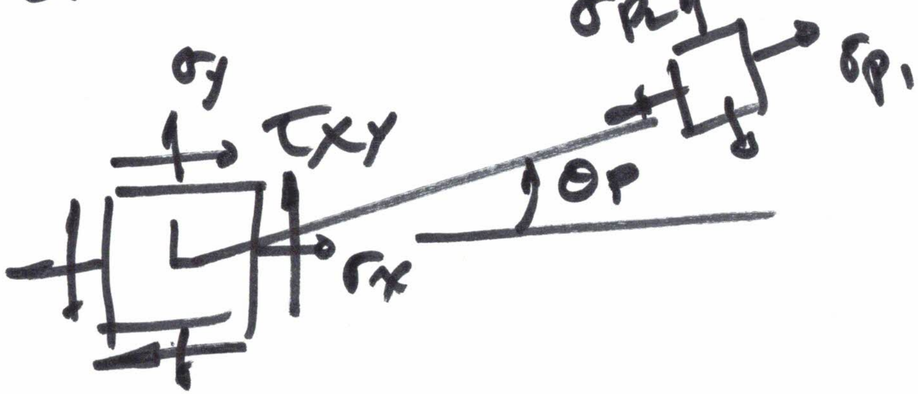
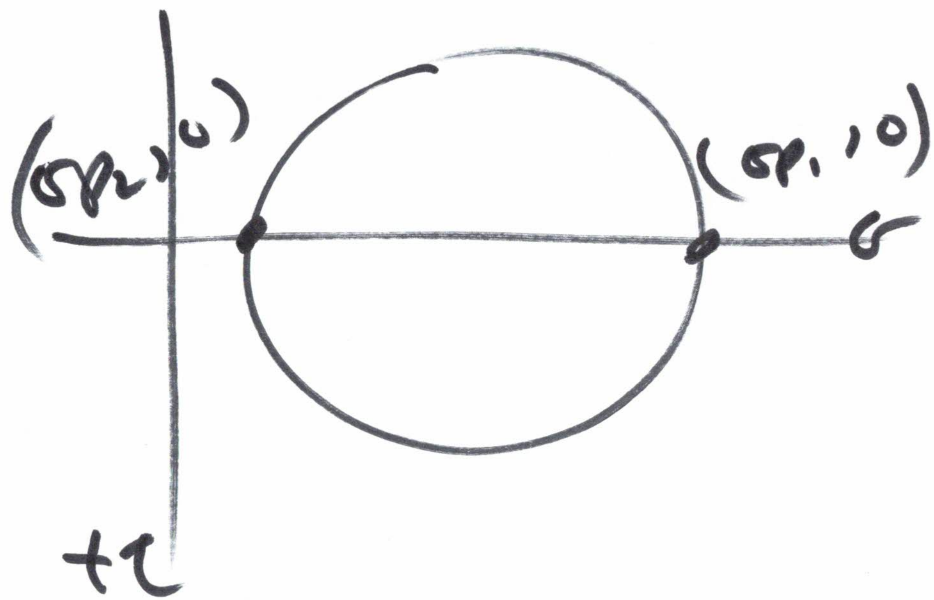
E. 3-D Principal stresses + τ_{max} ABSOLUTE



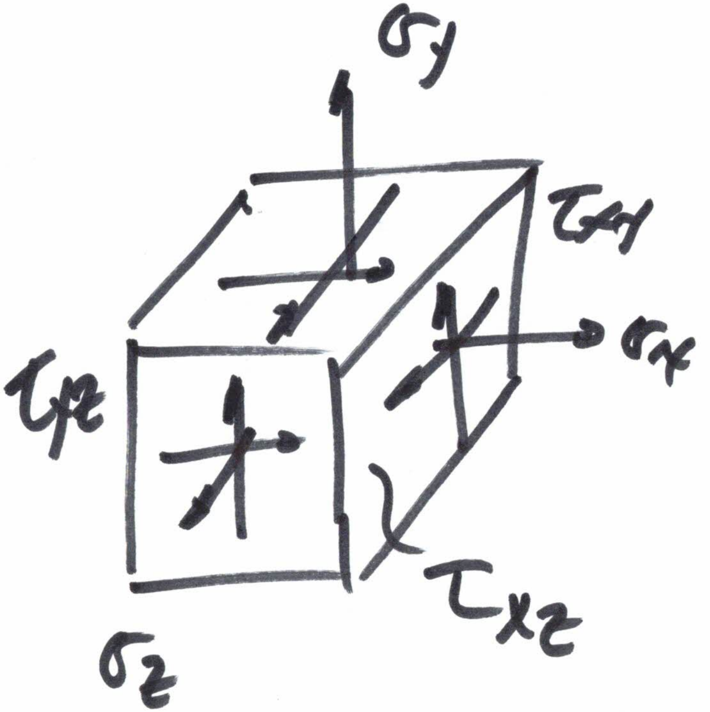


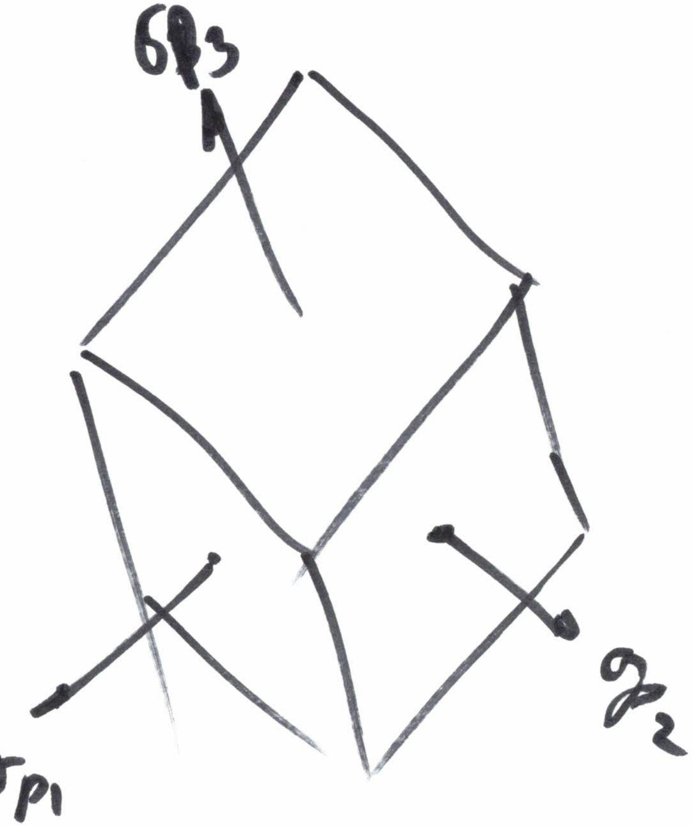
$$\tau_{\substack{max \\ in\text{-}plane}} = R$$

$$= \frac{\text{Diameter}}{2}$$

$$= \left| \frac{\sigma_{p_1} - \sigma_2}{2} \right|$$

In general, there are three principal stresses.





whenever there is a ~~shear~~ principal stress, there is no shear stress on that plane.

There are 3 local maximum shear stresses.

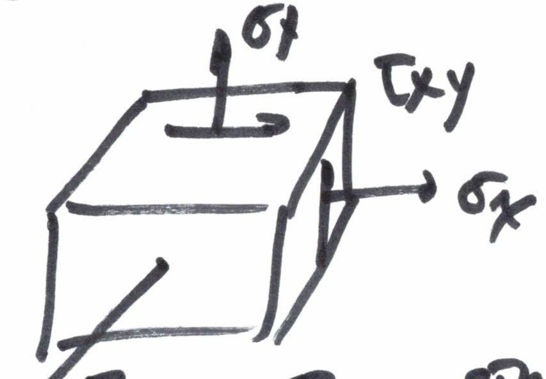
$$\tau_{\max_{1-2}} = \left|\frac{\sigma_{p_1} - \sigma_{p_2}}{2}\right| \qquad \tau_{\max_{1-3}} = \left|\frac{\sigma_{p_3} - \sigma_{p_1}}{2}\right|$$

$$\tau_{\max_{2-3}} = \left|\frac{\sigma_{p_2} - \sigma_{p_3}}{2}\right|$$

each are at 45° between the respective principal directions

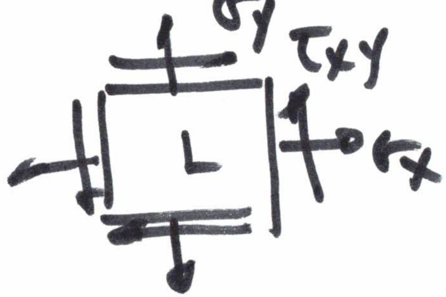
$$\tau_{\substack{MAX\\ABS}} = MAX\left\{\tau_{\max_{1-2}},\ \tau_{\max_{1-3}},\ \tau_{\max_{2-3}}\right\}$$

Generalized Plane Stress

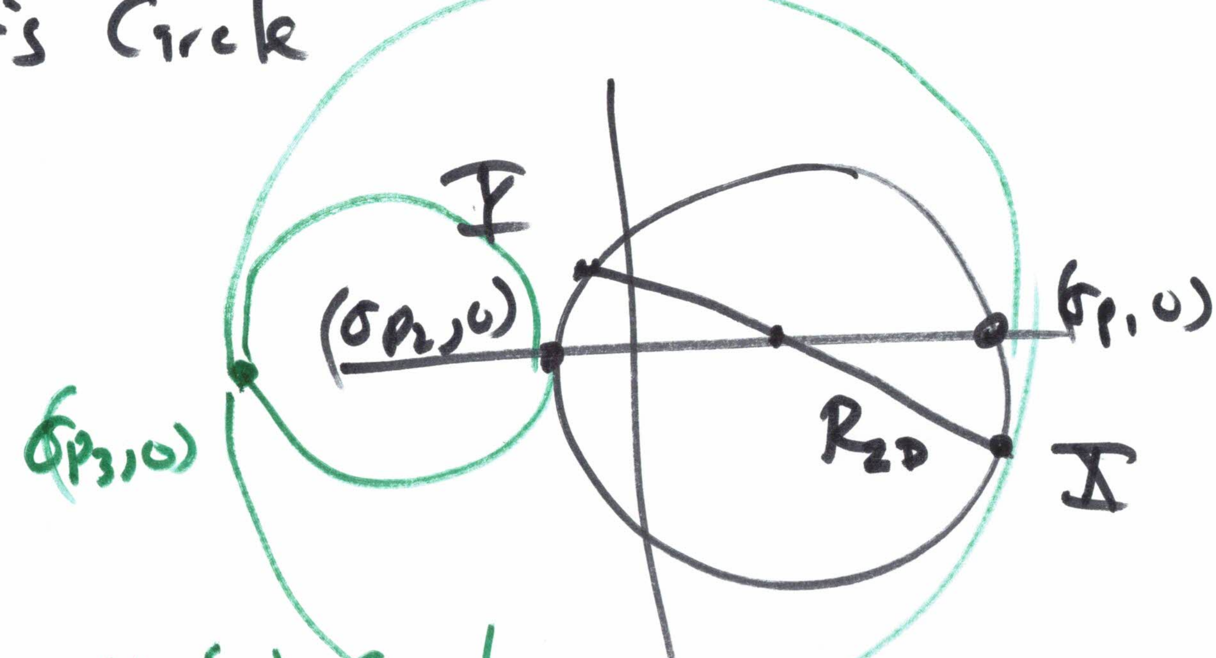


$\sigma_z = \sigma_{p_3}$ since there is no shear stress on this face

3-D Mohr's Circle



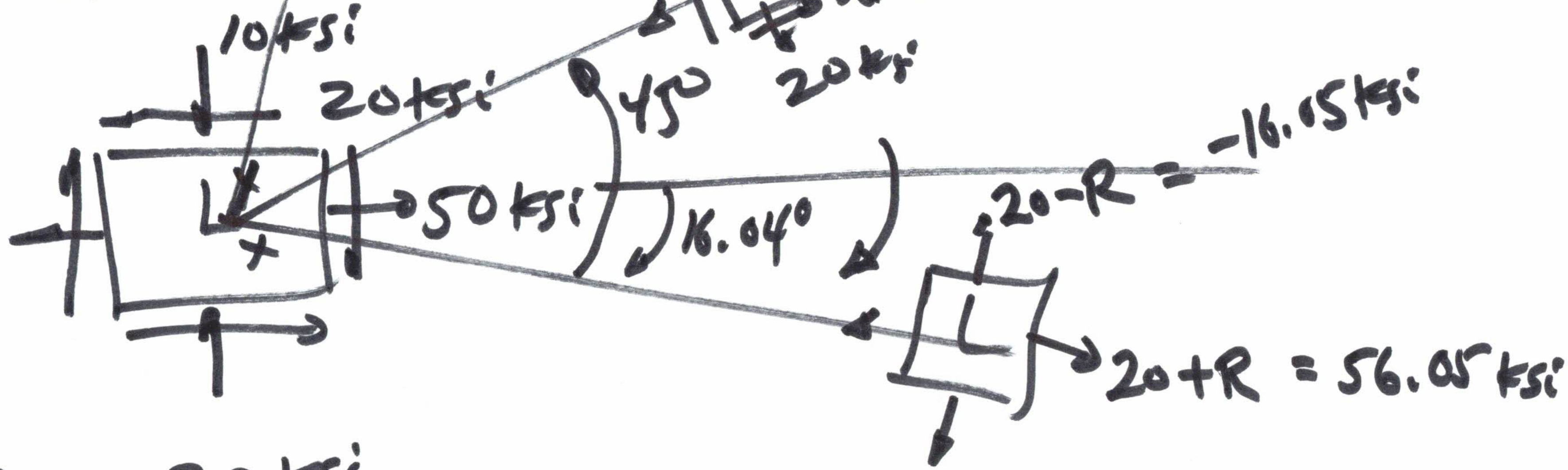
$\sigma_z = \_$



1. DRAW 2-D Mohr's Circle
2. Plot $(\sigma_{p_3}, 0) = (\sigma_z, 0)$
3. DRAW 2 more circles

then $\tau_{max_{ABS}} = R_{MAX}$

EXAMPLE



$\sigma_z = -20$ ksi

$X : (\sigma_x, \tau_{xy}) = (50, -20)$

$Y : (\sigma_y, -\tau_{xy}) = (-10, +20)$

$C : (\sigma_{ave}, 0) = (20, 0)$

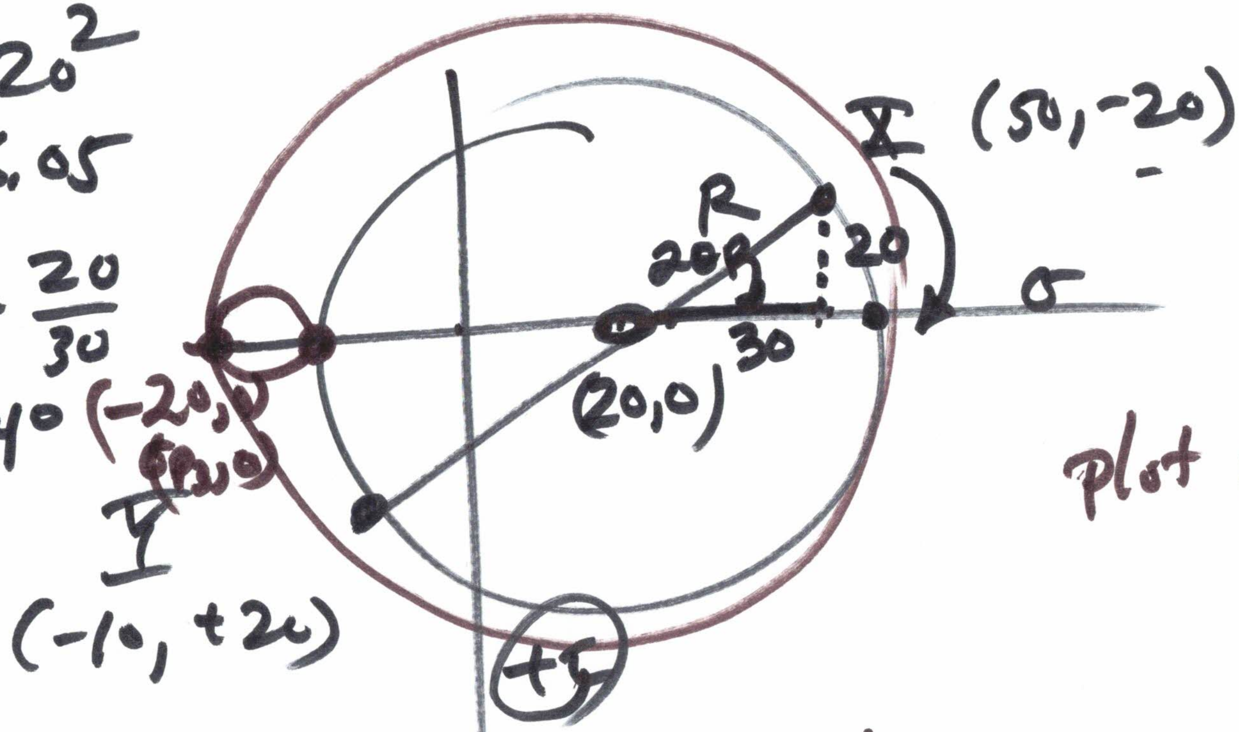
$\sigma_{ave} = \dfrac{\sigma_x + \sigma_y}{2}$

$R^2 = 30^2 + 20^2$

$R = 36.05$

$\tan 2\theta p = \frac{20}{30}$

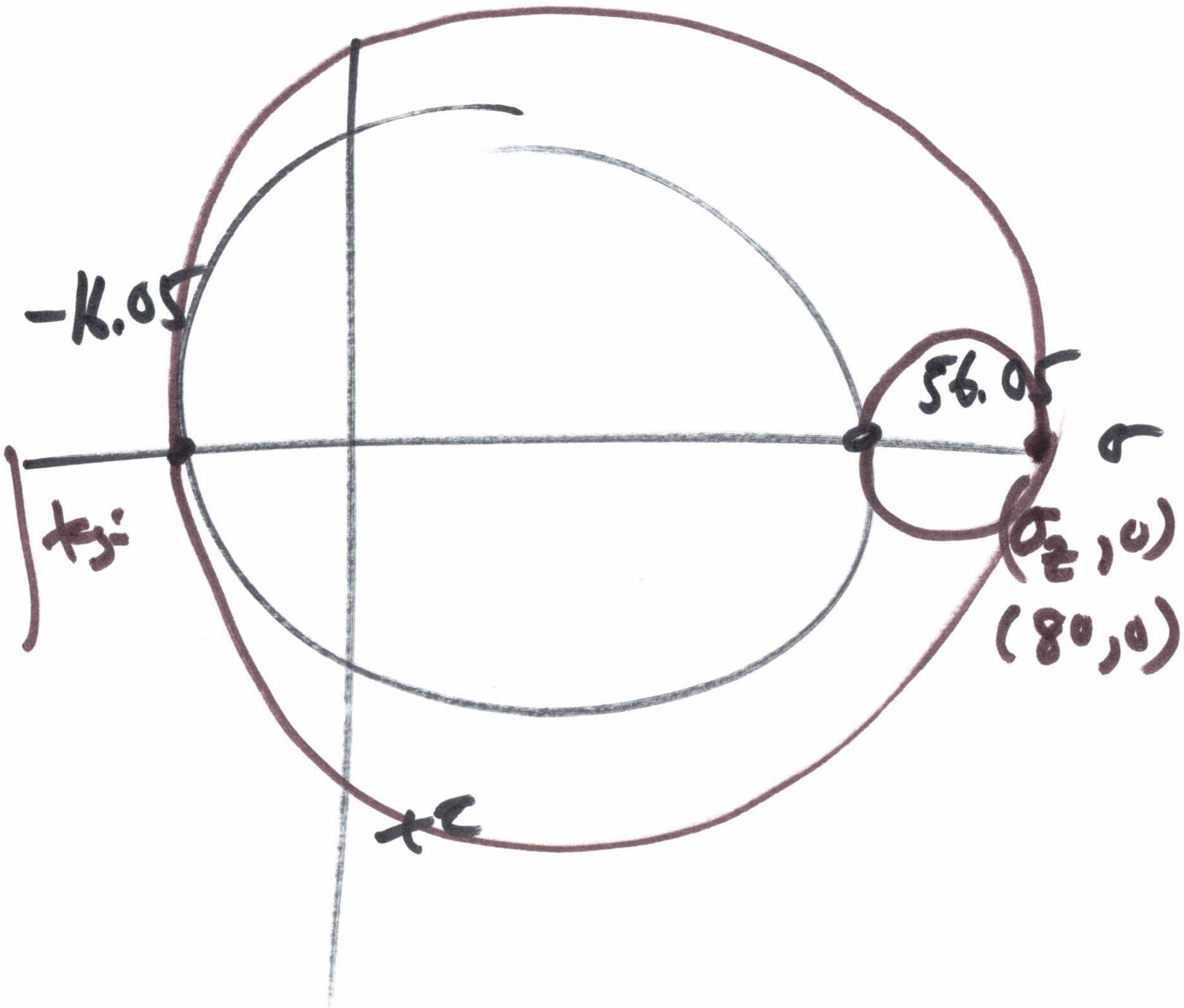
$\theta p = 16.04°$



plot (σ_z, τ)

$$\tau_{\substack{max \\ ABS}} = \underbrace{\left| \frac{56.05 - (-20)}{2} \right|}_{\text{Biggest Radius}} \text{ ksi} = 38.025 \text{ ksi}$$

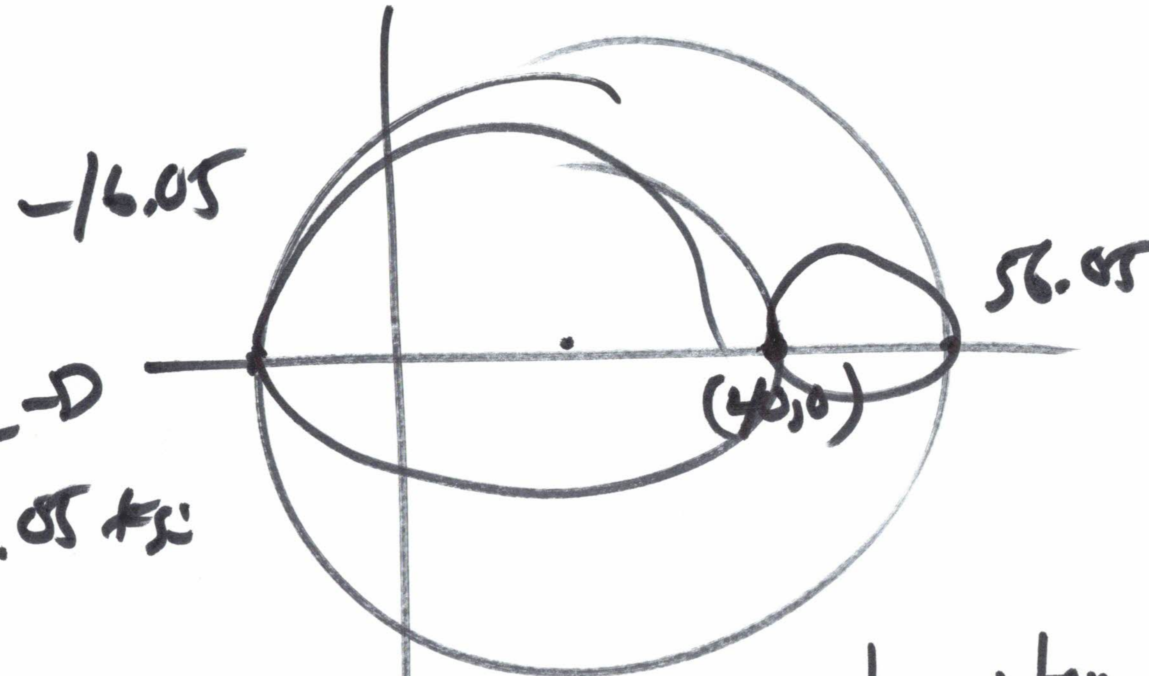
suppose $\sigma_z = 80$ ksi



$\tau_{MAX\ ABS} = \left| \dfrac{80 - (-16.05)}{2} \right|$ ksi

$= 48.xx$

$\sigma_z = 40$ ksi



$\tau_{\substack{MAX \\ ABS}} = R_{2\text{-}D}$

$= 36.05$ ksi

if $\tau_{\substack{MAX \\ ABS}}$ is $R_{2\text{-}D}$ is MAX, ~~shear~~ then max shear is in the plane of the material if τ_{max}^{ABS} is associated with the 3-D circle

then τ_{max}^{ABS} is out of plane