

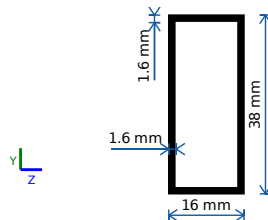
AS/NZS 1664 Aluminium Member Design



Input Summary

Input	Description	Value
<i>Label</i>	Member Label	Member 1
<i>Section Shape</i>	Section Shape	Hollow Rectangle
<i>Section Size</i>	Section Size	Custom
<i>Custom Material</i>	Custom Properties?	false
<i>Welded</i>	Welded	Welded
<i>Alloy</i>	Alloy	1100
<i>Temper</i>	Temper	H12
<i>Product</i>	Product	Sheet, plate
<i>D</i>	D Total height (or diameter) of section.	38 mm
<i>B</i>	B Total width of section.	16 mm
<i>t_f</i>	t_f Flange thickness, top/btm wall thickness (RHS/SHS).	1.6 mm
<i>t_w</i>	t_w Web thickness, or side wall thickness (RHS/SHS) or CHS thickness.	1.6 mm
<i>L_b</i>	L_b Length between bending restraints.	1200 mm
<i>L_z</i>	L_{z,comp} Distance between restraints for compression buckling about the Major Z axis.	1200 mm
<i>L_y</i>	L_{y,comp} Distance between restraints for compression buckling about the Minor Y axis.	1200 mm
<i>k_z</i>	k_z Effective length coefficient for buckling about the major Z axis.	1
<i>k_y</i>	k_y Effective length coefficient for buckling about the minor Y axis.	1
<i>M_z</i>	M[*]_z Major Axis Factored moment (About the Z-Axis). Positive value results in compression at top of section.	0.5 kN-m
<i>M_y</i>	M[*]_y Minor Axis Factored moment (About the Y-Axis). Positive value results in compression at right side of section.	0.25 kN-m
<i>V_y</i>	V[*]_y Major Axis Factored Shear (Y direction).	0.75 kN
<i>V_z</i>	V[*]_z Minor Axis Factored Shear (Z direction).	0.5 kN
<i>N_c</i>	N[*]_{comp} Factored Axial Compression.	5 kN
<i>N_t</i>	N[*]_{tension} Factored Axial Tension.	0 kN

Section Profile



Section Properties

Section Area	$A = 162.56\text{mm}^2$
Moment of Inertia (Z)	$I_z = 28208.86\text{mm}^4$
Moment of Inertia (Y)	$I_y = 6888.93\text{mm}^4$
Elastic Section Modulus (Compression Side, Z)	$Z_{z,c} = 1484.68\text{mm}^3$
Elastic Section Modulus (Tension Side, Z)	$Z_{z,t} = 1484.68\text{mm}^3$
Elastic Section Modulus (Compression Side, Y)	$Z_{y,c} = 861.12\text{mm}^3$

Elastic Section Modulus (Tension Side, Y)	$Z_{y,t} = 861.12\text{mm}^3$
First Moment of Area (Z)	$Q_z = 950.336\text{mm}^3$
First moment of Area (Y)	$Q_y = 503.296\text{mm}^3$
Radius of Gyration about Z	$r_z = 13.17\text{mm}$
Radius of Gyration about Y	$r_y = 6.51\text{mm}$
Torsion Constant	$J = 17306.69\text{mm}^4$

AS 1664.1 Table 3.3(A)	Material Properties	
	Material properties imported based on Welded 1100 - H12, Sheet, plate with material thickness of 1.6	
	Tensile Ultimate Strength	$F_{tu} = 76 \text{ MPa}$
	Tensile Yield Strength	$F_{ty} = 31 \text{ MPa}$
	Compressive Yield Strength	$F_{cy} = 31 \text{ MPa}$
	Shear Ultimate Strength	$F_{su} = 55 \text{ MPa}$
	Shear Yield Strength	$F_{sy} = 17 \text{ MPa}$
	Bearing Ultimate Strength	$F_{bu} = 158 \text{ MPa}$
	Bearing Yield Strength	$F_{by} = 55 \text{ MPa}$
	Modulus of Elasticity	$E = 70000 \text{ MPa}$
Coefficient for Tension Members	$k_t = 1$	
Coefficient for Compression Members	$k_c = 1$	

	Design Loads	
	Bending Stresses	
	Based on input M_z value, bending causes compression in the top of the section and M_y causes compression in the left of the section.	
	Bending stress about Z axis (Compression)	$\sigma_{z,comp} = \frac{M_z}{Z_{z,comp}} = \frac{500000}{1484.68} = 336.773\text{MPa}$
	Bending stress about Z axis (Tension)	$\sigma_{z,tens} = \frac{M_z}{Z_{z,tens}} = \frac{500000}{1484.68} = 336.773\text{MPa}$
	Bending stress about Y axis (Compression)	$\sigma_{y,comp} = \frac{M_y}{Z_{y,comp}} = \frac{250000}{861.12} = 290.32\text{MPa}$
	Bending stress about Y axis (Tension)	$\sigma_{y,tens} = \frac{M_y}{Z_{y,top}} = \frac{250000}{861.12} = 290.32\text{MPa}$
	Shear Stresses	
	Shear stress based on the max shear stress calculated for each principle axis	
	Shear stress along Z axis	$\tau_z = \frac{V_z Q_y}{I_y t} = \frac{500 \times 503.296}{6888.93 \times 3.2} = 11.415\text{MPa}$
Shear stress along Y Axis	$\tau_y = \frac{V_y Q_z}{I_z t} = \frac{750 \times 950.336}{28208.86 \times 3.2} = 7.896\text{MPa}$	
Axial Stresses		
Axial Compression	$\sigma_c = \frac{N_c}{A} = \frac{5000}{162.56} = 30.758\text{MPa}$	
Axial Tension	$\sigma_t = \frac{N_t}{A} = \frac{0}{162.56} = 0\text{MPa}$	

AS1664.1 Table 3.3(C)	Buckling Coefficients
	Buckling coefficients calculated to AS1664.1 Table 3.3(C) for a H12 temper
	Compression in columns and beam flanges

$$B_c = 33.078$$

$$D_c = 0.088$$

$$C_c = 250.405$$

Compression in flat plates

$$B_p = 37.716$$

$$D_p = 0.107$$

$$C_p = 234.503$$

Compression in round tubes under axial end load

$$B_t = 38.248$$

$$D_t = 0.845$$

Compressive bending stress in solid rectangular bars

$$B_{br} = 49.819$$

$$D_{br} = 0.163$$

$$C_{br} = 204.04$$

Compressive bending stress in round tubes

$$B_{tb} = 57.372$$

$$D_{tb} = 1.989$$

$$C_{tb} = 279.722$$

Shear stress in flat plates

$$B_s = 20.704$$

$$D_s = 0.044$$

$$C_s = 316.505$$

Strength Checks

Axial Tension

AS1664.1 Cl3.4.2

Check axial tension capacity

Capacity Factor
Capacity Factor

$$\phi_y = 0.95$$

$$\phi_u = 0.85$$

$$F_{Ly} = \phi_y F_{ty} = 29.45$$

$$F_{Lu} = \frac{\phi_u F_{tu}}{k_t} = 64.6$$

$$F_L = \min(F_{Ly}, F_{Lu})$$

$$\therefore \phi F_L = 29.45 \text{ MPa}$$

$$UR = \frac{\sigma_t}{\phi F_L} = \frac{0}{29.45}$$

UTILITY: 0.00

Axial Compression

Major-Axis Buckling (Z)

AS1664.1 Cl3.4.8

Check axial buckling capacity about major Z-axis

Modified Slope Constant
Slenderness Limit, S1
Slenderness Limit, S2

$$D_c^* = 13.147$$

$$S1 = 0.158$$

$$S2 = 1.677$$

Calculate slenderness value

$$\lambda_z = \left(\frac{kL_z}{r_z} \right) \left(\frac{1}{\pi} \right) \sqrt{F_{cy}/E}$$

$$\lambda_z = \left(\frac{1 \times 1200}{13.17} \right) \left(\frac{1}{\pi} \right) \sqrt{31/70000}$$

$$\lambda_z = 0.61$$

Calculate reduction factor

$$\lambda \leq 1.2$$

$$\therefore \phi_{cc} = \min(1 - 0.21\lambda, 0.95) = 0.872$$

$$S_1 \leq \lambda_z < S_2$$

$$\therefore \phi F_{Lz} = \phi_{cc}(B_c - D_c^* \times \lambda_z)$$

$$\phi F_L = 21.843 \text{ MPa}$$

$$UR = \frac{\sigma_c}{\phi F_L} = \frac{30.758}{21.843}$$

UTILITY: 1.41

Minor-Axis Buckling (Y)

AS1664.1 C13.4.8

Check axial buckling capacity about minor Y-axis

Modified Slope Constant

$$D_c^* = 13.147$$

Slenderness Limit, S1

$$S_1 = 0.158$$

Slenderness Limit, S2

$$S_2 = 1.677$$

Calculate slenderness value

$$\lambda_y = \left(\frac{kL_y}{r_y} \right) \left(\frac{1}{\pi} \right) \sqrt{F_{cy}/E}$$

$$\lambda_y = \left(\frac{1 \times 1200}{6.51} \right) \left(\frac{1}{\pi} \right) \sqrt{31/70000}$$

$$\lambda_y = 1.235$$

Calculate reduction factor

$$\lambda > 1.2$$

$$\therefore \phi_{cc} = \min(0.14\lambda + 0.58, 0.95) = 0.753$$

$$S_1 \leq \lambda_y < S_2$$

$$\therefore \phi F_{Ly} = \phi_{cc}(B_c - D_c^* \times \lambda_y)$$

$$\phi F_L = 12.682 \text{ MPa}$$

$$UR = \frac{\sigma_c}{\phi F_L} = \frac{30.758}{12.682}$$

UTILITY: 2.42

Local Buckling

AS1664.1 C13.4.10.1

Check capacity of top flange subjected to axial compression

Capacity Factor

$$\phi_y = 0.95$$

Capacity Factor

$$\phi_c = 0.85$$

Slenderness Limit, S1

$$S_1 = 17.889$$

Slenderness Limit, S2

S2 = 109.923

Calculate slenderness value

$$s = b/t$$

$$s = 12.8/1.6 = 8$$

$$s < S_1$$

$$\therefore \phi F_L = \phi_y F_{cy} / k_c$$

$$\phi F_L = 29.45 \text{ MPa}$$

$$UR = \frac{\sigma_c}{\phi F_L} = \frac{30.758}{29.45}$$

UTILITY: 1.04

AS1664.1 Cl3.4.10.1

Check capacity of web subjected to axial compression

Capacity Factor

 $\phi_y = 0.95$

Capacity Factor

 $\phi_c = 0.85$

Slenderness Limit, S1

S1 = 17.889

Slenderness Limit, S2

S2 = 109.923

Calculate slenderness value

$$s = b/t$$

$$s = 34.8/1.6 = 21.75$$

$$S_1 \leq s \leq S_2$$

$$\therefore \phi F_L = \phi_c (B_p - 1.6 D_p \times s)$$

$$\phi F_L = 28.887 \text{ MPa}$$

$$UR = \frac{\sigma_c}{\phi F_L} = \frac{30.758}{28.887}$$

UTILITY: 1.06

Maximum Axial Compression Limit and Governing Axial Compression Utility Ratio

$$\phi F_L = 12.682$$

UTILITY: 2.43

Bending

Major-Axis Bending (Z)

AS1664.1 Cl3.4.3

Check tension capacity of member subject to bending

Capacity Factor

 $\phi_y = 0.95$

Capacity Factor

 $\phi_u = 0.9$

$$F_{Ly} = \phi_y F_{ty} = 29.45$$

$$F_{Lu} = \frac{\phi_u F_{tu}}{k_t} = 68.4$$

$$F_L = \min(F_{Ly}, F_{Lu})$$

$$\therefore \phi F_L = 29.45 \text{ MPa}$$

$$UR = \frac{\sigma_{z.tens}}{\phi F_L} = \frac{336.773}{29.45}$$

UTILITY:
11.44

AS1664.1 C13.4.15

Check capacity member subject to bending about major axis

Capacity Factor	$\phi_y = 0.95$
Capacity Factor	$\phi_b = 0.85$
Slenderness Limit, S1	S1 = 124.024
Slenderness Limit, S2	S2 = 24493.271

Calculate slenderness value

$$\frac{s = L_b Z_c}{0.5 \sqrt{I_y J}}$$

$$s = \frac{1200 \times 1484.68}{0.5 \sqrt{28208.86 \times 17306.69}}$$

$$\therefore s = 161.267$$

$$S_1 \leq s \leq S_2$$

$$\therefore \phi F_L = \phi_b (B_c - 1.6 D_c \sqrt{s})$$

$$\phi F_L = 26.595 \text{ MPa}$$

$$UR = \frac{\sigma_{z.comp}}{\phi F_L} = \frac{336.773}{26.595}$$

UTILITY:
12.66

AS1664.1 C13.4.17

Check capacity of top flange subject to uniform compression due to bending about the major axis

Capacity Factor	$\phi_y = 0.95$
Capacity Factor	$\phi_b = 0.85$
Slenderness Limit, S1	S1 = 17.889
Slenderness Limit, S2	S2 = 109.923

Calculate slenderness value

$$s = b/t$$

$$s = 12.8/1.6 = 8$$

$$s < S_1$$

$$\therefore \phi F_L = \phi_y F_{cy}$$

$$\phi F_L = 29.45 \text{ MPa}$$

$$UR = \frac{\sigma_{z.comp}}{\phi F_L} = \frac{336.773}{29.45}$$

UTILITY:
11.44

AS1664.1 C13.4.22

Check capacity of web subject to bending about major axis, compression at one edge, tension at the other

Capacity Factor	$\phi_y = 0.95$
Capacity Factor	$\phi_b = 0.85$
Slenderness Limit, S1	S1 = 43.806
Slenderness Limit, S2	S2 = 228.403

Calculate slenderness value

$$s = h/t$$

$$s = 34.8/1.6 = 21.75$$

$$s < S_1$$

$$\therefore \phi F_L = 1.3\phi_b F_{cy}$$

$$\phi F_L = 34.255 \text{ MPa}$$

$$UR = \frac{\sigma_{z.comp}}{\phi F_L} = \frac{336.773}{34.255}$$

UTILITY: 9.83

Minor-Axis Bending (Y)

AS1664.1 C13.4.17

Check capacity of web subject to uniform compression due to bending about the minor axis

Capacity Factor	$\phi_y = 0.95$
Capacity Factor	$\phi_b = 0.85$
Slenderness Limit, S1	$S1 = 17.889$
Slenderness Limit, S2	$S2 = 109.923$

Calculate slenderness value

$$s = b/t$$

$$s = 34.8/1.6 = 21.75$$

$$S_1 \leq s \leq S_2$$

$$\therefore \phi F_L = \phi_b (B_p - 1.6D_p \times s)$$

$$\phi F_L = 28.887 \text{ MPa}$$

$$UR = \frac{\sigma_{y.comp}}{\phi F_L} = \frac{290.32}{28.887}$$

UTILITY: 10.05

AS1664.1 C13.4.22

Check capacity of flange subject to bending about minor axis, compression at one edge, tension at the other

Capacity Factor	$\phi_y = 0.95$
Capacity Factor	$\phi_b = 0.85$
Slenderness Limit, S1	$S1 = 43.806$
Slenderness Limit, S2	$S2 = 228.403$

Calculate slenderness value

$$s = h/t$$

$$s = 12.8/1.6 = 8$$

$$s < S_1$$

$$\therefore \phi F_L = 1.3\phi_b F_{cy}$$

$$\phi F_L = 34.255 \text{ MPa}$$

$$UR = \frac{\sigma_{y.comp}}{\phi F_L} = \frac{290.32}{34.255}$$

UTILITY: 8.47

AS1664.1 C13.4.5

Check capacity of section subject to bending about minor axis, tension in extreme fibre

Capacity Factor	$\phi_y = 0.95$
Capacity Factor	0.85

$$\phi_u = \text{[input field]}$$

$$F_{Ly} = 1.3\phi_y * F_{ty} = 38.285$$

$$F_{Lu} = \frac{1.42\phi_u F_{tu}}{k_t} = 91.732$$

$$F_L = \min(F_{Ly}, F_{Lu})$$

$$\therefore \phi F_L = 38.285 \text{ MPa}$$

$$UR = \frac{\sigma_{y,tens}}{\phi F_L} = \frac{290.32}{38.285}$$

Maximum Major Axis Bending Limit

UTILITY: 7.58

$$\phi F_{Lz} = 26.595$$

Maximum Minor Axis Bending Limit

UTILITY: 12.66

$$\phi F_{Ly} = 28.887$$

UTILITY: 10.05

Shear

Minor-Axis Shear (Y)

AS1664.1 C13.4.24

Check shear capacity for shear in web (minor axis shear)

Capacity Factor	$\phi_y = 0.95$
Capacity Factor	$\phi_v = 0.8$
Capacity Factor	$\phi_{vp} = 0.9$
Slenderness Limit, S1	S1 = 50.629
Slenderness Limit, S2	S2 = 200.553

Calculate slenderness value

$$s = h/t$$

$$s = 34.8/1.6 = 21.75$$

$$S_y < S1$$

$$\therefore \phi_{Ly} = \phi_y * F_{sy}$$

$$\phi F_{Ly} = 16.15 \text{ MPa}$$

$$UR = \frac{\tau_y}{\phi F_L} = \frac{7.896}{16.15}$$

UTILITY: 0.49

Major-Axis Shear (Z)

AS1664.1 C13.4.24

Check shear capacity for shear in flanges (major axis shear)

Capacity Factor	$\phi_y = 0.95$
Capacity Factor	$\phi_v = 0.8$
Capacity Factor	$\phi_{vp} = 0.9$
Slenderness Limit, S1	S1 = 50.629
Slenderness Limit, S2	S2 = 200.553

Calculate slenderness value

$$s = h/t$$

$$s = 12.8/1.6 = 8$$

$$S_z < S1$$

$$\therefore \phi_{Lz} = \phi_y * F_{sy}$$

$$\phi F_{Lz} = 16.15 MPa$$

$$UR = \frac{\tau_z}{\phi F_L} = \frac{11.415}{16.15}$$

UTILITY: 0.71

Combined Actions

AS1664.1 Cl4.1.1

Check combined bending and axial compression

$$\frac{f_a}{F_a} = \frac{30.758}{12.682} = 2.425$$

$$\frac{f_a}{F_a} > 0.15$$

$$\therefore UR = \max(UR_1, UR_2)$$

$$UR_1 = \frac{f_a}{F_a} + \frac{C_{mx} f_{bx}}{F_{bx}(1 - f_a/F_{ex})} + \frac{C_{my} f_{by}}{F_{by}(1 - f_a/f_{ey})}$$

For conservatism, assume member ends do not prevent sway

$$\therefore C_{mx} = C_{my} = 0.85$$

$$\lambda_z = 0.61$$

$$\lambda_y = 1.235$$

$$\phi_{cc,z} = 0.872$$

$$\phi_{cc,y} = 0.753$$

$$F_{ex} = 72.564$$

$$F_{ey} = 15.311$$

$$UR_1 = \frac{30.758}{12.682} + \frac{0.85 \times 336.773}{26.595(1 - 30.758/72.564)} + \frac{0.85 \times 290.32}{28.887(1 - 30.758/15.311)}$$

$$\therefore UR_1 = 12.64$$

$$UR_2 = \frac{f_a}{F_{ao}} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}}$$

Calculate Average Compressive Stress F_{ao}

Note, F_{ao} must be no greater than stress limited calculated to Cl3.4.8

$$\phi F_{L,Cl3.4.8} = 12.682$$

$$W_i = \frac{\text{Component Area}}{\text{Total Section Area}}$$

$$\text{Weighted Stress} = \phi F_L \times W_i$$

AS1664 Cl4.7.2

Average Compression Calculation

Component Name	Stress Limit (ϕF_L)	Component Area (mm ²)	Weighted % (Wt)	Weighted Stress Limit
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Component Name	Stress Limit (ϕF_t)	Component Area (mm ²)	Weighted % (Wt)	Weighted Stress Limit
Flange	29.45	20.48	12.598%	3.71
Flange	29.45	20.48	12.598%	3.71
Web	28.887	55.68	34.252%	9.894
Web	28.887	55.68	34.252%	9.894

$$\Sigma(\phi F_L \times Wt) = 27.209$$

$$F_{ao} = \min(\Sigma(\phi F_L \times Wt), \phi F_{L.CI3.4.8}) = 12.682$$

$$UR_2 = \frac{30.758}{12.682} + \frac{336.773}{26.595} + \frac{290.32}{28.887}$$

$$\therefore UR_2 = 25.138$$

$$\therefore UR = 25.138$$

UTILITY:
25.14

AS1664.1 CI4.1.2 Check combined bending and axial tension

$$UR = \frac{f_a}{F_t} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}}$$

$$UR = \frac{0}{29.45} + \frac{336.773}{26.595} + \frac{290.32}{28.887}$$

$$UR = 22.713$$

UTILITY:
22.71

AS1664.1 CI4.4 Check combined bending compression and shear, major axis

$$UR = \frac{f_a}{F_a} + \left(\frac{f_b}{F_b}\right)^2 + \left(\frac{f_s}{F_s}\right)^2$$

$$UR = \frac{30.758}{12.682} + \left(\frac{336.773}{26.595}\right)^2 + \left(\frac{7.896}{16.15}\right)^2$$

$$UR = 163.014$$

UTILITY:
163.01

AS1664.1 CI4.4 Check combined bending compression and shear, minor axis

$$UR = \frac{f_a}{F_a} + \left(\frac{f_b}{F_b}\right)^2 + \left(\frac{f_s}{F_s}\right)^2$$

$$UR = \frac{30.758}{12.682} + \left(\frac{290.32}{28.887}\right)^2 + \left(\frac{11.415}{16.15}\right)^2$$

$$UR = 103.931$$

UTILITY:
103.93

Results Summary

Result Name	Results
UTILISATION	
Tension	0.00
Compression	2.43
Major Axis Bending (Z)	12.66
Minor Axis Bending (Y)	10.05
Major Axis Shear (Z)	0.71
Minor Axis Shear (Y)	0.49

Result Name	Results
COMBINED UTILISATION	
Combined Compression + Bending	25.14
Combined Tension + Bending	22.71
Combined Bending and Shear (Major Axis)	163.01
Combined Bending and Shear (Minor Axis)	103.93

About this Calculator



Calculator Name: AS/NZS 1664 Aluminium Member Design

Description: Calculate the bending, shear, axial and combined utilisation of aluminium shapes as per AS/NZS 1664:1997.



URL: https://platform.skyciv.com/quick-design?uid=2601-aluminium-design&member_label=Member%201&shape=hollow%20rectangular&ion=custom&custom_material=false&welded=Welded&alloy=1100&temper=H12&product=Sheet,%20plate&D=38&B=16&t_f=1.6&t_w=1.6&Lb=1200&Lz=1200&Ly=1200&kz=1&ky=1&Mz=0.5&My=0.25&Vy=0.75&Vz=0.5&Nc=5&Nt=0

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