Solutions Pset #1

3.11 Fall 2003

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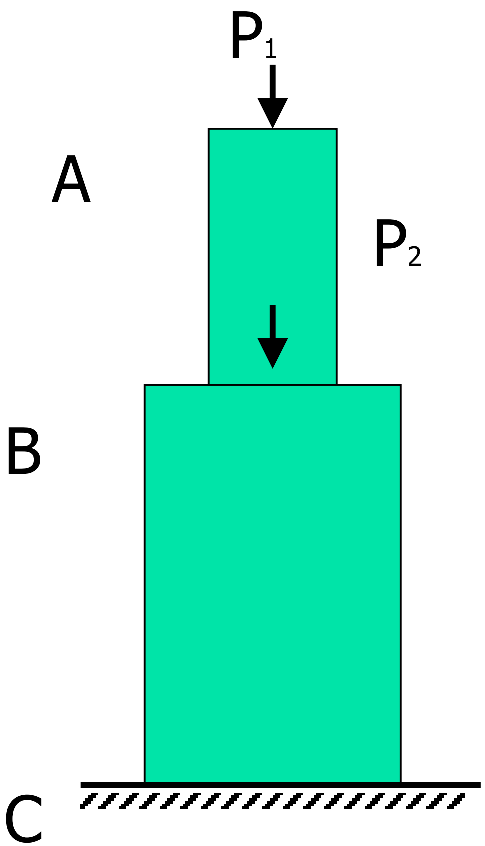
1.2-1



$P_1 = 1600$ lb., $d_{AB} = 1.2$in., $d_{BC} = 2.4$in.

(a) Normal Stress in Part AB

$\sigma_{AB} = P_1/A_{AB} = 1600\text{lb}/(\pi/4(1.2\text{in.}\hat{}2)) = 1415\text{psi}$

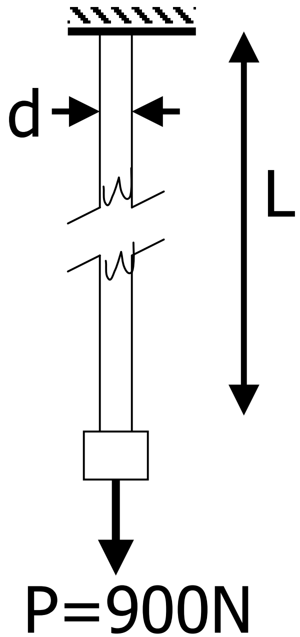
(b) Load P_2 for Equal Stresses

$\sigma_{AB} = (P_1+P_2)/A_{BC} = (1600\text{lb}+P_2)/(\pi/4(2.4\text{in.}\hat{}2))$
$= \sigma_{AB} = 1415\text{psi}$

Solve for P_2: $P_2 = 4800$lb.

Note: there is an alternate way to solve this, ask me if you'd like it.

1.2-2



Long Steel Rod in Tension

P=900N, L=30m, d=6mm,

Weight density: γ=77.0kN/m^3, W=Weight of Rod = γ(Volume)= γAL

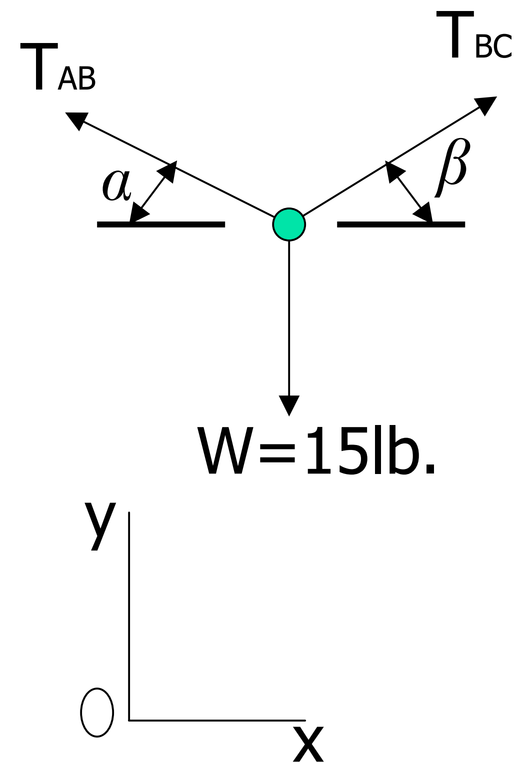
σ_{MAX} = (W+P)/A = γL +P/A

= (77.0kN/m^3)(30m) + 900N/(π/4(6mm^2))

= 2.3MPa + 31.8MPa

= 34.1 MPa

1.2-5



Two Steel Wires Supporting a Lamp

Free-body Diagram of Point B

α= 35°, β = 50°, d=25mils= 0.025in.,
A=((πd^2)/4)=490.9x10^-6in^2

Equations of Equilibrium

$\Sigma Fx=0 \quad -T_{AB}\cos\alpha + T_{BC}\cos\beta = 0$

$\Sigma Fy=0 \quad T_{AB}\cos\alpha + T_{BC}\cos\beta - W = 0$

Substitute numerical values:

$-T_{AB}(0.81915) + T_{BC}(0.64279) = 0$

$T_{AB}(0.57358) + T_{BC}(0.76604) = 15lb$

1.2-5 continued..

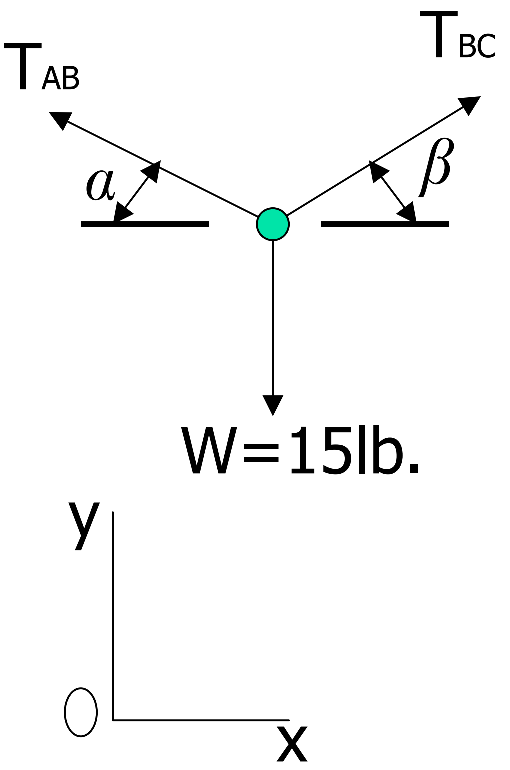
Solve the Equations

T_{AB}=9.679 lb. T_{BC}=12.334 lb.

Tensile stresses in the wires

$\sigma_{AB} = T_{AB}/A$ = 19,700psi

$\sigma_{BC} = T_{BC}/A$ = 25,100 psi



1.5-7

Hollow bronze cylinder in compression: d1=1.85in., d2=2.15in., E=16,000ksi, P=35k, Δd2=0.0017in. (inc. in diameter)

Lateral strain: $\varepsilon' = \Delta d_2 / d_2$ = 0.0017in./2.15in.

= 790.7x10^-6 (increase)

(a) Inc. in inner diameter

$\Delta d_1 = \varepsilon' d_1$ = (790.6x10^-6)(1.85in.) = 0.0015in.

(b) Inc. in wall thickness

$\Delta t = \varepsilon' t$ = (790.6x10^-6)(0.15in.) = 0.00012 in.

1.5-7 Continued…

Axial stress: σ= P/A , A= $\pi/4(d_2^2-d_1^2)=0.9425in^2$

σ = 35k/0.9425in^2 (compression) Assume that this stress is less than the yield stress for the bronze so that Hooke's law is valid

Axial strain: $\varepsilon = \sigma/E$ = 37.14ksi/16,000ksi = 2321x10^{-6} (decrease)

(c) Poisson's Ratio: $\nu = | \varepsilon'/\varepsilon |$ = 790.7x10^{-6}/2321x10^{-6} = 0.34

1.5-8

(a) Slope of diagonal line OA

Elongation in x-direction = ΔL

Shortening in y-direction = Δb

$\Delta L = \varepsilon_x L = \sigma L/E$ $\quad$ $\Delta b = \nu \varepsilon_x b = \nu \sigma b/E$

Slope = $(b - \Delta b)/(\Delta L + L) = (b(E - \nu\sigma))/ = (L(E + \sigma))$

1.5-8 Continued…

(b) Increase in area of the front face

Initial area=bL

Final area= (b- Δb)(ΔL+L) (L)(1+σ/ε)

=bL(1+ σ/ε - $(\sigma\nu)/\varepsilon$ - $(\nu\sigma^2)/\varepsilon^2$)

Increase in area = final area-initial area

= bL(σ/ε)(1-ν-$(\sigma\nu)/\varepsilon$)

Because σ/ε is small compared to the other terms, we may disregard the last term. Therefore, inc. in area = bL (σ/ε)(1-ν)

1.5-8 Continued…

(c) Decrease in cross-sectional area

Δt=decrease in thickness of plate= $((\nu\sigma)/E)t$

Initial area=bt

Final area= $(b- \Delta b)(t-\Delta t) = (b - (\nu\sigma b)/E) (t - (\nu\sigma t)/E)$
$= bt (1- (\nu\sigma)/E)^2 = bt [1- (2\nu\sigma)/E +((\nu\sigma)/E)^2]$

Decrease in area = initial area - final area
$= bt((\nu\sigma)/E)(2- \nu\sigma)/E)$

B/c σ/E is small compared to the other terms, we can disregard the last term. Therefore, the decrease in cross-sectional area = $bt((2\nu\sigma)/E)$