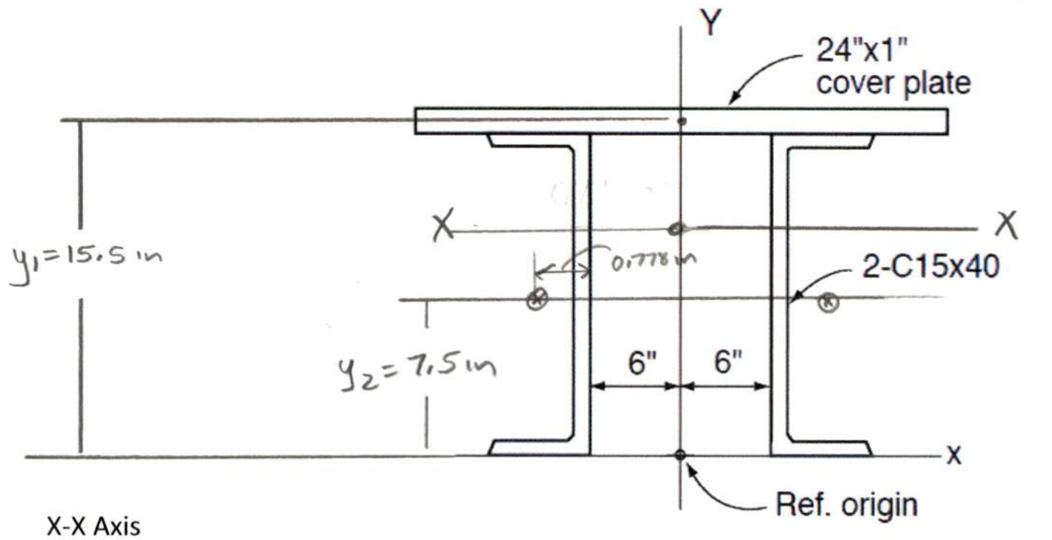
CMGT350	Exam #2 - Makeup	Fall 2021

One page of notes, front and back handwritten by you. Handout of Tables. Algebra and Trig Cheat Sheets

SHOW ALL WORK FOR FULL CREDIT

Name Solution

1. Determine the moment of inertia about the centroidal x- and the centroidal y-axes for the shape shown.



X-X Axis

Part	A (in²)	y (in)	Ay (in³)	$\bar{y} - y$ (in)	$A(\bar{y}-y)^2$ (in⁴)	I (in⁴)
PL 24×1	24	15.5	372	-3.97	378.26	2
C 15×40	11.8	7.5	88.5	4.03	191.64	349
C 15×40	11.8	7.5	88.5	4.03	191.64	349
Σ	47.6	Σ	549	Σ	761	700

$$\bar{y} = \frac{\Sigma Ay}{\Sigma A} = \frac{549\ in^3}{47.6\ in^2} = 11.53\ in$$

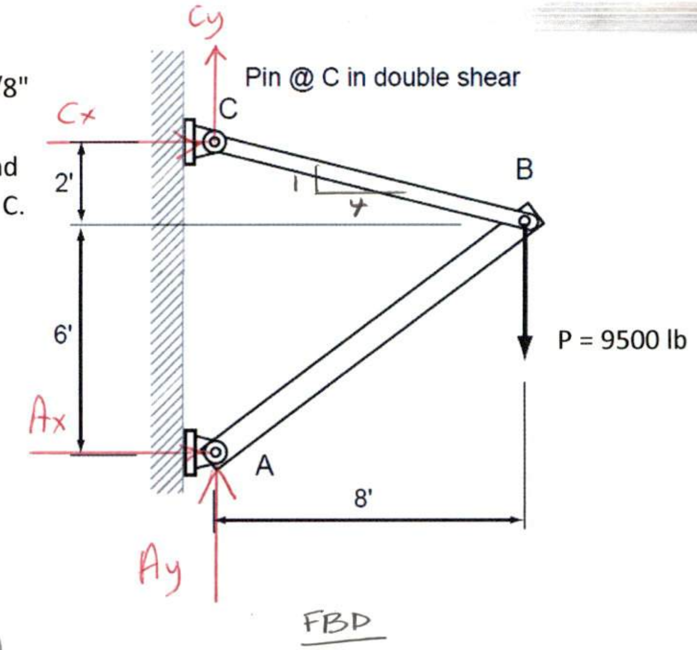
$$I_x = \Sigma\left[I + A(\bar{y}-y)^2\right] = 700\ in^4 + 761\ in^4 = 1461\ in^4$$

Y-Y Axis

Part	A (in²)	x (in)	Ax (in³)	$\bar{x} - x$ (in)	$A(\bar{x}-x)^2$ (in⁴)	I (in⁴)
PL 1×24	24	0	—	—		$\frac{1(24)^3}{12} = 1152$
C 15×40	11.8	6.778	—	—	542	9.23
C 15×40	11.8	6.778	—	—	542	9.23
Σ	47.6				1084	1170

$$I_y = \Sigma\left[I + A(\bar{x}-x)^2\right] = 1170\ in^4 + 1084\ in^4 = 2254\ in^4$$

2. A hoist consisting of a 6"x8" wooden post AB and a 1 1/8" diameter steel rod BC, supports a load P=9500 lb as shown. Determine (a) the axial stresses in AB and BC and (b) the average shear stress in the 1 ½" diameter pin at C. The pin at C is in double shear. Give all answers in psi.



Solution.

Equilibrium Equations

$[\Sigma M_A = 0] \quad -C_x(8\text{ ft}) - 9500\text{ lb}(8\text{ ft}) = 0$

$C_x = -9500\text{ lb} \rightarrow$

and $\boxed{C_x = 9500\text{ lb} \leftarrow}$

From Slope (Similar Triangles)

$C_y = \dfrac{C_x}{4} = \dfrac{9500\text{ lb}}{4} = \underline{\underline{2375\text{ lb}}} \uparrow$

$F_{BC} = \sqrt{9500\text{ lb}^2 + 2375\text{ lb}^2}$
$= \underline{\underline{9790\text{ lb}}}$

$[\Sigma F_x = 0] \quad A_x + C_x = 0$

$A_x = -C_x = -(-9500\text{ lb}) = 9500\text{ lb} \rightarrow$

$[\Sigma F_y = 0] \quad A_y + C_y - 9500\text{ lb} = 0$

$A_y = 9500\text{ lb} - 2375\text{ lb} = 7125\text{ lb} \uparrow$

$F_{AB} = \sqrt{9500\text{ lb}^2 + 7125\text{ lb}^2}$
$= \underline{\underline{11{,}875\text{ lb}}}$

a) $\sigma_{AB} = \dfrac{P}{A} = \dfrac{11875\text{ lb}}{6\text{ in} \times 8\text{ in}} = \underline{\underline{247\text{ psi}}}$

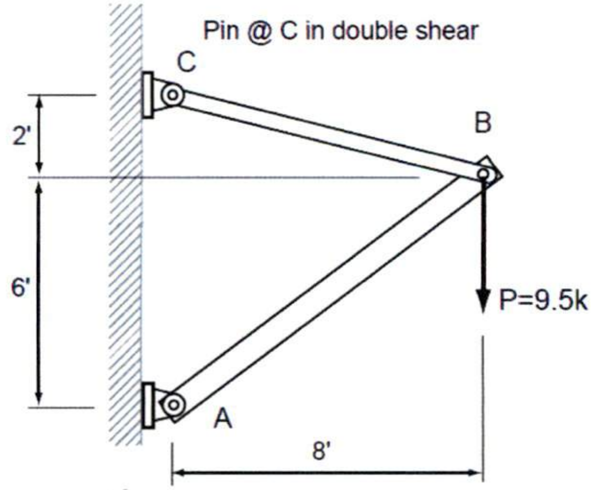
$\sigma_{BC} = \dfrac{P}{A} = \dfrac{9790\text{ lb}}{\frac{\pi (1.125\text{ in})^2}{4}} = \underline{\underline{9850\text{ psi}}}$

b) $\tau = \dfrac{P}{A} = \dfrac{9790\text{ lb}}{\frac{\pi (1.5\text{ in})^2}{4} \times 2} = \underline{2770\text{ psi}}$

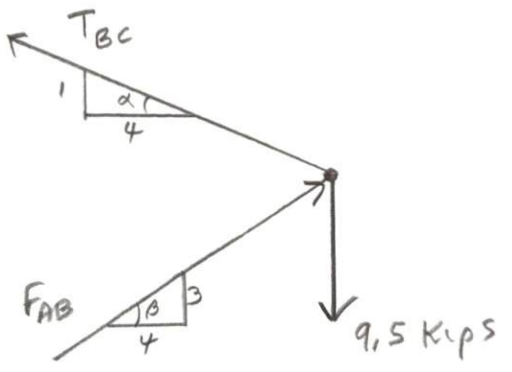
double-shear

2. A hoist consisting of a 6"x8" wooden post AB and a 1 1/8" diameter steel rod BC, supports a load P=9.5 Kips as shown. Determine (a) the axial stresses in AB and BC and (b) the average shear stress in the 1 ½" diameter pin at C. The pin at C is in double shear.

ANS in psi



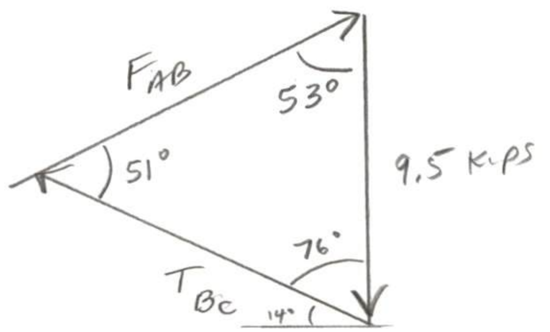
Solution.



FBD

$\alpha = \tan^{-1}\frac{1}{4} = 14^\circ$

$\beta = \tan^{-1}\frac{3}{4} = 37^\circ$



Force-Triangle

$$\frac{F_{AB}}{\sin 76^\circ} = \frac{T_{BC}}{\sin 53^\circ} = \frac{9.5\text{ Kips}}{\sin 51^\circ}$$

$$F_{AB} = \frac{\sin 76^\circ(9,5\text{ Kips})}{\sin 51^\circ} = 11.9\text{ Kips}$$

$$T_{BC} = \frac{\sin 53^\circ(9,5\text{ Kips})}{\sin 51^\circ} = 9.7\text{ Kips}$$

a) $$\sigma_{AB} = \frac{P}{A} = \frac{11,9\text{ Kips}}{6\text{ in} \times 8\text{ in}}\left(\frac{1000\text{ lb}}{\text{Kip}}\right) = 247\text{ psi}$$

$$\sigma_{BC} = \frac{P}{A} = \frac{9.7\text{ Kips}\left(\frac{1000\text{lb}}{\text{Kip}}\right)}{\underbrace{\frac{\pi(1,125\text{ in})^2}{4}}_{0.994\text{ in}^2}} = 9750\text{ psi}$$

b) $$\tau = \frac{P}{A} = \frac{9700\text{ lb}}{\underbrace{\frac{\pi(1,5\text{ in})^2}{4}}_{(3,53)} \times 2} = 2745\text{ psi}$$

double-shear

3. A vertical 6x8 timber column of ~~Douglas Fir~~ Western Hemlock is 10' - 6" tall and subjected to a compressive load of 30,000 lb. Calculate the normal stress and the total shortening that occurs under this load. A 6x8 has a dressed (actual) dimension of 5 ½ " x 7 ½ ". $E = 1.6 \times 10^6$ psi

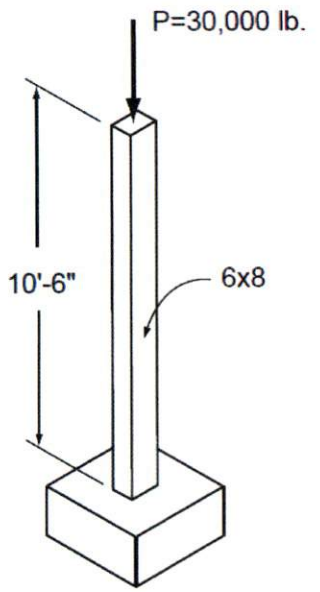


Table A-6(A)

6 x 8 $\quad A = 41.3\ in^2$

$$\sigma = \frac{P}{A} = \frac{30\,000\ lb}{41.3\ in^2} = 727\ psi$$

$$\delta = \frac{PL}{AE} = \frac{\sigma L}{E}$$

$$= \frac{727\ psi\ (126\ in)}{1.6 \times 10^6\ psi}$$

$$= \underline{\underline{0.057\ in.}}$$

Solution.

4. A steel cable with yield strength of 50 ksi is used to support a load of 225 Kips. Select the diameter if the cable to the nearest 1/16 of an inch using a factor of safety of 2.5 to guard against yielding.

$$\sigma_{allow} = \frac{\sigma_y}{2.5} = \frac{50\ ksi}{2.5} = 20\ ksi$$

$$A_{req} = \frac{P}{\sigma_{allow}} = \frac{225\ kips}{20\ ksi}$$

$$= 11.25\ in^2$$

$$\frac{\pi d^2}{4} = 11.25\ in^2$$

$$d = \sqrt{\frac{4(11.25\ in^2)}{\pi}}$$

$$= 3.7847\ in$$

use, $\underline{\underline{d = 3\ 13/16\ in}}$ $(3.8125\ in)$