భారతీయ సాంకేతిక విజ్ఞాన సంస్థ హైదరాబాద్
भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

26th Nov, Sunday

ME2110

Mechanics of Solids

-Dr. Prabhat Kumar

Simulation of
Mohr Circle

Team:

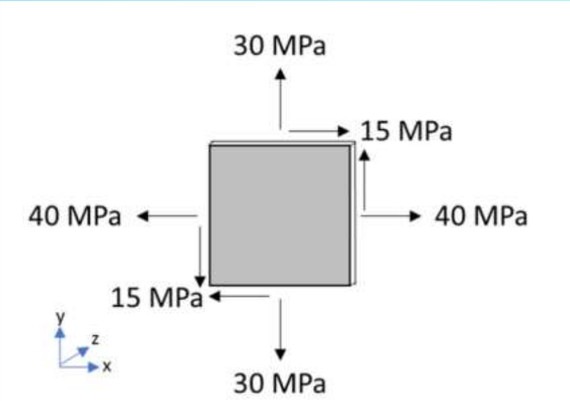
Ashish Bhardwaj (ms22btech11007)

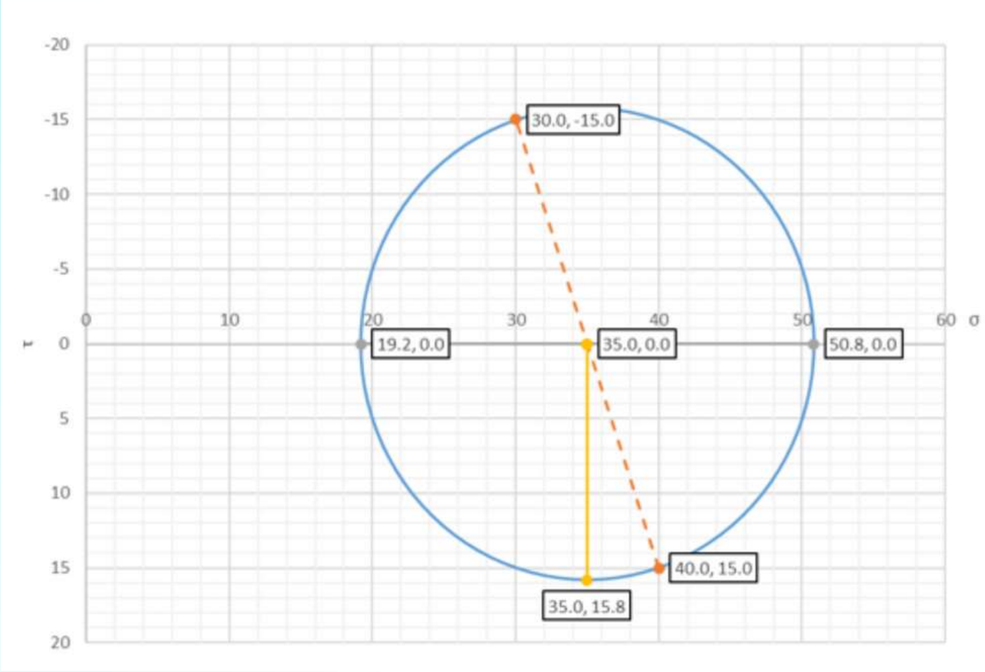
Swapnil Bag (es22btech11034)

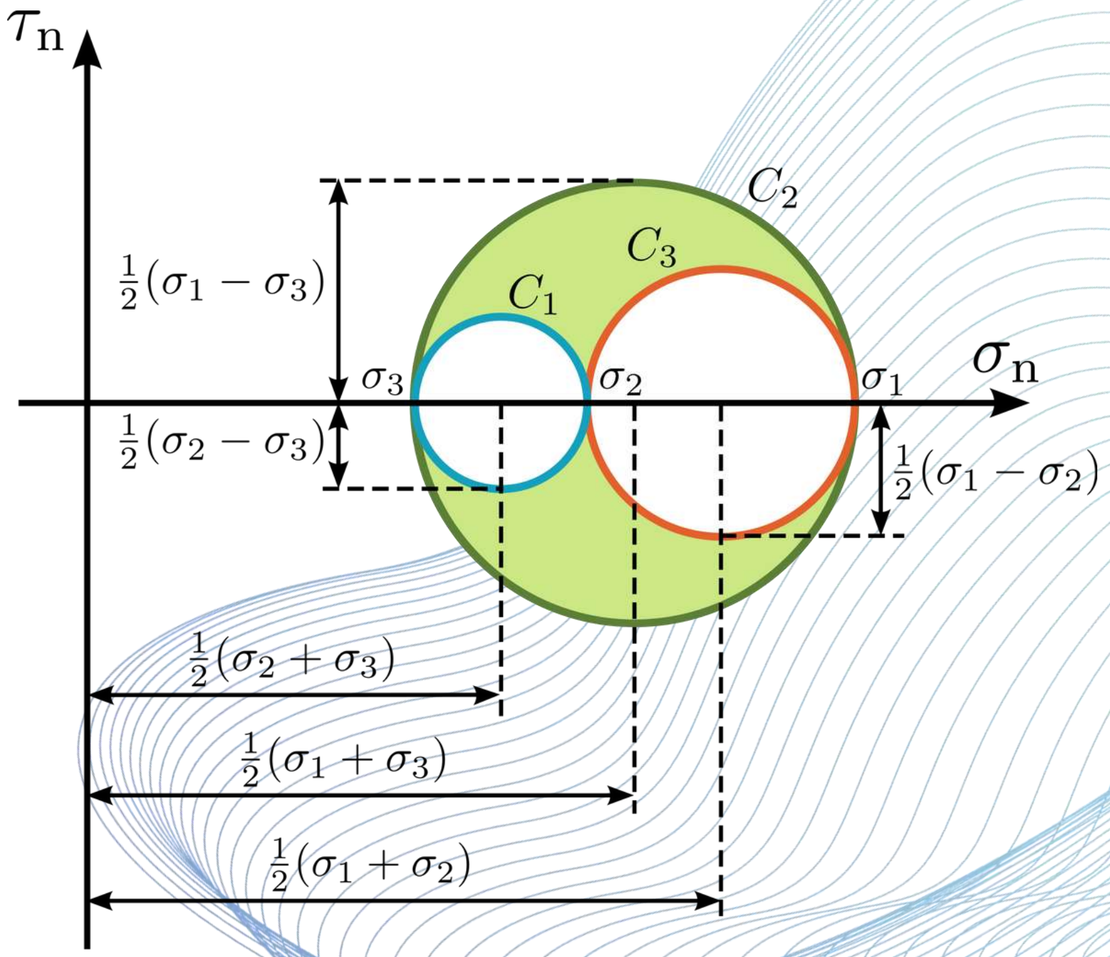
Reddicharla Naga Giri Vardhan (es22btech11031)

Devansh Agrawal (es22btech11010)

Mohr Circle

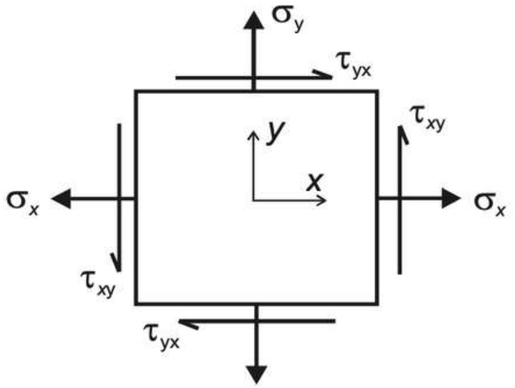

30 MPa
15 MPa
40 MPa
40 MPa
15 MPa
30 MPa
y
z
x

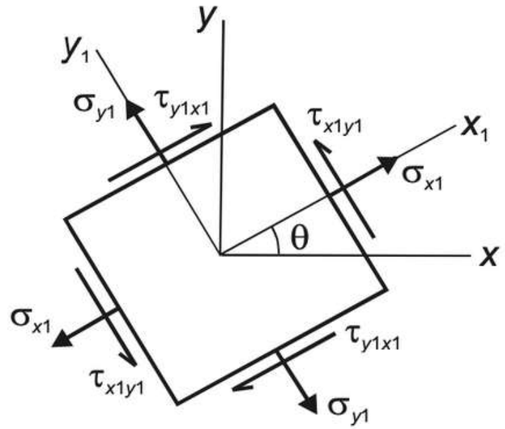

-20
-15
-10
-5
0
5
10
15
20
0
10
20
30
40
50
60
σ
τ
30.0, -15.0
19.2, 0.0
35.0, 0.0
50.8, 0.0
40.0, 15.0
35.0, 15.8


τ_n
σ_n
C_1
C_2
C_3
σ_3
σ_2
σ_1
$\frac{1}{2}(\sigma_1 - \sigma_3)$
$\frac{1}{2}(\sigma_2 - \sigma_3)$
$\frac{1}{2}(\sigma_1 - \sigma_2)$
$\frac{1}{2}(\sigma_2 + \sigma_3)$
$\frac{1}{2}(\sigma_1 + \sigma_3)$
$\frac{1}{2}(\sigma_1 + \sigma_2)$

Mohr Formulas

Sign Convention





$$\sigma_{x1} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$\tau_{x1y1} = -\frac{(\sigma_x - \sigma_y)}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

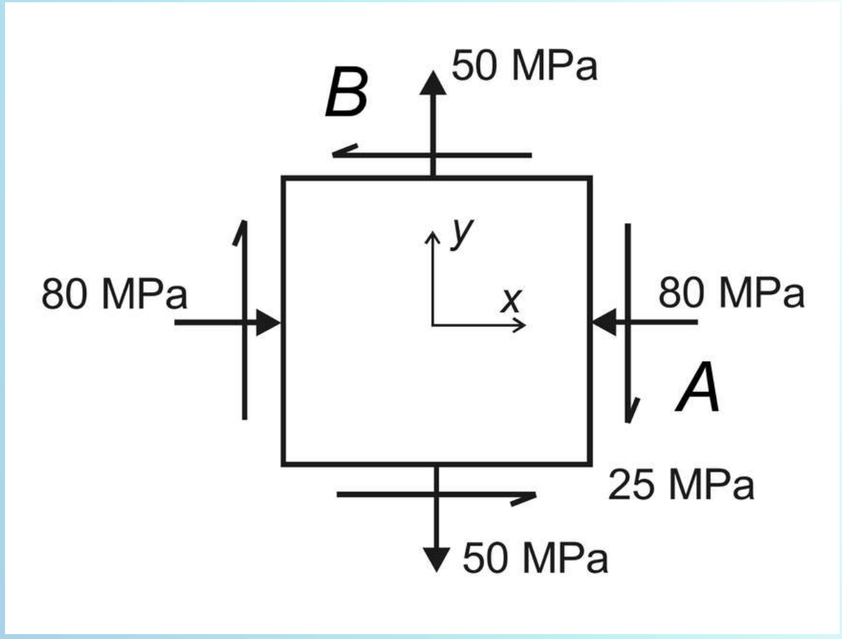
$$\sigma_{avg} = \frac{\sigma_x + \sigma_y}{2} \qquad R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\left(\sigma_{x1} - \sigma_{avg}\right)^2 + \tau_{x1y1}^2 = R^2$$

which is the equation for a circle with centre (σavg,0) and radius R.

Example

Draw the Mohr's Circle of the stress element shown below. Determine the principle and the maximum shear stresses.
Calculate the stress in a plane rotated 30° clockwise.



σx = -80 MPa
σy = +50 MPa
τxy = -25 MPa

$$\sigma_{avg} = \frac{-80+50}{2} = -15$$

$$R = \sqrt{\left(\frac{-80-50}{2}\right)^2 + (-25)^2}$$

$$= \sqrt{4850}$$

$$= 69.6$$

$$\tau_{max} = 69.6$$

$$\sigma_{avg} = c = -15$$

$$\sigma_j = \sigma_{avg} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$= -15 + \left(\frac{-80-50}{2}\right)\cos(-60^\circ) - 25\sin(-60)$$

$$= -15 - \frac{65}{2} + \frac{25\sqrt{3}}{2} = -25.85$$

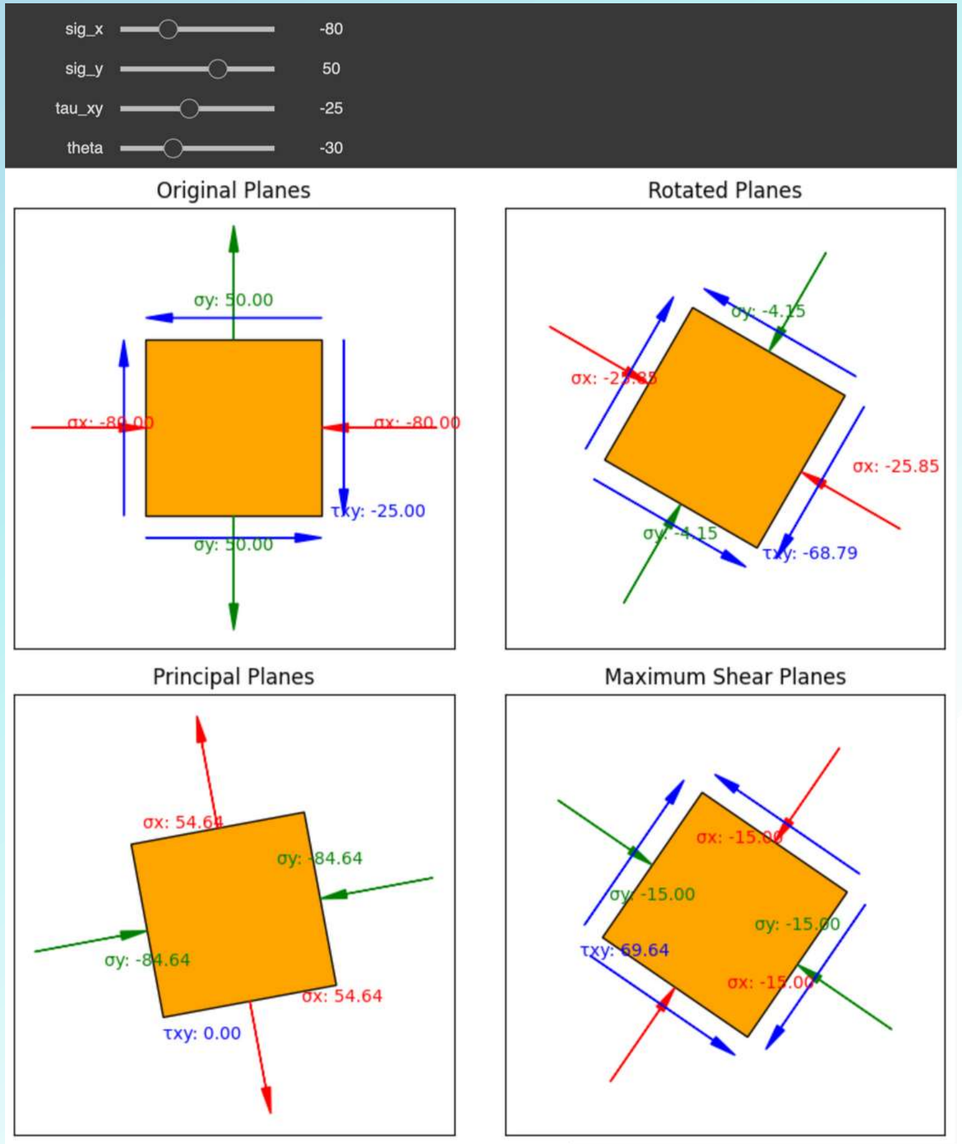
$$\tau_j = -\frac{(\sigma_x - \sigma_y)}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

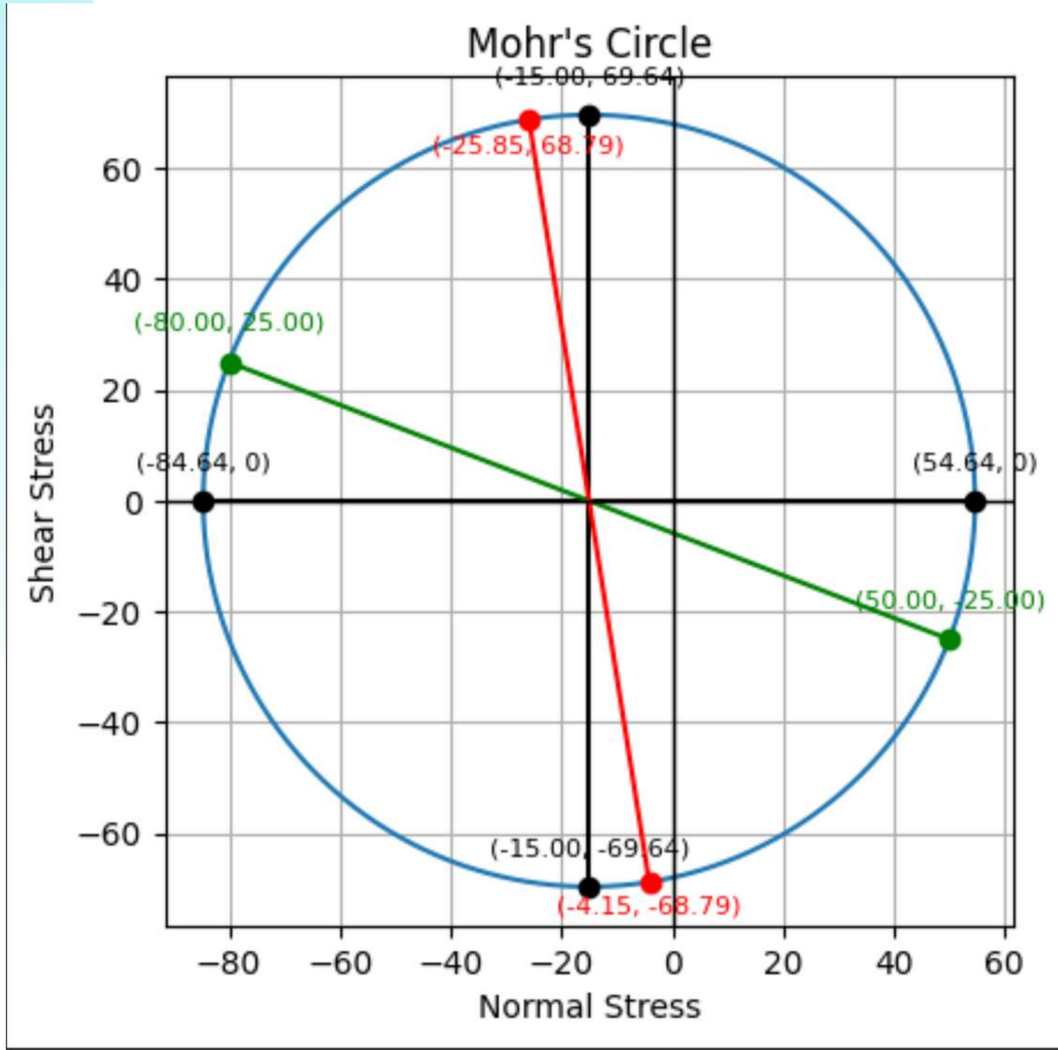
$$= -\frac{(-80-50)}{2}\sin(-60^\circ) - 25\cos(-60^\circ)$$

$$= -65\frac{\sqrt{3}}{2} - \frac{25}{2} = -68.79$$

$$\tan(\theta_1) = \frac{25}{65} = \frac{5}{13} \qquad \theta_1 = 21.0^\circ$$

Simulation Results






```
(-25.84936490538904, -4.1506350946109585, -68.79165124598852, -30)
<function __main__.calculate_stress_parameters(sig_x, sig_y, tau_xy, theta)>
```

Code Link

https://colab.research.google.com/drive/1mLxWgQq07r7yXUF7Ajpz2I_GV6H0kDhy?usp=sharing

Link for the Code has been sent on the mail also. Instructions for Google Collab are also there.

Thank You

Instructor: Dr. Prabhat Kumar

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