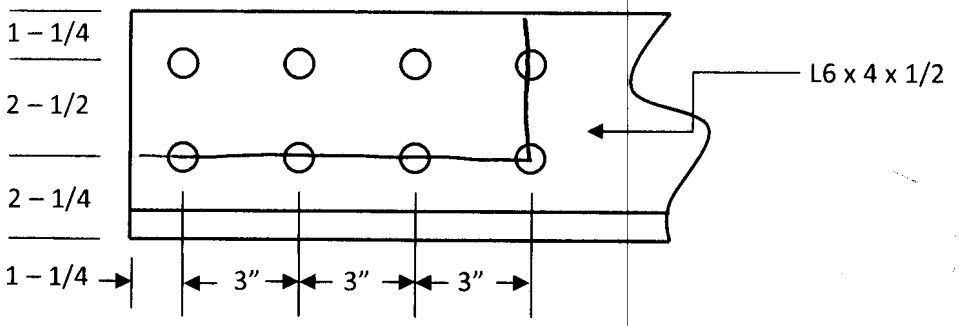
CEE 08 383 – Steel Frames

Exam 1

February 21, 2008

1. Determine the tensile capacity (ΦR_n) of the steel angle section below assuming block rupture is the controlling failure mode. Assume ¾" diameter bolts. (15 points)



$R_n = .6F_u A_{nv} + U_{bs} F_u A_{nt}$ OR $.6F_y A_{gv} + U_{bs} F_u A_{nt}$

$A_{nt} = 1/2"(3.75") - 1\frac{1}{2}(3/4 + 1/8)(1/2) = 1.22\ in^2$

$A_{gv} = 10.25"(1/2") = 5.125\ in^2$

$A_{nv} = 5.125_{in^2} - 3\frac{1}{2}(3/4 + 1/8)(1/2) = 3.59\ in^2$

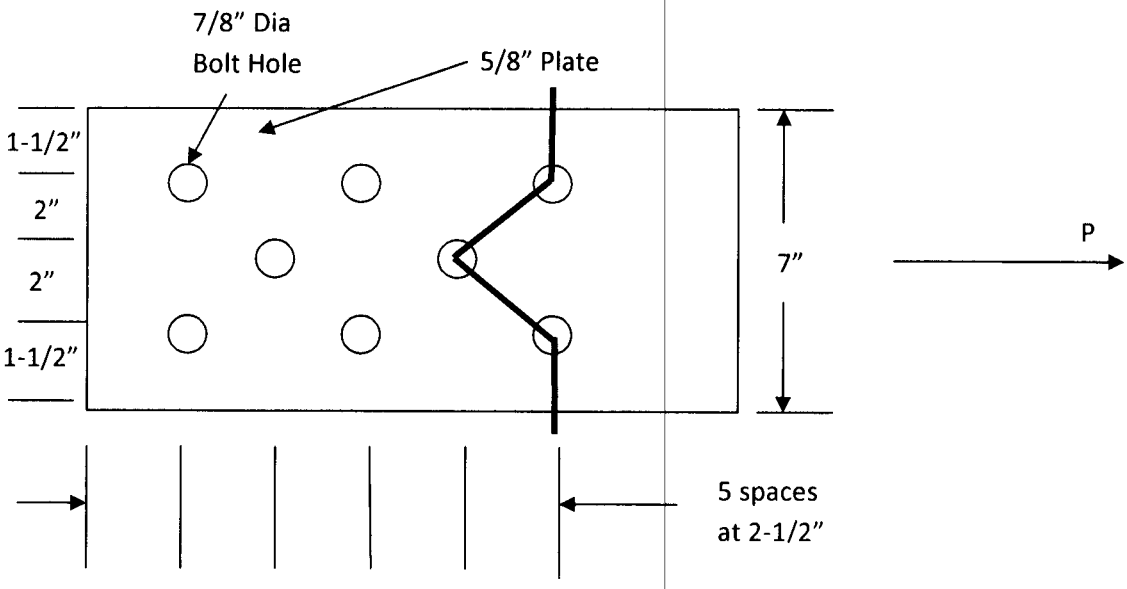
$.6F_u A_{nv} = .6(58\ KSI)(3.59\ in^2) = 125^K$

$.6F_y A_{gv} = .6(36\ KSI)(5.125_{in^2}) = 110.7^K$

$R_n = 110.7^K + 1(58)(1.22) = 181.46^K$

$\phi R_n = .75(181.46^K) = 136^K$

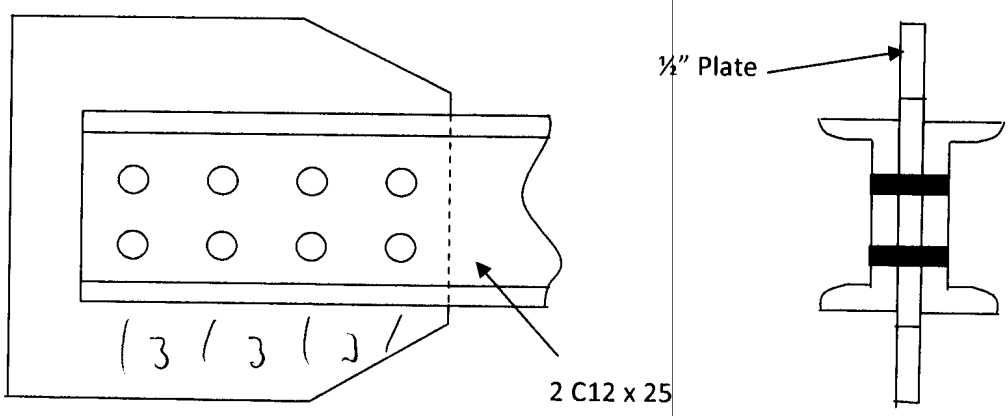
2. Determine the net tensile area along the indicated failure path for the plate below. (15 points)



NET WIDTH $= 7'' - 3\left(\frac{7}{8}'' + \frac{1}{16}''\right) + \frac{2\left(2\frac{1}{2}\right)^2}{4(2)} = 5.75''$

$A_n = 5.75\left(\frac{5}{8}''\right) = 3.59\ in^2$

3. Two channels are placed back-to-back as shown below. Determine the tensile capacity based on failure of the gross or effective areas only. Assume ¾" diameter bolts are used for the connection. (20 points)



$A_g = 7.34 in^2$ / CHANNEL

$t_w = 0.387"$ $\quad \bar{x} = .674"$

$\phi A_g F_y = 0.9(2)(7.34 in^2)(36 KSI) = 475.6^K$ ← CONTROLS

$A_n = 2\left[7.34 - .387(7/8)(2)\right] = 13.33 in^2$

$U = 1 - \frac{.674"}{9"} = .925$

$A_e = .925(13.33 in^2) = 12.33 in^2$

$\phi A_e F_u = .75(12.33 in^2)(58 KSI) = 536^K$

4. Double angles are to be used as a tension only brace. The angles are connected with a ½" plate between them. Select appropriate angles to support a service dead load of 95 kips, service live load of 125 kips, and a wind load of 85 kips. Consider the slenderness recommendations in your design (brace length is 25'). You may assume that two lines of ¾" diameter bolts are used and block shear rupture is not a controlling failure mode. (15 points)

$1.2(95) + 1.6(125) = 314^K$ ← CONTROLS

$1.2(95) + .8(85) = 182^K$

$1.2(95) + 1.6(85) + .5(125) = 312.5^K$

2L 4x4 x 3/4 OR 2L 5 x 3½ x 5/8

OR 2L 6x6 x 7/16 ← TRY

$A_n = 10.2\,in^2 - 4(7/8)(7/16) = 8.67\,in^2$

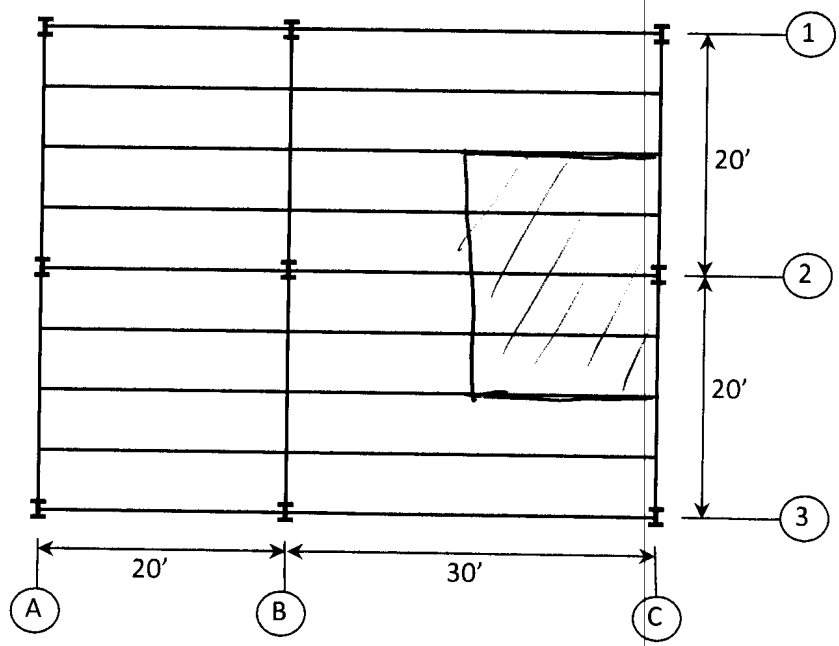
$A_e = .8(8.67\,in^2) = 6.94\,in^2$

$.75(6.94)(58) = 301^K$ → NO GOOD, ~~USE 2L6x6x7/16~~ USE 2L 6x6x½

SINGLE L6x6x½ $r = 1.18$ $\frac{25(12)}{1.18} = 254 < 300$ O.K.

SO 2L 6x6x½ WILL ACT AS O.C.

5. A floor plan is shown below. Assuming that dead load on each floor is 65 psf and column C2 supports the load from 10 stories. Determine the live load (per floor) that can be applied. The section column under consideration is 36' long, may be considered pinned at the top and fixed at the base, and has additional weak axis bracing 16' and 26' above the base of the column. You do not need to employ live load reduction. The column is a W12 x 79 A992 section. (20 points)



LOADED AREA = 20' x 15'
= 300 SF/FLOOR

65 x 300 = 19500 lb
X 10 STORIES
= 195 K DEAD

$(KL)_x = .8(36') = 28.8'$ → $\frac{28.8}{1.75} = 16.46'$ ← CONTROLS

$(KL)_y = .8(16') = 12.8'$

$(KL)_y = 1.0(10') = 10'$

FROM PG 4-17 $\phi P_n = 766^K$

$766^K = 1.2(195^K) + 1.6\,P_L \longrightarrow P_L = 332.5^K$

$\frac{332.5^K}{10\ \text{STORIES}} = 33.25^K \div 300\,ft^2 \times 1000 lb/K = 110.8\ lb/ft^2$

6. Select the lightest W14 section to support a service dead load of 400 kips and service live load of 600 kips. The structure is fixed at the base in both directions; pinned at the top in the weak direction; and free to sway and rotate at the top in the strong direction. The length of the section is 14'. (15 points)

$1.2(400) + 1.6(600) = 1440^K$

$(KL)_x = 2.1(14') = 29.4'$

$(KL)_y = .8(14') = 11.2'$

CONVERT STRONG TO WEAK AXIS $\frac{29.4'}{1.6} = 18.4'$

SELECT A W14 x145