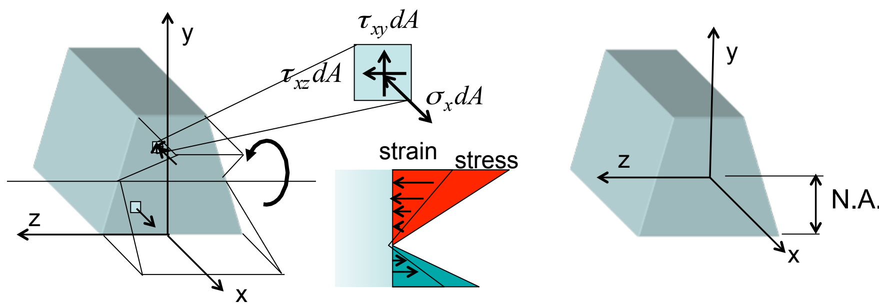
4.4 Stresses and Deformation



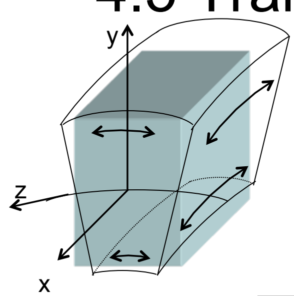
x components: $\int \sigma_x dA = \frac{E}{y}\int y dA = 0$ Determine Neutral Plane

Moment about y: $\int z\sigma_x dA = 0$ For a symmetry (about y) beam, it is always satisfied.

Moment about z: $\int\left(-y\sigma_x dA\right) = \frac{E}{y}\int\left(-y^2 dA\right) = M$

$$\sigma_x = E\varepsilon_x = -E\frac{y}{\rho} = -\left(\frac{y}{c}\right)\sigma_{\max} = \frac{Mc}{I}$$

4.5 Transverse Deformations



Is it then 1-D when you have the strains in all 3-directions?

One stress component

$$\varepsilon_y = -\nu\varepsilon_x = -\nu\frac{y}{\rho}$$

$$\varepsilon_z = -\nu\varepsilon_x = -\nu\frac{y}{\rho}$$

3-D:

$$\varepsilon_x = \frac{1}{E}\left(\sigma_x - \nu\sigma_y - \nu\sigma_z\right)$$
$$\varepsilon_y = \frac{1}{E}\left(\sigma_y - \nu\sigma_x - \nu\sigma_z\right)$$
$$\varepsilon_z = \frac{1}{E}\left(\sigma_z - \nu\sigma_x - \nu\sigma_y\right)$$

Plain Stress For σ_z=0:

$$\varepsilon_x = \frac{1}{E}\left(\sigma_x - \nu\sigma_y\right)$$
$$\varepsilon_y = \frac{1}{E}\left(\sigma_y - \nu\sigma_x\right)$$
$$\varepsilon_z = \frac{-\nu}{E}\left(\sigma_x + \sigma_y\right)$$

Plain Strain for ε_z=0:

$$\varepsilon_x = \frac{1}{E}\left(\left(1-\nu^2\right)\sigma_x - \nu\left(1+\nu\right)\sigma_y\right)$$
$$\varepsilon_y = \frac{1}{E}\left(\left(1-\nu^2\right)\sigma_y - \nu\left(1+\nu\right)\sigma_x\right)$$
$$\sigma_z = \nu\left(\sigma_x + \sigma_y\right)$$

1-D:

$$\varepsilon_x = \frac{\sigma_x}{E}$$
$$\varepsilon_y = \frac{\nu\sigma_x}{E}$$
$$\varepsilon_z = \frac{\nu\sigma_x}{E}$$