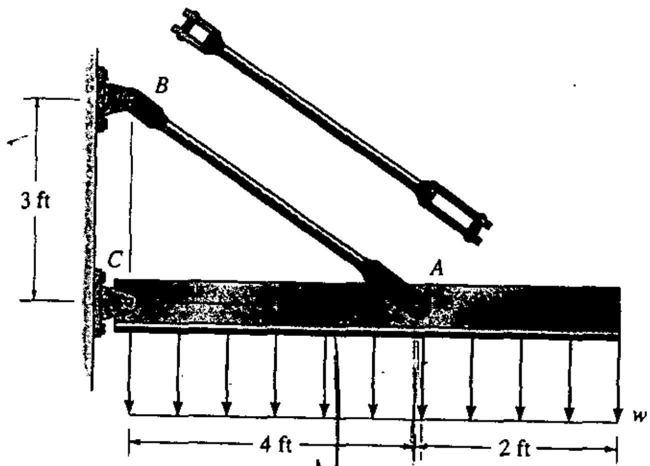
Arch 321

Instructor: Onouye

Exam #1
(50 pts)

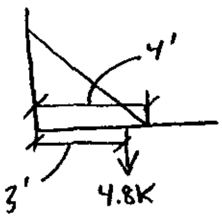
1. (10 pts)

The hanger assembly is used to support a distributed loading of $\omega = 0.8 \text{kip/ft}$.. Determine the average shear stress in the 0.40 in. diameter bolt at A and the average tensile stress in rod AB, which has a diameter of 0.50 in.



4.8K

start w/ moments



$P = 0.8 \times 6 = 4.8K$

@ 3 ft.

45/50

$$\Sigma M_C = \frac{(-4.8K)(3')}{4} + \frac{(AB_y)(4')}{4}$$

$$AB_y = 3.6K$$

Bolt shear = double shear

so $f_v = \frac{P}{2A}$

$$f_v = \frac{3.6K}{2\left(\frac{3.14 \times (.4)^2}{4}\right)}$$

$$f_v = \frac{3.6K}{.2512}$$

$$\boxed{\text{Bolt shear} = f_v = 14.33 \text{ Ksi}}$$

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3-4-5 triangle

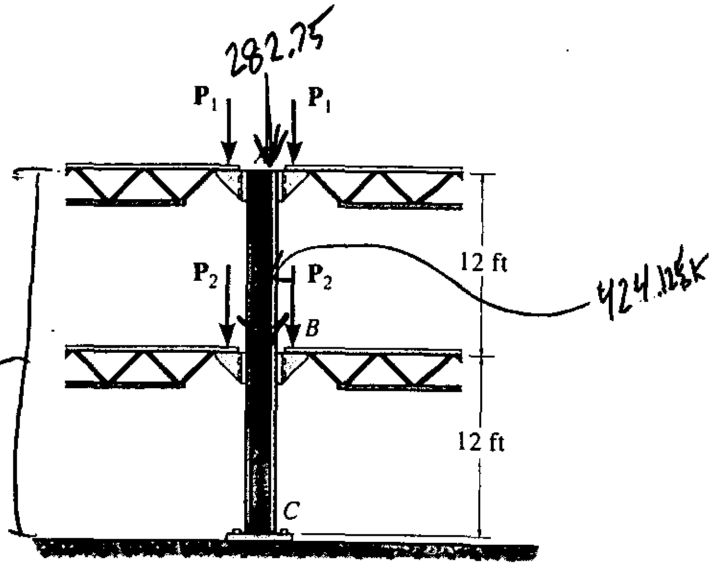
$$\frac{3.6}{3} = \frac{R}{5}$$

$1.2(5) = R = 6K$ in rod, so

$$f_t = \frac{P}{A}, \quad \frac{6K}{\frac{3.14 \times .5^2}{4}} = \frac{6K}{.1963} = \boxed{\text{Rod tension} = 30.57 \text{KSI}}$$

2. (10 pts)

The A-36 steel column shown is used to support the symmetric loads from the two floors of a building. Determine the loads P_1 and P_2 if A moves downward 0.12 in. due to P_1 and both A and B move downward an additional 0.09 in. (due to P_2) when the loads are applied.
The column has a cross-sectional area of 23.4 in.^{2}.



determine P1, P2

$f = \frac{P}{A}$

$\delta = \frac{fL}{E}$

E=29,000 KSI

$\delta = \frac{PL}{AE}$

P_1 compresses entire column

P_2 only compresses bottom 12'.

P_1

$\delta = 0.12 \quad L = 24'$

$.12 = \frac{2 \times P_1 (24' \times 12")}{(23.4)(29,000)}$

$\frac{.12(23.4)(29,000)}{.288} = \frac{\cancel{288} P_1}{288}$

$\boxed{P_1 = 282.75 K}$

P_2

$L = \cancel{12'} 24'$

$\delta = 0.09$

$E = 29,000 KSI$

$A = 23.4$

$0.09 = \frac{2 \times P_2 (12' \times 12")}{23.4(29,000)}$

$\frac{(0.09)(23.4)(29,000)}{144} = \frac{144 P_2}{144}$

$\boxed{P_2 = 424.125 K}$

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3. (10 pts)

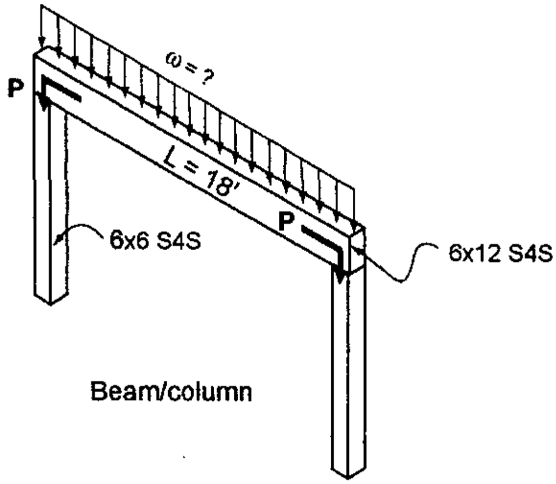
Same for Both

A 6x12 S4S timber beam is used to support a floor load as shown.

a) Determine the maximum reaction load **P** based on the beam's bearing capacity.

b) Determine the maximum reaction load **P** based on the column's compression capacity. ($F_{c_\perp}$ = 550 psi; $F_{c_\parallel}$ = 800 psi)

c) If the beam is a simply supported beam, uniformly loaded and spanning 18', what is the maximum load per foot ω that the beam can safely support based on the reaction **P** found in parts a/b.



$6\times12 = 5.5\times11.5$

$$f_c = \frac{P}{A} \qquad \overset{(6\times6)}{A} = 5.5\times5.5$$

$$800\text{ psi} = \frac{P}{5.5\times5.5}$$

$$800(30.25) = P$$

b) $\boxed{24{,}200\# = P_{max} \text{ per column}}$

$$f_t = \frac{P}{A}$$

$F_{c\perp} = 550$

$$550 = \frac{P}{18''\times5.5''} \qquad 5\tfrac{1}{2}'' \times 5\tfrac{1}{2}''$$

$$550(99) = P$$

a) $\boxed{P_{max} = 54{,}450\#}$

16,646

P_{max} then $= 24{,}200\times2 = 48{,}400$

c) so, $\omega = \dfrac{48{,}400}{18}$

$\boxed{\omega = 2688.89\#/ft}$

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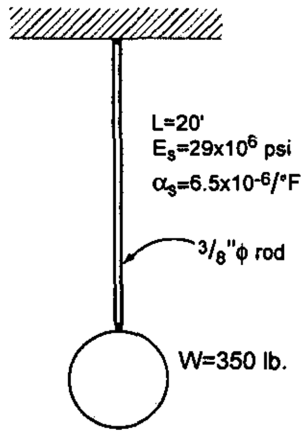
4. (10 pts)

A 350 lb. weight is suspended from a $^3/_8$" diameter steel rod, 20 feet long.

Determine the following:
a) the elongation of the rod due to the weight
b) the change in temperature that would cause the rod to return to its unloaded position.



neg temp to contract

$A = \frac{3.14(.375)^2}{4} = .11$

$f_t = \frac{P}{A}, \quad \frac{350}{.11} = 3181.8$

$\delta = \frac{(3181.8)(20' \times 12'')}{29 \times 10^6 \text{ psi}}$

a) $\boxed{\delta = 0.026''}$

$3/8'' = 0.375''$

b) $\delta = \alpha L \Delta T$

$\frac{0.026'' = (6.5 \times 10^{-6})(20' \times 12'')(\Delta T)}{.00156 \qquad .00156}$

$\Delta T = -16.67°$

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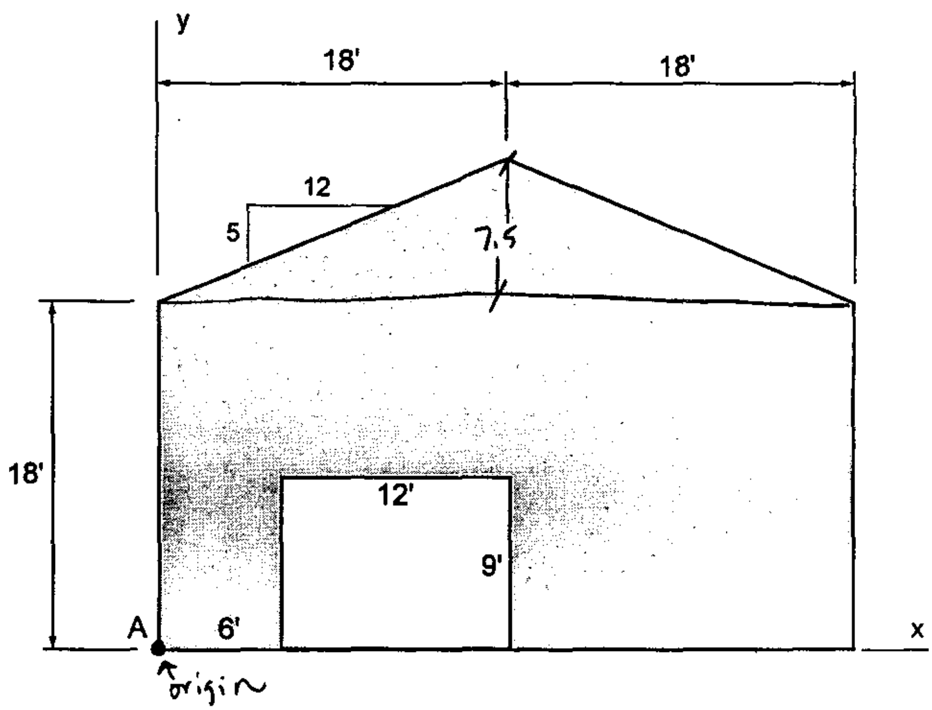
5. (10 pts)

A pre-cast concrete wall panel for an industrial building has the dimensions as shown. There is a large (12'x9') opening for moving equipment and materials. Determine the centroid of this large wall panel. Use the lower left hand corner at A as your reference point. Show your work. I recommend the use of a table to keep track of your values.



Component	Area (ΔA)	x	$x\Delta A$	y	$y\Delta A$
(pentagon)	$2\times\frac{1}{2}\times 7.5\times 18 = 135$; $18\times 36 = 648$; $\boxed{783}$	18	14094	12.75	9983.25
(rectangle)	$-9\times 12 = -108$	12	-1296	4.5	-486

$\Sigma\Delta A = 675$

$\Sigma x\Delta A = 12798$ $\quad \bar{x} = \frac{12798}{675} = \boxed{18.96}$

$\Sigma y\Delta A = 9497.25$ $\quad \bar{y} = \frac{9497.25}{675} = \boxed{14.07}$

Component	Area (ΔA)	x	$x\Delta A$	y	$y\Delta A$
(triangle)	135	18	2430	$18+2.5=20.5$	2767.5
(rectangle)	648	18	11664	9	5832
(opening)	-108	12	-1296	4.5	-486

$\Sigma = 675$

$\Sigma x\Delta A = 12798$

$\bar{x} = \frac{12798}{675} = \boxed{18.96}$

$\Sigma y\Delta A = 8113.5$

$\bar{y} = \frac{8113.5}{675} = \boxed{12.02}$

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