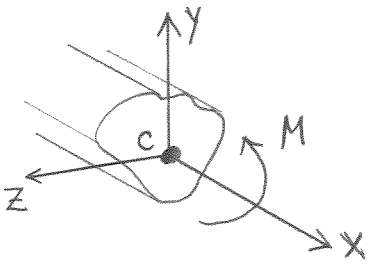
CLASS 17 - UNSYMMETRIC & COMPOSITE BEAMS

OBJECTIVES: ① DEFINE UNSYMMETRIC BEAMS
② CONSIDER MOMENT IN AN ARBITRARY ORIENTATION

① UNSYMMETRIC BENDING

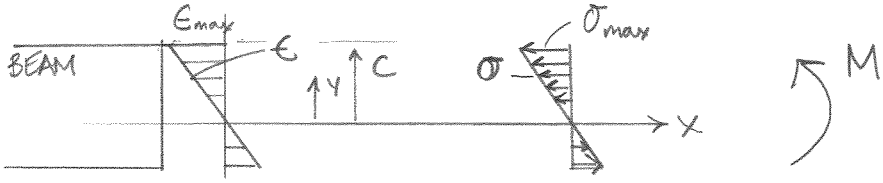
CONSIDER ARBITRARY CROSS-SECTIONS THAT ARE NOT SYMETTRIC



CONSIDER MOMENT ACTING ALONG PRINCIPAL AXIS

BEAM MUST BE IN EQUILIBRIUM:

$$\Sigma F_x = 0 \quad ; \quad \Sigma M_y = 0 \quad ; \quad \Sigma M_z = M$$



$$\Sigma F_x = 0 = \int_A \sigma \, dA \longrightarrow \text{AXIS PASSES THROUGH N.S.}$$

$$\Sigma M_y = 0 = \int_A z\sigma \, dA \quad \text{(only a function of "y")} \longrightarrow 0 = \int_A z\left(\frac{-y}{c}\right)\sigma_{max} \, dA$$

$$0 = \frac{-\sigma_{max}}{c}\int yz \, dA$$

$$\Sigma M_z = M = \int_A -y\sigma \, dA$$

$$\therefore \underbrace{\int yz \, dA = 0}_{\text{PRODUCT of INERTIA}}$$

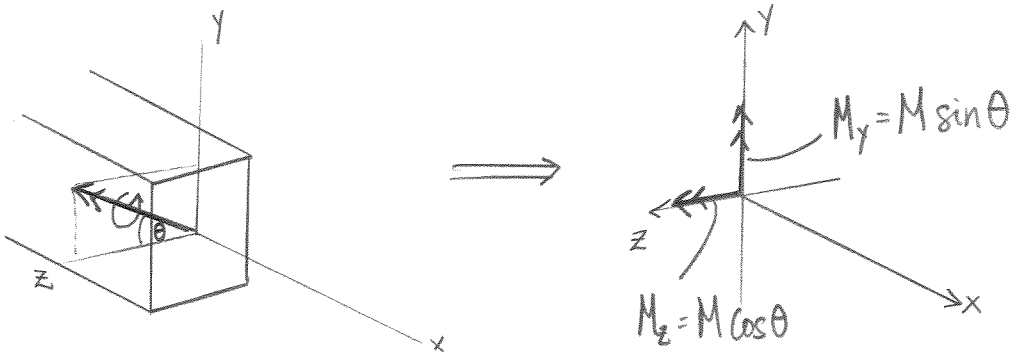
INDEED $\int yz\,dA = 0$ (PRODUCT of INERTIA) if z & y ARE BASED ON PRINCIPLE AXES of INERTIA

(FOR SYMETRIC ELEMENTS, AXIS of SYMETRY)

$$\Sigma M_z = M = \int_A -y\,\sigma\,dA \longrightarrow \boxed{\sigma = \frac{My}{I_z}}$$

FLEXURAL FORMULA

② MOMENT IN ARBITRARY PLANE



THEORY of SUPERPOSITION - SUM RESPONSE DUE TO INDIVIDUAL LOADS

$$\sigma = -\frac{M_z y}{I_z} + \frac{M_y z}{I_y}$$

WHERE IS NEUTRAL SURFACE?

$$\sigma = 0 = -\frac{M_z y}{I_z} + \frac{M_y z}{I_y} \longrightarrow \frac{M_z y}{I_z} = \frac{M_y z}{I_y}$$

$$y = \frac{M_y I_z}{M_z I_y} z$$

$$y = \frac{I_z}{I_y} (\tan\theta) z$$

$$\therefore \tan\alpha = \frac{I_z}{I_y} (\tan\theta)$$