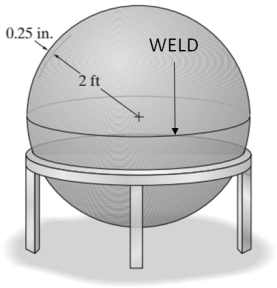
Example 12.4

A compressed air tank having an inner radius of 2ft. and a wall thickness of 0.25 in. is manufactured by welding two steel hemispheres as shown in the figure.

(a) If the allowable tensile stress is 14000 psi and the allowable shear stress is 6000 psi, what is the maximum permissible air pressure in the tank?

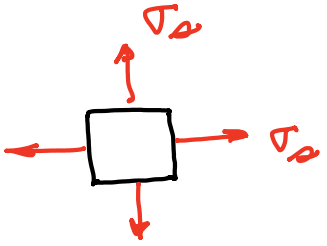
(b) The welded seam would fail if the tensile load on the weld exceeds 8 kips per inch of the weld. If the required factor of safety against failure of the weld is 2.5, what is the maximum permissible pressure?



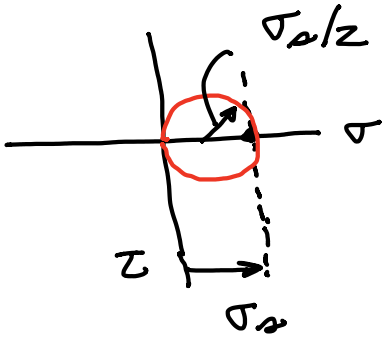
SOLUTION for (a)

- State of stress

$$\sigma_a = \frac{pr}{2t}$$



- Mohr's circle
  - Hydrostatic state of stress $\Rightarrow$ in-plane Mohr's circle reduces to a single point @ $(\sigma_a, 0)$
  - The out-of-plane Mohr's circle has a radius of $\sigma_a/2 \Rightarrow$



$$(|\tau|_{max})_{abs} = \frac{\sigma_a}{2} = \frac{pr}{4t}$$

$$\therefore \quad \sigma_{allow} = \frac{p_{max} r}{2t} \Rightarrow p_{max} = \frac{2t\sigma_{allow}}{r}$$

$$\tau_{allow} = \frac{p_{max} r}{4t} \Rightarrow p_{max} = \frac{4t\tau_{allow}}{r}$$

} choose smaller of the two