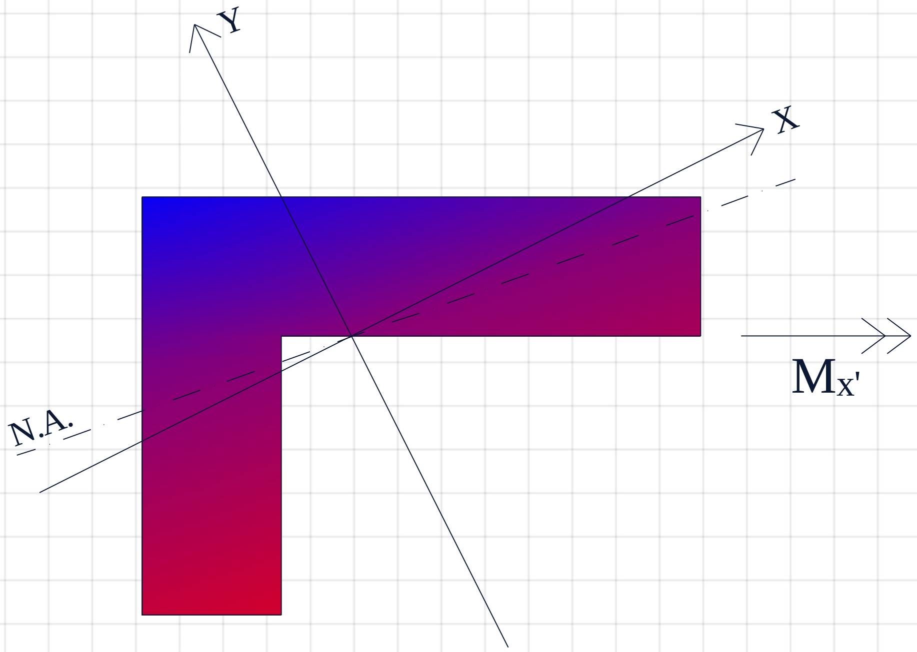
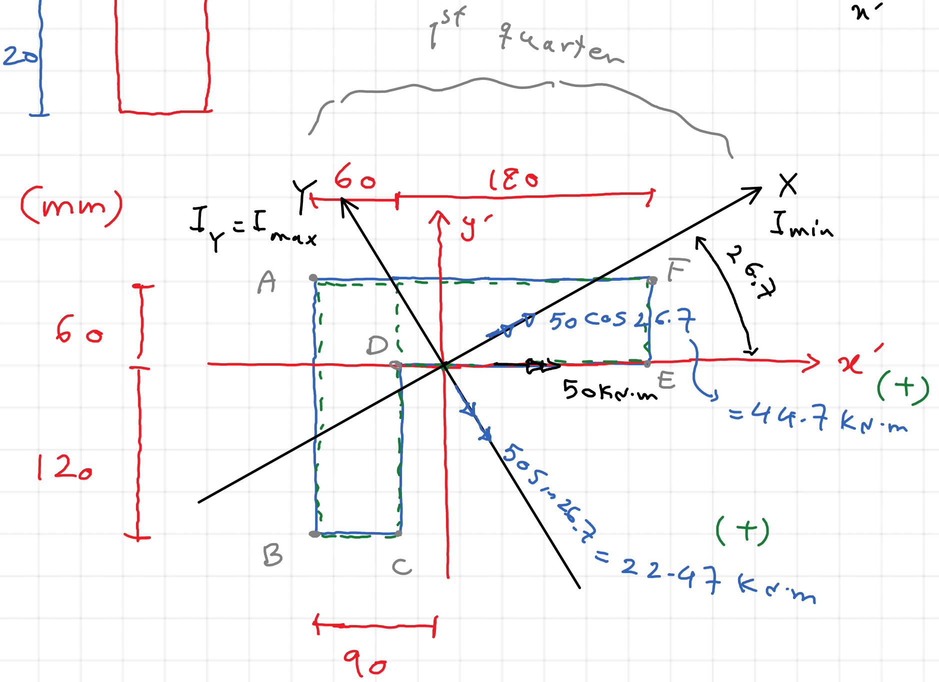
In the previous video, we discussed calculating two crucial parameters for a given cross-section. These parameters are the principal axes and the angle between the principal axes and the two horizontal and vertical axes that pass through the centroid of the cross-section. Knowing these parameters is crucial for analyzing the stress state of the cross-section and its behavior under different loading conditions.

In this video, we will learn how to locate the neutral axis (N.A.) in cross-sectional analysis. The neutral axis is an important concept in structural engineering because it is the line along which the cross-section experiences no bending stress when subjected to bending moments. Furthermore, we will apply a moment to the cross-section and calculate the resulting stresses at the corner points.



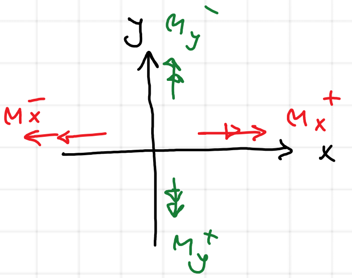
$\longrightarrow M_{x'} = 50\,kN\cdot m$

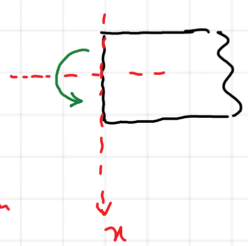


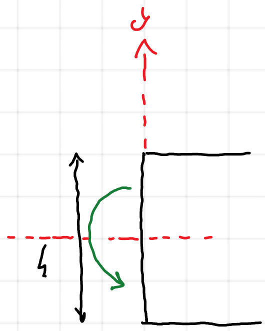
$I_X = 3.24 \times 10^7\ mm^4$

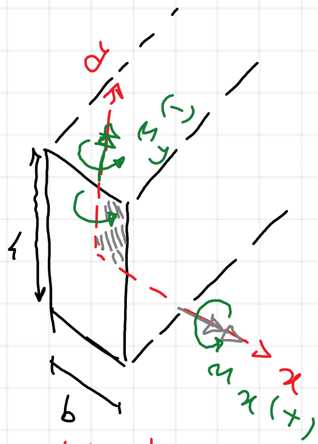
$I_Y = 12.96 \times 10^7\ mm^4$

$\theta = 26.7^\circ$









kN m
+44.7

kN m
22.47

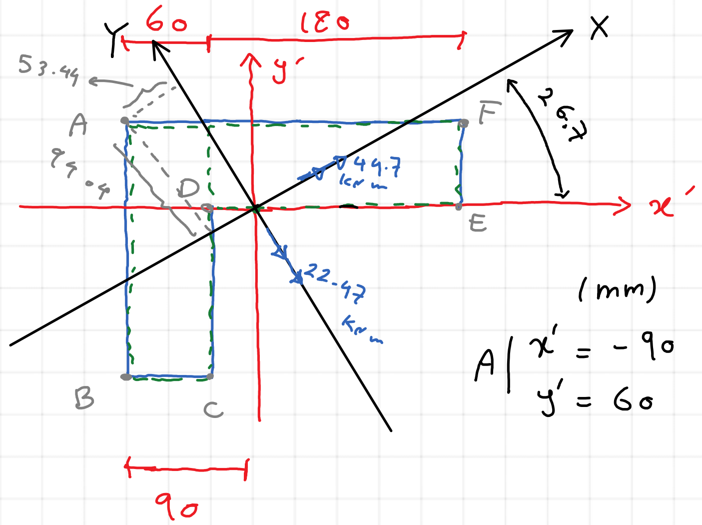
$$\sigma(X,Y) = \frac{M_X \cdot Y}{I_X} + \frac{M_Y\ X}{I_Y} = \frac{44.7\times10^6 \cdot Y}{3.24\times10^7\ mm^4} + \frac{22.47\times10^6 \cdot X}{12.96\times10^7\ mm^4}$$

(N mm) (N mm)

$I_X \rightarrow I_{min} \rightarrow 3.24\times10^7\ mm^4$

$I_Y \rightarrow I_{max} \rightarrow 12.96\times10^7\ mm^4$

$$\boxed{\sigma(x,y) = 1.38\,Y + 0.17\,X}$$



(mm)

$$A \left| \begin{array}{l} x' = -90 \\ y' = 60 \end{array} \right.$$

$$\begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$$

$$\begin{bmatrix} X \\ Y \end{bmatrix} = \begin{bmatrix} \cos(26.7) & \sin(26.7) \\ -\sin(26.7) & \cos(26.7) \end{bmatrix} \begin{bmatrix} x' \\ y' \end{bmatrix} \Rightarrow \begin{cases} X = -53.44 \text{ mm} \\ Y = 94.04 \text{ mm} \end{cases}$$

$$\sigma(X,Y) = 1.38\,Y + 0.17\,X \rightarrow \sigma_A = 1.38(94.04) + 0.17(-53.44) = 120.5 \text{ MPa}$$

all (mm)

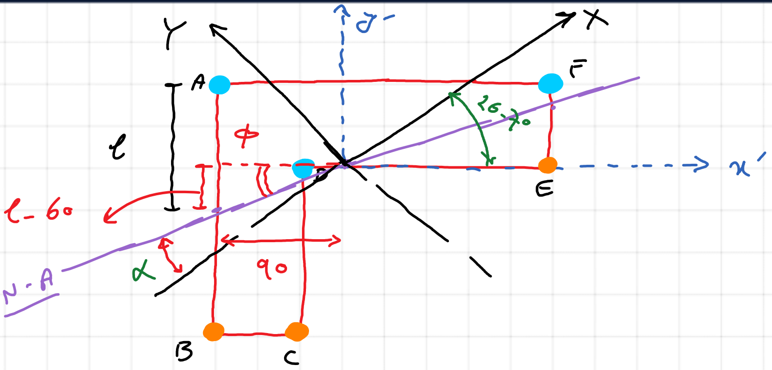
$$B: \begin{cases} x' = -90 \\ y' = -120 \end{cases} \rightarrow \begin{cases} X = -134.3 \\ Y = -66.77 \end{cases} \rightarrow \sigma_B = -115 \text{ MPa}$$

$$C: \begin{cases} x' = -30 \\ y' = -120 \end{cases} \rightarrow \begin{cases} X = -80.72 \\ Y = -93.72 \end{cases} \rightarrow \sigma_C = -143.1 \text{ MPa}$$

$$D: \begin{cases} x' = -30 \\ y' = 0 \end{cases} \rightarrow \begin{cases} X = -26.8 \\ Y = 13.48 \end{cases} \rightarrow \sigma_D = 14 \text{ MPa}$$

$$E: \begin{cases} x' = 150 \\ y' = 0 \end{cases} \rightarrow \begin{cases} X = 134 \\ Y = -67.4 \end{cases} \rightarrow \sigma_E = -70 \text{ MPa}$$

$$F: \begin{cases} x' = 150 \\ y' = 60 \end{cases} \rightarrow \begin{cases} X = 160 \\ Y = -13.8 \end{cases} \rightarrow \sigma_F = 8.3 \text{ MPa}$$



$\sigma_A = 120$ MPa

$\sigma_B = -115$ MPa

$\sigma_C = -143$ MPa

$\sigma_D = 14$ MPa

$\sigma_E = -70$ MPa

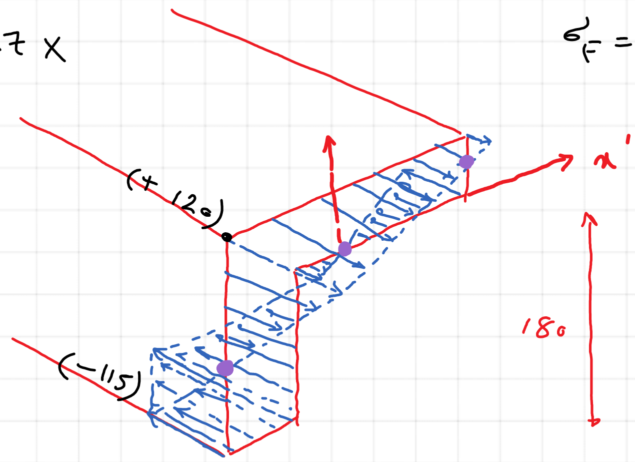
$\sigma_F = 83$ MPa

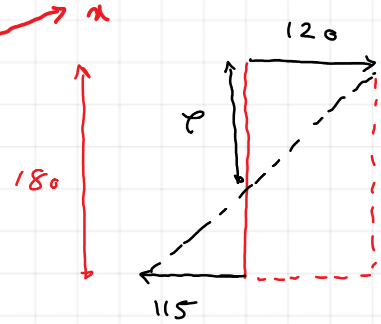
$$\sigma = 1.38\,Y + 0.17\,X$$

$$\sigma = 0 \Rightarrow$$

$$Y = \frac{-0.17}{1.38}\,X$$

$$\boxed{Y = \underbrace{-0.123}_{m}\,X}$$





$$\frac{120}{\ell} = \frac{120+115}{180} \rightarrow \ell = 91.9\text{ mm}$$

$$\phi = \tan^{-1}\left(\frac{91.9-60}{90}\right) = 19.52°$$

$$\alpha = 26.7 - \phi = 7.18°$$

$$m = \tan\alpha \rightarrow \alpha = \tan^{-1}(0.123) = 7.01 \cong$$