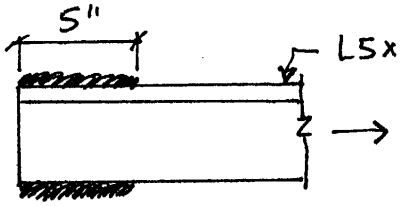
CE470 HW2 Segui 3.3-1 (a,b,c), DUE 2/5/09
3.3-8(a), 3.5-3(a), 3.6-2(a), 3.6-3(a), 3.7-5(a).

Problem 3.3-1 (a,b,c).

Determine effective Area, Ae, for each case.

(a)



AISC (Table 1-7)

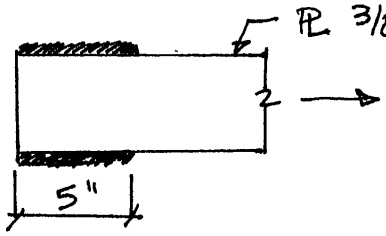
$\bar{x} = 1.47"$

$U = 1 - \frac{\bar{x}}{\ell} = 1 - \frac{1.47"}{5"} = 0.706$

$A_e = UA_g = (0.706)(5.86\ in^2)$

$\boxed{A_e = 4.14\ in^2}$

(b)



Plate; longitudinal welds only
Table D3.1 Case 4

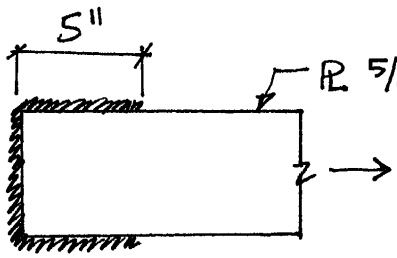
$\frac{\ell}{w} = \frac{5"}{4"} = 1.25$

$\therefore U = 0.75$

$A_e = UA_g$
$= (0.75)(4")(3/8")$

$\boxed{A_e = 1.125\ in^2}$

(c).



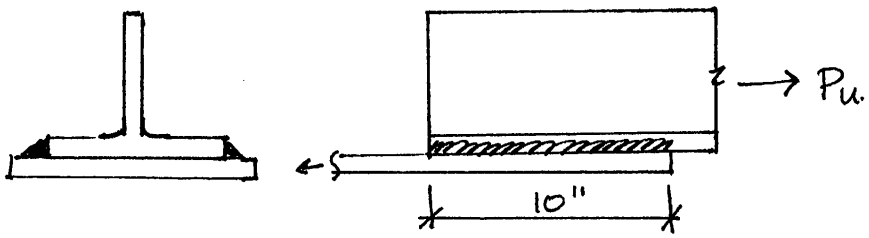
longitudinal + transverse welds
$U = 1.0$

$A_e = UA_g$
$= (1.0)(5/8")(5")$

$\boxed{A_e = 3.125\ in^2}$

Problem 3.3-8(a)

A WT6×17.5 is welded to a plate as shown. Fy = 50 ksi and Fu = 70 ksi. Determine whether the member can resist the following service loads: D = 75 kips, Lr = 40 kips, S = 50 kips, and W = 70 kips. Use LRFD.



AISC [2-8]

$1.4D = 1.4(75^k) = 105^k$

$1.2D + 1.6\cancel{L}^{0} + 0.5(L_r \text{ or } S \text{ or } R) = 1.2(75^k) + 0.5(50^k) = 115^k$

(S higher than Lr)

$1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (0.5L \text{ or } 0.8W) = 1.2(75^k) + 1.6(50^k) + 0.8(70^k) = 226^k$

$1.2D + 1.6W + 0.5\cancel{L}^{0} + 0.5(L_r \text{ or } S \text{ or } R) = 1.2(75^k) + 1.6(70^k) + 0.5(50^k) = \textcircled{227^k}$ ← controls = Pu

$0.9D \pm 1.6W$? will be less than previous one ↑

AISC Table 1-6 $A = 5.17\ in^2$

$\bar{x} = \bar{y} = 1.30"$

Yield $\phi P_n = 0.9(50 ksi)(5.17\ in^2) = 233$ kips. > Pu ✓OK

Fracture $U = 1 - \frac{\bar{x}}{l} = 1 - \frac{1.30"}{10"} = 0.87$

$\phi P_n = 0.75(70 ksi)(0.87)(5.17\ in^2) = 236$ kips > Pu ✓OK.

→ Block shear? $A_{gv} = A_{nv} = (10")(0.3") = 3\ in^2$ ← through web

$U_{bs} = 1.0$ $A_{nt} = (6.56")(0.52") = 3.41\ in^2$ ← through flange

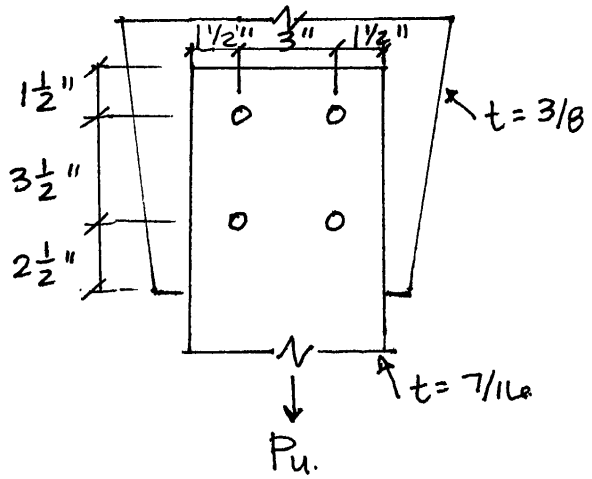
$\phi R_n = 0.75(0.6(70 ksi)(3\ in^2) + (1.0)(70 ksi)(3.41\ in^2)) = 274^k$

$\leq 0.75(0.6(50 ksi)(3\ in^2) + (1.0)(70 ksi)(3.41\ in^2)) = \textcircled{247^k} > Pu$ ✓OK

YES, WT IS ADEQUATE

Problem 3.5-3(a).

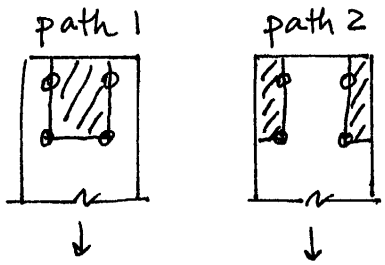
In the connection shown, the bolts are 3/4" diameter, and A36 steel is used for all components. Consider both the tension member and the gusset plate and compute the design block shear strength of the connection.



3/4" > 3/8"
> 7/16"
✓ punched ok

$d_{hole} = \frac{3}{4}" + \frac{1}{8}" = \frac{7}{8}"$

tension member

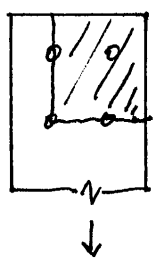


1 or 2 have same Ant & Agv / Anv.

$A_{nt} = (3" - (1\ hole)(7/8")(7/16") = 0.93\ in^2$
$A_{gv} = 2(5")(7/16") = 4.38\ in^2$
$A_{nv} = 2(5" - 1.5(7/8"))(7/16") = 3.23\ in^2$
$U_{bs} = 1.0$

$\phi R_n = 0.75(0.6(58ksi)(3.23in^2) + (1.0)(58ksi)(0.93in^2))$
$\leq 0.75(0.6(36ksi)(4.38in^2) + (1.0)(58ksi)(0.93in^2))$
$\phi R_n = 125^k \leq (111^k)$

path 3.



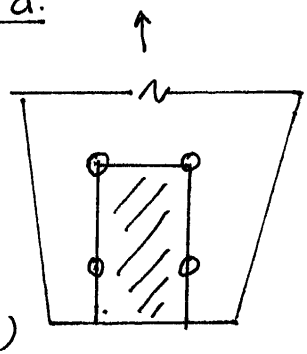
$A_{gv} = (5")(7/16") = 2.19\ in^2$
$A_{nv} = (5" - 1.5(7/8"))(7/16") = 1.61\ in^2$
$A_{nt} = (4.5" - 1.5(7/8"))(7/16") = 1.395\ in^2$
$U_{bs} = 1.0$

$\phi R_n = 0.75(0.6(58ksi)(1.61in^2) + 1.0(58ksi)(1.395in^2))$
$\leq 0.75(0.6(36ksi)(2.19in^2) + 1.0(58ksi)(1.395in^2))$
$\phi R_n = 103^k \leq (96^k)$

→

Problem 3.5-3(a) cont'd.

gusset plate



$A_{gv} = 2(6")(3/8")$
$= 4.5\ in^2$

only 1 path since dimensions to edges of plate not given (also looks to be larger Ant for block shear path to edges)

$A_{nv} = 2\,[6" - 1.5(7/8")](3/8")$
$= 3.52\ in^2$

$A_{nt} = (3" - 1(7/8"))(3/8") = 0.797\ in^2$

$U_{bs} = 1.0$

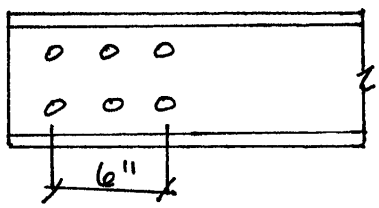
$\phi R_n = 0.75\,[0.6(58\,ksi)(3.52\,in^2) + (1.0)(58\,ksi)(0.797\,in^2)]$
$\leq 0.75\,[0.6(36\,ksi)(4.5\,in^2) + (1.0)(58\,ksi)(0.797\,in^2)]$
$\phi R_n = 126.5^K \leq$ (108 K)

of all possible block shear paths, path 3 for tension member controls

$\boxed{\phi R_n = 96^K}$

Problem 3.6-2 (a)

Use A36 steel and select the lightest American Standard Channel for a tension member that will safely support a service dead load of 100K and a service live load of 50K. The member is 20ft. long, and it is connected through the web with 2 lines of 1" dia. bolts. The length of the connection is 6". Use LRFD.



$1.4D = 1.4(100^K)$
$= 140^K$
$1.2D + 1.6L$
$= 1.2(100^K) + 1.6(50^K)$
$P_u = \underline{\underline{200^K}}$

AISC D1.

$L/r \leq 300$

$r \geq \frac{L}{300} = \frac{20ft\left(\frac{12in}{ft}\right)}{300} = 0.8\ in$

Yield. $\phi P_n \geq P_u$

$0.9(36ksi)(A_g) \geq 200^K$

$A_g \geq 6.17\ in^2$

Fracture $0.75(58ksi)(A_e) \geq 200^K$

$A_e \geq 4.59\ in^2$

Table 1-5 $r_y \geq 0.8$ $(r_x > r_y)$

C15x33.9 is lightest with $r_y = 0.901 > 0.8$

(Note: C12x25 is close. $r_y = 0.779$, $A_g = 7.34\ in^2$ could check C12x25 since AISC D1 is a recommendation, not a requirement.)

C15x33.9 $A = 10.0\ in^2$ ✓ $t_w = 0.40\ in$

$\bar{x} = 0.788\ in$

$U = 1 - \frac{\bar{x}}{\ell} = 1 - \frac{0.788\ in}{6\ in} = 0.87$

→

Problem 3.6-2(a), cont'd.

$1" > 0.40"$ punched ✓ OK
d_{bolt} t_w $d_{hole} = 1" + \frac{1}{8}" = 1\frac{1}{8}"$

$A_n = 10.0\ in^2 - 2(1\frac{1}{8}")(0.40") = 9.10\ in^2$
$A_e = UA_n = 0.87(9.10 in^2) = 7.92\ in^2 > 4.59\ in^2$ ✓

USE C15x33.9

(or C12x25 should work, also)

see note p.5

Not enough information given to check block shear.

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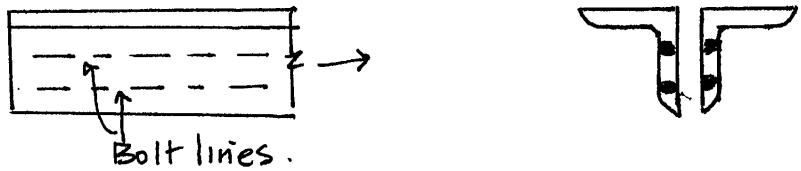
Problem 3.6-3(a)

Select a double-angle tension member to resist a service dead load of 30^k and a service live load of 90^k. The member will be connected with 2 lines of 7/8" dia. bolts placed at the usual gage distances. There will be more than 3 bolts in a line. The member is 25ft long and will be connected to a 3/8" thick gusset plate. Use A572 Gr.50 steel. Use LRFD



$P_u = 1.2D + 1.6L = 1.2(30^k) + 1.6(90^k) = 180^k$

AISC D1 $L/r \leq 300$

$r \geq \frac{L}{300} = \frac{25ft \times 12\frac{in}{ft}}{300} = 1.0$ in

Yield $\phi P_n \geq P_u$ $\quad 0.9(50ksi)(A_g) \geq 180^k$

$A_g \geq 4.0\ in^2$

Fracture $\phi P_n > P_u$ $\quad 0.75(65ksi)A_e \geq 180^k$

$A_e \geq 3.692\ in^2$

ℓ not given; More than 3 fasteners

Table D3.1, Case 8, $U = 0.8$

$A_e = UA_n$

$A_n \geq \frac{3.692\ in^2}{0.8} = 4.62\ in^2$ ← need $A_g > 6\ in^2$? > 5.62?

See AISC [1-46]

Angle leg must be ≥ 5" for 2 rows of bolts

too small? 2L5x3x3/8 $\quad A = 5.73\ in^2$ $\quad r_y = 1.22"$ $\quad r_x = 1.60"$

ok? 2L5x3x7/16 $\quad A = 6.62\ in^2$ $\quad r_y = 1.23"$ $\quad r_x = 1.59"$

→ 2L5x5x5/16 $\quad A = 6.13\ in^2$ $\quad r_y = 2.19"$ $\quad r_x = 1.56"$

lighter? TRY this one.

$A = 6.13\ in^2 > 4.0\ in^2$ ✓OK. $\quad r_x = 1.56" > 1.0$ in ✓OK

→

Problem 3.6-3(a), cont'd.

$7/8" > 5/16"$ punched ✓OK $d_{hole} = 7/8" + 1/8" = 1"$
d_b t

2 holes each angle.

$A_n = 6.13 in^2 - 4(1")(5/16") = 4.88 in^2 > 4.62 in^2$ ✓OK
$A_e = (0.8)(4.88 in^2) = 3.90 in^2 > 3.692 in^2$ ✓OK

TRY 2L5x3x3/8 $A = 5.73 in^2 > 4.0 in^2$ ✓OK.
$r_x = 1.60" > 1.0"$ ✓OK

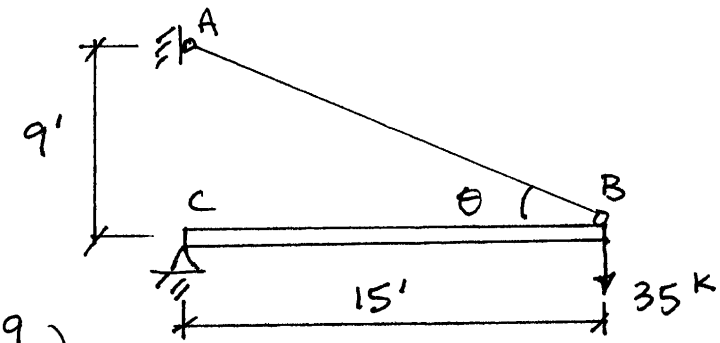
$A_n = 5.73 in^2 - 4(1")(3/8") = 4.23 in^2 < 4.62 in^2$ N.G

USE 2L5x5x$\frac{5}{16}$

Again, not enough information to check block shear.

Problem 3.7-5(a)

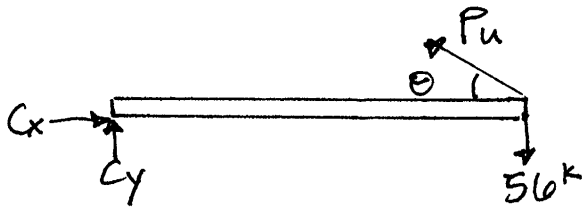
What size threaded rod (A36) is required for member AB? The load is a service live load. (Neglect the weight of member CB.) Use LRFD.



$L = 35^K$

$P_u = 1.6L$
$= 1.6(35^K)$
$= 56^K$

$\theta = \tan^{-1}\left(\frac{9}{15}\right)$
$\theta = 30.96°$



$+\circlearrowleft \Sigma M_C = 0 = (-56^K)(15') + P_u(\sin 30.96°)(15')$
$P_u = 108.9^K$
$P_u = \underline{109^K}$

AISC J3.6
Table J3.2

$\phi R_n = \phi F_n A_b$
$= 0.75(0.75F_u)A_b \geq 109^K$
$0.75(0.75)(58 ksi)A_b \geq 109^K$
$A_b \geq 3.34 in^2$

$\frac{\pi d^2}{4} \geq 3.34 in^2$

$d \geq 2.06 in$ USE $2\frac{1}{8}$ in.?

AISC Table 7-18 → $2\frac{1}{8}$" not listed

USE $2\frac{1}{4}$ in. rod or $2\frac{1}{8}$ in. rod if available.

(required $d \geq 2.06$")