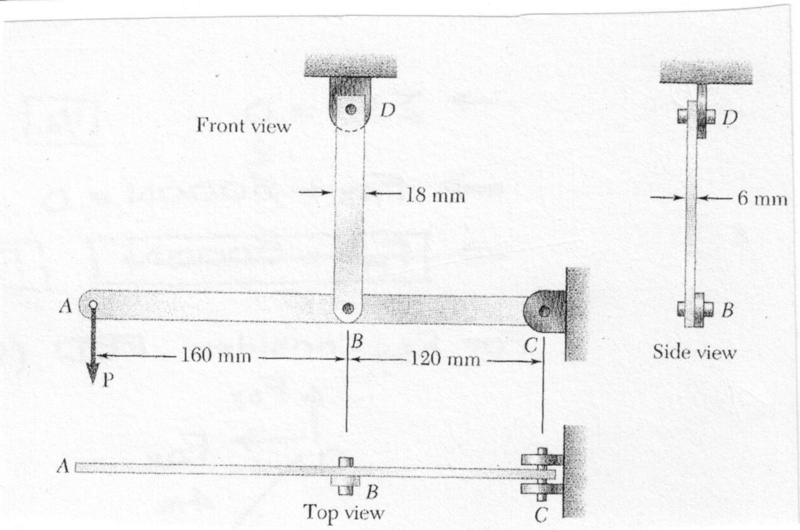
Ex 1



6mm dia. pin at C;
10mm dia pins at B, D;
Ultimate shearing stress is 150 MPa in all connections;
Ultimate tensile stress 400MPa in BD.
F.S desired is = 3.
Find: Largest P.

$F_{BD} = \frac{280}{120} P = \frac{7}{3} P.$; $R_C = -P + F_{BD} = \frac{4}{3} P.$

$$\sigma_{BD} = \frac{F_{BD}}{(18-10)*6/(1000)^2} \text{ (at B, D, critical) } = (\sigma_u)_{BD} / F.S = 400/3 \rightarrow (1)$$

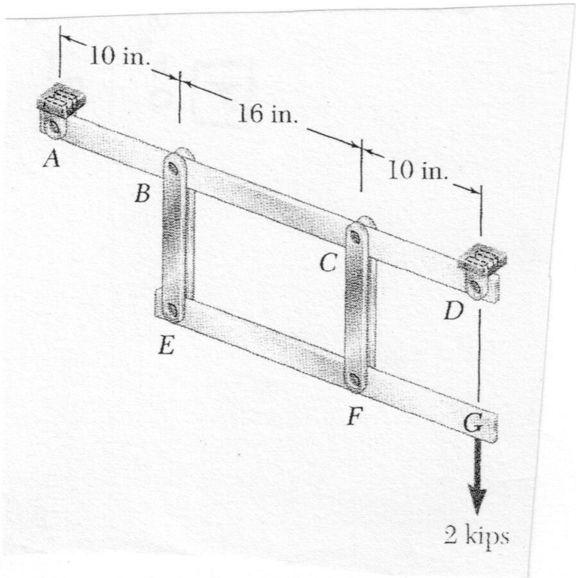
$$\tau_{pin,D} = \frac{F_{BD}}{\pi (10/1000)^2/4} = \tau_{pin,B} = \tau_u / FS = 150/3 \rightarrow (2)$$

$$\tau_{pin,C} = \frac{R_C}{2\pi (6/1000)^2/4} = 150/3 \rightarrow (3)$$

(1) → P = 2743 N, (2) → P = 1683 N, P = 2121 N

$P_{cr} = 1683$ N.

Ex2



Each link CF is $\frac{1}{4}'' \times 1''$ area.

$(\sigma_u)_{CF} = 60$ ksi

Pins at C, F, dia $= 1/2''$

$(\tau_u)_{\text{pins } C,F} = 25$ ksi

Find: F.S. for CF and pins C and F.

$F_{CF} = 2 * \frac{26}{16}$ carried by two links.

So each link carries $\frac{F_{CF}}{2} = \frac{13}{8}$

$\sigma_{CF} = \frac{13/8}{0.25 * (1 - \frac{1}{2})} = 13$ ksi.

$(FS)_\sigma = \frac{60}{13} = \frac{9.23}{2} = 4.62$

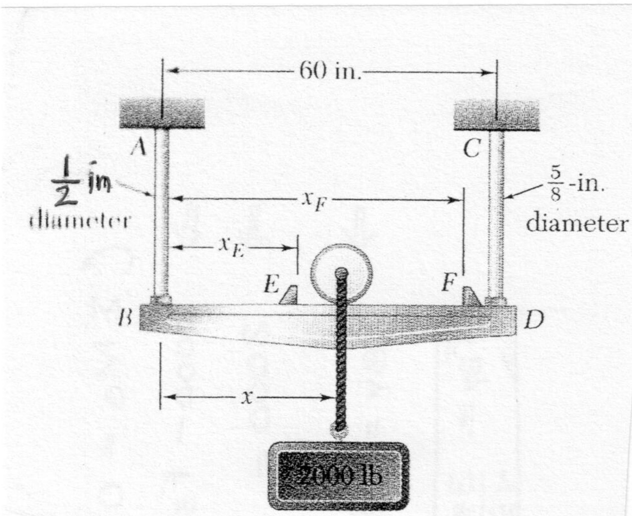
$(\tau)_{\text{pin } C,F} = \frac{F_{CF}}{2\pi(0.5)^2/4} = 8.276$ ksi

$(FS)_\tau = \frac{25}{8.276} = 3.02$

$\Rightarrow FS = 3.02$ (overall)

Ex 3

3



$\sigma_{all} = 6$ ksi for AB, CD

Find: where stops E, F to be placed to allow max motion of load 2000 lb

$$(F_{AB})_{max} = \frac{60 - x_E}{60} * 2000 \quad , \quad (F_{CF})_{max} = \frac{x_F}{60} * 2000$$

For $(F_{AB})_{max}$, $\frac{60 - x_E}{60} * \frac{2000}{\pi (0.5)^2/4} = \sigma_{all} = 6$ ksi. $= 6 * 10^3$ psi.

$$x_E = 24.657''$$

check: $F_{CF} = \frac{x_E}{60} * 2000$, $\sigma_{CF} = \frac{x_E}{60} * \frac{2000}{\pi (5/8)^2/4}$

{Actually this check not reqd ∵ $F_{CD} < F_{AB}$ when load at x_E and $A_{CD} > A_{AB}$} $= 2679$ psi. < 6000 psi so OK.

For $(F_{CF})_{max}$, $\frac{x_F}{60} * \frac{2000}{\pi (5/8)^2/4} = 6000$ psi.

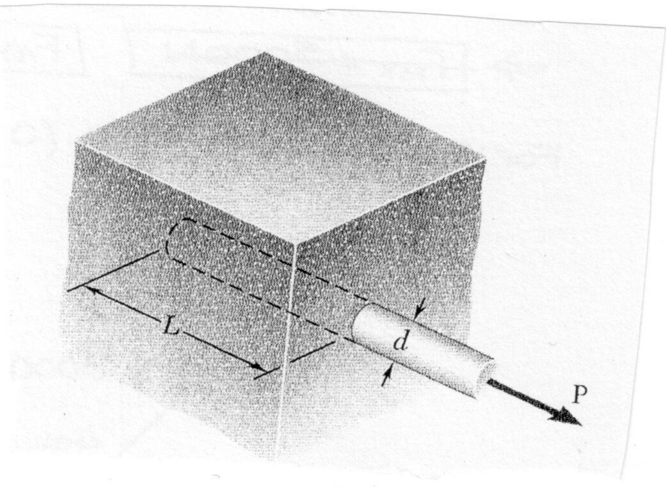
$$x_F = 55.223''$$

So load between 24.7" to 55.2".

check: $\sigma_{AB} = \left(\frac{60 - x_F}{60}\right)(2000) \cdot \left(\frac{1}{\pi\, 0.5^2/4}\right)$

{required ∵ $F_{AB} < F_{CD}$ when load at x_F but $A_{AB} < A_{CD}$} $= 810.96$ psi < 6000 psi., so OK

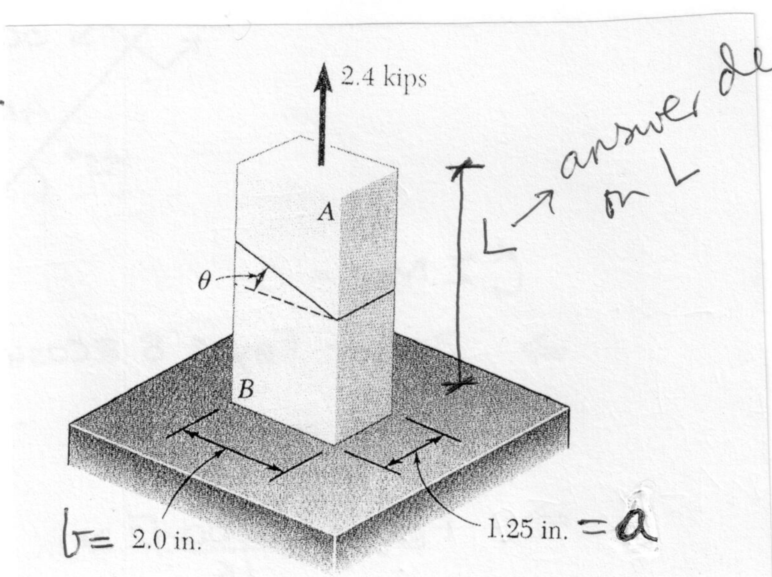
Ex4



Find L_{min} to develop full σ_{all} in steel bar embedded in concrete. Use τ_{all} bond strength between steel bar & concrete.

$$P = \sigma_{all}\, \pi \frac{d^2}{4} = \tau_{all}\, \pi d L_{min} \Rightarrow L_{min} = \frac{\sigma_{all}\, d}{4\, \tau_{all}}$$

Ex5



Two portions of AB glued along plane θ.
$\sigma_u = 2.5$ ksi (tension)
$\tau_u = 1.3$ ksi (shear)
Find θ for which F.S. is max, and corresponding F.S.

$$(FS)_\sigma = 2.5 \Big/ \left(\frac{P}{A_0} \cos^2\theta\right) = \frac{5 A_0}{P} \frac{1}{(1+\cos 2\theta)} \rightarrow (1)$$

$$(FS)_\tau = 1.3 \Big/ \left(\frac{P}{A_0} \frac{\sin 2\theta}{2}\right) = \frac{2.6\, A_0}{P} \frac{1}{\sin 2\theta} \rightarrow (2)$$

For $0 \le \theta \le \pi/2$, $(FS)_\sigma \uparrow$ as $\theta \uparrow$
$0 \le \theta \le \pi/4$, $(FS)_\tau \downarrow$ as $\theta \uparrow$
$\frac{\pi}{4} \le \theta \le \frac{\pi}{2}$, $(FS)_\tau \uparrow$ as $\theta \uparrow$

$\rightarrow$ So these curves of $(FS)_\sigma$ v/s θ & $(FS)_\tau$ v/s θ intersect. (see Fig on next pg)

$(FS)_\sigma = (FS)_\tau$ gives intersection, $5 \sin 2\theta = 2.6\,(1+\cos 2\theta)$
$= 5.2 \cos^2\theta$

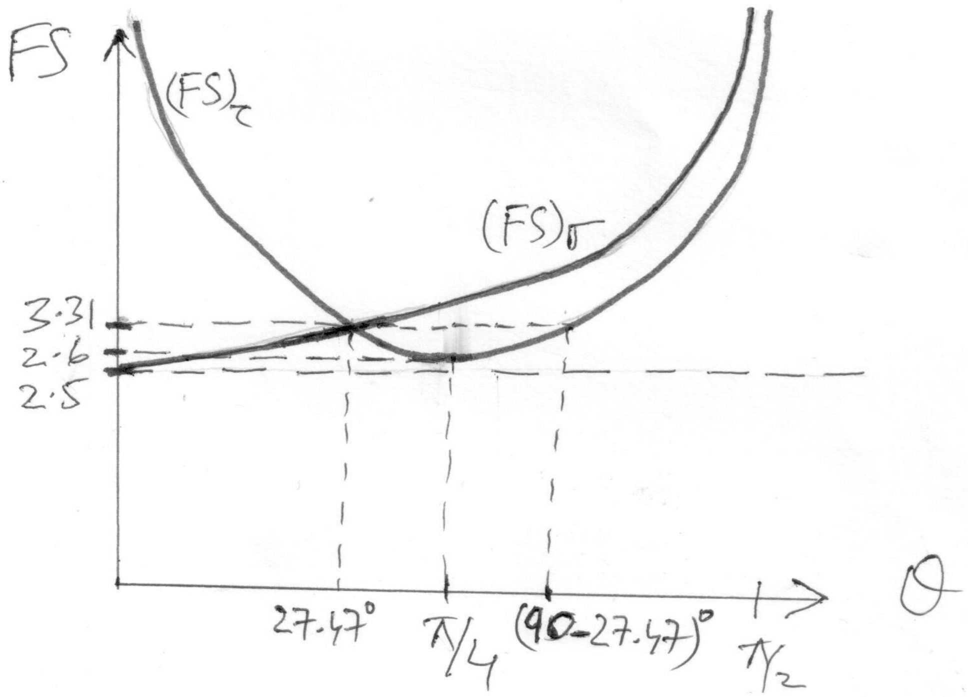
5

$$\tan\theta = \frac{5.2}{10}, \quad \theta = 27.47^\circ$$

$$(FS)_\sigma = (FS)_\tau = \frac{5*(2*1.25)}{2.4} \cdot \frac{1}{1+\cos(2*27.47^\circ)}$$

$$= 3.31$$

Above is valid if $\tan^{-1}\left(\frac{L}{b}\right) \le (90-27.47)^\circ$



If $\tan^{-1}\left(\frac{L}{b}\right) > 62.53^\circ$, $\theta = \tan^{-1}\left(\frac{L}{b}\right)$

$(FS)_{max}$ = from Eqn 2 using this θ

$= (FS)_\tau$