Name: ____________________________ Date: 12/09/13

CE-470 Laboratory Assignment

Problem 1: A C12x30 is connected with 1-in. diameter bolts in each flange, as shown in Fig. 1.If F_y =50 ksi, F_u =65 ksi, and A_e=0.9A_n, compute the following.

a) The design strength for LRFD
b) The allowable strength for ASD

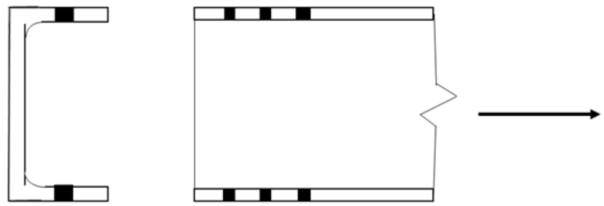

Fig. 1

LABORATORY 2 CE470 SOLUTION

PROBLEM 1

GIVEN: C12x30
1" DIA BOLTS
$F_y = 50$ KSI
$F_u = 65$ KSI
$A_e = 0.9 A_n$

COMPUTE: DESIGN STRENGTH FOR LRFD AND ASD

$d_{hole} = d_{bolt} + 1/8" = 1" + 1/8" = 1.125"$

FOR A C12x30: $A_g = 8.81 \text{ IN}^2$, $t_f = 0.501"$

FOR THE SPECIFIC CONNECTION: $A_n = A_g - 2 d_{hole} t_f$
$= 8.81 \text{ IN}^2 - 2(1.125")(0.501") = 7.685 \text{ IN}^2$

$A_e = 0.9 A_n = 0.9(7.685 \text{ IN}^2) = 6.92 \text{ IN}^2$

LRFD

YIELD $\rightarrow P_n = A_g F_y \rightarrow \overset{\phi = 0.9}{\phi} P_n = (0.9)(8.81 \text{ IN}^2)(50 \text{ KSI}) = 397 \text{ K}$

NET SECTION FRACTURE $\rightarrow P_n = A_e F_u \rightarrow \overset{\phi = 0.75}{\phi} P_n = (0.75)(6.92 \text{ IN}^2)(65 \text{ KSI}) = \underline{\underline{337 \text{ K}}}$ CONTROLS

ASD

YIELD $\rightarrow \Omega = 1.67 \rightarrow \dfrac{P_n}{\Omega} = \dfrac{(8.81 \text{ IN}^2)(50 \text{ KSI})}{1.67} = 264 \text{ K}$

NET SECTION FRACTURE $\rightarrow \Omega = 2.0 \rightarrow \dfrac{P_n}{\Omega} = \dfrac{(6.92 \text{ IN}^2)(65 \text{ KSI})}{2.0} = \underline{\underline{225 \text{ K}}}$ CONTROLS

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Problem 2: A double angle tension member, 2L 3x2x1/4 LLBB, of an A36 steel is subjected to a dead load of 12 kips and a live load of 36 kips. It is connected to a gusset plate with 3/4-in.-diameter bolts through the long legs. Does this member have enough strength? Assume that $A_e = 0.85A_{n.}$

a) Use LRFD.
b) Use ASD.

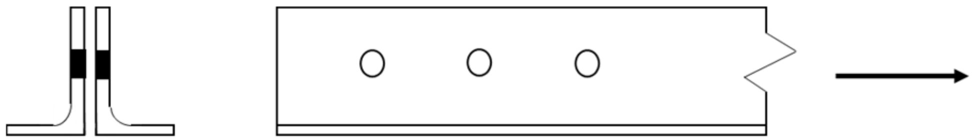

Fig. 2

PROBLEM 2

GIVEN: 2L $3 \times 2 \times 1/4$

A36

$D_L = 12\,K$

$L_L = 36\,K$

3/4" DIA BOLTS

COMPUTE STRENGTH: ASSUME $A_e = 0.85 A_n$

LRFD AND ASD

$d_{hole} = 0.75'' + 1/8'' = 0.875''$

$A36 \rightarrow F_y = 36\,KSI\,,\ F_u = 58\,KSI$

$A_g = 2.40\,IN^2\,,\ t = 0.25''$

$A_n = A_g - d_{hole}(t)(2) = (2.40\,IN^2) - (0.875'')(0.25'')(2) = 1.9625\,IN^2$

$A_e = 0.85 A_n = 1.668\,IN^2$

LRFD $\quad P_u = 1.2 D_L + 1.6 L_L = 1.2(12K) + 1.6(36K) = 72\,K$

YIELD $\phi P_n = (0.9)(A_g)(F_y) = 0.9(2.40\,IN^2)(36\,KSI) = 77.8\,K$

FRACTURE $\phi P_n = (0.75)(A_e)(F_y) = 0.75(1.668\,IN^2)(58\,KSI) = \underline{72.6\,K} > P_u = 72K$ OK

ASD $\quad P = D_L + L_L = 48K$

YIELD $\frac{P_n}{\Omega} = \frac{1}{1.67}(A_g)(F_y) = \frac{1}{1.67}(2.40\,IN^2)(36\,KSI) = 51.7K$

FRACTURE $\frac{P_n}{\Omega} = \frac{1}{2.0}(A_e)(F_u) = \frac{1}{2.0}(1.668\,IN^2)(58\,KSI) = \underline{48.4K} > P = 48K$ OK

MEMBER SUFFICIENT FOR LRFD AND ASD

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Problem 3: A W16x45 of A992 steel is connected to a plate at each flange as shown on the Fig. 3. Determine the nominal strength based on the net section as follows:

a) Using Equation for shear lag factor, U, from AISC Table D3.1.
b) Use the alternative value from the table.

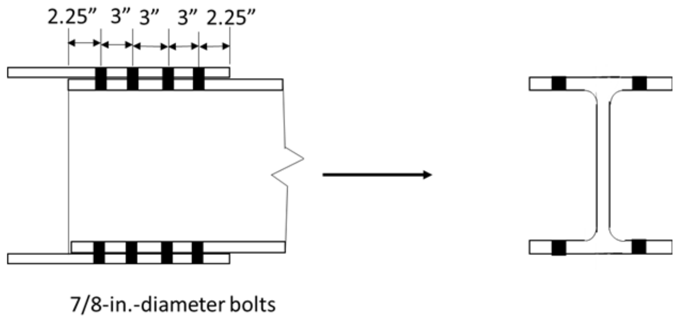


Fig. 3

PROBLEM 3

GIVEN: W16x45

A992 STEEL

7/8" DIA BOLTS

a) COMPUTE SHEAR LAG FACTOR U

b) ALTERNATIVE VALUE FROM TABLE

$F_y = 50$ KSI
$F_u = 65$ KSI   FOR A992 STEEL

$A_g = 13.3 \text{ IN}^2$, $t_f = 0.565''$

$A_n = A_g - 4(7/8'' + 1/8'')(t_f) = 11.04 \text{ IN}^2$

a) $U = 1 - \frac{\bar{x}}{L}$, $L = 3'' + 3'' + 3'' = 9''$, $\bar{x} = 1.86''$ (FROM WT 8x22.5)

$U = 1 - \frac{1.86''}{9''} = 0.7933$

$A_e = U A_n = 8.758 \text{ IN}^2$

YIELD $P_n = A_g F_y = (13.3 \text{ IN}^2)(50 \text{ KSI}) = 665 K$

FRACTURE $P_n = A_e F_u = (8.758 \text{ IN}^2)(65 \text{ KSI}) = \underline{\underline{569 K}}$ CONTROLS

b) FOR W SHAPE W/ FLANGE CONNECTED W/ 3 OR MORE FASTENERS PER LINE IN THE DIRECTION OF LOADING, $b_f = 7.04 \text{ IN} < 2/3 d = 10.8''$

$\therefore U = 0.85$ PER TABLE D3.1 CASE 7

YIELD → $P_n = 665K$

FRACTURE → $P_n = [(0.85)(11.04 \text{ IN}^2)](65 \text{ KSI}) = \underline{\underline{610 K}}$ CONTROLS

<u>Problem 4:</u> The tension member shown in Fig. 4 is PL 5/8x10, and the steel is A36. The bolts are 7/8-in. in diameter.

a) Determine the design strength for LRFD
b) Determine the allowable strength for ASD.

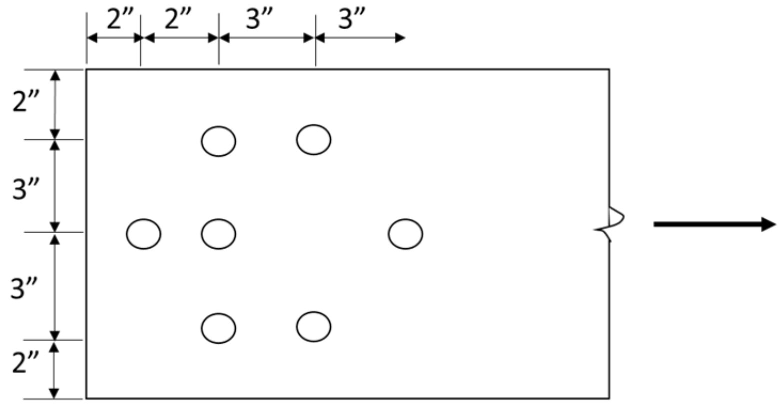


Fig. 4

PROBLEM 4

GIVEN: PL 5/8" x 10"
A36 → $F_y = 36$ ksi, $F_u = 58$ ksi
Bolts are 7/8" DIA

COMPUTE: DESIGN STRENGTH FOR LRFD AND ALLOWABLE STRENGTH FOR ASD

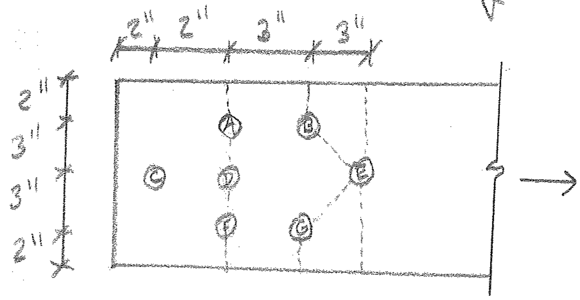
$t = 5/8"$

$d_{hole} = 7/8" + 1/8" = 1"$

$w_g = 2" + 3" + 3" + 2" = 10"$

$A_g = (5/8")(10") = 6.25\ \text{in}^2$

$w_n = w_g - \sum d_{hole} + \sum \frac{s^2}{4g}$



$w_{n\text{-}E} = 10" - 1" = 9"$

$w_{n\text{-}BEG} = 10" - 3(1") + \left[\frac{(3")^2}{4(3")} + \frac{(3")^2}{4(3")}\right] = 8.5"$ ← CONTROLS

$w_{n\text{-}ADF} = [10" - 3(1")]\ 7/4 = 12.25"$

$A_n = w_{n\text{-}BEG} \cdot t = 8.5" \cdot (5/8") = 5.3125\ \text{in}^2 = A_e$ ($U = 1.0$, CASE 1 IN TABLE D3.1)

LRFD

YIELD → $\phi P_n = (0.9) A_g F_y = 0.9(6.25\ \text{in}^2)(36\ \text{ksi}) = 203\text{K}$

NSF → $\phi P_n = (0.75) A_e F_u = 0.75(5.3125\ \text{in}^2)(58\ \text{ksi}) = 231\ \text{ksi}$

$\underline{\phi P_n = 203\text{K}}$

ASD

YIELD → $\frac{P_n}{\Omega} = \frac{(6.25\ \text{in}^2)(36\ \text{ksi})}{1.67} = 135\text{K}$

NSF → $\frac{P_n}{\Omega} = \frac{(5.3125\ \text{in}^2)(58\ \text{ksi})}{2.0} = 154\text{K}$

$\underline{\frac{P_n}{\Omega} = 135\text{K}}$