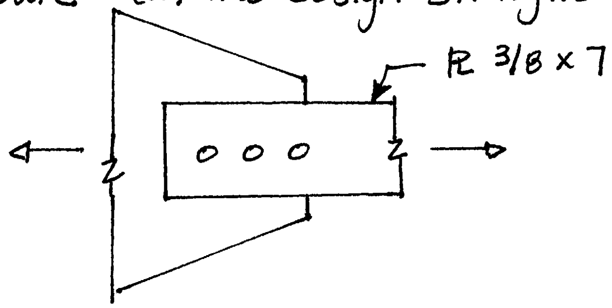
CE 470 HW1: 3.2-1 (a), 3.2-3(a)
3.3-2 (a, b), 3.4-1, 3.4-4(a), 3.4-6(a)

DUE 1/29/09

Problem 3.2-1 (a)

A PL 3/8 × 7 tension member is connected with three 1" dia. bolts, as shown. The steel is A36. Assume that $A_e = A_n$ and compute (a) the design strength for LRFD.



Hole punched?
1" > 3/8" ✓OK
Assume standard holes, punched
$\therefore d_{hole} = 1" + \frac{1}{8}" = 1\frac{1}{8}"$

$A_g = (3/8")(7") = 2.625 \text{ in}^2$

$A_n = (7" - 1.125")(3/8") = 2.20 \text{ in}^2$

Yield $\phi P_n = \phi F_y A_g = 0.9(36 \text{ ksi})(2.625 \text{ in}^2) = 85.1 \text{ kips}$

Fracture $\phi P_n = \phi F_u A_e = 0.75(58 \text{ ksi})(2.20 \text{ in}^2) = 95.7 \text{ kips}$

$\therefore \boxed{\phi P_n = 85.1 \text{ kips.}}$

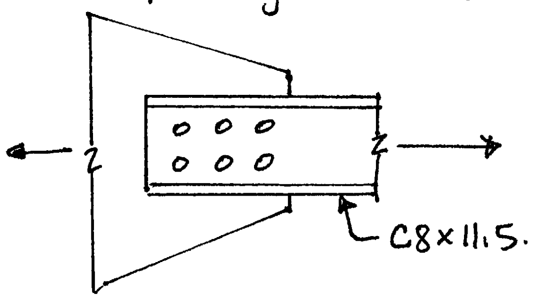
Problem 3.2-3(a)

A C 8×11.5 is connected to a gusset plate with 7/8" dia. bolts as shown. The steel is A572 Gr. 50. If the member is subjected to dead and live load only, what is the total service load capacity if the live-to-dead load ratio is 3? Assume that $A_e = 0.85A_n$. (a) use LRFD

AISC Table 1-5 $A = 3.37\ in^2$
$t_w = 0.220\ in$

Holes punched?
$7/8" > 0.22"$ ✓ok, yes
Assume standard holes
$\therefore d_{hole} = 7/8" + 1/8" = 1"$

$A_n = A_g - \Sigma d_{hole} t = 3.37\ in^2 - 2(1")(0.22") = 2.93\ in^2$



AISC Table 2-3
A572 Gr. 50
$F_y = 50\ ksi$
$F_u = 65\ ksi$

Yield $\phi P_n = \phi F_y A_g = 0.9(50\ ksi)(3.37\ in^2) = 151.7\ kips$

Fracture $\phi P_n = \phi F_u A_e = 0.75(65\ ksi)(0.85)(2.93\ in^2) = \underline{121.4\ kips}$
controls

$\phi P_n \geq P_u = 1.4D$ or $1.2D + 1.6L$
$= 1.2D + 1.6(3D) = \underline{6D}$
more critical

$121.4\ kips \geq 6D$
$D \leq 20.2^k$

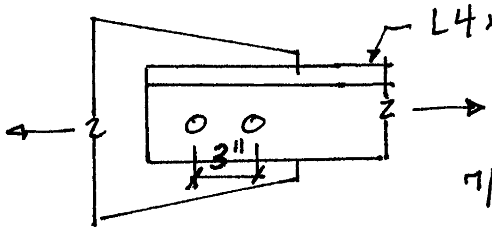
$\therefore D + L = D + 3D = 4(20.2^k) = \boxed{80.8\ kips} = P$
total service load capacity

Problem 3.3-2(a,b)

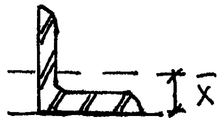
A single-angle tension member is connected to a gusset plate. The yield stress is $F_y = 50$ ksi and the ultimate tensile stress is $F_u = 70$ ksi. The bolts are 7/8" dia.

a) Determine the nominal strength based on the effective area. Use Eq. 3.1 for U

b) Repeat (a), but use alternative value of U from AISC Table D3.1



AISC Table 1-7
$A = 3.31 \text{ in}^2$
$\bar{y} = \bar{x} = 1.15 \text{ in}$



7/8" > 7/16" Assume std. punched hole
$\therefore d_{hole} = 7/8" + 1/8" = 1"$

a) Yield $\phi P_n = \phi F_y A_g = 0.9(50\text{ksi})(3.31\text{ in}^2) = 149$ kips

$A_n = 3.31\text{ in}^2 - (1")(7/16") = 2.873 \text{ in}^2$

$U = 1 - \dfrac{\bar{x}}{l} = 1 - \dfrac{1.15"}{3"} = 0.617$

$A_e = UA_n = 0.617(2.873\text{in}^2) = 1.77 \text{ in}^2$

Fracture $\phi P_n = \phi F_u A_e = 0.75(70\text{ksi})(1.77\text{in}^2) = \underline{92.9}$ kips
controls.

$\therefore \phi P_n = 92.9^k$ (design strength)

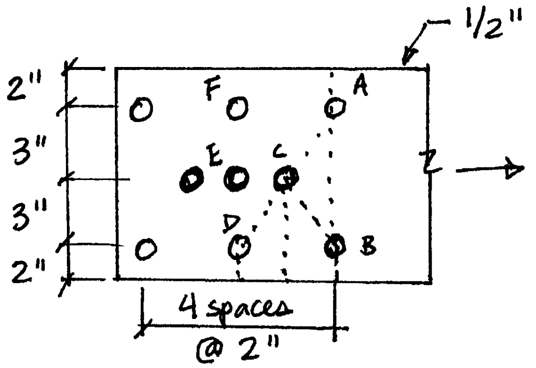
nominal strength $= P_n = \boxed{124 \text{ kips.}}$

b) Table D3.1, Case 8, 2 fasteners, $U = 0.6$.

$\therefore P_n = F_u A_e = (70\text{ksi})(0.6)(2.873\text{ in}^2) = \boxed{121 \text{ kips.}}$

Problem 3.4-1

The tension member shown is a 1/2 x 10 plate of A36 steel. The connection is with 7/8" dia. bolts. Compute the nominal strength based on the net section.



$F_u = 58$ ksi

$7/8" > 1/2"$

∴ assume standard, punched holes

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

path AB $\quad W_n = W_g - \Sigma d_{hole} + \cancel{\Sigma \frac{s^2}{4g}}$

$W_n = 10" - 2(1") = 8"$

path ACB $\quad W_n = 10" - 3(1") + 2\left(\frac{(2")^2}{4(3")}\right) = 7.67"$ ← controls

path AC $\quad W_n = 10" - 2(1") + \frac{(2")^2}{4(3")} = 8.33"$ (also only 8/9 load)

path ACD $\quad W_n = 10" - 3(1") + 2\left(\frac{(2")^2}{4(3")}\right) = 7.67"$ (also only 8/9 load)

$A_n = (7.67")(1/2") = 3.835 \text{ in}^2$ $\quad A_e = A_n$ (plate) $U = 1.0$

$P_n = F_u A_e = (58 \text{ ksi})(3.835 \text{ in}^2) = \boxed{222 \text{ Kips}}$

another possibility — path DEF?

$A_n = 5 \text{ in}^2 - (1/2")(1")(3 \text{ holes}) = 3.5 \text{ in}^2$

but because of load transfer, $A_n = \frac{9}{6}(3.5 \text{ in}^2)$

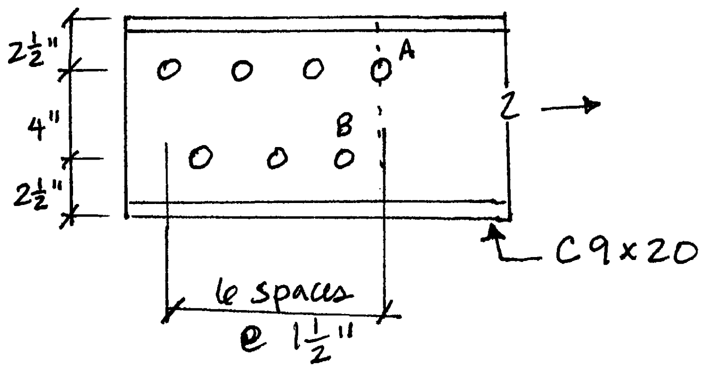
$= 5.25 \text{ in}^2$

∴ DEF does not control

Problem 3.4-4(a)

A C9x20 tension member is connected with 1 1/8" dia. bolts. $F_y = 50$ ksi and $F_u = 70$ ksi. The member is subjected to the following service loads: dead load = 36^k and live load = 110^k. Determine whether the member has enough strength, (a) use LRFD.

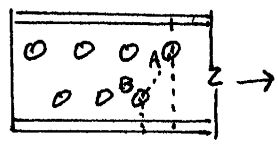
AISC Table 1-5
$A = 5.87 \text{ in}^2$
$\bar{x} = 0.583$ in
$t_w = 0.448$ in



Punched?
$1\frac{1}{8}" > 0.448"$ ✓ok
Assume standard, punched
$d_{hole} = 1\frac{1}{8}" + \frac{1}{8}" = 1.25"$

Yield $\quad \phi P_n = 0.9(50 \text{ ksi})(5.87 \text{ in}^2) = 264^k$

Fracture
$A_n = ?$ path A



$$A_n = A_g - \Sigma d_{hole}(t) + \Sigma\left(\frac{s^2}{4g}\right)(t)$$

$$A_n = 5.87 \text{ in}^2 - (1.25")(0.448") = 5.31 \text{ in}^2$$

path AB $\quad A_n = 5.87 \text{ in}^2 - 2(1.25")(0.448") + \frac{(1\frac{1}{2}")^2}{4(4")}(0.448")$

$A_n = \underline{4.81 \text{ in}^2}$ ← controls

$$U = 1 - \frac{\bar{x}}{\ell} = 1 - \frac{0.583"}{6(1\frac{1}{2}")} = 0.935$$

$A_e = UA_n$
$= 0.935(4.81)$
$= 4.50 \text{ in}^2$

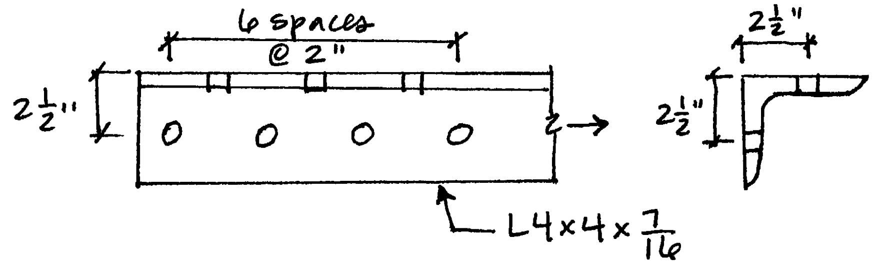
$\phi P_n = 0.75(70 \text{ ksi})(4.50 \text{ in}^2)$
$= \underline{236 \text{ kips}}$.

? $P_u = 1.4D = 1.4(36^k) = 50.4^k$
$= 1.2D + 1.6L = 1.2(36^k) + 1.6(110^k) = \underline{219.^k}$ ←

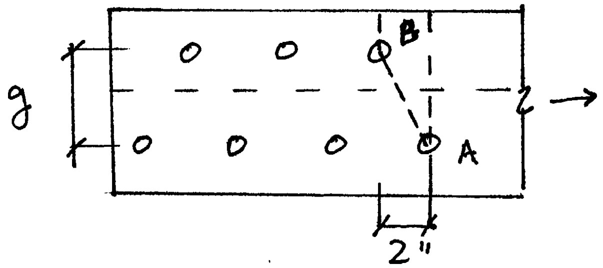
$236.^k > 219^k$ ✓ OK $\boxed{\text{YES, ENOUGH STRENGTH.}}$

Problem 3.4-6(a)

An L4x4x 7/16 tension member is connected with 3/4"dia. bolts, as shown. Both legs of the angle are connected. If A36 steel is used, (a) what is the design strength?



AISC
Table 1-7
$A = 3.31\ in^2$



Holes punched?
$3/4" > 7/16"$ ✓
Assume standard holes
$d_{hole} = 3/4" + 1/8"$
$= 7/8"$

$g = 2\frac{1}{2}" + 2\frac{1}{2}" - 7/16" = 4.5625"$

Yield $\phi P_n = 0.9(36ksi)(3.31\ in^2) = \underline{107^K}$

$A_n = ?$ path A $A_n = 3.31 in^2 - (7/8")(7/16") = 2.93\ in^2$

path AB $A_n = 3.31\ in^2 - (2)(7/8")(7/16") + \left(\frac{(2")^2}{4(4.5625")}\right)\left(\frac{7}{16}"\right)$

$A_n = 2.64\ in^2$ controls

$U = 1.0$ since both legs connected
$A_e = A_n$.

Fracture $\phi P_n = 0.75(58ksi)(2.64\ in^2) = 115^K$

$\therefore$ $\boxed{\phi P_n = 107 \text{ Kips.}}$ yield controls