MEMBER REPORT FOR LIPPED CHANNEL SECTION

Design Provision used: AS/NZS 4600:2005

PROJECT DETAILS

Project Name:
Project ID:
Company:
Designer:
Client:
Project Notes:
Project Units: Metric

General member design information

Section Name: C10010
Shape: C-Section w/ Lips

Dimensions:
Height, \( h = 102 \text{ mm} \)
Web Thickness, \( W_t = 1 \text{ mm} \)
Top Flange Width, \( TFW = 51 \text{ mm} \)
Top Thickness, \( TFF = 1 \text{ mm} \)
Bottom Flange Width, \( BW = 51 \text{ mm} \)
Bottom Thickness, \( BFF = 1 \text{ mm} \)
Lip Depth, \( d = 12.5 \text{ mm} \)
Fillet Radius, \( r = 5 \text{ mm} \)

Properties:
Area, \( A = 216 \text{ mm}^2 \)
Moment of Inertia about the z-axis, \( I_z = 364000 \text{ mm}^4 \)
Moment of Inertia about the Y-Axis, \( I_y = 75500 \text{ mm}^4 \)
Plastic Section Modulus about the z-axis, \( Z_z = 9814.276 \text{ mm}^3 \)
Plastic Section Modulus about the Y-Axis, \( Z_y = 4181.596 \text{ mm}^3 \)
Torsion Constant, \( J = 71.9 \text{ mm}^4 \)
Warping Constant, \( I_w = 160000000 \text{ mm}^6 \)

Material properties:
Material Name: Australian/New Zealand Standard (AS/NZS) - AS/NZS 1594 - H300, HU300 - Standard
Modulus of Elasticity, \( E = 200000 \text{ mpa} \)
Yield Strength, \( F_y = 300 \text{ mpa} \)
Ultimate Tensile Strength, \( F_u = 400 \text{ mpa} \)

Flexural Buckling parameters:
Member length for flexural buckling, \( L = 3625 \text{ mm} \)
Length between braced points, \( L_b = 3625 \text{ mm} \)

Lateral Torsional Buckling parameters:
Coefficient for lateral-torsional buckling, \( C_S = 1 \)
End moment coefficient in interaction formula, \( C_{TF} = 1 \)
Bending coefficient dependent on moment gradient, \( C_b = 1 \)
Member length for Lateral Torsional Buckling, \( L = 3625 \text{ mm} \)

Design Internal Forces
Load Case:
Name = Worst Case Load Combination

For check axial strength:
Absolute Maximum Axial Force, $P = 56.4$ N

For check flexural strength about Z-Axis:
Absolute Maximum Major Bending Moment, $M_z = 40$ N-mm

For check flexural strength about Y-Axis:
Absolute Maximum Major Bending Moment, $M_y = 19470$ N-mm

For check shear strength Y-Axis:
Absolute Maximum Shear Force, $V_x = 0.01$ N

For check shear strength Z-Axis:
Absolute Maximum Shear Force, $V_y = 5.37$ N

For check interaction of combined compression and bending strength:
Axial Force, $P = 56.4$ N
Z-Axis Bending Moment, $M_z = 40$ N-mm
Y-Axis Bending Moment, $M_y = 19470$ N-mm

For check interaction of combined bending and shear strength:
Z-Axis Bending Moment, $M_z = 40$ N-mm
Y-Axis Bending Moment, $M_y = 19470$ N-mm
Shear Force, $V_x = 5.37$ N
Shear Force, $V_y = 0.01$ N

### BENDING CAPACITY

**Bending about Y-Axis**

$$M_{sy} = Z_{sy} F_p$$

$$M_{sy} = (2033.16) (300) = 609948 \text{ N-mm}$$

Calculate Nominal flexural strength about Y-Axis ($M_{sy}$)

Design Flexural Strength = $M_{sy} \phi_s = (609948) (0.9) = 548953.2 \text{ N-mm}$

$$\frac{M_s}{\text{Design Flexural Strength}} = \frac{19470}{548953.2} = 0.035 \leq 1.0$$

**Bending about Z-Axis**

$$M_{sz} = Z_{sz} F_p$$

$$M_{sz} = (811.98) (300) = 1832339 \text{ N-mm}$$

Calculate Nominal flexural strength about Z-Axis ($M_{sz}$)

Design Flexural Strength = $M_{sz} \phi_s = (1832339) (0.9) = 1649105.1 \text{ N-mm}$

$$\frac{M_s}{\text{Design Flexural Strength}} = \frac{40}{1649105.1} = 0 \leq 1.0$$

### FLEXURAL BUCKLING CAPACITY

Concentrically loaded compression members, fox (Section 3.4) Clause 3.3.3.2(14)

$$\frac{L_s}{r_e} = \frac{3625}{41.061} = 88.305$$

$$\frac{L_s}{r_s} = \frac{3625}{18.696} = 193.892$$
Since $\frac{L_y}{r_y} > \frac{L_z}{r_z}$, Euler buckling about the y-axis will control.

Determine controlling euler buckling

$$f_{cr} = \frac{\pi^2 E}{(l_y/r_y)^2} = \frac{\pi^2 (200000)}{((3625) / (18.696))^2} = 52.506 \text{ mpa}$$

Calculate Elastic Buckling Stress ($f_{cr}$)

$$\lambda = \sqrt{\frac{F_p}{F_{cr}}} = \sqrt{\frac{300}{52.506}} = 2.39$$

Calculate Slenderness factor ($\lambda$)

$$f_u = \left(0.877/(\lambda)^2\right) F_y = \left(0.877/(2.39)^2\right) 300 = 46.048 \text{ mpa}$$

Calculate Critical Stress ($f_u$)

$$N_c = A_f f_u = (216)(46.048) = 9946.27 N$$

Calculate Nominal axial strength ($N_v$)

$$Design Strength = N_v, f = (9946.27)(0.85) = 8454.329 N$$

$$\frac{N^*}{Design \ Strength} = \frac{56.4}{8454.329} = 0.007 \leq 1.0$$

**COMBINED AXIAL COMPRESSION AND BENDING CHECK**

$$\frac{N^*}{\phi_v N_v} + \frac{M^*_z}{\phi_v M_{z,v}} + \frac{M^*_y}{\phi_v M_{y,v}} = \frac{56.4}{0.85 (29748.108)} + \frac{1 (40)}{0.9 (1832339) (0.999)} + \frac{1 (19470)}{0.9 (609948) (0.994)} =$$

$$\frac{N^*}{\phi_v N_v} + \frac{M^*_z}{\phi_v M_{z,v}} + \frac{M^*_y}{\phi_v M_{y,v}} = \frac{56.4}{0.85 (41648.4)} + \frac{40}{0.9 (1832339)} + \frac{19470}{0.9 (609948)} = 0.037 \leq 1.0$$

**FLEXURAL TORSIONAL BUCKLING CAPACITY CHECK**

$$f_{m1} = \frac{1}{2} \left( f_{m2} + f_{m3} \right) - \sqrt{\left( f_{m2} + f_{m3} \right)^2 - 4 \beta f_{m2} f_{m3}} = \frac{1}{2} \left( f_{m2} + f_{m3} \right) - \sqrt{\left( f_{m2} + f_{m3} \right)^2 - 4 \beta f_{m2} f_{m3}}$$

$$\beta = 1 - \left( z_m / r_m \right)^2 = 1 - \left( -40.164 / 66.398 \right)^2 = 0.558$$

$$f_{m2} = \frac{\pi^2 E}{(l_{m2}/r_{m2})^2} = \frac{\pi^2 (200000)}{(3625/41.051)^2} = 253.14 \text{ mpa}$$

$$f_{m3} = \frac{G J_{min}}{A r_{m1}^2} \left( 1 + \frac{\pi^2 E f_{m}}{G J_{m1}} \right) = \frac{(80000)(71.9)}{(216)(60.398)^2} \left( 1 + \frac{\pi^2 (200000)(1600000000)}{(80000)(71.9)(3625)^2} \right) = 37.803 \text{ mpa}$$

Calculate Flexural-Torsional Buckling ($f_{m1}$).