3.3-1

(a) $U = 1 - \frac{\bar{x}}{\ell} = 1 - \frac{1.47}{5} = 0.7060$

$A_e = A_g U = 5.86(0.7060) = 4.14 \text{ in.}^2$ $\underline{A_e = 4.14 \text{ in.}^2}$

(b) Plate with longitudinal welds only:

$\frac{\ell}{w} = \frac{5}{4} = 1.25, \quad U = 0.75 \text{ in.}^2$

$A_e = A_g U = \left(\frac{3}{8} \times 4\right)(0.75) = 1.125 \text{ in.}^2$ $\underline{A_e = 1.13 \text{ in.}^2}$

(c) $U = 1.0$

$A_e = A_g U = \left(\frac{5}{8} \times 5\right)(1.0) = 3.13 \text{ in.}^2$ $\underline{A_e = 3.13 \text{ in.}^2}$

(d) $U = 1.0$

$A_g = 0.5(5.5) = 2.750 \text{ in.}^2$

$A_n = A_g - A_{holes} = 2.750 - \frac{1}{2}\left(\frac{3}{4} + \frac{1}{8}\right) = 2.313 \text{ in.}^2$

$A_e = A_n U = 2.313(1.0) = 2.313 \text{ in.}^2$ $\underline{A_e = 2.31 \text{ in.}^2}$

(e) $U = 1.0$

$A_g = \frac{5}{8} \times 6 = 3.750 \text{ in.}^2$

$A_n = A_g - A_{holes} = 3.750 - \frac{5}{8}\left(\frac{7}{8} + \frac{1}{8}\right) = 3.125 \text{ in.}^2$

$A_e = A_n U = 3.125(1.0) = 3.125 \text{ in.}^2$ $\underline{A_e = 3.13 \text{ in.}^2}$

3.3-2

(a) $A_n = A_g - A_{holes} = 3.31 - \frac{7}{16}\left(\frac{7}{8} + \frac{1}{8}\right) = 2.873 \text{ in.}^2$

$U = 1 - \frac{\bar{x}}{\ell} = 1 - \frac{1.15}{3} = 0.6167$

$A_e = A_n U = 2.873(0.6167) = 1.772 \text{ in.}^2$

$P_n = F_u A_e = 70(1.772) = 124 \text{ kips}$ $\underline{P_n = 124 \text{ kips}}$

(b) From AISC Table D3.1, Case 8, $U = 0.60$

$A_e = A_n U = 2.873(0.60) = 1.724 \text{ in.}^2$

$P_n = F_u A_e = 70(1.724) = 121 \text{ kips}$ $\underline{P_n = 121 \text{ kips}}$

3.3-8

Gross section: $P_n = F_y A_g = 50(5.17) = 258.5$ kips

Net section:

$$U = 1 - \frac{\bar{x}}{\ell} = 1 - \frac{1.30}{10} = 0.87$$

$$A_e = A_g U = 5.17(0.87) = 4.498 \text{ in.}^2$$

$$P_n = F_u A_e = 70(4.498) = 314.9 \text{ kips}$$

(a) The design strength based on yielding is

$$\phi_t P_n = 0.90(258.5) = 233 \text{ kips}$$

The design strength based on fracture is

$$\phi_t P_n = 0.75(314.9) = 236 \text{ kips}$$

The design strength is the smaller value: $\phi_t P_n = 233$ kips

Load combination 3:

$$P_u = 1.2D + 1.6S + 0.8W = 1.2(75) + 1.6(50) + 0.8(70) = 226 \text{ kips}$$

Load combination 4:

$$P_u = 1.2D + 1.6W + 0.5S = 1.2(75) + 1.6(70) + 0.5(50) = 227 \text{ kips}$$

Load combination 4 controls. Since $P_u < \phi_t P_n$, (227 kips < 233 kips),

The member is adequate.

3.4-1

Gross section: $A_g = 10(1/2) = 5 \text{ in.}^2$

Net section: Hole diameter $= \frac{7}{8} + \frac{1}{8} = 1$ in.

Possibilities for net area:

$$A_n = A_g - \sum t \times (d \text{ or } d') = 5 - (1/2)(1)(2) = 4.0 \text{ in.}^2$$

or $$A_n = 5 - (1/2)(1) - (1/2)\left[1 - \frac{(2)^2}{4(3)}\right] - (1/2)\left[1 - \frac{(2)^2}{4(3)}\right] = 3.833 \text{ in.}^2$$

or $A_n = 5 - (1/2)(1)(3) = 3.5 \text{ in.}^2$, but because of load transfer,

use $A_n = \frac{9}{6}(3.5) = 5.25 \text{ in.}^2$ for this possibility.

The smallest value controls. Use $A_n = 3.833 \text{ in.}^2$

$$A_e = A_n U = A_n(1.0) = 3.833 \text{ in.}^2$$

$$P_n = F_u A_e = 58(3.833) = 222 \text{ kips}$$

The nominal strength based on the net section is $\underline{P_n = 222 \text{ kips}}$

3.4-4

Gross section: $A_g = 5.87 \text{ in.}^2, \quad P_n = F_y A_g = 50(5.87) = 293.5 \text{ kips}$

Net section: Hole diameter $= 1\frac{1}{8} + \frac{1}{8} = 1.25$ in.

$$A_n = A_g - \sum t_w \times (d \text{ or } d') = 5.87 - 0.448(1.25) = 5.310 \text{ in.}^2$$

or $$A_n = 5.87 - 0.448(1.25) - 0.448\left[1.25 - \frac{(1.5)^2}{4(4)}\right] = 4.813 \text{ in.}^2$$

$$U = 1 - \frac{\bar{x}}{\ell} = 1 - \frac{0.583}{6(1.5)} = 0.9352$$

$$A_e = A_n U = 4.813(0.9352) = 4.501 \text{ in.}^2$$

$$P_n = F_u A_e = 70(4.501) = 315.1 \text{ kips}$$

(a) Gross section: $\phi_t P_n = 0.90(293.5) = 264$ kips

Net section: $\phi_t P_n = 0.75(315.1) = 236$ kips (controls)

$P_u = 1.2D + 1.6L = 1.2(36) + 1.6(110) = 219 \text{ kips} < 236 \text{ kips}$ (OK)

Since $P_u < \phi_t P_n$ (219 kips < 236 kips), The member has enough strength.