EQUATIONS

$$E = \frac{f}{\epsilon} \tag{2.6.3}$$

$$\mu = -\frac{\epsilon_x}{\epsilon_z} = -\frac{\epsilon_y}{\epsilon_z} \tag{2.6.5}$$

$$G = \frac{E}{2(1 + \mu)} \tag{2.6.6}$$

$$\alpha = [6.10 + 0.0019T] \times 10^{-6} \tag{2.6.7}$$

$$\int f_r \, dA = 0; \quad \int f_r \, y \, dA = 0; \quad \int f_r \, x \, dA = 0 \tag{2.6.8}$$

$$A = \sum_{i=1}^{n} A_i \tag{2.8.1}$$

$$\bar{y} = \frac{\sum_{i=1}^{n} A_i \bar{y}_i}{A} \tag{2.8.2}$$

$$I_x = \sum_{i=1}^{n} \left[I_{oi} + A_i d_i^2 \right]_x \tag{2.8.3}$$

$$r_x = \sqrt{\frac{I_x}{A}} \tag{2.8.4}$$

$$S_{xt} = \frac{I_x}{c_t}; \quad S_{xb} = \frac{I_x}{c_b} \tag{2.8.5}$$

$$I_o = \frac{1}{12} b h^3 \tag{2.8.6}$$

$$L = r_L L_o \qquad (4.6.1)$$

$$r_L = \left[0.25 + \frac{15}{\sqrt{K_{LL} A_T}}\right] \quad \text{and} \quad r_{L\,\min} \le r_L \le 1.0 \qquad (4.6.2)$$

$$q_z = 0.00256\, K_z K_{zt} K_d I_w V^2 \qquad (4.7.1)$$

$$p = p_e - p_i \qquad (4.7.2)$$

$$p = q_z\, G\, C_p - q_h\, (G\, C_{pi}) \qquad (4.7.3a)$$

$$= q_h\, G\, C_p - q_h\, (G\, C_{pi}) \qquad (4.7.3b)$$

$$\phi R_n \ge \Sigma \gamma_i Q_i \qquad (4.10.1)$$

Factored resistance ≥ Factored load effects

$$R_d \ge R_{req} \qquad (4.10.2)$$

Design strength provided ≥ Required strength

$1.4D$	(LC-1)	
$1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$	(LC-2)	
$1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (0.5L \text{ or } 0.8W)$	(LC-3)	(4.10.3)
$1.2D + 1.6W + 0.5L + 0.5(L_r \text{ or } S \text{ or } R)$	(LC-4)	
$1.2D + 1.0E + 0.5L + 0.2S$	(LC-5)	
$0.9D + 1.6W$	(LC-6)	
$0.9D + 1.0E$	(LC-7)	

$$f \le F_a = \frac{F_{\lim}}{\Omega} \qquad ((4.10.6)$$

$$p_{Lb} = \max\left\{\left[0.25 + \frac{15}{\sqrt{A_{Ib}}}\right]L_o;\ \ 0.5\,L_o\right\} \tag{5.2.1}$$

$$q_{Db} = (q_b + p_{Db}\,S_b) \tag{5.2.2}$$

$$q_{Lb} = (p_{Lb}\,S_b) \tag{5.2.3}$$

$$q_{ub} = (1.2\,q_{Db} + 1.6\,q_{Lb}) \tag{5.2.4}$$

$$p_{Lg} = \max\left\{\left[0.25 + \frac{15}{\sqrt{A_{Ig}}}\right]L_o;\ \ 0.5\,L_o\right\} \tag{5.2.5}$$

$$Q_{Db} = (q_b + p_{Db}\,S_b)L_b \tag{5.2.6}$$

$$Q_{Lb} = (p_{Lg}\,S_b)L_b \tag{5.2.7}$$

$$Q_{ug} = (1.2\,Q_{Db} + 1.6\,Q_{Lb}) \tag{5.2.8}$$

$$q_{ug} = 1.2\,q_g \tag{5.2.9}$$

$$p_{Lc} = \max\left\{\left[0.25 + \frac{15}{\sqrt{A_{Ic}}}\right]L_o;\ \ 0.4\,L_o\right\} \tag{5.2.10}$$

$$\beta = \frac{I_c/h}{I_g/L} \tag{5.3.1}$$

$$M_{\mathrm{B}} = -\frac{qL^2}{12}\,\frac{3\beta}{3\beta + 2} \tag{5.3.2}$$

$$M_{\mathrm{E}} = \frac{qL^2}{24}\,\frac{3\beta + 6}{3\beta + 2} \tag{5.3.3}$$

$$P_g = \frac{qL}{12}\,\frac{3\beta}{3\beta + 2}\left(\frac{L}{h}\right) \tag{5.3.4}$$

$$\delta_{\mathrm{E}} = \frac{1}{384}\left(\frac{3\beta + 10}{3\beta + 2}\right)\frac{qL^4}{EI_g} \tag{5.3.4}$$

$$M_B = -M_C = \frac{Hh}{2} \tag{5.3.6}$$

$$\Delta = \frac{2\beta + 1}{12\beta}\frac{Hh^3}{EI_c} \tag{5.3.7}$$

$$M_B = -\frac{qL^2}{12}\frac{2\beta}{2\beta + 1}; \quad M_A = -\frac{1}{2}M_B \tag{5.3.8}$$

$$M_E = \frac{qL^2}{24}\frac{2\beta + 3}{2\beta + 1} \tag{5.3.9}$$

$$P_g = \frac{qL}{8}\frac{2\beta}{2\beta + 1}\left(\frac{L}{h}\right) \tag{5.3.10}$$

$$\delta_E = \frac{1}{384}\left(\frac{2\beta + 5}{2\beta + 1}\right)\frac{qL^4}{EI_g} \tag{5.3.11}$$

$$M_B = -M_C = \frac{Hh}{2}\frac{3}{\beta + 6} \tag{5.3.12}$$

$$M_A = -M_D = -\frac{Hh}{2}\frac{\beta + 3}{\beta + 6} \tag{5.3.13}$$

$$\Delta = \frac{2\beta + 3}{12\beta + 72}\frac{Hh^3}{EI_c} \tag{5.3.16}$$

$$L_{ce} = L_e - 0.5 d_h \tag{6.2.2}$$

$$L_{ci} = p - d_h \tag{6.2.3}$$

$$L_e \leq \min\,[12\,t_p; \;\; 6 \text{ in.}] \tag{6.2.4a}$$

$p \leq \min\,[24\,t_{p1}; \;\; 12 \text{ in.}]$ for painted members (6.2.4*b*)

$\leq \min\,[14\,t_{p1}; \;\; 7 \text{ in.}]$ for members of weathering steel (6.2.4*c*)

$$P = F \leq S = \mu C_o N_s = \mu B_o N_s \tag{6.4.1}$$

$$T_b = 0.7 F_{ub} A_b \tag{6.5.1}$$

$$B_{dv} \equiv \phi B_{nv} = \phi (F_{nv} A_b) N_s \tag{6.7.3}$$

$$= 0.75 (0.50 F_{ub}) A_b N_s \qquad \text{for X-type bolts}$$

$$= 0.75 (0.40 F_{ub}) A_b N_s \qquad \text{for N-type bolts}$$

$$B_{dbo} = \phi F_{nb} dt \tag{6.8.2}$$

$$= 0.75 (2.4 F_{up}) dt$$

$$B_{dbte} = \phi F_{up} (1.2 L_c) t = 0.75 F_{up} (1.2)(L_e - 0.5 d_h) t \tag{6.8.5}$$

$$B_{dbti} = \phi F_{up} (1.2 L_c) t = 0.75 F_{up} (1.2)\left(p - d_h\right) t \tag{6.8.6}$$

$$L_{e,\text{full}} = 2.5 d + \frac{1}{32} \text{ in.}; \qquad p_{\text{full}} = 3 d + \frac{1}{16} \text{ in.} \tag{6.8.7}$$

$$B_{dbe} = \min\left(B_{dbo}, B_{dbte}\right) \tag{6.8.8a}$$

$$B_{dbi} = \min\left(B_{dbo}, B_{dbti}\right) \tag{6.8.8b}$$

$$B_{dt} \equiv \phi B_{nt} = \phi F_{nt} A_b = 0.75 (0.75 F_{ub}) A_b \tag{6.9.3}$$

$$f_{tu} \leq F'_{dt} \equiv \phi F'_{nt} \tag{6.10.3}$$

$$F'_{nt} = 117 - 2.5 f_{vu} \leq 90 \quad \text{for } f_{vu} \leq 36 \text{ ksi, for A325-N type} \tag{6.10.4a}$$

$$= 117 - 2.0 f_{vu} \leq 90 \quad \text{for } f_{vu} \leq 45 \text{ ksi, for A325-X type} \tag{6.10.4b}$$

$$= 147 - 2.5 f_{vu} \leq 113 \quad \text{for } f_{vu} \leq 45 \text{ ksi, for A490-N type} \tag{6.10.4c}$$

$$= 147 - 2.0 f_{vu} \leq 113 \quad \text{for } f_{vu} \leq 56 \text{ ksi, for A490-X type} \tag{6.10.4d}$$

$$B'_{nt} = C_1 - C_2 B_{vu} \leq B_{nt} \tag{6.10.5}$$

$$C_{dv} = N B_{dv} \tag{6.13.1}$$

$$C_{db} = n_e B_{dbe} + n_i B_{dbi} \tag{6.13.2}$$

$$C_d = \min[C_{dv}, C_{db}] \tag{6.13.3}$$

$$w_{\max} = t_p \qquad \text{for } t_p < ¼ \text{ in.}$$

$$\leq t_p - \frac{1}{16} \qquad \text{for } t_p \geq ¼ \text{ in.} \tag{6.16.1}$$

$$CE = \text{C} + \frac{(\text{Mn} + \text{Si})}{6} + \frac{(\text{Cu} + \text{ni})}{15} + \frac{(\text{Cr} + \text{Mo} + \text{V})}{5} \tag{6.14.1}$$

$$w_{\max} = t_p \qquad \text{for } t_p < 1/4 \text{ in.} \tag{6.16.1a}$$

$$\leq t_p - \frac{1}{16} \qquad \text{for } t_p \geq 1/4 \text{ in.} \tag{6.16.1b}$$

$$t_e = w \sin 45^o = 0.707\, w \tag{6.16.2}$$

$$t_e = w \qquad \text{for } w \leq ⅜ \text{ in.} \tag{6.16.3a}$$

$$= 0.707\, w + 0.11 \qquad \text{for } w > ⅜ \text{ in.} \tag{6.16.3b}$$

$$w = t_p \qquad \text{for } t_p \leq \frac{5}{8} \text{ in.} \tag{6.16.8a}$$

$$w \geq \max(t_p/2;\ 5/8 \text{ in.}) \qquad \text{for } t_p > \frac{5}{8} \text{ in.} \tag{6.16.8b}$$

$$L_w = L_g - 2w \tag{6.16.4}$$

$$L_w \geq L_{w,\min} = 4w \quad \text{orelse} \quad w_e = L_w/4 \tag{6.16.5}$$

$$A_w = L_w t_e \tag{6.16.6}$$

$$L_{iw} \geq \max(4w;\ 1½ \text{ in.}) \tag{6.16.7}$$

$$w = t_p \qquad \text{for } t_p \leq ⅝ \text{ in.} \tag{6.16.8a}$$

$$w \geq \max(t_p/2;\ ⅝ \text{ in.}) \quad \text{for } t_p > ⅝ \text{ in.} \tag{6.16.8b}$$

$$d_{pw,\min} = t_p + \frac{5}{16}\text{ in.}; \qquad d_{pw,\max} = \min[d_{pw,\min} + \frac{1}{8}\text{ in.};\ 2¼ w]$$

$$d_{pw,\min} \leq d_{pw} \leq d_{pw,\max} \tag{6.16.9}$$

$$s_{tpw} \geq 4\, d_{pw}\,; \qquad s_{lsw} \geq 4\, d_{pw}$$

$$d_{sw,\,\min} = t_p + \frac{5}{16}\text{ in.}; \qquad d_{sw,\,\max} = \min\left[d_{sw,\,\min} + \frac{1}{16}\text{ in.};\ \ 2\tfrac{1}{4}\, w\right]$$

$$d_{sw\ \min} \leq d_{sw} \leq d_{sw\ \max} \tag{6.16.10}$$

$$L_{sw} \leq 10\, w\,; \qquad r_h \geq t_p$$

$$S_{tsw} \geq 4\, d_{sw}; \qquad S_{lsw} \geq 2\, L_{sw}$$

$$A_w = \frac{\pi\, d_{pw}^2}{4} \quad \text{for a plug weld} \tag{6.16.11a}$$

$$A_w = (L_{sw} - 0.22\, d_{sw})\, d_{sw} \quad \text{for a slot weld with semi-circular ends} \tag{6.16.11b}$$

$$R_{dw} = 0.75\left(0.60\, F_{EXX}\right) t_e\, L_w \tag{6.19.4}$$

$$R_{dBM1} = 0.75\,(0.6)\,F_{uBM}\, t_p\, L_w \tag{6.19.5a}$$

$$R_{dBM2} = 0.90\,(0.60)\,F_{yBM}\, t_p\, L_w \tag{6.19.5b}$$

$$R_{dBM} = \min[R_{dBM1};\ \ R_{dBM2}] \tag{6.19.6}$$

$$R_d = \min\left[R_{dw},\ \ R_{dBM}\right] \tag{6.19.7}$$

$$R_{dw} = W_d\, L_w \tag{6.19.8}$$

$$W_d = 0.75\,(0.60\, F_{\text{EXX}})\, t_e \quad \text{for a unit length fillet weld of size } w \tag{6.19.9}$$

$$W_d = 1.392\, D \quad \text{for a unit length E70 fillet weld of size } D \tag{6.19.10}$$

$$R_{dw} = 0.75\left(0.6\, F_{\text{EXX}}\, t_e\, L_w\right)\left[1.0 + 0.50\,(\sin\theta)^{1.5}\right] \tag{6.19.11}$$

$$R_{dw} = \phi\,(0.6\, F_{\text{EXX}})\, A_w \tag{6.19.12}$$

$$\Delta = \epsilon L = \frac{T L}{A E} \tag{7.3.1}$$

$$T_{d1} = \phi_{t1} F_y A_g = 0.9 F_y A_g \tag{7.4.5}$$

$$T_{d2} = \phi_{t2} F_u A_e = 0.75 F_u A_e \tag{7.4.6}$$

$$A_h = d_e t \tag{7.6.2}$$

$$A_n = A_g - \sum_{i=1}^{n_e} n_i d_e t_i \tag{7.6.3}$$

$$A_{nk} = A_g - n d_e t + \sum_{j=1}^{n_d} \frac{s_j^2}{4 g_j} t \tag{7.6.4}$$

$$A_n = \min \left[A_{n1}, A_{n2}, \ldots A_{nk}, \ldots A_{nM} \right] \tag{7.6.5}$$

$$g_{ab} = g_a + g_b - t \tag{7.6.6}$$

$$A_{nk} = A_g - \sum_{i=1}^{n_e} n_i d_e t_i + \sum_{j=1}^{n_d} \frac{s_j^2}{4 g_j} t_j \tag{7.6.7}$$

$$g_{ab} = \left(g_a - ½ t_w\right) + \left(g_b - ½ t_f\right); \quad t = ½ (t_f + t_w) \tag{7.6.8}$$

$$A_n \leq 0.85 A_g \tag{7.6.9}$$

$$A_e = U A_n \tag{7.7.1}$$

$$U = \min \left[\left(1 - \frac{\bar{x}_{\text{con}}}{L_{\text{con}}} \right); \; 0.90 \right] \tag{7.7.2}$$

$$T_{dbs} = T_{fnt} + \min [T_{ygv}, T_{fnv}] \quad \text{if} \quad T_{fnt} \geq T_{fnv} \tag{7.8.1}$$

$$T_{dbs} = T_{fnv} + \min [T_{ygt}, T_{fnt}] \quad \text{if} \quad T_{fnv} > T_{fnt} \tag{7.8.2}$$

$$T_{ygt} = \phi F_y A_{gt} \tag{7.8.3a}$$

$$T_{fnt} = \phi F_u A_{nt} \qquad (7.8.3b)$$

$$T_{ygv} = \phi (0.6 F_y) A_{gv} \qquad (7.8.3c)$$

$$T_{fnv} = \phi (0.6 F_u) A_{nv} \qquad (7.8.3d)$$

$$A_{nt} = A_{gt}; \quad A_{nv} = A_{gv} \qquad (7.8.4)$$

$$\frac{L}{r_{\min}} \leq 300 \qquad (7.9.1)$$

$$T_{d1} \geq T_u; \quad T_{d2} \geq T_u; \quad T_{d3} \geq T_u; \quad T_{d4} \geq T_u \qquad (7.10.2)$$

$$A_{g1} = \frac{T_u}{0.9 F_y} \qquad (7.10.3)$$

$$A_{g2} = \frac{T_u}{0.75 F_u U} + \text{estimated loss in area due to bolt holes} \qquad (7.10.5)$$

$$A_g \geq \max [A_{g1}; \; A_{g2}] \qquad (7.10.6)$$

$$r_{\min} \geq \frac{L}{300} \qquad (7.10.7)$$

$$N \geq \frac{T_u}{B_d} \qquad (7.10.8)$$

$$L_{tp} \geq \frac{2}{3} G; \qquad t_{tp} \geq \frac{G}{50}; \qquad s \leq 6 \text{ in.}$$

$$(7.11.1)$$

$$S_{tp} \leq 300\, r_{\min}; \qquad W_{tp} \geq G + 2 L_{eh}$$

$$T_{d\mathrm{R}} = 0.75 (0.75 F_u) A_{\mathrm{R}} \qquad (7.12.10)$$

$$P_y = A F_y \qquad (8.1.2)$$

$$P_E = P_{cr1} = \frac{\pi^2 EI}{L^2} \qquad (8.4.14)$$

$$P_{Ex} = \frac{\pi^2 EI_x}{L_x^2}; \quad P_{Ey} = \frac{\pi^2 EI_y}{L_y^2} \tag{8.4.19}$$

$$P_E = \min\left[P_{Ex}, \quad P_{Ey}\right] \tag{8.4.20}$$

$$P_e = \frac{\pi^2 EI}{(KL)^2} \tag{8.5.1}$$

$$G = \frac{\Sigma_c (E_c I_c)/L_c}{\Sigma_g (E_g I_g)/L_g} \quad \text{for a column in a braced or unbraced frame} \tag{8.5.2c}$$

$$G_{\mathrm{A}} = \frac{\dfrac{I_c}{L_c} + \dfrac{I_{c1}}{L_{c1}}}{\alpha_{g1}\dfrac{I_{g1}}{L_{g1}} + \alpha_{g2}\dfrac{I_{g2}}{L_{g2}}}, \quad G_{\mathrm{B}} = \frac{\dfrac{I_c}{L_c} + \dfrac{I_{c2}}{L_{c2}}}{\alpha_{g3}\dfrac{I_{g3}}{L_{g3}} + \alpha_{g4}\dfrac{I_{g4}}{L_{g4}}} \tag{8.5.7}$$

$$K = \frac{3G_{\mathrm{A}}G_{\mathrm{B}} + 1.4(G_{\mathrm{A}} + G_{\mathrm{B}}) + 0.64}{3G_{\mathrm{A}}G_{\mathrm{B}} + 2.0(G_{\mathrm{A}} + G_{\mathrm{B}}) + 1.28} \tag{8.5.8}$$

$$K = \frac{31.4\,G_{\mathrm{B}} + 14.6}{32.0\,G_{\mathrm{B}} + 21.3} \tag{8.5.10}$$

$$K = \frac{4.4\,G_{\mathrm{B}} + 2.04}{5.0\,G_{\mathrm{B}} + 3.28} \tag{8.5.12}$$

$$K = \frac{G + 0.4}{G + 0.8} \tag{8.5.13}$$

$$K = \sqrt{\frac{G_{\mathrm{A}}(1.6G_{\mathrm{B}} + 4.0) + (4G_{\mathrm{B}} + 7.5)}{G_{\mathrm{A}} + G_{\mathrm{B}} + 7.5}} \tag{8.5.14}$$

$$K = \sqrt{\frac{20.0\,G_{\mathrm{B}} + 47.5}{G_{\mathrm{B}} + 17.5}} \tag{8.5.16}$$

$$K = \sqrt{\frac{5.6 G_B + 11.5}{G_B + 8.5}} \tag{8.5.18}$$

$$K = \sqrt{0.8 G + 1.0} \tag{8.5. 19}$$

$$K = 0.75 + 0.25 \frac{P_1}{P_2} \tag{8.5.21}$$

$$P_{ex} = \frac{\pi^2 E I_x}{(K_x L_x)^2}, \quad P_{ey} = \frac{\pi^2 E I_y}{(K_y L_y)^2} \tag{8.5.22}$$

$$P_e = \min\left[P_{ex}, P_{ey}\right] \tag{8.5.23}$$

$$F_{ex} = \frac{\pi^2 E}{\left(\frac{K_x L_x}{r_x}\right)^2}, \quad F_{ey} = \frac{\pi^2 E}{\left(\frac{K_y L_y}{r_y}\right)^2} \tag{8.5.24}$$

$$F_e = \min\left[F_{ex}, F_{ey}\right] \tag{8.5.25}$$

$$K_m = K_o \sqrt{\frac{\Sigma P_i + \Sigma Q_j}{\Sigma P_i}} \tag{8.5.29}$$

$$K_{mi} = \sqrt{\frac{P_{Ei}}{P_{ui}} \frac{(\Sigma_i P_{ui} + \Sigma_j Q_{uj})}{\Sigma_i P_{eoi}}} \tag{8.5.30}$$

$$P_{cr} = P_t = \frac{\pi^2 E_t I}{L^2} \tag{8.6.1}$$

$$P_d \equiv \phi_c P_n \geq P_{\text{req}} = P_u \tag{8.7.1}$$

$$P_n = F_{cr} A_g \tag{8.7.2}$$

$$\lambda_c = \frac{K L}{r \pi} \sqrt{\frac{F_y}{E}} \tag{8.7.3}$$

$$P_d = \phi_c \left[0.658^{\lambda_c^2} \right] F_y A_g \quad \text{for } \lambda_c \le 1.5 \tag{8.7.6}$$

$$P_d = \phi_c \frac{0.877}{\lambda_c^2} F_y A_g \quad \text{for } \lambda_c > 1.5 \tag{8.7.7}$$

$$\lambda_c = \frac{KL/r}{\pi \sqrt{E/F_y}} = \sqrt{\frac{F_y}{F_e}} = \sqrt{\frac{P_y}{P_e}} \tag{8.7.8}$$

$$F_e = \frac{\pi^2 E}{(KL/r)^2} \tag{8.7.9}$$

$$F_{cr} = \left[0.658^{\frac{F_y}{F_e}} \right] F_y \quad \text{for } \frac{KL}{r} \le 4.71 \sqrt{\frac{E}{F_y}} \tag{8.7.10}$$

$$F_{cr} = 0.877 F_e \quad \text{for } \frac{KL}{r} > 4.71 \sqrt{\frac{E}{F_y}} \tag{8.7.11}$$

$$(K_x L_x)_y \equiv \frac{K_x L_x}{(r_x / r_y)} \tag{8.7.13}$$

$$G_i = \frac{\Sigma \left(E_t I/L \right)_c}{\Sigma (EI/L)_g} = \frac{E_t}{E} G_e = \tau G_e \tag{8.8.1}$$

$$\tau = 1.0 \quad \text{for } \frac{P_u}{P_y} \le \frac{1}{3} \tag{8.8.7a}$$

$$= -7.38 \left(\frac{P_u}{P_y} \right) \log \left(\frac{P_u}{\phi_c P_y} \right) \quad \text{for } \frac{P_u}{P_y} > \frac{1}{3} \tag{8.8.7b}$$

$$f_{cr} = \frac{\pi^2 E k_c}{12 (1 - \mu^2)(b/t)^2} \tag{8.9.2}$$

Single angle: $\rightarrow \lambda_{ra} = 0.45 \sqrt{E/F_y}$ (8.9.6*a*)

Flange half: $\rightarrow \lambda_{rf} = 0.56 \sqrt{E/F_y}$ (8.9.6*b*)

Stem of tee: $\rightarrow \lambda_{rs} = 0.75 \sqrt{E/F_y}$ (8.9.6*c*)

Web of an I- or C-shape: $\rightarrow \lambda_{rw} = 1.49 \sqrt{E/F_y}$ (8.9.7*a*)

Side of a tube: $\rightarrow \lambda_{rt} = 1.40 \sqrt{E/F_y}$ (8.9.7*b*)

$$M_y = \left(\frac{1}{6}bd^2\right)F_y = SF_y \qquad (9.2.7)$$

$$M_p = \frac{bd^2}{4}F_y = ZF_y \qquad (9.2.9)$$

$$M_{rx} = S_x(F_y - f_{rc}) \qquad (9.2.16)$$

$$M_{yx} = S_x F_y \qquad (9.2.17)$$

$$M_{px} = Z_x F_y \qquad (9.2.18)$$

$$A_t = A_c \qquad (9.2.19)$$

$$M_p = T_p e_p = (A_t \bar{y}_t + A_c |\bar{y}_c|)F_y = ZF_y \qquad (9.2.20)$$

$$\alpha = \frac{M_p}{M_y} = \frac{ZF_y}{SF_y} = \frac{Z}{S} \qquad (9.2.21)$$

$$\tau = \frac{VQ'}{Ib} = \frac{VA'\bar{y}'}{Ib} = \frac{q_{sv}}{b} \qquad (9.3.1)$$

$$f_v = \frac{V}{A_w} \qquad (9.3.2)$$

$\lambda_f \leq \lambda_{pf}$ and $\lambda_w \leq \lambda_{pw}$ for compact shapes (9.5.1)

$\lambda_f > \lambda_{rf}$ or $\lambda_w > \lambda_{rw}$ for slender-element section (9.5.2)

$$\lambda_{pf} = 0.38\sqrt{\frac{E}{F_y}}; \qquad \lambda_{pw} = 3.76\sqrt{\frac{E}{F_y}} \qquad (9.5.3)$$

$$\lambda_{rf} = 0.83\sqrt{\frac{E}{F_L}}; \qquad \lambda_{rw} = 5.70\sqrt{\frac{E}{F_y}} \qquad (9.5.4)$$

$$\lambda_w \leq \lambda_{pv} \qquad (9.5.5)$$

$$\lambda_{pv} = 2.45 \sqrt{\frac{E}{F_y}} \tag{9.5.6}$$

$$M_d \equiv \phi_b M_n = \min[\phi_b M_p;\ \phi_b (1.5) M_y] \tag{9.7.1}$$

$$M_{dx} = \phi_b M_{px} = \phi_b Z_x F_y \tag{9.7.2}$$

$$L_b \le L_p \tag{9.7.3}$$

$$L_p = 1.76\, r_y \sqrt{\frac{E}{F_y}} \tag{9.7.4}$$

$$\lambda_f \le \lambda_{pf}; \quad \lambda_w \le \lambda_{pw} \tag{9.7.5a,b}$$

$$M_{dy} = \phi_b M_n = \phi_b (1.5 S_y) F_y \tag{9.7.8}$$

$$V_d \equiv \phi_v V_n = \phi_v (0.6 F_y)\, d t_w \quad \text{for} \quad \lambda_w \le \lambda_{pv} \tag{9.7.9}$$

$$\lambda_{pv} = 2.45 \sqrt{\frac{E}{F_y}} \tag{9.7.10}$$

$$M^{-}_{\text{req}} = \frac{9}{10} M_2 \tag{9.7.11}$$

$$M^{+}_{\text{req}} = M_3 + \frac{1}{10} \left| \frac{M_1 + M_2}{2} \right| \tag{9.7.12}$$

$$Z_{x\,\text{req}} \ge \frac{12\, M_u}{\phi_b F_y} \tag{9.7.18}$$

$$N_1 = \frac{R_u - \phi R_1}{\phi R_2} \tag{9.9.2}$$

$$\phi R_1 = \phi (2.5\, k t_w F_{yw}); \quad \phi R_2 = \phi\, t_w F_{yw} \tag{9.9.3}$$

$$N_2 = \frac{R_u - \phi_r R_3}{\phi_r R_4} \qquad \text{when} \quad \frac{N}{d} \le 0.2 \tag{9.9.6}$$

$$N_2 = \frac{R_u - \phi_r R_5}{\phi_r R_6} \qquad \text{when} \quad \frac{N}{d} > 0.2 \tag{9.9.7}$$

$$\phi_r R_3 = 0.75 \left[0.4 t_w^2 \sqrt{\frac{t_f}{t_w} E F_{yw}} \right] \tag{9.9.8a}$$

$$\phi_r R_4 = 0.75 \left[0.4 t_w^2 \left(\frac{3}{d} \right) \left(\frac{t_w}{t_f} \right) \sqrt{\frac{t_f}{t_w} E F_{yw}} \right] \tag{9.9.8b}$$

$$\phi_r R_5 = 0.75 \left[0.4 t_w^2 \left\{ 1 - 0.2 \left(\frac{t_w}{t_f} \right)^{1.5} \right\} \sqrt{\frac{t_f}{t_w} E F_{yw}} \right] \tag{9.9.8c}$$

$$\phi_r R_6 = 0.75 \left[0.4 t_w^2 \left(\frac{4}{d} \right) \left(\frac{t_w}{t_f} \right) \sqrt{\frac{t_f}{t_w} E F_{yw}} \right] \tag{9.9.8d}$$

$$N \ge \max\left[N_1;\ N_2;\ k;\ 3\,\text{in.} \right] \tag{9.9.9}$$

$$R_{dp} \equiv \phi_c R_{np} = \phi_c F_p A_1 = \phi_c (0.85 f_c' \beta) B N \tag{9.9.10}$$

$$\beta = \min\,[\sqrt{\rho}\,,\ 2]; \qquad \rho = \frac{A_2}{A_1} \tag{9.9.11a, b}$$

$$B \ge \frac{R_u}{\phi_c (0.85 f_c' \beta) N} \tag{9.9.12}$$

$$t \ge \sqrt{\frac{2 n^2 R_u}{\phi_b B N F_{ypl}}} \tag{9.9.13}$$

$$t_f \geq \sqrt{\frac{2\,n_f^2\,R_u}{\phi_b\,b_f\,N\,F_{yf}}} \tag{9.9.14}$$

$$P_{dp} = \phi_c\,F_p\,A_1 = \phi_c(0.85\,f_c{}'\,\beta)\,BN \tag{9.10.1}$$

$$\beta = \min\,[\sqrt{\rho}\,,\ 2]; \qquad \rho = \frac{A_2}{A_1} \tag{9.10.2a, b}$$

$$A_2 = (B + 2e)(N + 2e); \qquad e = \min(e_1,\ e_2,\ e_3,\ e_4) \tag{9.10.2c, d}$$

$$m = \frac{(N - 0.95\,d)}{2}, \qquad n = \frac{(B - 0.80\,b_f)}{2} \tag{9.10.4}$$

$$t_1 \geq m\sqrt{\frac{2\,P_u}{\phi_b\,F_{ypl}\,B\,N}} \tag{9.10.7}$$

$$t_2 \geq n\sqrt{\frac{2\,P_u}{\phi_b\,F_{ypl}\,B\,N}} \tag{9.10.8}$$

$$t_3 \geq n^*\sqrt{\frac{2\,P_u}{\phi_b\,F_{ypl}\,B\,N}} \tag{9.10.9}$$

$$n^* = \lambda\,n'; \qquad n' = \frac{1}{4}\sqrt{b_f\,d}$$

$$\lambda = \min\left[\frac{2\,\sqrt{x}}{1 + \sqrt{1 - x}};\ \ 1\right] \tag{9.10.10}$$

$$x = \left[\frac{4\,b_f\,d}{(b_f + d)^2}\right]\frac{P_u}{P_{dp}}$$

$$t \geq \max\,[t_1,\ t_2,\ t_3] \tag{9.10.11}$$

$$M_{cr}^{o} = \frac{\pi}{L}\sqrt{EI_y\,GJ}\,\sqrt{1 + \frac{\pi^2}{L^2}\,\frac{EC_w}{GJ}} \tag{10.2.34}$$

$$M_{cr} = C_b\left(\frac{\pi}{K_b\,L_b}\right)\sqrt{EI_y\,GJ}\,\sqrt{1 + \frac{\pi^2}{(K_b\,L_b)^2}\,\frac{EC_w}{GJ}} \tag{10.2.40}$$

$$M_{cr} = C_b\left(\frac{\pi}{K_b\,L_b}\right)^2\sqrt{EI_y\,E\,C_w}\,\sqrt{1 + \frac{(K_b\,L_b)^2}{\pi^2}\,\frac{GJ}{EC_w}} \tag{10.2.41}$$

$$L_r = \frac{r_y\,X_1}{(F_y - F_r)}\sqrt{1 + \sqrt{1 + X_2(F_y - F_r)^2}} \tag{10.3.2}$$

$$X_1 = \frac{\pi}{S_x}\sqrt{\frac{EAGJ}{2}}; \qquad X_2 = \frac{4\,C_w}{I_y}\left(\frac{S_x}{GJ}\right)^2 \tag{10.3.3}$$

$$L_p = 1.76\,r_y\sqrt{\frac{E}{F_y}} \tag{10.3.7}$$

$$M_d \equiv \phi_b\,M_n \geq M_u \tag{10.4.1}$$

$$M_d = \phi_b\,M_{px} = \phi_b\,Z_x\,F_y \qquad \text{for } L_b \leq L_p \tag{10.4.5}$$

$$M_d = M_{dI} = \min\,[C_b\,M_{dI}^{o};\ \phi_b\,M_{px}] \qquad \text{for } L_p < L_b \leq L_r \tag{10.4.6}$$

$$M_{dI}^{o} = \phi_b\,M_{px} - (\phi_b\,M_{px} - \phi_b\,M_{rx})\,\frac{(L_b - L_p)}{(L_r - L_p)} \tag{10.4.7}$$

$$= \phi_b\,M_{px} - BF\,(L_b - L_p) \tag{10.4.8}$$

$$BF = \frac{(\phi_b M_{px} - \phi_b M_{rx})}{(L_r - L_p)} \tag{10.4.9}$$

$$M_r = S_x F_L = S_x (F_y - F_r) \tag{10.4.10}$$

$$M_d = M_{dE} = \min [\, C_b M^o_{dE} ; \;\; \phi_b M_{px} \,] \quad \text{for} \quad L_b > L_r \tag{10.4.11}$$

$$M^o_{dE} = \phi_b M^o_{cr} \tag{10.4.12}$$

$$M^o_{cr} = \frac{\pi}{L_b} \sqrt{EI_y GJ + \frac{\pi^2}{L_b^2} EC_w EI_y} \tag{10.4.13a}$$

$$= \frac{S_x X_1 \sqrt{2}}{L_b / r_y} \sqrt{1 + \frac{X_1^2 X_2}{2 (L_b / r_y)^2}} \tag{10.4.13b}$$

$$C_b = \frac{12.5 M_{\max}}{2.5 M_{\max} + 3 M_{\mathrm{A}} + 4 M_{\mathrm{B}} + 3 M_{\mathrm{C}}} \tag{10.4.14}$$

$$r_M = \pm \frac{|M_1|}{|M_2|} \tag{10.4.15}$$

$$L_p^* = L_p + (C_b - 1) \frac{\phi_b M_{px}}{BF} \quad \leq \quad L_r \tag{10.4.16}$$

$$C_b^* = \frac{\phi_b M_{px}}{\phi_b M_{rx}} \tag{10.4.17}$$

$$\min [\, C_b M^o_d ; \;\; \phi_b M_{px} \,] \quad \geq \quad M_u \tag{10.4.18}$$

$$M^o_d \quad \geq \quad \frac{M_u}{C_b} \quad \equiv \quad M^o_{ueq} \tag{10.4.19a}$$

$$\phi_b M_{px} \geq M_u \tag{10.4.19b}$$

$$A_{fe} = \frac{5}{6}\frac{F_u}{F_y}A_{fn} \tag{10.5.1}$$

$$M_d = \phi_b S_{xe} F_y \tag{10.5.2}$$

$$S_{xe} = \frac{I_{xe}}{d_b/2} \quad \text{where} \quad I_{xe} = I_x - 2(A_{fg} - A_{fe})\bar{y}_h^2 \tag{10.5.3}$$

$$M_d \equiv \phi_b M_n = \phi_b M_{px} - (\phi_b M_{px} - \phi_b M_{rx})\frac{(\lambda - \lambda_p)}{(\lambda_r - \lambda_p)} \quad \text{for} \quad \lambda_p < \lambda \leq \lambda_r \tag{10.5.4}$$

$$\lambda = \lambda_f = \frac{b_f}{2t_f}; \quad \lambda_{pf} = 0.38\sqrt{\frac{E}{F_y}}; \quad \lambda_{rf} = 0.83\sqrt{\frac{E}{F_L}} \tag{10.5.5}$$

$$\lambda = \lambda_w = \frac{h}{t_w}; \quad \lambda_{pw} = 3.76\sqrt{\frac{E}{F_y}}; \quad \lambda_{rw} = 5.70\sqrt{\frac{E}{F_y}} \tag{10.5.6}$$

$$M_d = \min[M_{d,LTB};\ M_{d,FLB};\ M_{d,WLB}] \tag{10.5.7}$$

$$M_d = \min[M_{d,LTB};\ M_{d,FLB}] \tag{10.5.8}$$

$$L_p' = L_p + \frac{(\phi_b M_{px} - M_{dFLB})}{BF} \tag{10.5.9}$$

$$M_{ccrE}^o = \sqrt{\frac{(I_x + I_y)}{A}(P_{Ey} - P)(P_{Ez} - P)} \tag{11.4.1}$$

$$P_{Ey} = \frac{\pi^2 E I_y}{L^2}; \quad P_{Ez} = \frac{1}{\bar{r}_o^2}\left[\frac{\pi^2 E C_w}{L^2} + GJ\right] \tag{11.4.2}$$

$$M^o_{crE} = \sqrt{\frac{\pi^2 E I_y}{L^2}\left(\frac{\pi^2}{L^2} E C_w + G J\right)} = \sqrt{\frac{(I_x + I_y)}{A} P_{Ey} P_{Ez}} \tag{11.4.3}$$

$$M^o_{ccrE} = \sqrt{\left(1 - \frac{P}{P_{Ey}}\right)\left(1 - \frac{P}{P_{Ez}}\right)} \tag{11.4.4}$$

$$\frac{P_u}{\phi_c P_n} + \frac{8}{9}\left[\frac{M_{ux}}{\phi_b M_{nx}} + \frac{M_{uy}}{\phi_b M_{ny}}\right] \leq 1 \quad \text{for} \quad \frac{P_u}{\phi_c P_n} \geq 0.2 \tag{11.9.1a}$$

$$\frac{1}{2}\frac{P_u}{\phi_c P_n} + \frac{M_{ux}}{\phi_b M_{nx}} + \frac{M_{uy}}{\phi_b M_{ny}} \leq 1 \quad \text{for} \quad \frac{P_u}{\phi_c P_n} < 0.2 \tag{11.9.1b}$$

$$M_u = M_u^* \tag{11.9.2}$$

$$M_u \equiv M_u^* = B_1 M_{nt} + B_2 M_{lt} \tag{11.9.3}$$

$$B_1 = \max\left[\frac{C_m}{1 - \frac{P_u}{P_{e1}}}, \ 1.0\right] \tag{11.9.4}$$

$$P_{e1} = \frac{\pi^2 E I}{(K L)^2_{nt}} = \frac{\pi^2 E A}{(K L/r)^2_{nt}} = F_e A \tag{11.9.5}$$

$$C_m = 0.6 - 0.4 r_M \tag{11.9.6}$$

$$r_M = \pm \frac{|M_1|}{|M_2|}; \quad -1.0 \leq r_M \leq +1.0 \tag{11.9.7a, b}$$

$$B_2 = \frac{1}{1 - \frac{\Delta_{oh}}{L}\frac{\sum_{i=1}^{n} P_{ui}}{\sum_{j=1}^{m} H_j}} \tag{11.9.8}$$

$$B_2 = \frac{1}{1 - \dfrac{\sum_{i=1}^{n} P_{ui}}{\sum_{i=1}^{n} P_{e2i}}} \tag{11.9.9}$$

$$P_{e2} = \frac{\pi^2 EI}{(KL)_{lt}^2} = \frac{\pi^2 EA}{(KL/r)_{lt}^2} = F_e A \tag{11.9.10}$$

$$\frac{P_u}{P_d} + \frac{8}{9}\left[\frac{M_{ux}^*}{M_{dx}} + \frac{M_{uy}^*}{M_{dy}}\right] \le 1.0 \quad \text{for} \quad \frac{P_u}{P_d} \ge 0.2 \tag{11.9.11a}$$

$$\frac{1}{2}\frac{P_u}{P_d} + \frac{M_{ux}^*}{M_{dx}} + \frac{M_{uy}^*}{M_{dy}} \le 1.0 \quad \text{for} \quad \frac{P_u}{P_d} < 0.2 \tag{11.9.11b}$$

$$\lambda_{pw} = \lambda_{pwb}\left[1 - 2.75\frac{P_u}{\phi_b P_y}\right] \quad \text{for} \quad \frac{P_u}{\phi_b P_y} \le 0.125 \tag{11.10.4}$$

$$= \left[1.12\sqrt{\frac{E}{F_y}}\left(2.33 - \frac{P_u}{\phi_b P_y}\right);\ \lambda_{rwc}\right] \quad \text{for} \quad \frac{P_u}{\phi_b P_y} > 0.125 \tag{11.10.5}$$

$$\lambda_{rw} = \lambda_{rwb}\left[1 - 0.74\frac{P_u}{\phi_b P_y}\right] \tag{11.10.6}$$

$$\lambda_{pwb} = 3.76\sqrt{\frac{E}{F_y}};\quad \lambda_{rwb} = 5.70\sqrt{\frac{E}{F_y}};\quad \lambda_{rwc} = 1.49\sqrt{\frac{E}{F_y}} \tag{11.10.7a,b,c}$$

$$\frac{T_u}{T_d} + \frac{8}{9}\left[\frac{M_{ux}}{M_{dx}} + \frac{M_{uy}}{M_{dy}}\right] \le 1 \quad \text{for} \quad \frac{T_u}{T_d} \ge 0.2 \tag{11.12.1a}$$

$$\frac{1}{2}\frac{T_u}{T_d} + \left[\frac{M_{ux}}{M_{dx}} + \frac{M_{uy}}{M_{dy}}\right] \leq 1 \quad \text{for} \quad \frac{T_u}{T_d} < 0.2 \tag{11.12.1b}$$

$$P_u + m M^*_{ux} + m u M^*_{uy} \leq P_d \tag{11.14.2}$$

$$P_{ueq} \leq P_d \tag{11.14.3}$$

$$m = \frac{8}{9}\frac{P_d}{M_{dx}} = \frac{8}{9}\frac{\phi_c P_n}{\phi_b M_{nx}}, \qquad u = \frac{M_{dx}}{M_{dy}} = \frac{M_{nx}}{M_{ny}} \tag{11.14.4}$$

$$P_{ueq} = P_u + m M^*_{ux} + m u M^*_{uy} \tag{11.14.5a}$$

$$P_{ueq} = \frac{1}{2} P_u + \frac{9}{8} m M^*_{ux} + \frac{9}{8} m u M^*_{uy} \tag{11.14.5b}$$

$$b P_u + m M^*_{ux} + n M^*_{uy} \leq 1.0 \quad \text{for} \quad b P_u \geq 0.2 \tag{11.14.10a}$$

$$\frac{1}{2} b P_u + \frac{9}{8} m M^*_{ux} + \frac{9}{8} n M^*_{uy} \leq 1.0 \quad \text{for} \quad b P_u < 0.2 \tag{11.14.10b}$$

$$b = \frac{1}{P_d} = \frac{1}{\phi_c P_n} \tag{11.14.11}$$

$$m = \frac{8}{9}\frac{1}{M_{dx}} = \frac{8}{9}\frac{1}{\phi_b M_{nx}} \tag{11.14.12}$$

$$n = \frac{8}{9}\frac{1}{M_{dy}} = \frac{8}{9}\frac{1}{\phi_b M_{ny}} \tag{11.14.13}$$

$$\frac{M_{ux}}{\phi_b M_{nx}} + \frac{M_{uy}}{\phi_b M_{ny}} = 0 \quad \rightarrow \quad \frac{M_{ux}}{M_{dx}} + \frac{M_{uy}}{M_{dy}} = 0 \tag{11.16.2}$$

$$\frac{9}{8} m M_{ux} + \frac{9}{8} n M_{uy} \leq 1.0 \tag{11.16.3}$$

$$Q_f = \frac{M_T}{y_S} \tag{11.16.4}$$

$$Q_f = \frac{M_T}{h_o} \tag{11.16.5}$$

$$\frac{M_{ux}}{M_{dx}} + \frac{M_{uf}}{½\, M_{dy}} = 0 \quad \rightarrow \quad \frac{M_{ux}}{M_{dx}} + \frac{2\, M_{uf}}{M_{dy}} = 0 \tag{11.16.6}$$

$$M_{ux} = \frac{1}{8} q_{uy} L^2; \quad M_{uf} = \frac{1}{8} q_{ux} L^2 \tag{11.16.7}$$

$$M_{ux} = \frac{1}{8} q_{uy} L^2; \quad M_{uf} = \frac{1}{32} q_{ux} L^2 \tag{11.16.8}$$

$$M_{ux} = \frac{1}{8} q_{uy} L^2; \quad M_{uf} = \frac{1}{90} q_{ux} L^2 \tag{11.16.9}$$

$$\bar{x}' = \frac{\Sigma A_{bi}\, x_i'}{\Sigma A_{bi}}; \quad \bar{y}' = \frac{\Sigma A_{bi}\, y_i'}{\Sigma A_{bi}} \tag{12.2.1}$$

$$\bar{x}' = \frac{\Sigma x_i'}{N}; \quad \bar{y}' = \frac{\Sigma y_i'}{N} \tag{12.2.2}$$

$$p \leq \frac{n B_d}{q_{sv}} = \frac{n B_d I}{V A' \bar{y}'} \tag{12.3.2}$$

$$B_{xD} = \frac{P_x}{N}; \quad B_{yD} = \frac{P_y}{N} \tag{12.4.1}$$

$$B_{xT}^* = \frac{M_T(-y^*)}{\Sigma r_i^2}; \quad B_{yT}^* = \frac{M_T x^*}{\Sigma r_i^2} \tag{12.4.8}$$

$$B_x^* = B_{xD} + B_{xT}^* \tag{12.4.9a}$$

$$B_y^* = B_{yD} + B_{yT}^* \tag{12.4.9b}$$

$$\Sigma r_i^2 = \Sigma x_i^2 + \Sigma y_i^2 \tag{12.4.10}$$

$$B^* = \sqrt{(B_x^*)^2 + (B_y^*)^2} \tag{12.4.11}$$

$$B^* \leq B_d \tag{12.4.12}$$

$$P_d = C B_d \tag{12.4.13}$$

$$N_1 \geq \frac{P_{uy}}{B_{dv}} \tag{12.6.1}$$

$$N_2 \geq \frac{P_{uz}}{B_{dt}} \tag{12.6.2}$$

$$N_3 \geq \frac{P_{uz} + C_2 P_{uy}}{C_1} \tag{12.6.3}$$

$$N \geq \max\left[N_1;\ N_2;\ N_3\right] \tag{12.6.4}$$

$$\frac{b_e \bar{y}^2}{2} = \sum_{i=k}^{n} n_r A_b (d_i - \bar{y}) \tag{12.7.7}$$

$$I = \frac{b_e \bar{y}^3}{3} + \sum_{i=k}^{n} (n_r A_b)(d_i - \bar{y})^2 \tag{12.7.8}$$

$$P_{els1} = \frac{B_{dt}' I}{A_b c_n e_z} \tag{12.7.9b}$$

$$P_{dels2} = \frac{\phi F_{bp} I}{\bar{y}} \tag{12.7.10b}$$

$$P_{dels} = \min[P_{dels1};\ P_{dels2}] \tag{12.7.11b}$$

$$b_e \bar{y}_p F_{bp} = n_r \sum_{i=j}^{n} B_{nt}' \tag{12.7.12}$$

$$P_{dpls} = \left[\frac{1}{2} b_e \bar{y}_p^2 \phi F_{bp} + \sum_{i=j}^{n} n_r B_{dt}' (d_i - \bar{y}_p)\right] / e_z \tag{12.7.13}$$

$$B_{tu} = \frac{P_u e_z}{n' d_m}; \quad B_{vu} = \frac{P_u}{N} \tag{12.7.14, 15}$$

$$B_{tu} = B_{dt}'; \quad B_{vu} \le B_{dv} \tag{12.7.16}$$

$$L_{\text{req}} = \frac{T_u}{W_d} \tag{12.8.1}$$

$$L_1 + L_2 + 1.5c = L_{\text{req}} \tag{12.8.7b}$$

$$L_1 = \frac{\bar{y}}{c} L_{\text{req}} - \frac{1.5c}{2} \tag{12.8.8b}$$

$$L_2 = \frac{c - \bar{y}}{c} L_{\text{req}} - \frac{1.5c}{2} \tag{12.8.9b}$$

$$2W_d \ge q_{sv} = \frac{VQ'}{I} = \frac{VA'\bar{y}'}{I} \tag{12.8.10}$$

$$p_{iw} \le \frac{\left(2W_d L_{iw}\right)I}{(A' \bar{y}')V} \tag{12.8.11}$$

$$A = t_e L \equiv t_e A_l \tag{12.9.7a}$$

$$I_{pli} = \frac{1}{12} b_i^3 + b_i(\bar{x}_i^2 + \bar{y}_i^2) \text{ for a weld segment parallel to } x\text{-axis} \tag{12.9.7d}$$

$$I_{pli} = \frac{1}{12} d_i^3 + d_i(\bar{x}_i^2 + \bar{y}_i^2) \text{ for a weld segment parallel to } y\text{-axis} \tag{12.9.7e}$$

$$W_{xD} = \frac{P_x}{A_l}; \quad W_{yD} = \frac{P_y}{A_l} \tag{12.9.9}$$

$$W_{xT}^* = \frac{M_T(-y^*)}{I_{pl}}; \quad W_{yT}^* = \frac{M_T x^*}{I_{pl}} \tag{12.9.10}$$

$$W^* = \sqrt{(W_{xD} + W_{xT}^*)^2 + (W_{yD} + W_{yT}^*)^2} \tag{12.9.11}$$

$$W_{\text{req}} = W_u^* \leq W_d \quad (12.9.12)$$

$$P_u = \phi R_n = C C_1 D l \quad (12.9.13)$$

$$W_{uy} = \frac{P_{uy}}{2L}; \quad W_{uz} = \frac{P_{uz}}{2L} \quad (12.10.1)$$

$$W_u = \sqrt{W_{uy}^2 + W_{uz}^2} \quad (12.10.2)$$

$$W_d \geq W_{\text{req}} = W_u \quad (12.10.3)$$

$$W_y = \frac{P}{A_l}; \quad W_z^* = \frac{M_x}{I_{xl}} c = \frac{M_x}{S_{xl}} \quad (12.11.6)$$

$$W^* = \sqrt{(W_y)^2 + (W_z^*)^2} \quad (12.11.7)$$

$$W_{\text{req}} = W^* \leq W_d \quad (12.11.8)$$

$$L_{WM} = a + 2 b \sin 30^o \quad (12.14.1)$$

$$\sum_{i=1}^{N} B_{ix} = 0 \quad (12.15.1)$$

$$\sum_{i=1}^{N} B_{iy} - V_o = 0 \quad (12.15.2)$$

$$\sum_{i=1}^{N} B_i r_i - [V_o(e_o + r_o) + (M_o - F_f d_s)] = 0 \quad (12.15.3)$$

$$\sum_{i=1}^{N} B_i r_i - [V_o(e_o + r_o)] = 0 \quad (12.15.4)$$

$$\sum_{i=1}^{N} B_i r_i - [V_o(e^* + r_o)] = 0; \quad \text{with} \quad e^* = e_o + \frac{(M_o - F_f d_s)}{V_o} \quad (12.15.5, 6)$$

$$P_{dp} \equiv \phi P_n = 0.75[1.8 F_y A_{pb}] \quad (12.16.1)$$