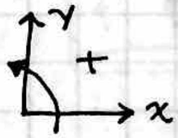
ENGR 213

STANDARD SOLUTION:

PICTURE → FBD → LABEL FORCES → NUMBER FORCES FOR REFERENCE → SOLVE. (MUST INCLUDE COORDINATE SYSTEM!)
- CLEARLY MARK BOTH INTERMEDIATE / FINAL SOLUTIONS

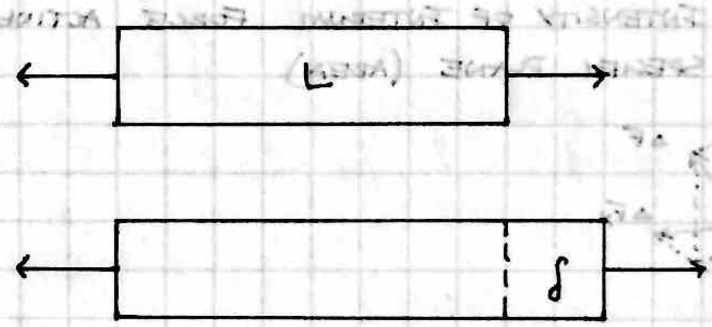
EX. COORDINATE SYSTEM



NORMAL STRAIN:

$$\boxed{\varepsilon = \frac{\delta}{L}}$$

δ = CHANGE IN LENGTH
L = ORIGINAL LENGTH

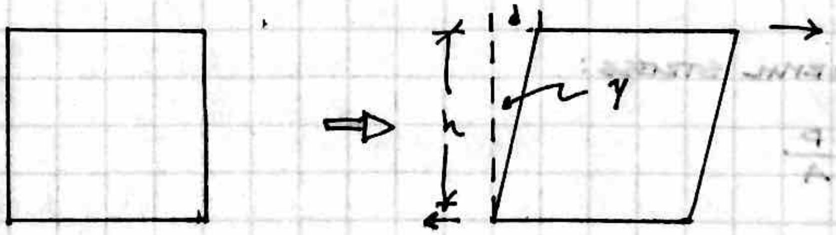


NORMAL STRESS:

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

SHEAR STRAIN:

SHEAR STRAIN IS THE ANGLE OF DEFORMATION, γ ← GAMMA



$$\gamma = \tan^{-1}\left(\frac{d}{h}\right)$$

SHEAR STRESS:

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

V = SHEAR FORCE
A = AREA

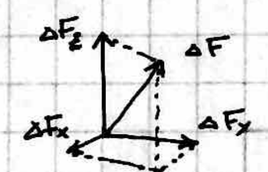
SHEAR STRESS IS SHEAR FORCE PER UNIT AREA.

4-2-2012 READING NOTES:

CHAPTER 7:

* MECHANICS OF MATERIALS: A BRANCH OF MECHANICS THAT STUDIES THE RELATIONSHIPS BETWEEN THE EXTERNAL LOADS APPLIED TO A DEFORMABLE BODY, AND THE INTENSITY OF INTERNAL FORCES ACTING WITHIN THE BODY. INCLUDES COMPUTING DEFORMATIONS, AND STUDYING THE BODIES STABILITY UNDER APPLIED FORCES.

* STRESS: INTENSITY OF INTERNAL FORCE ACTING ON A SPECIFIC PLANE (AREA)



- NORMAL STRESS:

$$\sigma_z = \lim_{\Delta A \to 0} \frac{\Delta F_z}{\Delta A}$$

- SHEAR STRESS:

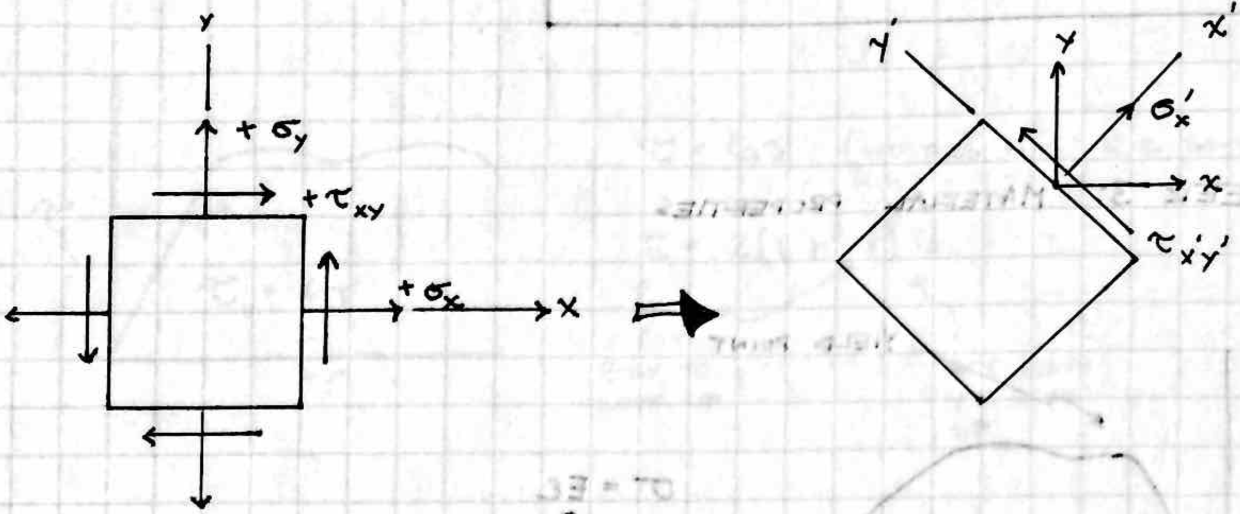
$$\tau_{zx} = \lim_{\Delta A \to 0} \frac{\Delta F_x}{\Delta A}, \quad \tau_{zy} = \frac{\Delta F_y}{\Delta A}$$

- AVERAGE NORMAL STRESS:

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

* CHAPTER 14 READING NOTES:

- GENERAL EQUATIONS OF PLANE - STRESS TRANSFORMATION:



$$\boxed{\sigma_{x'} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos(2\theta) + \tau_{xy}\sin(2\theta)}$$

$$\boxed{\tau_{x'y'} = -\frac{\sigma_x - \sigma_y}{2}\sin(2\theta) + \tau_{xy}\cos(2\theta)}$$

$$\boxed{\tan(2\theta_p) = \frac{\tau_{xy}}{(\sigma_x - \sigma_y)/2}}$$ ← ANGLE OF MAXIMUM AND MINIMUM NORMAL STRESSES

* MAXIMUM OR MINIMUM IN-PLANE NORMAL STRESS ACTING AT A POINT:

$$\boxed{\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}}$$

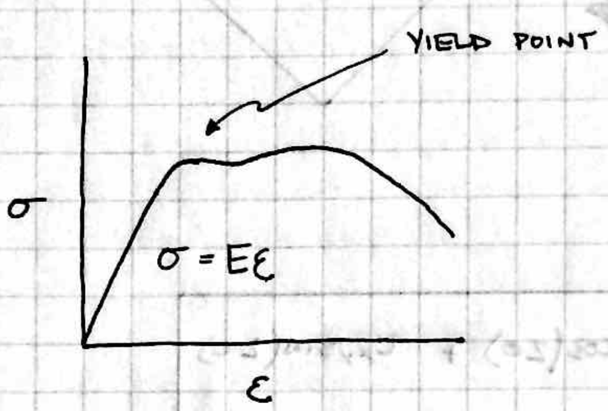
* MAXIMUM IN-PLANE SHEAR STRESS:

$$\boxed{\tan(2\theta_s) = \frac{-(\sigma_x - \sigma_y)/2}{\tau_{xy}}}$$

* CHAPTER 14 :

$$\boxed{\tau_{\substack{MAX \\ IN\ PLANE}} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^{\ 2}}}$$

WEEK 3: MATERIAL PROPERTIES



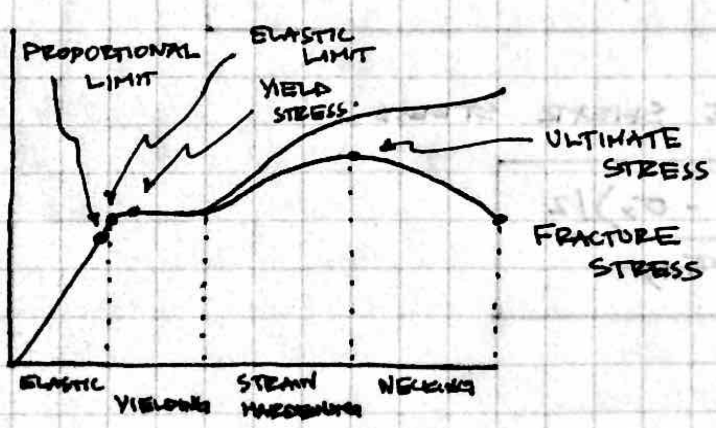
$\sigma = E\varepsilon$

MODULUS OF ELASTICITY
(SLOPE OF LINEAR PART)

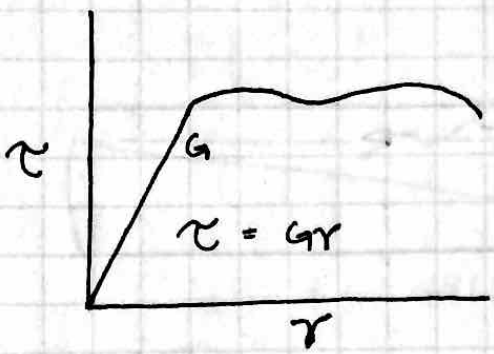
* POISSON'S RATIO: NORMAL STRESS

THE DEFLECTIONS δ_{LONG} AND $\delta_{LATERAL}$ ARE RELATED BY POISSON'S RATIO.

$$\nu = -\frac{\varepsilon_{LATERAL}}{\varepsilon_{LONG}}$$



* POISSON'S RATIO: SHEAR STRESS



$\tau = G\gamma$ (HOOKE'S LAW FOR SHEAR)

$E = 2(1 + \nu)\,G$

EASY TO LOOK UP

NOT EASY TO LOOK UP

* TEMPERATURE EFFECT'S:

THERMAL COEFFICIENT OF EXPANSION α HAS UNITS OF 1/TEMPERATURE. IT RELATES LENGTH AND TEMPERATURE:

$$\boxed{\delta_{THERMAL} = \alpha \cdot \Delta T \cdot L}$$

* FACTOR OF SAFTEY:

$$F.S. = \frac{F_{FAIL}}{F_{ALLOW}}$$

4/26/2012

* ELASTIC DEFORMATION OF AXIALLY LOADED MEMBERS

$$\varepsilon = \frac{\delta}{L} \rightarrow \delta = \varepsilon L$$

$$\sigma = E\varepsilon \rightarrow \delta = \left(\sigma/_E\right)L \quad , \quad \sigma = \frac{P}{A} \rightarrow$$

$$\boxed{\delta = \frac{PL}{AE}}$$ THE ELASTIC DEFORMATION

MORE GENERAL FORM:

$$\delta = \frac{L}{E}\int \frac{P(x)}{A(x)}\,dx$$

* SIGN CONVENTION *

(+) TENSION

(−) COMPRESSION

* EXAM *

1:50 MIN LONG

~ % 50 SHORT LIKE QUIZ

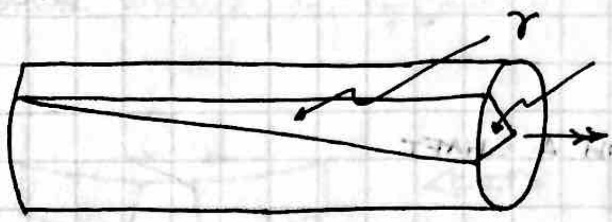
~ % 50 PROBLEMS LIKE HOMEWORK

~ 1 3/5 NOTECARD

5/2/2012 WEEK 5

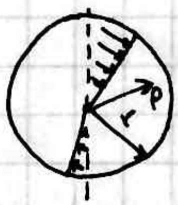
* LECTURE (VIDEO) NOTES

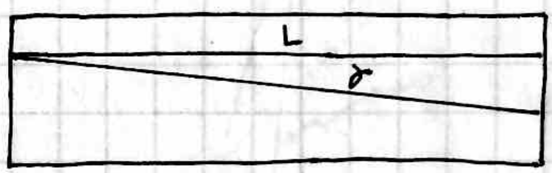
* TORSION



$$\tau = G\gamma$$

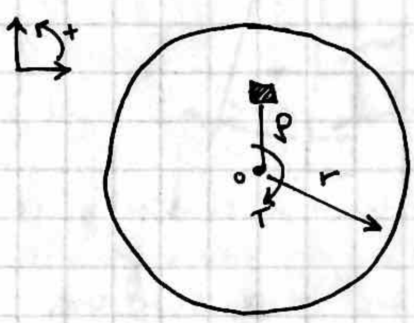
$$\tau = \frac{\rho}{r}\tau_{MAX}$$





$$L\gamma = r\phi$$

$$\gamma = \frac{r\phi}{L} \leftarrow \text{DEFLECTION}$$



$$\sum M_o = 0 = -T + \int_A \rho \tau \, dA \text{ , BUT } \tau = \frac{\rho}{r} \text{, SO}$$

$$T = \frac{\tau_{MAX}}{r}\int \rho^2 dA \rightarrow \tau_{MAX} = \frac{Tr}{J} \text{, WHERE}$$

$J_{cyl} = \frac{\pi}{2} r^4$

J = POLAR MOMENT OF INERTIA (FUNCTION OF THE SHAPE)

TORSION FORMULA:

$$\boxed{\tau = \frac{T\rho}{J}}$$

WHERE $0 \leq \rho \leq r$

* **DEFLECTION** :

$$\boxed{\phi = \frac{TL}{GJ}} \quad \text{AND} \quad \boxed{\delta = \frac{PL}{EA}}$$

* POWER :

- POWER OFTEN TRANSMITTED THROUGH A SHAFT

$$\boxed{P = T\omega}$$

WHERE P IS OFTEN IN HP OR KW AND ω IS IN RAD/TIME

* INDETERMINATE PROBLEMS:

5/3/2012

* EXAM NEXT FRIDAY

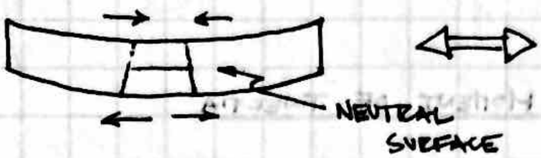
~50% SHORT ANSWER (QUIZ)
~50% WORK OUT

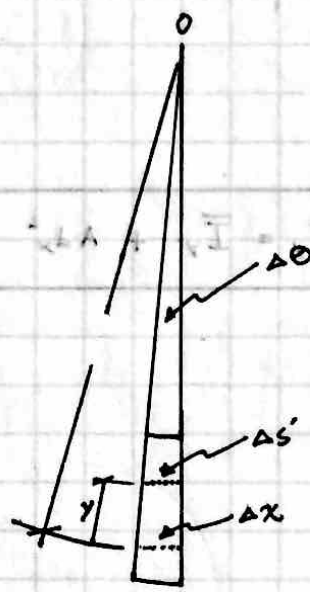
WEEK 7:

*** STRESS DUE TO BENDING**

- NORMAL STRESS: $\sigma = -\dfrac{My}{I}$ M = INTERNAL MOMENT
- SHEAR STRESS: $\tau = \dfrac{VQ}{It}$ V = SHEAR FORCE

* NORMAL STRESS = BENDING STRESS *





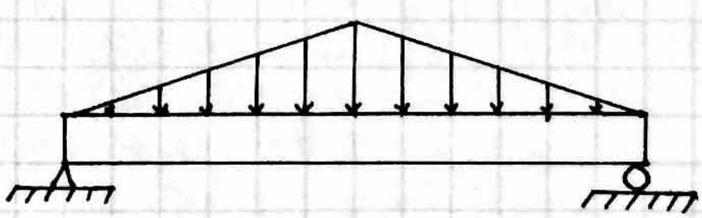
$$\varepsilon = \frac{\delta}{L} = \frac{\Delta s' - \Delta x}{\Delta x}, \text{ BUT } \Delta x = \rho \Delta \theta$$

AND $\Delta s' = (\rho - y)\Delta\theta$, SO:

$$\varepsilon = \frac{[(\rho - y)\Delta\theta] - [\rho\Delta\theta]}{[\rho\Delta\theta]}$$

$$\varepsilon = -\frac{y}{\rho}$$

y ← DISTANCE FROM NEUTRAL AXIS.



σ_{MAX} @ M_{MAX}

ALSO

σ_{MAX} @ y_{MAX}

($+y_{MAX} \rightarrow C$)

($-y_{MAX} \rightarrow T$)

5/24/2012

$$\boxed{\tau = \frac{VQ}{IB}}$$

V = SHEAR FORCE AT LOCATION OF INTEREST
I = MOMENT OF INERTIA ABOUT CENTROID OF BEAM CROSS SECTION
B = WIDTH OF BEAM WHERE τ IS BEING CALCULATED
Q = FIRST MOMENT OF INERTIA CAUSING τ

$Q = \bar{y}A$

* CHAPTER 6 READING NOTES: SECOND MOMENT OF INERTIA

$$\boxed{J_o = \int r^2 \, dA = I_x + I_y}$$

* PARALLEL-AXIS THEORUM:

$$\boxed{I_x = \bar{I}_{x'} + A d_y^2} \quad \text{AND} \quad \boxed{I_y = \bar{I}_{y'} + A d_x^2}$$

- POLAR MOMENT OF INERTIA:

$$\boxed{J_o = \bar{J}_c + A d^2}$$

"THE MOMENT OF INERTIA FOR AN AREA ABOUT AN AXIS IS EQUAL TO ITS MOMENT OF INERTIA ABOUT AN AXIS PASSING THROUGH THE AREA'S CENTROID PLUS THE PRODUCT OF THE AREA AND THE SQUARE OF THE PERPENDICULAR DISTANCE BETWEEN AXIS".