FE Review
9/16/09
Mechanics of Mat'ls
Dynamics

Sign convention

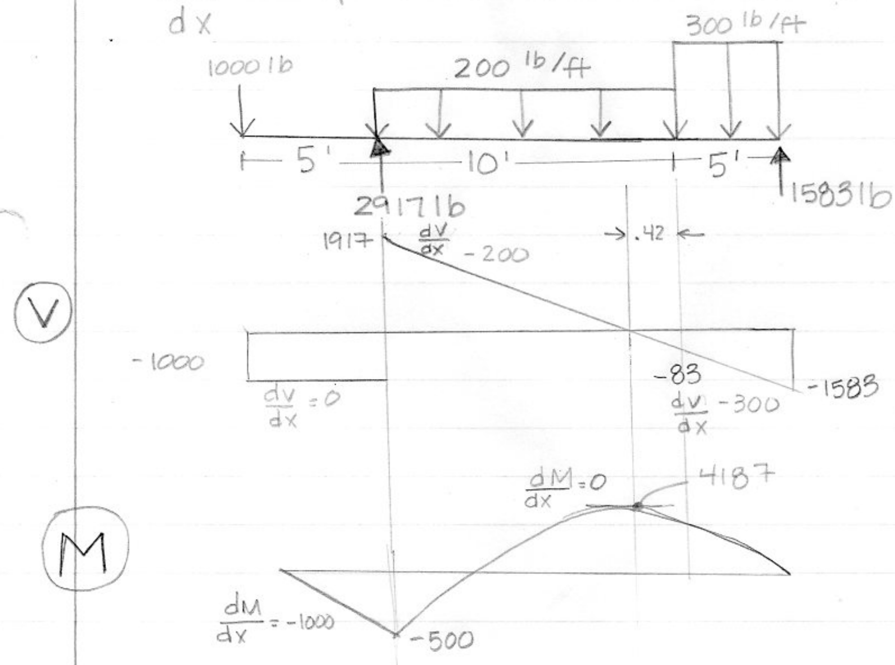
	Positive	Negative
Axial Force	←[T]→	→[C]←
Shear Force	↑[+]↓	↓[−]↑
Bending Moment	↻[+]↺	↺[−]↻

* Dr. Varma's ppt present posted online. - View as notes for extra info

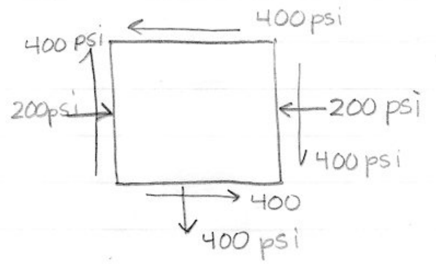
$\frac{dV}{dx}$ = Slope of Shear force diagram = $-W$

$\frac{dM}{dx}$ = Slope of BMD = V

} W downwards is positive



Mohr's Circle for Stress



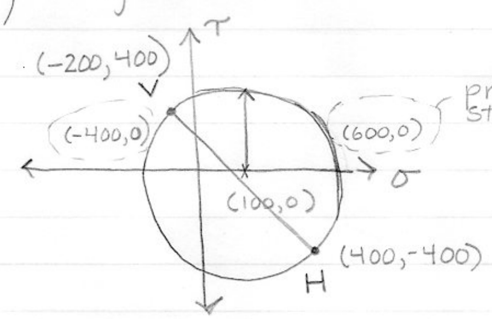
$\sigma_x = -200_{psi}$ (- bc compression)

$\sigma_y = 400psi$

$\tau_{xy} = -400psi$

$\frac{\sigma_x + \sigma_y}{2} = 100_{psi} \rightarrow$ center

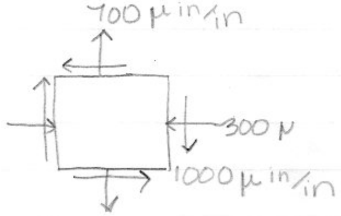
$r = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} = 500_{psi} \rightarrow$ radius



principle stress $\begin{cases} \sigma_{p1} = 600 \\ \sigma_{p2} = -400 \end{cases}$

$\tan 2\theta_p = 2\frac{\tau_{xy}}{\sigma_x \sigma_y} = 26.6°$ -principle direction

Mohrs Circle for Strain



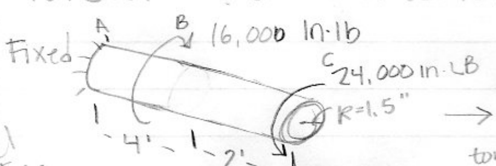
$\gamma_{xy} = \frac{\tau_{xy}}{G}$

$\varepsilon_{xy} = \frac{\gamma_{xy}}{2}$

} all equations same except $\tau_{xy} = \frac{\gamma_{xy}}{2}$

$\sigma = \epsilon$

Torsional Deformation



→ rxn A = 8,000 in·LB

Torsional moment of inertia

$J = \frac{\pi R^4}{2}$

$= \frac{\pi (1.5)^4}{2}$

$= 7.95$

$\theta = \left(\frac{TL}{JG}\right)_{A\ to\ B} + \left(\frac{TL}{JG}\right)_{BC}$

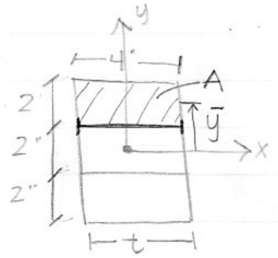
(T = torque, G = shear modulus)

$\theta = \frac{(8{,}000)(48)}{} + \frac{(24000)(24)}{}$

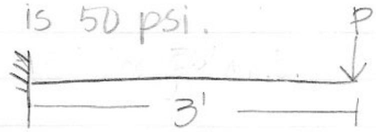
$\tau_{max} = \frac{T\rho}{J}$

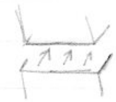
(ρ = radius)

Shear Stresses in Bending



Allowable Shear stress in glued joints is 50 psi.





$I = \frac{bh^3}{12} = \frac{4(6)^3}{12} in^4 = 72 \, in^4$

$Q = A\bar{y} \Rightarrow \tau = \frac{VQ}{It}$ ← allowable shear stress; VQ ~ max shear stress = P (V diagram)

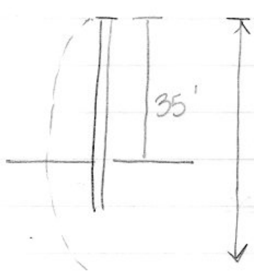
$= (4)(2)(2)$

$= 16 \, in^3$

$50 = \frac{P(16 in^3)}{(72 in^4)(4 in)} \Rightarrow P = 900 \, lb.$

$\sigma = \frac{MC}{I} = \frac{(900 \times 36)(3 in)}{72 in^4}$ (M; max dist to centroid)

Euler Buckling in Columns



(for fix/free = $L_e = 2L$)

$L_e = 70$

radius of gyration = $r = \sqrt{I/A} = 1.16''$

slenderness ratio = $L_e/r = 724$

$P_{critical} = \frac{\pi^2 EI}{(L_e)^2}$

for fix/pin → $L_e = .7L$