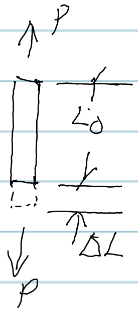
CH. 2.1–2.2 STRAIN

DEF!

STRAIN, NORMAL

$$\varepsilon = \frac{\Delta L}{L_o}$$

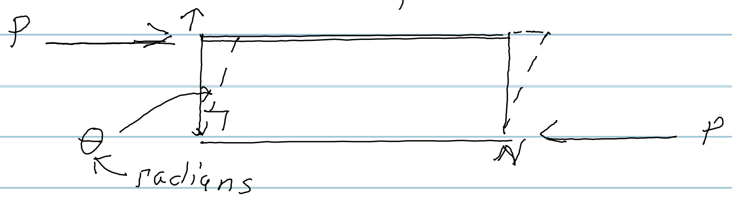
NO UNITS



SHEAR STRESS

SHEAR STRAIN

$$\gamma = \frac{\pi}{2} - \theta$$



SMALL STRAIN ANALYSIS

USUAL THAT $\varepsilon << 1$ γ

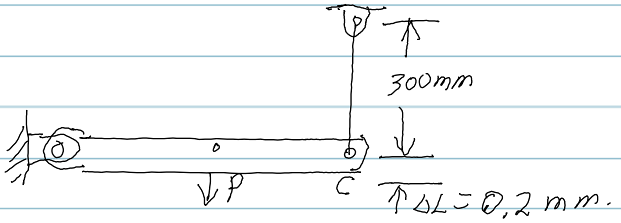
$\theta << 1$ $\sin(\theta) = \theta$, $\cos(\theta) = 1$, $\tan(\theta) = \theta$

radians

Prob. F 2-1 (MODIFIED SO $\Delta L = .2\,mm$ @ "C")

FIND: NORMAL STRAIN $\varepsilon = ?$ FOR CABLE

SKETCH



SOLUTION:

$$\varepsilon = \frac{\Delta L}{L_o} = \frac{0.2\,mm}{300\,mm} = \underline{\underline{6.7 \cdot 10^{-4}}}$$ NO UNIT, in/in, mm/mm

$$\varepsilon = 670 \cdot 10^{-6} = \underline{\underline{670\,\mu}}$$

$$\%\varepsilon = 100 \cdot \varepsilon = 6.7 \cdot 10^{-4}(100) = 6.7 \cdot 10^{-2} = \underline{\underline{.067\%}}$$

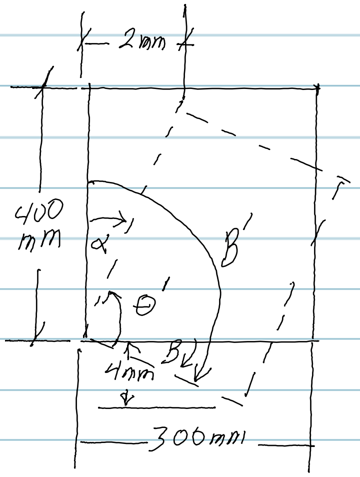
$$\underline{\underline{\varepsilon = .067\%}}$$

CH. 2 STRAIN (CONT.)

PROB. F2-3

FIND: SHEAR STRAIN @ CORNER "A"

SKETCH



SOLUTION:

$$\gamma = \frac{\pi}{2} - \theta'$$

SMALL ANGLE APPROXIMATION

ARC LENGTH
RADIUS

$$S = r\theta$$

radians

$$\theta = \alpha = \frac{S}{r} = \frac{2\,mm}{400\,mm} = .005\ rad$$

$$TAN\,\alpha = \frac{2\,mm}{400\,mm.}$$

$$\alpha = .005\ rad$$

$$B = \frac{S}{r} = \frac{4\,mm}{300} = .013\bar{3}\ rad.$$

$$B' = \frac{\pi}{2} + B = \frac{\pi}{2} + .0133\ rad$$

$$\theta' = B' - \alpha = \frac{\pi}{2} + .0133 - .005 = \frac{\pi}{2} + .00833$$

$$\underline{\underline{\gamma = \frac{\pi}{2} - \theta' = \frac{\pi}{2} - \left[\frac{\pi}{2} + .00833\right] = -.00833}}$$

CH. 3-1 TO 3-5 STRESS STRAIN DIAGRAMS

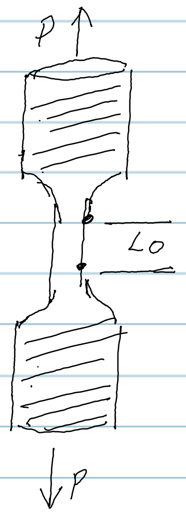
SECTION 3-1 & 3-2

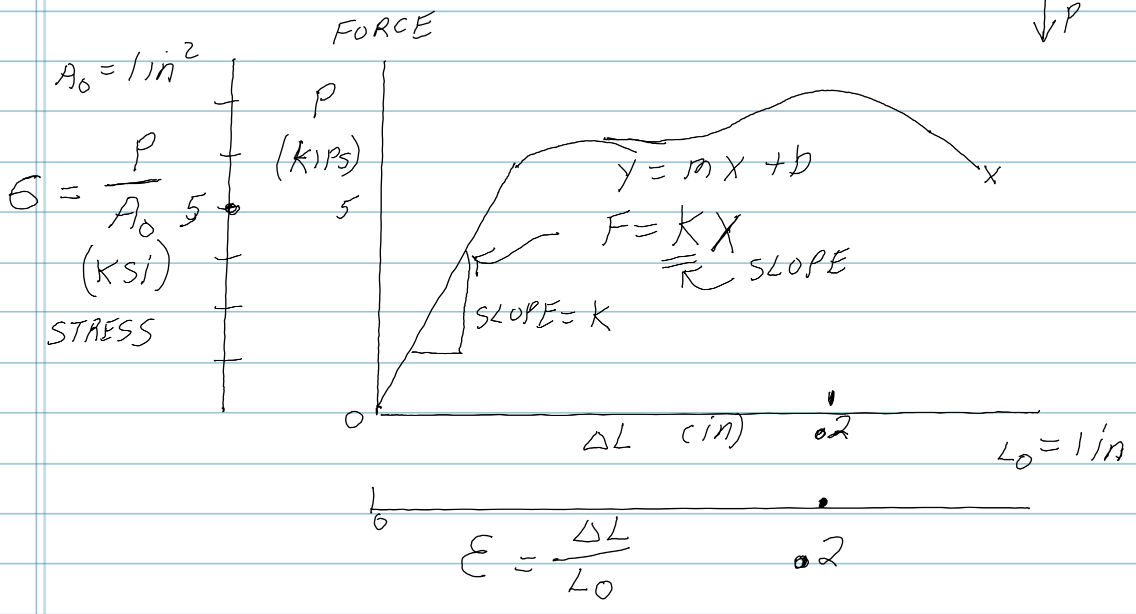
DEFINE

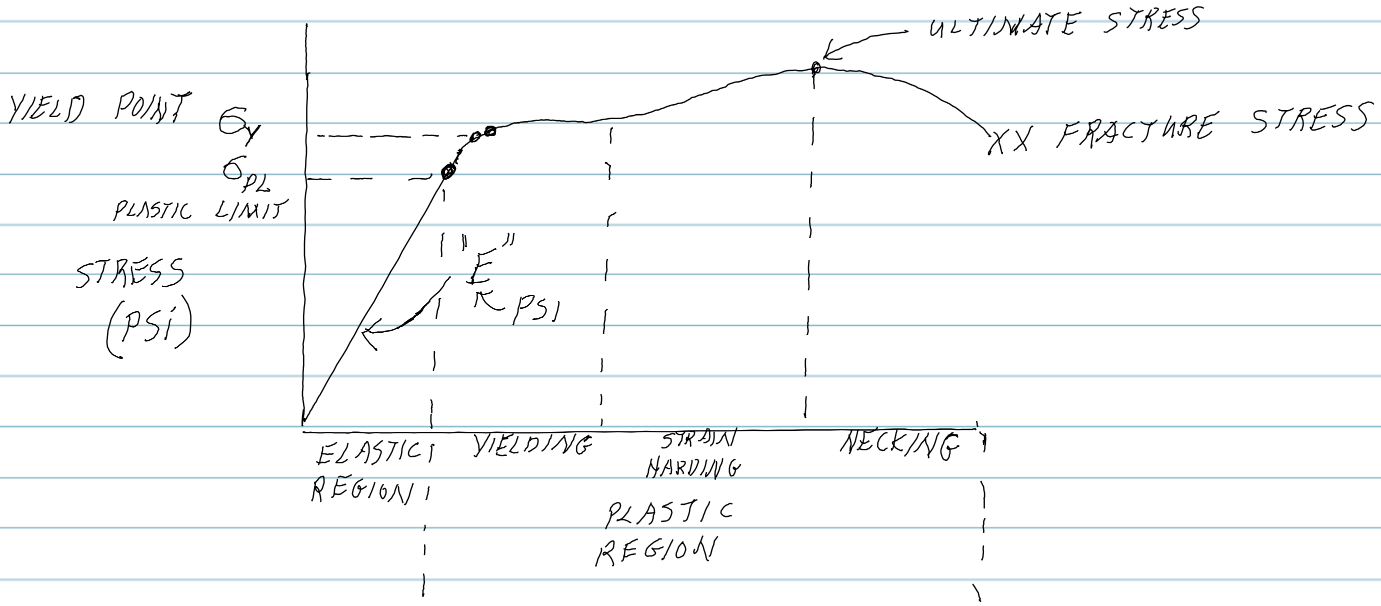
$$\sigma = \frac{P}{A_0} \leftarrow \text{ORIGINAL AREA}$$

↖ PSI

$$\varepsilon = \frac{\Delta L}{L_0} = \frac{\delta}{L_0}$$



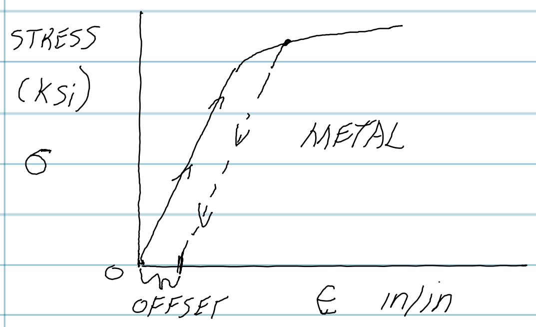


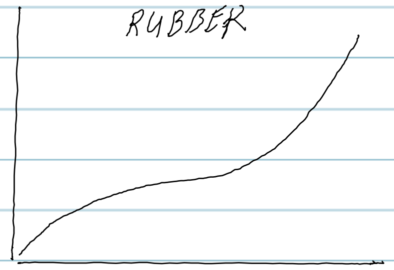


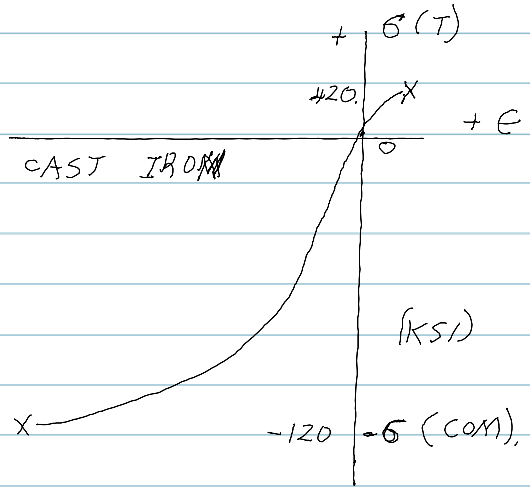
CH. 3.1 - 3.5 STRESS + STRAIN DIAGRAMS

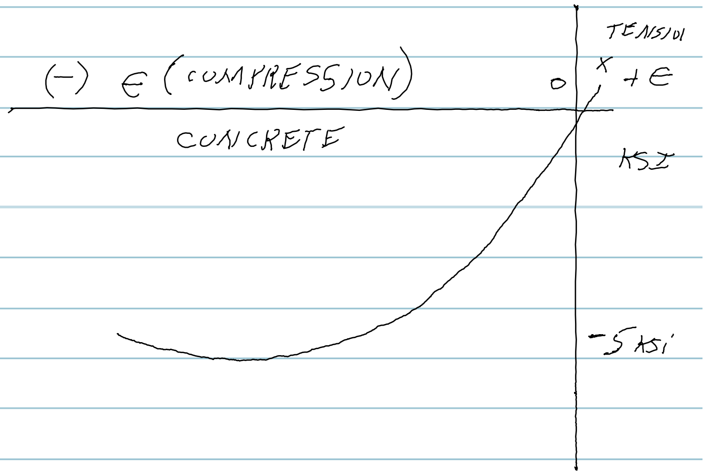
SECTION 3.3 DUCTILE + BRITTLE MATERIALS

$$\% \text{ ELONGATION} = \% E = \frac{L_f - L_0}{L_0}(100)$$









SECTION 3.4 HOOK'S LAW

* $F = KX$ $\underline{\underline{\sigma = E\epsilon}}$ ASSUME - STAY IN ELASTIC RANGE

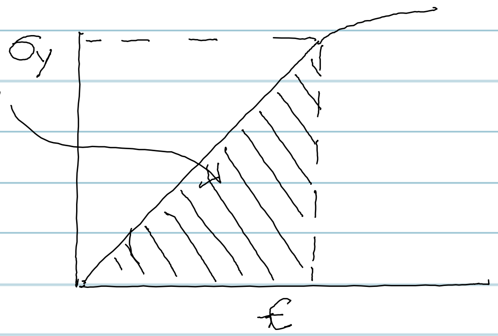
"E" σ_y

SECTION 3.5 STRAIN ENERGY

AREA UNDER σ VS ε = ENERGY DENSITY

MODULUS OF RESILIENCE

$$u_r = \tfrac{1}{2}\sigma_{pl}\,\epsilon_{pl} = \tfrac{1}{2}\frac{\sigma_{pl}^2}{E}$$



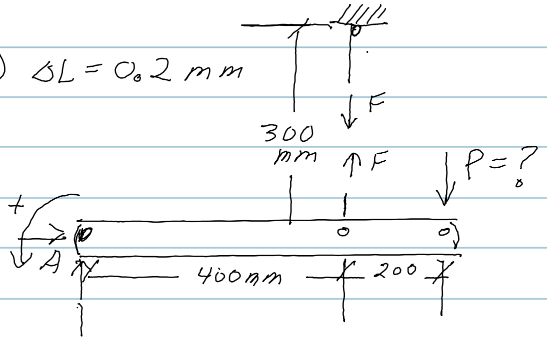
CH. 3.1 - 3.5 STRESS + STRAIN (CONT.)

SECTION 3.5 (CONT.)

MODULUS OF TOUGHNESS

PROB. F3-12

GIVEN: CABLE A-36 STEEL ($d = 3\,mm$) $\Delta L = 0.2\,mm$



SOLUTION: WORK BACKWARD!

$P = ?$ $\qquad \Sigma M_A = 0$

① $+F(400) - P(600) = 0 \qquad P = \frac{400}{600} F$

$F = ?$

② $\sigma_N = \frac{F}{A} \longleftarrow A = \frac{\pi}{4} d^2 = \frac{\pi}{4}(3mm)^2 = 7.08 mm^2$

$\sigma_N = ?$

③ $\sigma_N = E\epsilon \qquad E = 200\,GPa = 200 \cdot 10^9 Pa$

④ $\epsilon = ? \qquad \epsilon = \frac{\Delta L}{L_0} = \frac{.2\,mm}{300\,mm} = 6.67 \cdot 10^{-4}$ NO UNITS!

WORK UPWARDS

③ $\sigma_N = E\epsilon = 200 \cdot 10^9 Pa\,(6.67 \cdot 10^{-4}) = 133.3\,MPa = 1.33 \cdot 10^8 Pa$

② $F = \sigma_N A = (1.33 \cdot 10^8 Pa)\, 7.08\,mm^2 \left(\frac{1\,m}{1000\,mm}\right)^2 = 942\,N$

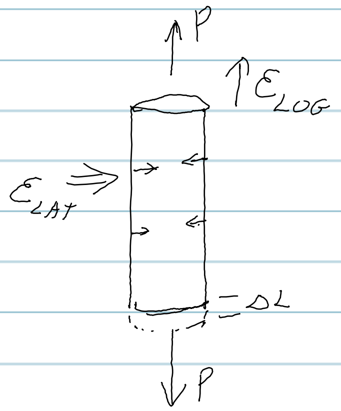
① $P = \frac{400}{600} P = \frac{2}{3}(942N) = \underline{\underline{628N}}$

CH 3.6 - 3.7 POISSON'S RATIO & CREEP & FATIGUE

SECTION 3.6 POISSON'S RATIO

$$\nu = -\frac{\epsilon_{LAT}}{\epsilon_{LONG}}$$

"ν" SPECIFIC FOR A MATERIAL
(LOOK UP)



SECTION 3.7 SHEAR STRESS-STRAIN DIAGRAM

$$\sigma_N = E\,\epsilon$$

$$\tau = G\,\gamma$$

SHEAR STRAIN

SHEAR MODULUS OF ELASTICITY or (modulus of rigidity

SHEAR STRESS (psi)

$$G = \frac{E}{2(1+\nu)}$$

POISSON'S RATIO

SECTION 3.8 FATIGUE OF MATERIAL

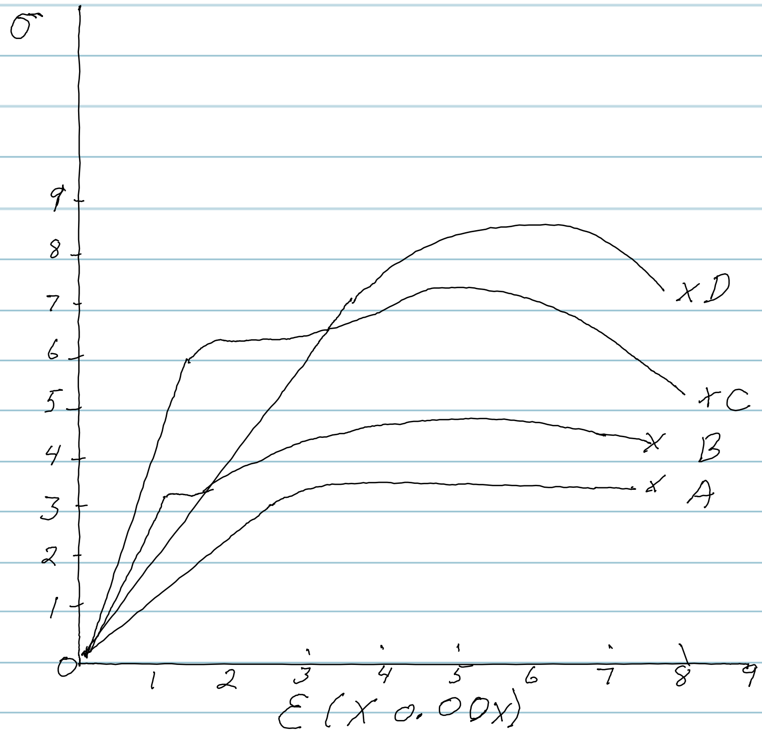
FATIGUE - CYCLE OF LOADING & UNLOADING
10 - 100 M CYCLES

CREEP ← ΔL CONTINUOUS LOAD - BOOK SHELF

WOOD - CONCRETE
HIGH TEMP - STEEL

RANKING - MODULUS OF ELASTICITY

RANK ~~TO~~ THE MODULUS OF ELASTICITY FOR EACH OF THE 4 FIGURES (A-D)



LARGEST 1)

2)

3)

4)

MODULUS OF ELASTICITY SAME FOR ALL. ____

STATE YOUR REASON:

CONFIDENCE (CIRCLE ONE)

LOW MEDIUM HIGH