# Homework 4 - Solutions:

7.7-1 Bolts $\phi$ 1⅛" A325 (Assume -N)

* Gross section yielding : $\phi T_n = \phi(0.9)(A_g)(F_y) = 0.9(6 \times \tfrac{1}{2})(50) = 135$ kips

* Net section fracture : $\phi T_n = \phi(0.75)(t)(6 - 2(1\tfrac{1}{8} + \tfrac{1}{8}))(F_u)(65)$

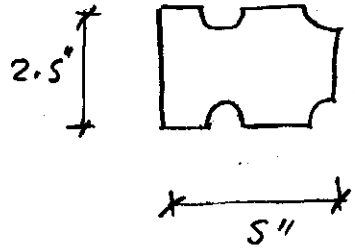
$= 85.3$ kips.

* Block shear : Member controls ( $t = \tfrac{1}{2}$" )

$A_{gv} = 5(\tfrac{1}{2})(2) = 5$ sq in

$A_{nv} = (5 - 1.5(1\tfrac{1}{8} + \tfrac{1}{8}))\tfrac{1}{2}(2)$

$= 3.125$ sq in




$A_{gt} = 2.5(\tfrac{1}{2}) = 1.25$ sq in

$A_{nt} = [2.5 - (1\tfrac{1}{8} + \tfrac{1}{8})](\tfrac{1}{2}) = 0.625$ sq in

Shear frac/tens. yield

$\phi R_n = 0.75(0.6 * 65 * 3.125 + 50(1.25))$

$= 138.3$ kips.

Shear yield / tens. frac

$\phi R_n = 0.75(0.6 * 50 * 5 + 65(0.625))$

$= 142.9$ kips ⟸ Controls block shear

* Bolt shear : $\phi R_n = \phi(0.99)(A_b)(48)(4) = 0.75(0.99)(48)(4)$

$= 142.6$ kips.

* Bearing: edge dist = 2" $>$ $1.5(1\frac{1}{8}^{d})$

bolt spacing = 3" $<$ $3(1\frac{1}{8}^{d})$

$\therefore$ Edge bolt strength = $2.4(65^{F_u})(\frac{1}{2}^{t})(1\frac{1}{8}^{d})$ = 87.8 kips

Inner bolt strength = $65^{F_u}(\frac{1}{2}^{t})(3^{s} - \frac{1\frac{1}{8}}{2})$ = 79.2 kips

$\phi R_n = {}^{\phi}0.75[2(87.8)^{\text{edge}} + 2(79.2)^{\text{inner bolts}}]$ = 250.5 kips

Maximum Factored Load = 85.3 kips (Net section fracture)

Slip critical strength (unfactored) = $17(0.99^{A_b})(4)$

= 67.3 kips

7.7-3 $T_u = 1.2(20) + 1.6(40) = 88$ kips

$T_w = 20 + 40 = 60$ kips.

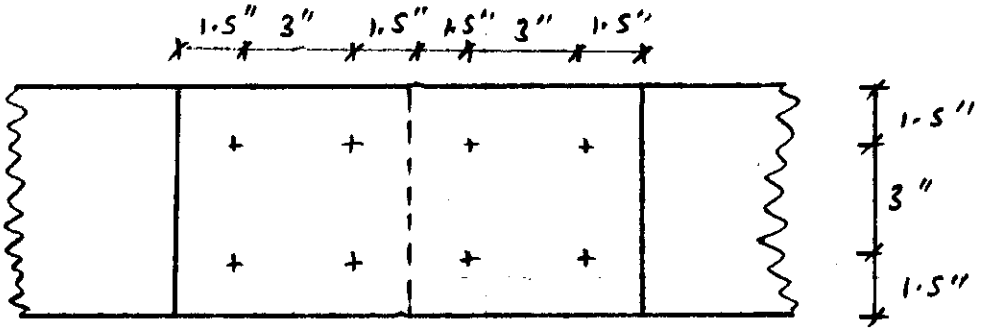
* slip critical str. = $2 * A_b(17) = 26.67$ kips/bolt.
  (2 surfaces)

* Shear strength = $2 * \phi^{0.75} * A_b * 48^{A325-N} = 56.6$ kips/bolt.

* Bearing strength = $\phi^{0.75} * 2.4 * d^{1.0} * t * F_u^{65} = 117t$ kips/bolt
  (t: thickness of splice pl.)

* N° of bolts for slip critical conds. = $60/26.69 = 2.3$

  Use 4 for symm.




* Min. splice plate thickness for bearing strength

  $4 * 117t\,(2) = 88 \Rightarrow t = 0.09"$
  (4 bolts; 2 plates)

* Min splice pl. thickness for gross section yielding.

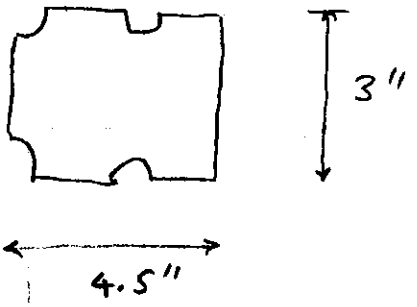
  (2 plates) $2 * \phi^{0.9}(6)(t)(50) = 88 \Rightarrow t = 0.16"$

* Min. splice pl. thickness for net section fracture

$$2 * \underset{0.75}{\phi} * \left(6 - 2\left(1+\tfrac{1}{8}\right)\right) t * \underset{F_u}{65} = 88 \Rightarrow t = 0.24''$$

* Min splice pl. thickness for block shear :

2 plates ⇒




$A_{gv} = \underset{2\,\text{sides}}{\underset{2\,\text{pl.}}{2} * 2} * 4.5 * t = 18t$

$A_{gn} = 2 * 2 * (4.5 - 1.5(1+\tfrac{1}{8}))\, t = 11.25t$

$A_{gt} = 2 * 3 * t = 6t$

$A_{nt} = 2 * (3 - 1\tfrac{1}{8})(t) = 3.75t$

Shear fmc / tens. yield $\quad \phi R_n = 88 = \phi(0.6 * 65 * 11.25t + 50 * 6t) \Rightarrow t = 0.16''$

Shear yield / tens. fmc. $\quad \phi R_n = 88 = \phi(0.6 * 50 * 18t + 65(3.75t)) \Rightarrow t = 0.149''$

∴ Min pl. thickness = 0.24" ⇒ Net section fracture

Use 1/4" plates

7.11-4

Weld strength = $\phi^{0.75}\, 0.707\left(\frac{1}{4}\right)(0.6 * 70) = 5.56$ kips/in

Base metal = $0.9(0.6 F_y^{50})(t^{(1/2)}) = 13.5$ kips/in

Weld strength controls $\Rightarrow \phi R_n = 5.56 * (3+3+3) * 2$

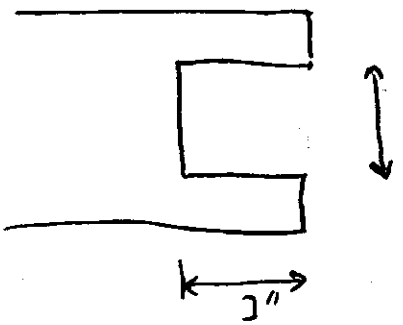
$= 100$ kips

Gross section yielding (inner member) $= 0.9(50)(.6 * \frac{1}{2}) = 135$ kips

Gross section yielding (outer members) $= 0.9(50)(2 * 3 * 5/16) = 84.3$ kips

↑ Controls.

Block shear calculation:




$A_{gt} < A_{nt} = 3(1/2) = 1.5$ sq. in

$A_{gv} = A_{nv} = 3(1/2)(2) = 3$ sq. in

$\phi R_n = 0.75\left(0.6(65)(3) + 50\left(\frac{3}{2}\right)\right) = 144$ kips

$\phi R_n = 0.75\left(0.6(50)(3) + 65\left(\frac{3}{2}\right)\right) = 140.625$ kips

7.11-6

Weld strength = $\phi\,(0.707)(s)(0.6 \times 70) = 2.78$ kips/in

($s$ = min weld size = $1/8$")

Required length = $45 / (2.78 \times 2) = 8.08$"

(2 sides)

Use 8.5"

Check tension member gross section yielding

$\phi T_n = (8.5 \times 1/4)(0.9)(50) = 90$ kips $> 45$ kips (o/c)

($A_g$, $\phi$)