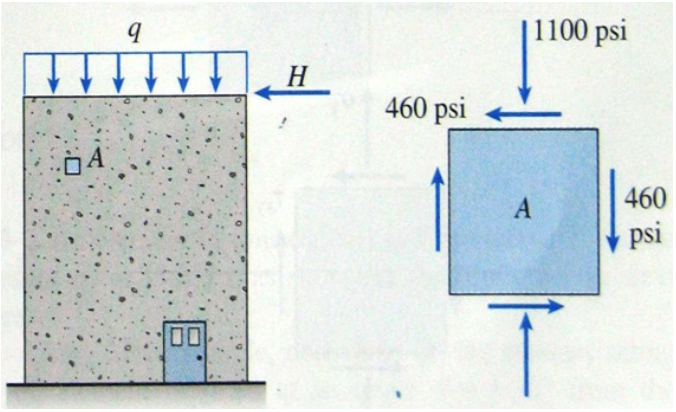
Answers: σ_{x1} = -108.2 MPa, τ_{x1y1} = -84.2 MPa.

7.2-11. A rectangular plate of dimensions 3.0 in x 5.0 in is formed by welding two triangular plates. The plate is subjected to a tensile stress of 600 psi in the short direction and a compressive stress of 250 psi in the short direction. Determine the normal stress σ_w acting perpendicular to the line of the weld and the shear stress τ_w acting parallel to the weld. Show these stresses on a sketch of an element having its sides parallel and perpendicular to the weld.



Answers: σ_w = -25 psi, τ_w = 375 psi.

7.3-9. A shear wall in a reinforced concrete building is subjected to a vertical uniform load of intensity q and a horizontal force H. As a consequence of these loads, the stresses at point A on the surface of the wall have the values shown in the fiure. a) Determine the principal stresses and show them on a sketch of a properly oriented element. b) Determine the maximum shear stresses and associated normal stresses and show them on a sketch of a properly oriented element.

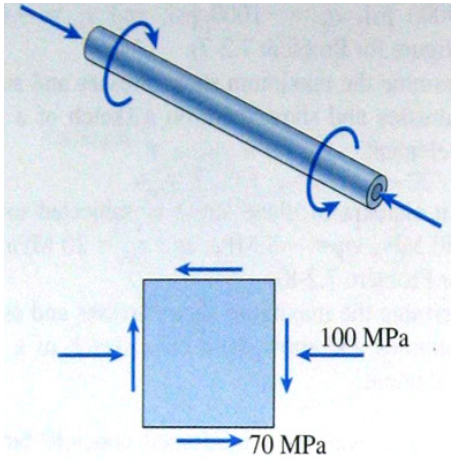


Answers:

a) $\sigma_1 = 167$ *psi,* $\theta_{p1} = -19.95°$.

b) $\tau_{max} = 717$ *psi,* $\theta_{p1} = -64.95°$.

7.3.-10. A propeller shaft subjected to combined torsion and axial thrush is designed to resist a shear stress of 70 MPa and a compressive stress of 100 MPa.
Use Mohr's circle: a) Determine the principal stresses and show them on a sketch of a properly oriented element. b) Determine the maximum shear stresses and associated normal stresses and show them on a sketch of a properly oriented element.
Show the location of each of these points on Mohr's circle.

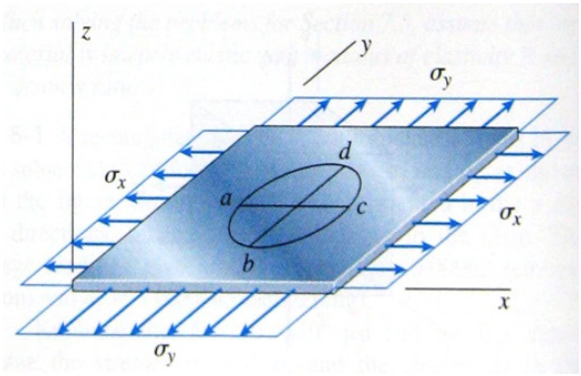


Answers:

c) $\sigma_1 = 36.0$ *MPa,* $\theta_{p1} = 117.23°$.

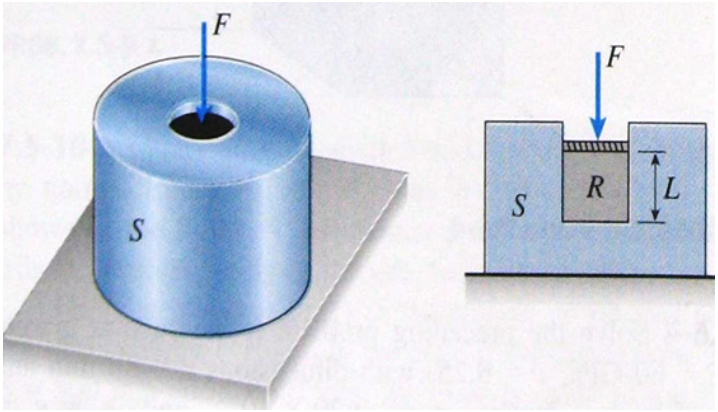
d) $\tau_{max} = 86.0$ *MPa,* $\theta_{p1} = 72.23°$.

7.5-12. A circle of diameter d = 200 mm is etched on a bras plate. The plate has dimensions 400 x 400 x 20 mm. Forces are applied to the plate, producing uniformly distributed normal stresses $\sigma_x = 42$ MPa and $\sigma_y = 14$ MPa.
Calculate the following quantities: a) the change in length Δac of diameter *ac*; b) the change in length Δbd of diameter *bd*; c) the change Δt in the thickness of the plate, and d) the change ΔV in the volume of the plate.



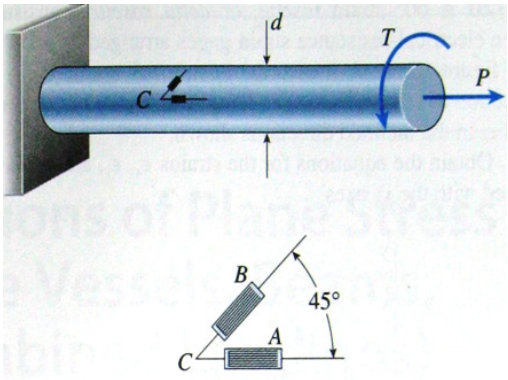
Answers: a) $\Delta ac = 0.745$; *b)* $\Delta bd = -0.00056$ *mm; c)* $\Delta t = -0.00381$ *mm; d)* $\Delta V = 573$ *mm*^{3}.

7.6-7. A rubber cylinder R of length L and cross-sectional area A is compressed inside a steel cylinder S by a force F that applies a uniformly distributed pressure to the rubber. A) Derive a formula for the lateral pressure p between the rubber and the steel (disregard friction). b) Derive a formula for the shortening δ of the rubber cylinder.



Answers: a) $p = \nu F / \left[A(1-\nu) \right]$, *b)* $\delta = FL(1+\nu)(1-2\nu) / \left[EA(1-\nu) \right]$

7.7-17. A solid circular bar of diameter d = 0.2 m is subjected to an axial force P and a torque T. Strain gages A and B mounted on the surface of the bar give readings $\varepsilon_A = 200\times10^{-6}$ and $\varepsilon_B = -40\times10^{-6}$. The bar is made of steel having $E = 40\times10^6$ Pa and ν=0.3.
a) Determine the axial force P and the torque T.
b) Determine the maximum shear strain γ_{max} and the maximum shear stress τ_{max} in the bar.



Answers: a) P = 251N, T = -5.31 Nm; b) $\gamma_{max} = 341\times10^{-6}$, $\tau_{max} = 5240$ *Pa.*

7.7-22. The strains on the surface of an experimental device made of pure aluminum (E = 70 GPa, ν=0.33) and tested in a space shuttle were measured by means of strain gages. The gages were oriented as shown in the figure, and the measured strains were $\varepsilon_A = 1100\times10^{-6}$ and $\varepsilon_B = 1496\times10^{-6}$, and $\varepsilon_C = -39.44\times10^{-6}$. What is the stress σ_x in the x direction?

Answer: $\sigma_x = 91.6$ *MPa*