The following calculation procedure is produced by sCheck - Computations & Graphics, Inc.

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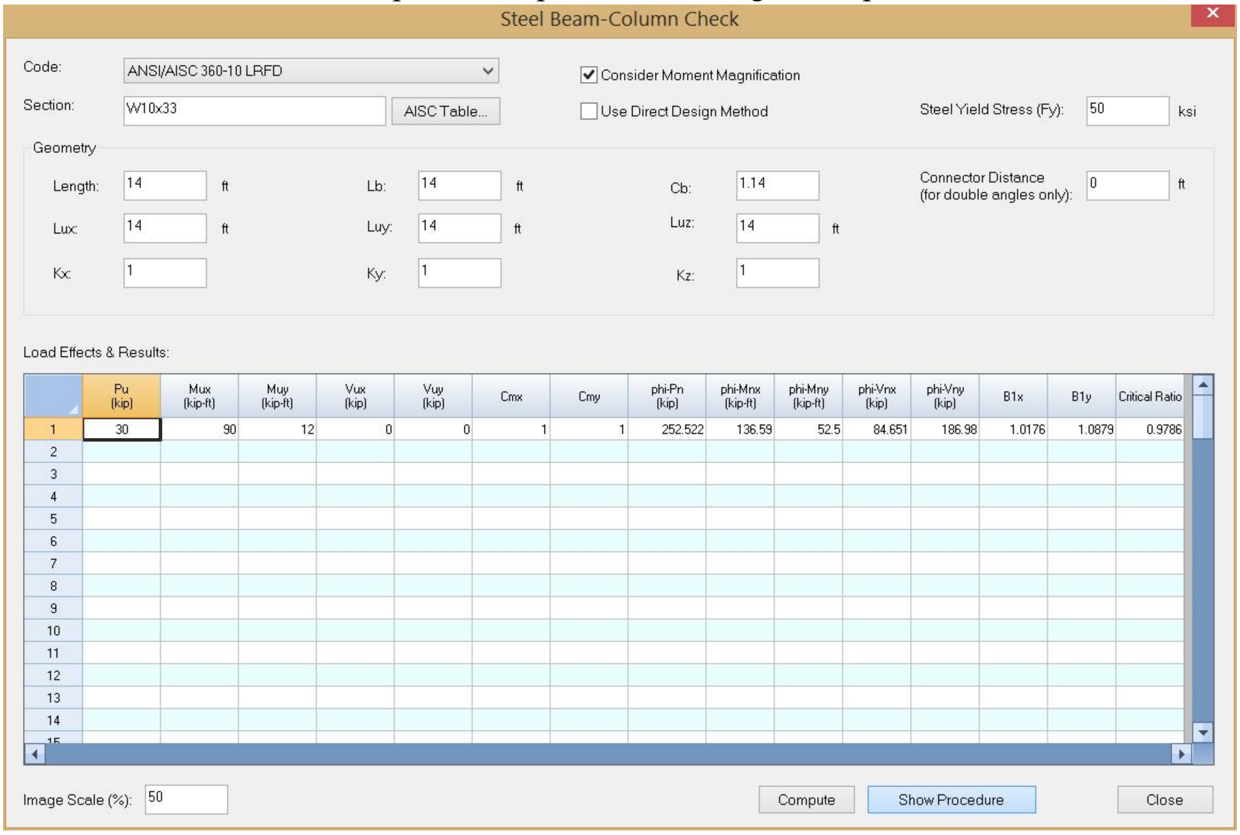
file: C:\CGInc\sCheck\examples\Example05-AiscDesignExamples-H4.sck



W10x33 - using AISC 360-10 LRFD Method

Section Input

Section W10X33

A = Ag = 9.71 in^2; bf = 7.96 in; tf = 0.435 in; tw = 0.29 in; d = 9.73 in; h / tw = 27.1 ; Cw = 791 in^6; h0 = 9.3 in; rts = 2.2 in;

Zx = 38.8 in^3; Sx = 35 in^3; Ix = 171 in^4; rx = 4.19 in; Zy = 14 in^3; Sy = 9.2 in^3; Iy = 36.6 in^4; ry = 1.94 in; J = 0.583 in^4;

Using Effective Length Method; Consider Multiplier B1 for P-δ Effect

Pu = Pr = 30 kips; Mux = Mxr = 90 kip-ft; Muy = Myr = 12 kip-ft; Cmx = 1 ; Cmy = 1 ; Vux = 0 kips; Vuy = 0 kips;

Fy = 50 ksi; Cb = 1.14 ; Lb = 14 ft; Kx = 1 ; Ky = 1 ; Kz = 1 ; Lx = 14 ft; Ly = 14 ft; Lz = 14 ft;

Axial Capacity Calculation

b = bf / 2

Unstiffened b / tf = 9.14943

$$0.56\sqrt{\frac{E}{F_y}}$$

= 13.4866

$$\frac{b}{t} \le 0.56\sqrt{\frac{E}{F_y}}$$

$$Q_s = 1.0 \qquad \text{(E7-4)}$$

= 1

Stiffened b / t = h / tw = 27.1

$$\lambda_r = 1.49\sqrt{\frac{E}{F_y}}$$

= 35.884

The section has non-slender stiffened element

Qa = 1

Compressive strength to account for Flexural Buckling

$$\frac{K_x L_x}{r_x}$$

= 40.0955

$$\frac{K_y L_y}{r_y}$$

= 86.5979

$$\frac{KL}{r} = \max\left(\frac{K_x L_x}{r_x}, \frac{K_y L_y}{r_y}\right)$$

= 86.5979

$$F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2} \qquad \text{(E3-4)}$$

= 38.1665 ksi

$$4.71\sqrt{\frac{E}{F_y}}$$

= 113.432

$$\frac{KL}{r} \leq 4.71\sqrt{\frac{E}{F_y}}$$

$$F_{cr} = \left[0.658^{\frac{F_y}{F_e}}\right]F_y \qquad \text{(E3-2)}$$

= 28.896 ksi

$$P_n = F_{cr} A_g \qquad \text{(E3-1)}$$

= 280.58 kips

Flexural Buckling Controls: Pn = 280.58 kips

$\phi_c P_n$

= 252.522 kips

<u>Moment Magnification Calculation</u>

Moment magnifier B1 for P-delta effects in local x direction

$$P_{e1} = \frac{\pi^2 EI *}{(K_1 L)^2} \qquad \text{(A-8-5)}$$

= 1734.1 kips

$$B_1 = \frac{C_m}{1 - \alpha P_r / P_{e1}} \geq 1 \qquad \text{(A-8-3)}$$

= 1.0176

Magnified Mux = Mux * B1 = 91.5844 kip-ft

Moment magnifier B1 for P-delta effects in local y direction

$$P_{e1} = \frac{\pi^2 EI *}{(K_1 L)^2} \qquad \text{(A-8-5)}$$

= 371.159 kips

$$B_1 = \frac{C_m}{1 - \alpha P_r / P_{e1}} \geq 1 \qquad \text{(A-8-3)}$$

= 1.08794

Magnified Muy = Muy * B1 = 13.0552 kip-ft

Mrx = Mux; Mry = Muy

<u>Major Flexural Capacity Calculation</u>

Web compactness:

$$\lambda = \frac{h_c}{t_w}$$

= 27.1

$$\lambda_{pw} = 3.76\sqrt{\frac{E}{F_y}}$$

= 90.5528

$$\lambda_{rw} = 5.70\sqrt{\frac{E}{F_y}}$$

= 137.274

Web is compact

Flange compactness:

$$\lambda = \frac{b_f}{2t_f}$$

= 9.14943

$$\lambda_{pf} = 0.38\sqrt{\frac{E}{F_y}}$$

= 9.15161

$$\lambda_{rf} = 1.0\sqrt{\frac{E}{F_y}}$$

= 24.0832

Flange is compact

Mnx to account for Yielding

$$M_n = M_p = F_y Z_x \qquad \text{(F2-1)}$$

= 161.667 kip-ft

Mnx to account for Flange Local Buckling

$$\lambda < \lambda_{pf}$$

$$M_n = M_p$$

= 161.667 kip-ft

Mnx to account for Lateral-Torsional Buckling

$$L_p = 1.76 r_y \sqrt{\frac{E}{F_y}} \qquad \text{(F2-5)}$$

= 6.85247 ft

For I section, c = 1

$$L_r = 1.95 r_{ts} \frac{E}{0.7F_y} \sqrt{\frac{Jc}{S_x h_o} + \sqrt{\left(\frac{Jc}{S_x h_o}\right)^2 + 6.76\left(\frac{0.7F_y}{E}\right)^2}} \qquad \text{(F2-6)}$$

= 21.7757 ft

$$M_n = M_p = F_y Z_x \qquad \text{(F2-1)}$$

= 161.667 kip-ft

Lp < Lb < Lr

$$M_n = C_b\left[M_p - \left(M_p - 0.7F_y S_x\right)\left(\frac{L_b - L_p}{L_r - L_p}\right)\right] \le M_p \qquad \text{(F2-2)}$$

= 151.767 kip-ft

Therefore Mnx = 151.767 kip-ft

$$M_{cx} = \phi_b M_{nx}$$

= 136.59 kip-ft

<u>Minor Flexural Capacity Calculation</u>

Mny to account for Yielding

$$M_n = M_p = F_y Z_y \le 1.6 F_y S_y \qquad \text{(F6-1)}$$

= 58.3333 kip-ft

Mny to account for Lateral-Torsional Buckling

$$\lambda < \lambda_{pf}$$

$$M_n = M_p$$

= 58.3333 kip-ft

Therefore Mny = 58.3333 kip-ft

$$M_{cy} = \phi_b M_{ny}$$

= 52.5 kip-ft

Flexural and Axial Interaction Calculation

$$\frac{P_r}{P_c} = \frac{P_u}{\phi_c P_n}$$

= 0.118802

$$\frac{P_r}{P_c} < 0.2$$

$$\frac{P_r}{2P_c} + \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \leq 1.0 \qquad \text{(H1-1b)}$$

= 0.978576

Axial-Flexural Strength: OK

Major Shear Capacity Calculation

$$A_w = dt_w$$

$$k_v = 5$$

$$h/t_w$$

= 27.1

$$2.24\sqrt{E/F_y}$$

= 53.9463

$$h/t_w \leq 2.24\sqrt{E/F_y}$$

$$C_v = 1.0 \qquad \text{(G2-2)}$$

$$V_n = 0.6F_y A_w C_v \qquad \text{(G2-1)}$$

= 84.651 kips

$$h/t_w \leq 2.24\sqrt{E/F_y}$$

$$\phi_v = 1.00$$

$$\phi_v V_n$$

= 84.651 kips

$$\frac{V_u}{\phi_v V_n}$$

= 0

Shear Strength (Major Axis): OK

Minor Shear Capacity Calculation

$A_w = 2b_f t_f$
$k_v = 1.2$
$h/t_w = b/t_f$
= 9.14943

$1.10\sqrt{k_v E / F_y}$
= 29.02

$1.37\sqrt{k_v E / F_y}$
= 36.1431

$h / t_w \leq 1.10\sqrt{k_v E / F_y}$
$C_v = 1.0$ (G2-3)
= 1

$V_n = 0.6 F_y A_w C_v$ (G2-1)
= 207.756 kips

$\phi_v = 0.90$
$\phi_v V_n$
= 186.98 kips

$$\frac{V_u}{\phi_v V_n}$$
= 0

Shear Strength (Minor Axis): OK