3.5-1

Shear areas:

$$A_{gv} = \frac{7}{16}(4.5) = 1.969 \text{ in.}^2$$

$$A_{nv} = \frac{7}{16}[4.5 - 1.5(1.0)] = 1.313 \text{ in.}^2$$

Tension area $= A_{nt} = \frac{7}{16}[1.75 - 0.5(1.0)] = 0.5469 \text{ in.}^2$

For this type of connection, $U_{bs} = 1.0$, and from AISC Equation J4-5,

$$R_n = 0.6F_uA_{nv} + U_{bs}F_uA_{nt}$$

$$= 0.6(65)(1.313) + 1.0(65)(0.5469) = 86.8 \text{ kips}$$

with an upper limit of

$$0.6F_yA_{gv} + U_{bs}F_uA_{nt} = 0.6(50)(1.969) + 1.0(65)(0.5469) = 94.6 \text{ kips}$$

$$\underline{R_n = 86.8 \text{ kips}}$$

3.5-3

Tension member:

The shear areas are $A_{gv} = \frac{7}{16}(3.5 + 1.5) \times 2 = 4.375 \text{ in.}^2$

$$A_{nv} = \frac{7}{16}\left[3.5 + 1.5 - 1.5\left(\frac{3}{4} + \frac{1}{8}\right)\right] \times 2 = 3.227 \text{ in.}^2$$

The tension area is $A_{nt} = \frac{7}{16}\left[3.0 - (0.5 + 0.5)\left(\frac{3}{4} + \frac{1}{8}\right)\right] = 0.9297 \text{ in.}^2$

For this type of connection, $U_{bs} = 1.0$, and from AISC Equation J4-5,

$$R_n = 0.6F_uA_{nv} + U_{bs}F_uA_{nt}$$

$$= 0.6(58)(3.227) + 1.0(58)(0.9297) = 166.2 \text{ kips}$$

with an upper limit of

$$0.6F_yA_{gv} + U_{bs}F_uA_{nt} = 0.6(36)(4.375) + 1.0(58)(0.9297) = 148.4 \text{ kips}$$

The nominal block shear strength of the tension member is therefore 148.4 kips.

Gusset Plate:

$$A_{gv} = \frac{3}{8}(3.5 + 2.5) \times 2 = 4.5 \text{ in.}^2$$

$$A_{nv} = \frac{3}{8}[3.5 + 2.5 - 1.5(7/8)] \times 2 = 3.516 \text{ in.}^2$$

$$A_{nt} = \frac{3}{8}[3.0 - (0.5 + 0.5)(7/8)] = 0.7969 \text{ in.}^2$$

From AISC Equation J4-5,

$$R_n = 0.6F_uA_{nv} + U_{bs}F_uA_{nt}$$

$$= 0.6(58)(3.516) + 1.0(58)(0.7969) = 168.6 \text{ kips}$$

with an upper limit of

$$0.6F_yA_{gv} + U_{bs}F_uA_{nt} = 0.6(36)(4.5) + 1.0(58)(0.7969) = 143.4 \text{ kips}$$

The nominal block shear strength of the gusset plate is therefore 143.4 kips

The gusset plate controls, and the nominal block shear strength of the connection is 143.4 kips

(a) The design strength is $\phi R_n = 0.75(143.4) = 108$ kips $\underline{\phi R_n = 108 \text{ kips}}$

3.5-4

Gross section nominal strength:

$$P_n = F_y A_g = 50(3.60) = 180.0 \text{ kips}$$

Net section nominal strength:

$$A_n = 3.60 - 0.314(7/8)(2) = 3.051 \text{ in.}^2$$

$$U = 1 - \frac{\bar{x}}{\ell} = 1 - \frac{0.525}{(3+3)} = 0.9125$$

$$A_e = A_n U = 3.051(0.9125) = 2.784 \text{ in.}^2$$

$$P_n = F_u A_e = 65(2.784) = 181.0 \text{ kips}$$

Block shear strength of tension member:

The shear areas are $A_{gv} = 0.314(1.5 + 3 + 3) \times 2 = 4.710 \text{ in.}^2$

$$A_{nv} = 0.314[1.5 + 3 + 3 - 2.5(7/8)] \times 2 = 3.336 \text{ in.}^2$$

The tension area is

$$A_{nt} = 0.314[3.0 - (0.5 + 0.5)(7/8)] = 0.6673 \text{ in.}^2$$

For this type of connection, $U_{bs} = 1.0$, and from AISC Equation J4-5,

$$R_n = 0.6F_u A_{nv} + U_{bs} F_u A_{nt}$$

$$= 0.6(65)(3.336) + 1.0(65)(0.6673) = 173.5 \text{ kips}$$

with an upper limit of

$$0.6F_y A_{gv} + U_{bs} F_u A_{nt} = 0.6(50)(4.710) + 1.0(65)(0.6673) = 184.7 \text{ kips}$$

The nominal block shear strength of the tension member is therefore 173.5 kips.

Block shear strength of gusset plate:

$$A_{gv} = \frac{3}{8}(1.5 + 3 + 3) \times 2 = 5.625 \text{ in.}^2$$

$$A_{nv} = \frac{3}{8}[1.5 + 3 + 3 - 2.5(7/8)] \times 2 = 3.984 \text{ in.}^2$$

$$A_{nt} = \frac{3}{8}[3 - (0.5 + 0.5)(7/8)] = 0.7969 \text{ in.}^2$$

From AISC Equation J4-5,

$$R_n = 0.6F_u A_{nv} + U_{bs} F_u A_{nt}$$

$$= 0.6(58)(3.984) + 1.0(58)(0.7969) = 184.9 \text{ kips}$$

with an upper limit of

$$0.6F_y A_{gv} + U_{bs} F_u A_{nt} = 0.6(36)(5.625) + 1.0(58)(0.7969) = 167.7 \text{ kips}$$

The nominal block shear strength of the gusset plate is therefore 167.7 kips. The gusset plate controls, and the nominal block shear strength of the connection is 167.7 kips

(a) Design strength for LRFD:

For tension on the gross area, $\phi_t P_n = 0.90(180.0) = 162$ kips

For tension on the net area, $\phi_t P_n = 0.75(181.0) = 136$ kips

For block shear, $\phi R_n = 0.75(167.7) = 126$ kips

Block shear controls. <u>Maximum factored load = design strength = 126 kips</u>