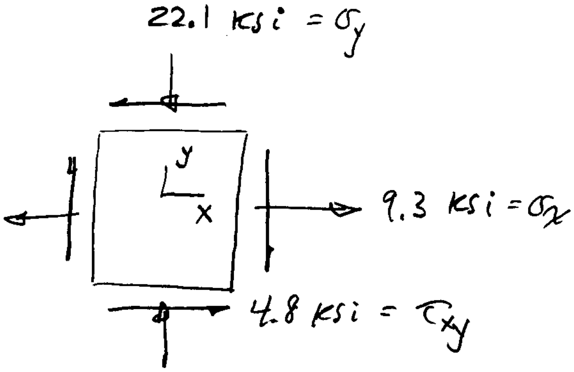
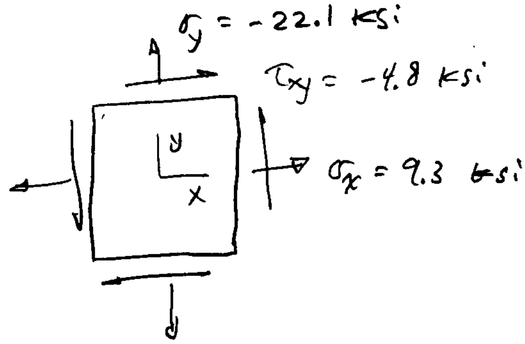
Mohr's Circle : Example Problem



Redraw in positive directions:



① Find Center of Circle

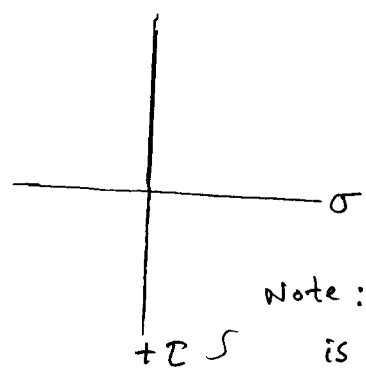
$$C = \sigma_{AVE} = \frac{\sigma_x + \sigma_y}{2} = \frac{9.3 - 22.1}{2} = -6.4$$

② Plot Points:

$(\sigma_{ave}, 0) = (-6.4, 0)$

$(\sigma_x, \tau_{xy}) = (9.3, -4.8)$

$(\sigma_y, -\tau_{xy}) = (-22.1, 4.8)$



Note: $+\tau$-dir. is <u>down</u>.

③ Draw Circle around Center (over)

④ Find radius of circle (see figure)

$$R^2 = l^2 + h^2 = [9.3 - (-6.4)]^2 + [4.8]^2 \Rightarrow R = 16.42$$

⑤ Use Trig. to find answers to questions like:

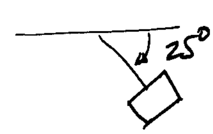
ⓐ Find maximum & minimum principal stresses, & θ_p (principal angle)

ⓑ Draw Principal Stress State

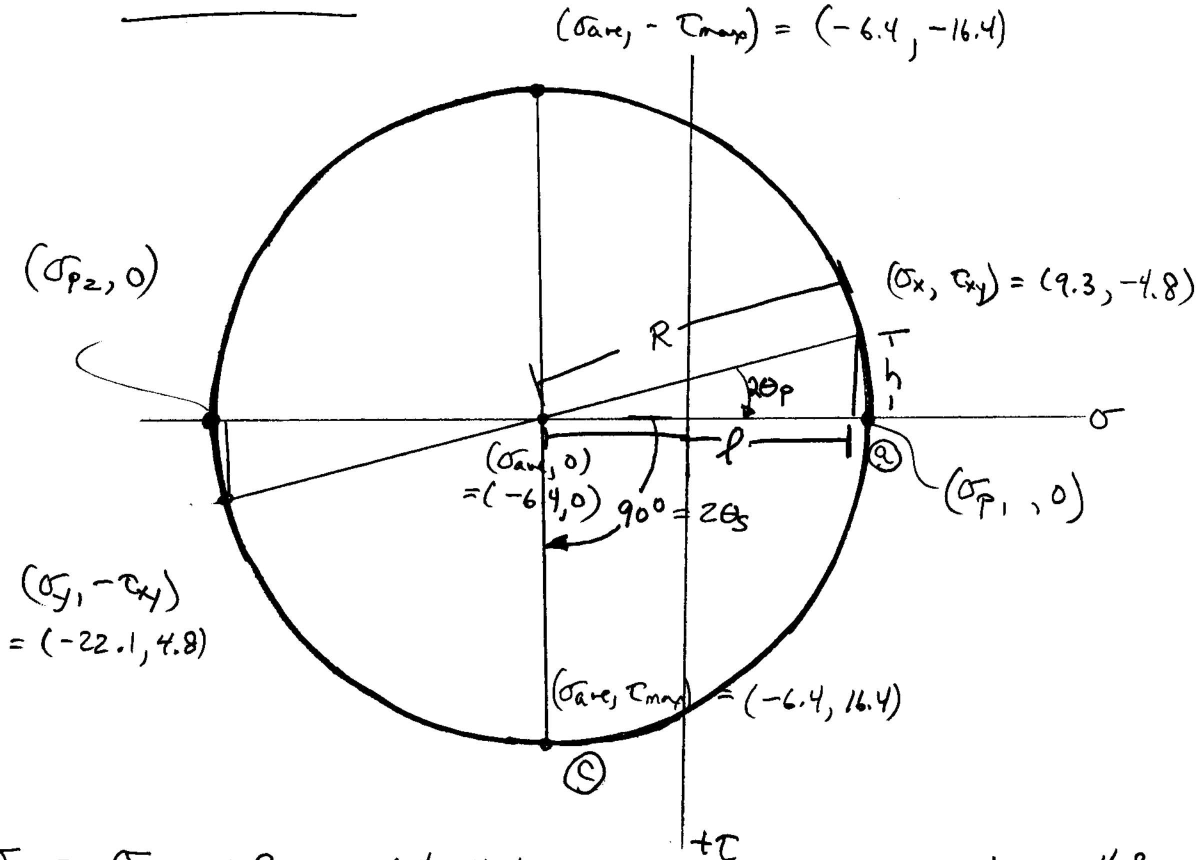
ⓒ Find maximum shear stress state

ⓓ Draw max shear stress state

ⓔ Rotate block $\theta = 25°$ to find new components



All units ksi.



(a)

$\sigma_{p1} = \sigma_{AVE} + R = -6.4 + 16.42$

$\sigma_{p1} = 10.02$ ksi

$\sigma_{p2} = \sigma_{AVE} - R = -6.4 - 16.42$

$\sigma_{p2} = -22.82$ ksi

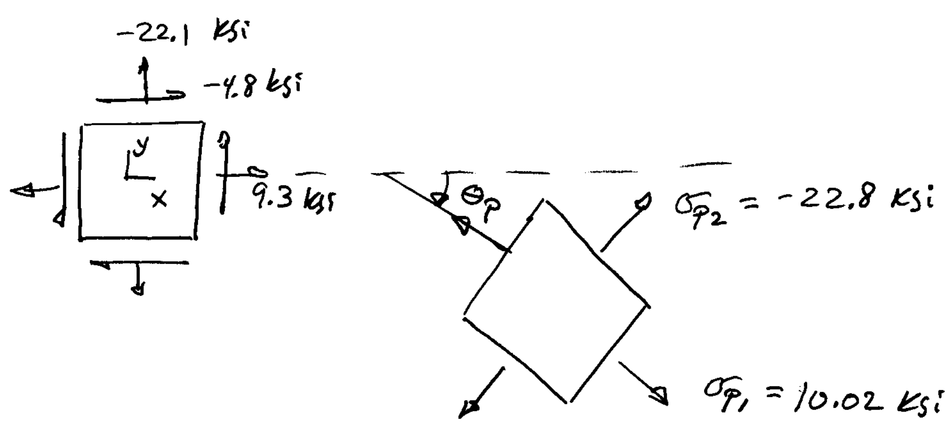
$\tan 2\theta_p = \dfrac{h}{\ell} = \dfrac{4.8}{(9.3 - (-6.4))}$

$2\theta_p = 17^\circ$

$\theta_p = 8.5^\circ$

(b)

ORIGINAL STRESS STATE



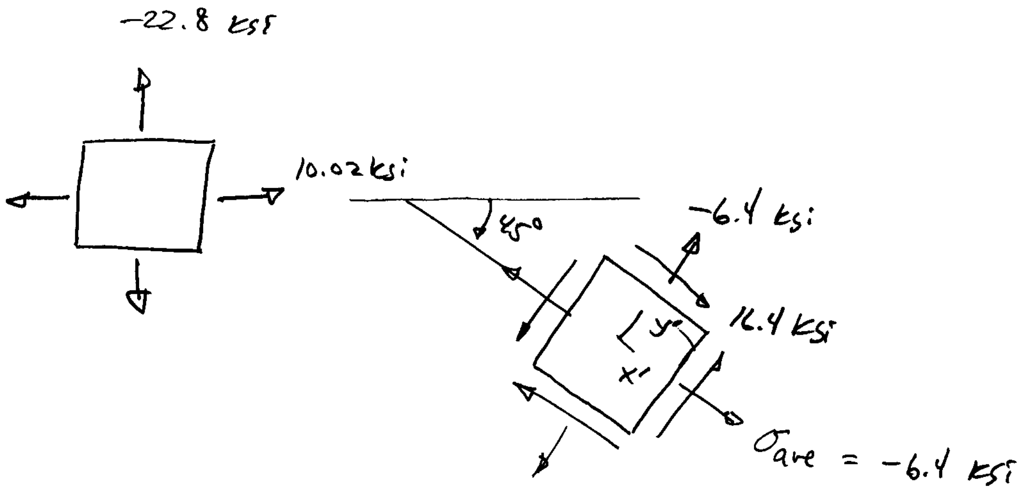
PRINCIPAL STRESS STATE

NOTICE THAT (σ_x, τ_{xy}) WAS ROTATED TO $(\sigma_{p1}, 0)$.

(c) MAX SHEAR STRESS IS AT TOP & BOTTOM OF CIRCLE

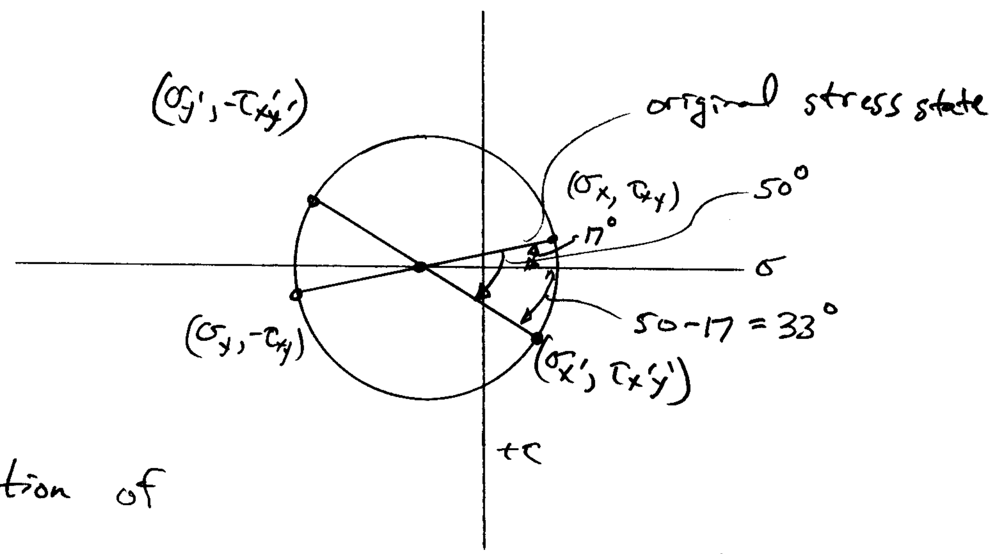
Rotate $2\theta_s = 90^\circ$ from principal stress state on circle.

(d)

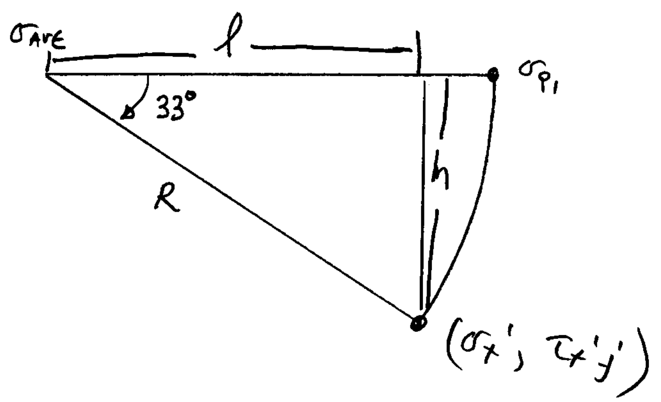


NOTICE THAT $(\sigma_{p_1}, 0)$ WAS ROTATED TO $(\sigma_{ave}, \tau_{max})$.

(e) 25° ON BLOCK $\Rightarrow$ 50° ON CIRCLE



New location of σ_x'



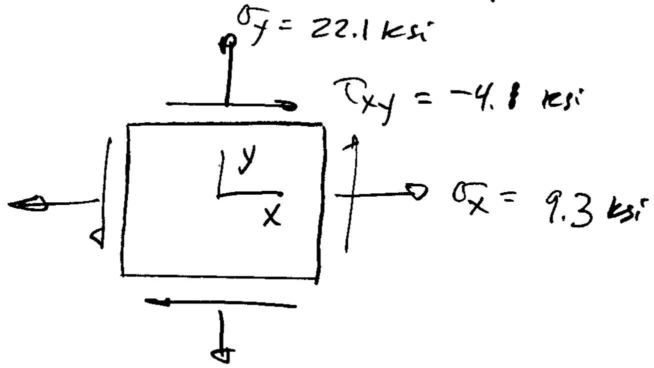
$l = R\cos 33^\circ = 16.4(\cos 33^\circ) = 13.8$ ksi

$h = R\sin 33^\circ = 8.9$ ksi

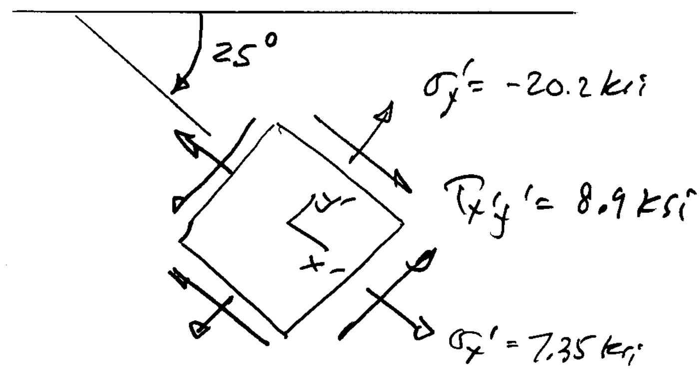
$\sigma_x' = \sigma_{ave} + l = -6.4 + 13.8$
$= 7.35$ ksi

$\tau_{x'y'} = h = 8.9$ ksi

Also $\sigma_y' = \sigma_{ave} - R = -6.4 - 13.8 = -20.2$ ksi



ORIGINAL STRESS STATE



NOTICE THAT (σ_x, τ_{xy}) ROTATED TO $(\sigma_x', \tau_{x'y'})$ OF PART (e)

The old x component rotates to the new x' component.
The old y component rotates to the new y' component.
The shear stress direction (sign) is determined by where the new pt. $(\sigma_x', \tau_{x'y'})$ end up:

$\tau_{x'y'}$ is positive below the σ axis,

$\tau_{x'y'}$ is negative above the σ axis

when looking at $(\sigma_x', \tau_{x'y'})$