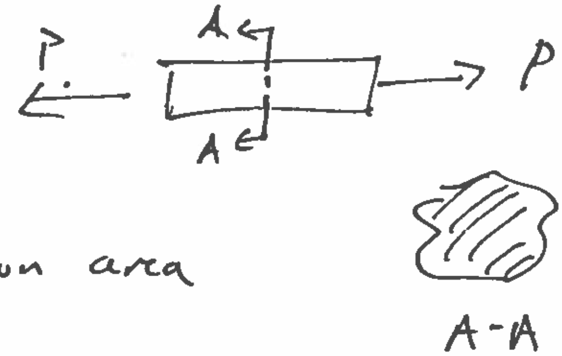
Types of stress

Lecture 7
Wednesday, October 5, 2016

Normal

From Axial Loads

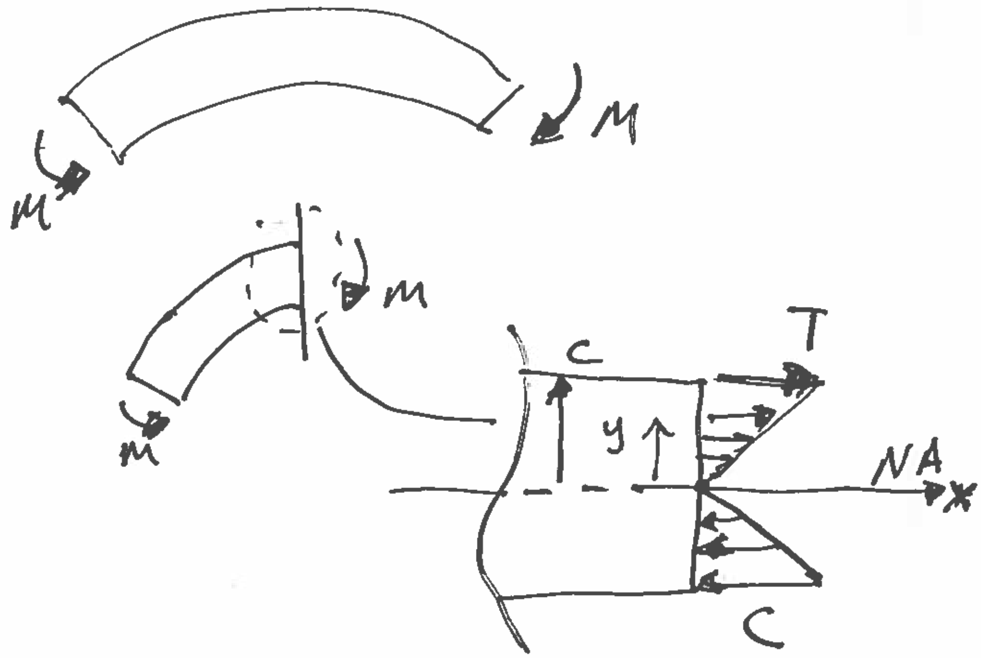


$$\sigma = \frac{P}{A}$$

P : load
A : cross section area

From bending

$$\sigma = \frac{My}{I}$$



M: moment
I: second moment of area
y: distance from the NA

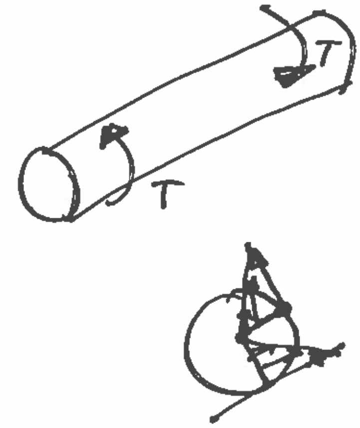
$$\sigma_{max} = \frac{Mc}{I}$$

S'

See Table A-18 for common values of I and J.

Shear stresses

From torsional loads



$$\tau = \frac{Tr}{J}$$

J: polar moment of inertia

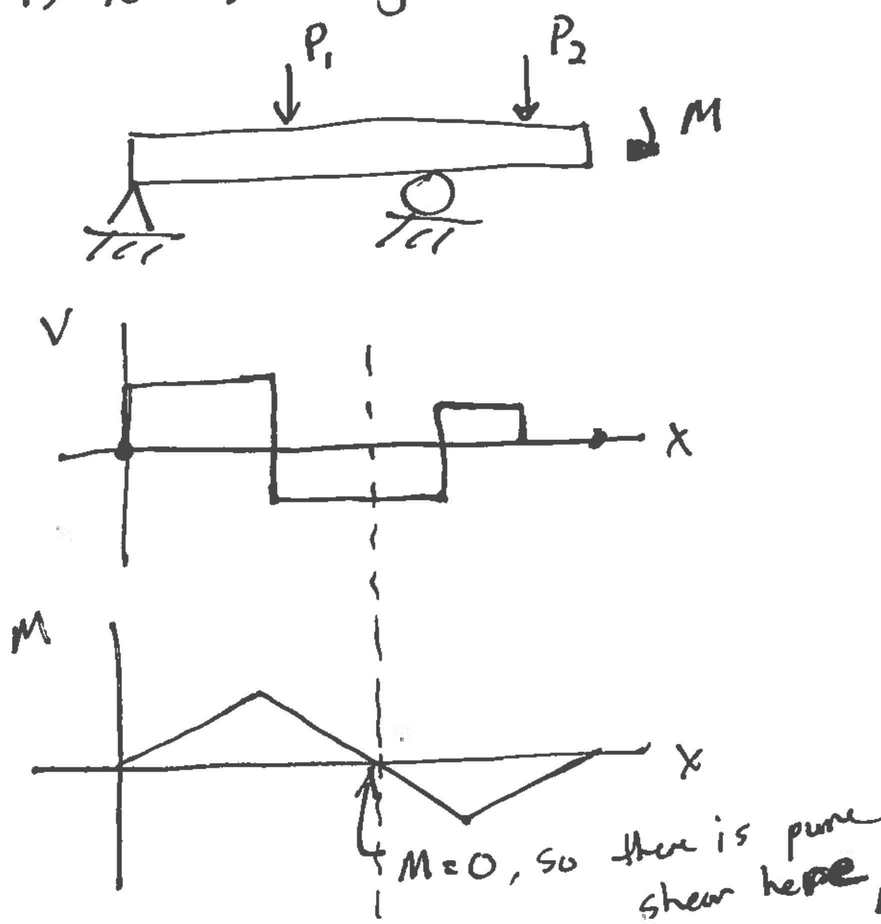
T: torque

r: radius from center

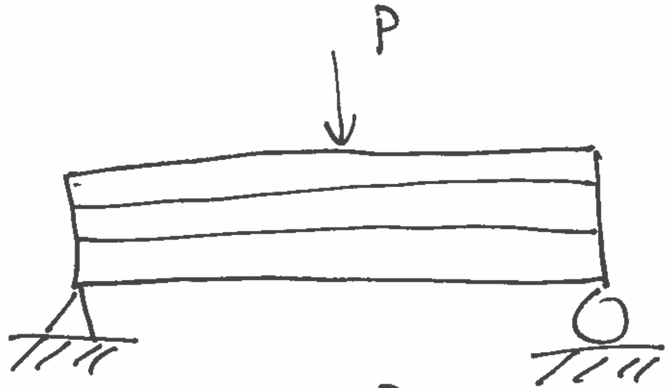
Pure Shear stress

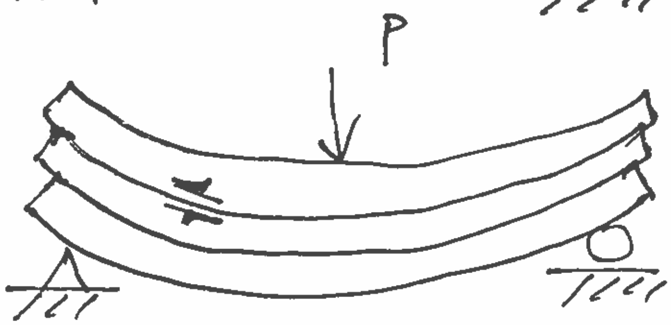
when there is no bending

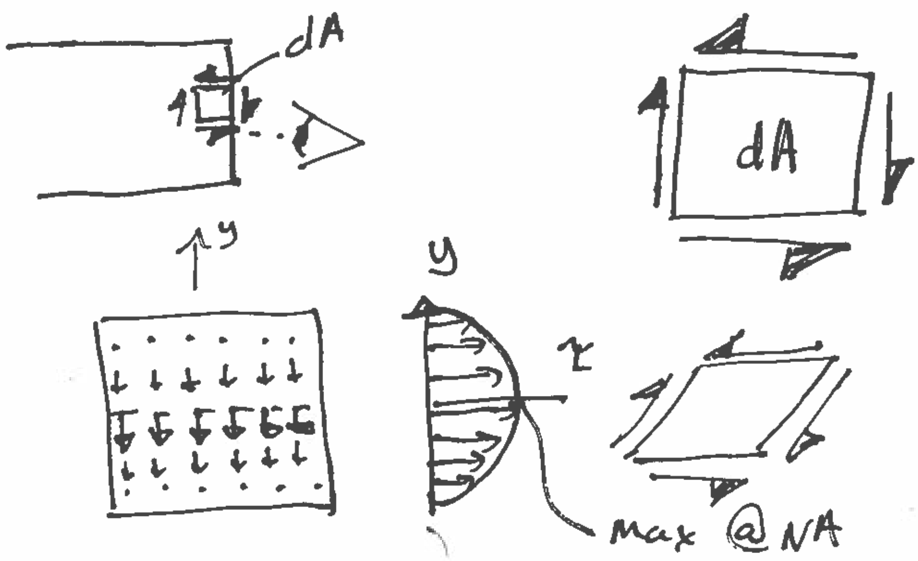
$$\tau = \frac{V}{A}$$



Transverse Shear







Zero at the top and bottom

shear is complementary

four shear components equal in mag

$$\tau = \frac{VQ}{Ib}$$

V: shear force

I: second moment of area of entire cross section

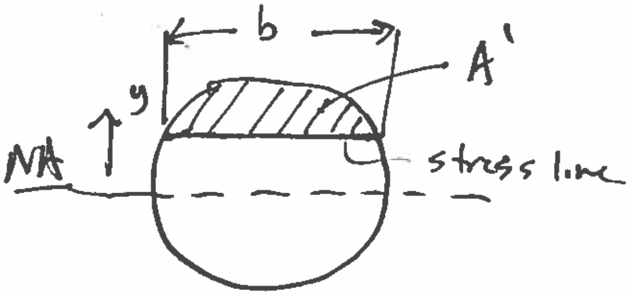
b: width at line of interest

Q: first moment of area of A'

$$Q = \int y \, dA' = \bar{y}' A'$$

A' = cross sectional area above (or below) the stress line

$\bar{y}'$ = distance from the NA to centroid of A'



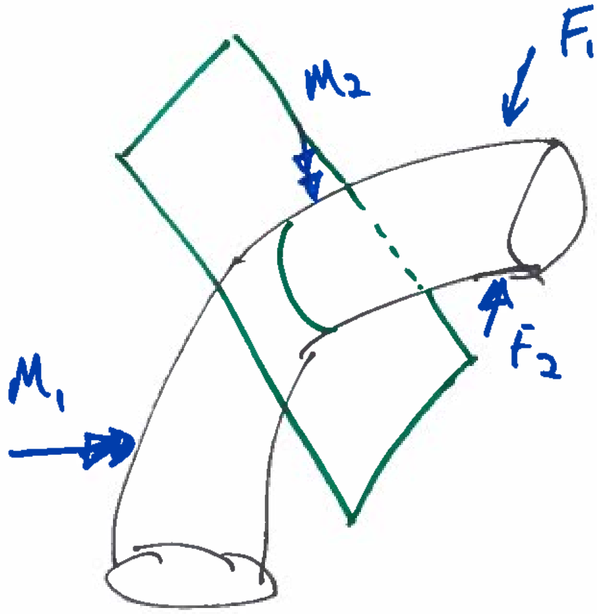
τ is negligible for long beams

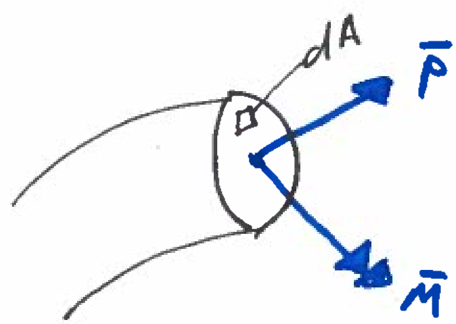
$$\left(\frac{\text{beam length}}{\text{beam height}} > 10 \right)$$

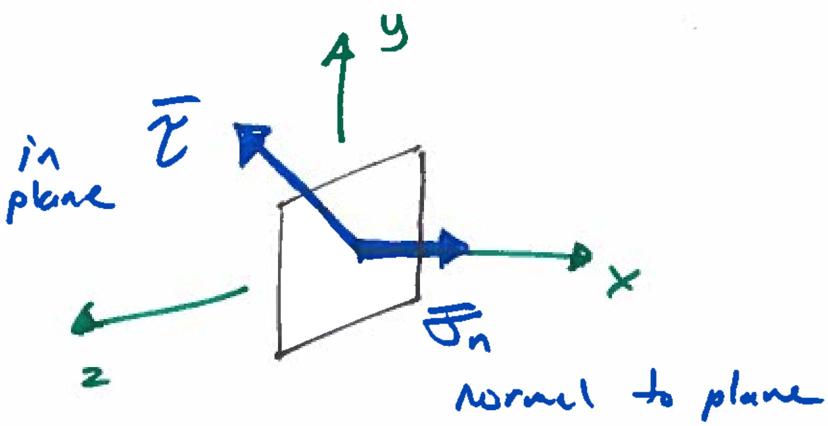
But shapes that have thin webs that extend far from NA may have no negligible transverse shear eg. (I beams, channels)

See table 3-2 for τ_{max} for some cross sections.

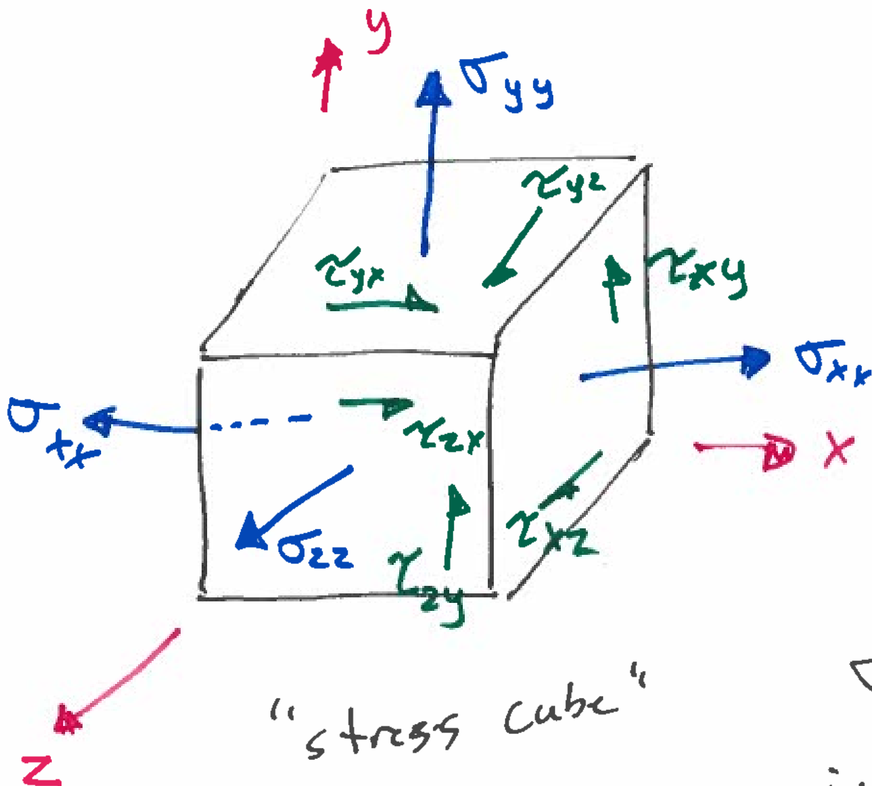
Multi-Axial Stresse







dA is a face of an infintesimal volumetric element dV which must be in equilibrium



"stress cube"

subscripts

σ / τ_{ij}

i: normal vector of the face

j: direction of the stress component

- 9 components of stress
- only 6 unique values (due to complementary shear)

$$\tau_{ij} = \tau_{ji}$$