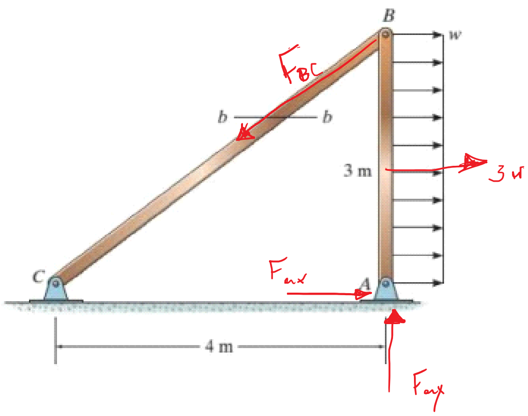
Homework 4

Wednesday, September 30, 2020 10:06 PM

"I pledge my honor I have abided by the Stevens Honor system."

- Alex Gaskins

7–27. Determine the largest intensity w of the uniform loading that can be applied to the frame without causing either the average normal stress or the average shear stress at section b–b to exceed $\sigma = 15$ MPa and $\tau = 16$ MPa, respectively. Member CB has a square cross section of 30 mm on each side.



$\tan(\theta) = \frac{AC}{AB}$; $\theta = \tan^{-1}\left(\frac{4}{3}\right) = 53.13^\circ$

$M_A = 0$

$F_{BC}\sin(\theta)(3) - 3w\left(3/2\right) = 0$

$F_{BC} = \frac{4.5w}{3\sin(53.13)} = 1.875w$

$F_x = 0$; $F_{BC}\sin(\theta) - F_\tau = 0$

$F_\tau = 1.5w$

$F_y = 0$; $F_{BC}\cos(\theta) - F_N = 0$

$F_N = 1.125w$

$\sigma = \frac{F_N}{A_{b\text{-}b}}$

$A_{b\text{-}b} = \frac{A}{\cos(\theta)} = \frac{900}{\cos(53.13)} = 1500\ \text{mm}^2$

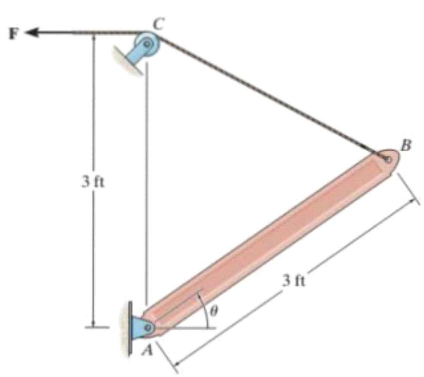
$15 = \frac{1.125w \times 10^3}{1500}$

$w = 20\ \text{kN/m}$

$\tau = \frac{F_\tau}{A_{b\text{-}b}}$; $16 = \frac{1.5w \times 10^3}{1500}$

$\boxed{w = 16\ \text{kN/m}}$

7–34. The boom has a uniform weight of 600 lb and is hoisted into position using the cable BC. If the cable has a diameter of 0.5 in., plot the average normal stress in the cable as a function of the boom position θ for $0° \le \theta \le 90°$.



$M_A = 0$

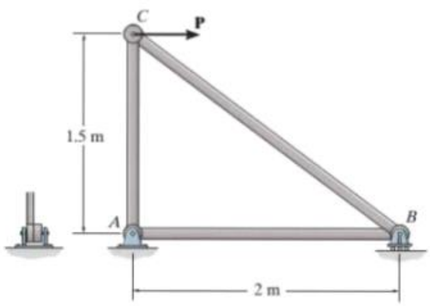
$F_{BC}\sin\left(45 + \frac{\theta}{2}\right)(3) - 600\left(1.5\cos(\theta)\right) = 0$

$F_{BC} = \frac{300\cos(\theta)}{\sin\left(45 + \frac{\theta}{2}\right)}$

$\sigma = \frac{F_{BC}}{A_{BC}} = \left(\frac{300\cos(\theta)}{\sin\left(45 + \frac{\theta}{2}\right)}\right) \Big/ \frac{\pi}{4}(.5)^2$

$$\boxed{\sigma = \frac{1.528\cos(\theta)}{\sin\left(45 + \frac{\theta}{2}\right)}\ \text{ksi}}$$

7–37. Determine the maximum average shear stress in pin A of the truss. A horizontal force of $P = 40$ kN is applied to joint C. Each pin has a diameter of 25 mm and is subjected to double shear.



$M_A = 0$

$B_y(2) - 40(1.5) = 0$

$B_y = 30\,kN$

$F_x = 0$

$30 - A_x = 0$

$A_y = 30\,kN$

$F_A = \sqrt{(40)^2 + (30)^2}$

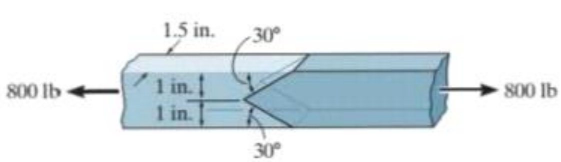
$F_A = 50\,kN$

$V_A = \frac{F_A}{2} = 25\,kN$

$A_A = \frac{\pi}{4}(.025)^2 = .49 \cdot 10^{-3}\,m^2$

$\tau = \frac{V_A}{A_A} = \frac{25 \cdot 10^3}{.49 \cdot 10^{-3}} = \boxed{50.9\,MPa}$

7–49. The two members used in the construction of an aircraft fuselage are joined together using a 30° fish-mouth weld. Determine the average normal and average shear stress on the plane of each weld. Assume each inclined plane supports a horizontal force of 400 lb.



$N - 400\sin(30) = 0$

$N = 200\,lbs$

$400\cos(30) - V = 0$

$A = \frac{bh}{\sin(\theta)} = \frac{1.5(1)}{\sin(30)} = 3\,in.^2$

$\sigma = \frac{N}{A} = \frac{200}{3} = 66.67\,psi$

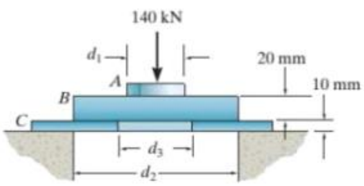
$V \quad 346 \quad = 115.3$ psi

$$400\cos(30) - V = 0$$

$$V = 346 \text{ lbs}$$

$$\tau = \frac{V}{A} = \frac{346}{3} = 115.3\text{ psi}$$

***7–68.** The assembly consists of three disks A, B, and C that are used to support the load of 140 kN. Determine the smallest diameter d_1 of the top disk, the diameter d_2 within the support space, and the diameter d_3 of the hole in the bottom disk. The allowable bearing stress for the material is $(\sigma_b)_{allow} = 350$ MPa and allowable shear stress is $\tau_{allow} = 125$ MPa.



$$\tau_{allow} = \frac{V}{A}$$

$$\tau_{allow} = \frac{P}{2\pi \frac{d_2}{2} t} \; ; \; d_2 = 35.6\text{ mm.}$$

$$\sigma_{b\,allow} = \frac{P}{A}$$

$$\sigma_{b\,allow} = \frac{P}{\frac{\pi}{4}(d_2^2 - d_3^2)} \; ; \; d_3 = 27.6\text{ mm.}$$

$$\tau = \frac{V}{A} = \frac{V}{\pi d_1 \times .01}$$

$$\tau = \frac{140\times10^3}{\pi(.0226)(.01)}$$

$$\tau = 98.7\text{ MPa}$$

$$98.7 < \tau_{allow}$$

$$\sigma_{allow} = \frac{P}{A} = 350\times10^6 = \frac{140\times10^3}{\frac{\pi}{4} d_1^2}$$

$$\boxed{d_1 = 22.6\text{ mm.}}$$