

CEILING BATTENS

For
BATTEN MANUFACTURERS LIMITED
At
ALL SITES WITHIN NEW ZEALAND

STRUCTURAL CALCULATIONS

Project No. **10754**

Rev. -

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ISSUE 4 : 27 August 2024

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Signed by: Jamie Macredie BEPGDip(Fire) CMEngNZ CPEng IntPE

Approved by: Graham Rundle BE MIPENZ

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DOCUMENT CONTROL

ISSUE NUMBER	DATE OF ISSUE	EXPIRATION OF PSI	PURPOSE OF ISSUE
1	Nov-11	N/A	Original Calculations
2	24-Aug-17	N/A	PS1 Renewal
3	20-Apr-2023	20-Apr-2024	PS1 Renewal
4	27-Aug-2024	27-Aug-2025	PS1 Renewal



adding 'engineuity' to building projects

Consulting Professional Engineers

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PRODUCER STATEMENT – PS1 DESIGN

BUILDING CODE CLAUSE(S): B1 | **JOB NUMBER:** 10754 |

ISSUED BY: Redco NZ Ltd |
(Engineering Design Firm)

TO: Batten Manufacturers Limited |
(Owner/Developer)

TO BE SUPPLIED TO: Building Consent Authorities |
(Building Consent Authority)

IN RESPECT OF: Ceiling Battens (Redco Project No. 10754) |
(Description of Building Work)

AT: Sites within New Zealand |
(Address, Town/City)

LEGAL DESCRIPTION: | **N/A**

We have been engaged by the owner/developer referred to above to provide (Extent of Engagement):
Structural Engineering |
in respect of the requirements of the Clause(s) of the Building Code specified above for Part only |, as specified in the
Schedule, of the proposed building work.

The design carried out by us has been prepared in accordance with:

- Compliance documents issued by the Ministry of Business, Innovation & Employment (Verification method/acceptable solution) B1/VM1 & AS1 | and/or;
- Alternative solution as per the attached Schedule.

The proposed building work covered by this producer statement is described on the drawings specified in the Schedule, together with the specification, and other documents set out in the Schedule.

On behalf of the Engineering Design Firm, and subject to:

- Site verification of the following design assumptions: NZS3604:2011 Wind Zone Extra High or less |.
- All proprietary products meeting their performance specification requirements;

I believe on reasonable grounds that:

- the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the Schedule, will comply with the relevant provisions of the Building Code and that;
- the persons who have undertaken the design have the necessary competency to do so.

I recommend the CM 1 level of construction monitoring.

I, (Name of Engineering Design Professional) J C Macredie, am:

- CPEng number 160766 |
and hold the following qualifications BE PGDip(Fire) CMEngNZ CPEng IntPE

The Engineering Design Firm holds a current policy of Professional Indemnity Insurance no less than \$200,000
The Engineering Design Firm is not a member of ACE New Zealand.

SIGNED BY (Name of Engineering Design Professional): J C Macredie
(Signature below):

ON BEHALF OF (Engineering Design Firm): Redco NZ Ltd

Date: 27/08/2024

Note: This statement has been prepared solely for the Building Consent Authority named above and shall not be relied upon by any other person or entity. Any liability in relation to this statement accrues to the Engineering Design Firm only. As a condition of reliance on this statement, the Building Consent Authority accepts that the total maximum amount of liability of any kind arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in tort or otherwise, is limited to the sum of \$200,000.

This form is to accompany **Form 2 of the Building (Forms) Regulations 2004** for the application of a Building Consent.

SCHEDULE to PS1

Please include an itemised list of all referenced documents, drawings, or other supporting materials in relation to this producer statement below:

Alternative solution as per the attached schedule New Zealand Steel Durability Statement

The proposed building work covered by this producer statement is described on the drawings titled Ceiling Battens and in Calculation Pages 5-14.

GUIDANCE ON USE OF PRODUCER STATEMENTS

Information on the use of Producer Statements and Construction Monitoring Guidelines can be found on the Engineering New Zealand website

<https://www.engineeringnz.org/engineer-tools/engineering-documents/producer-statements/>

Producer statements were first introduced with the Building Act 1991. The producer statements were developed by a combined task committee consisting of members of the New Zealand Institute of Architects (NZIA), Institution of Professional Engineers New Zealand (now Engineering New Zealand), Association of Consulting and Engineering New Zealand (ACE NZ) in consultation with the Building Officials Institute of New Zealand (BOINZ). The original suite of producer statements has been revised at the date of this form to ensure standard use within the industry.

The producer statement system is intended to provide Building Consent Authorities (BCAs) with part of the reasonable grounds necessary for the issue of a Building Consent or a Code Compliance Certificate, without necessarily having to duplicate review of design or construction monitoring undertaken by others.

PS1 DESIGN Intended for use by a suitably qualified independent engineering design professional in circumstances where the BCA accepts a producer statement for establishing reasonable grounds to issue a Building Consent;

PS2 DESIGN REVIEW Intended for use by a suitably qualified independent engineering design review professional where the BCA accepts an independent design professional's review as the basis for establishing reasonable grounds to issue a Building Consent;

PS3 CONSTRUCTION Forms commonly used as a certificate of completion of building work are Schedule 6 of NZS 3910:2013 or Schedules E1/E2 of NZIA's SCC 2011²

PS4 CONSTRUCTION REVIEW Intended for use by a suitably qualified independent engineering construction monitoring professional who either undertakes or supervises construction monitoring of the building works where the BCA requests a producer statement prior to issuing a Code Compliance Certificate.

This must be accompanied by a statement of completion of building work (Schedule 6).

The following guidelines are provided by ACE New Zealand and Engineering New Zealand to interpret the Producer Statement.

Competence of Engineering Professional

This statement is made by an engineering firm that has undertaken a contract of services for the services named, and is signed by a person authorised by that firm to verify the processes within the firm and competence of its personnel.

The person signing the Producer Statement on behalf of the engineering firm will have a professional qualification and proven current competence through registration on a national competence-based register such as a Chartered Professional Engineer (CPEng).

Membership of a professional body, such as Engineering New Zealand provides additional assurance of the designer's standing within the profession. If the engineering firm is a member of ACE New Zealand, this provides additional assurance about the standing of the firm.

Persons or firms meeting these criteria satisfy the term "suitably qualified independent engineering professional".

Professional Indemnity Insurance

As part of membership requirements, ACE New Zealand requires all member firms to hold Professional Indemnity Insurance to a minimum level.

The PI Insurance minimum stated on the front of this form reflects standard practice for the relationship between the BCA and the engineering firm.

Professional Services during Construction Phase

There are several levels of service that an engineering firm may provide during the construction phase of a project (CM1-CM5 for engineers³). The building Consent Authority is encouraged to require that the service to be provided by the engineering firm is appropriate for the project concerned.

Requirement to provide Producer Statement PS4

Building Consent Authorities should ensure that the applicant is aware of any requirement for producer statements for the construction phase of building work at the time the building consent is issued as no design professional should be expected to provide a producer statement unless such a requirement forms part of the Design Firm's engagement.

Refer Also:

- 1 Conditions of Contract for Building & Civil Engineering Construction NZS 3910: 2013
- 2 NZIA Standard Conditions of Contract SCC 2011
- 3 Guideline on the Briefing & Engagement for Consulting Engineering Services (ACE New Zealand/Engineering New Zealand 2004)
- 4 PN01 Guidelines on Producer Statements

www.acenz.org.nz
www.engineeringnz.org

Client: **BATTEN MANUFACTURERS LIMITED**
 Project: **CEILING BATTENS**

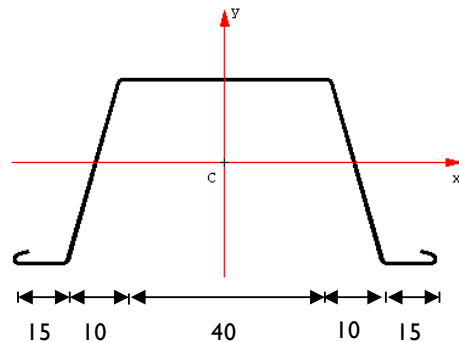
24 August 2017
 Project No. **10754**

I.0 DESIGN SUMMARY (NZBC B1)

Battenman CB35

Description

Battenman CB35 ceiling battens are manufactured from 0.50mm G550 Z275 galvanised steel and have the following dimensions and section properties:



Properties

A (full section)	=	69 mm ²
Mass per unit length	=	0.54 kg/m
I _x (full section)	=	13021 mm ⁴
I _y (full section)	=	42093 mm ⁴
r _x (full section), radius of gyration	=	14 mm
r _y (full section), radius of gyration	=	25 mm
I _w , warping constant (full section)	=	1.69 × 10 ⁶ mm ⁶
J, torsion constant (full section)	=	6 mm ⁴

Compliance

The battens meet the requirements of the New Zealand Building Code Clause B1, B2 when installed in compliance with AS/NZS 2589 and the usage guidance below.

B1 - Checked in accordance with B1/VM1

- Loading in accordance with AS/NZS 1170 Structural Design Actions and NASH Standard Part 1: Design Criteria. NZS 3604 Timber Framed Buildings wind zones have been for wind speeds.
- Deflection limits in accordance with NASH Standard Part 1: Design Criteria for Level 4 finish to AS/NZS 2589.
- Battens design to AS/NZS4600 Cold Formed Steel Structures

B2 - Alternative solution

Durability in accordance with NZ Steel Durability Statement. The battens are designed for dry internal environments and should not be used where they are in external or damp situations.

Usage

Battenman CB35 ceiling battens can replace all sizes of timber ceiling battens in Table 13.1 of NZS3604:2011 and form part of a seismic or wind resisting diaphragm as set out in cl 13.5 of NZS3604 when direct fixed.

Loading

- Battenman CB35 battens are designed to carry a ceiling material with a maximum weight of 17.5kg/m².
 - Light fittings or similar point loads up to 15kg may be supported on the ceiling batten for batten spans up to 900mm
 - Light fittings or similar point loads up to 9kg may be supported on the ceiling batten for batten spans up to 1200mm
- The ceiling battens are only designed to carry the ceiling material and point loads as outlined above. They are not designed to support foot traffic or any other loads such as storage.

Span

Maximum span	1200 mm
Maximum spacing	600 mm

Fixing

Substrate	Recommended Fastener
Timber (J5, Radiata pine)	Hand-driven nails - 2/50x3.15 Power-driven nails - 2/50x2.78 annular grooved nails
Steel (0.75mm)	2/10-16TPI teks screws. 3 threads penetration minimum.

Battenman BH35 batten hangers may be used in place of direct fixing. See hanger installation guide for details.

Diaphragm

If the battens are used as part of a seismic or wind resisting diaphragm, as set out in cl 13.5 of NZS3604, then they shall be direct fixed.

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2.0 DURABILITY STATEMENT (NZBC B2)



DURABILITY STATEMENT

For Galvsteel™ (galvanised steel) and Axxis® steel manufactured by New Zealand Steel Limited and used for structural building elements

Galvsteel™ material, when used for purlins or girts, or Axxis® steel used for framing will have a durability of 50 years when used and maintained as defined below.

The above statements are subject to the following:

1. Specifications

Zinc coating weight;	275g/m ² (Z275) or 450g/m ² (Z450).
Complying with;	AS 1397:2001.
Steel grade;	G250, G300, G450, G500 or G550.
Steel thickness range;	0.55-2.25 mm.
Bend diameter;	G250, G300; ≥ 2T. G450, G500, G550; ≥ 4T (where T = total coated thickness).

2. Fixing, Handling and Maintenance according to the following publications:

- a) New Zealand Steel Limited, *Specifiers and Builders Guide*, and *Installers Guide* (refer www.nzsteel.co.nz for most current version).
- b) *NZ Metal Roof & Wall Cladding, Code of Practice*, (refer www.metalroofing.org.nz for most current version and updates).
- c) AS/NZS 2312:2002 (Incorporating Amendment No. 1) *Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings*.
- d) Instructions and literature published by individual purlin and steel framing manufacturers.
- e) NASH Handbook Best Practice for Design and Construction of Residential and Low-Rise Steel Framing.

3. Additional Fixing and Handling and Design Requirements.

- a) The bottom plate detail must ensure that the bottom plate remains dry in service (i.e. it is not subject to water ingress from internal or external sources).
- b) Separation methods as described within E2/AS1 are required between any timber or concrete and any steel structural building element, (this especially applies to the bottom plate).
- c) Where damp-proof course (DPC) is used this must be at least 10mm wider than the steel building element.
- e) Site storage conditions must ensure that the building components are kept dry when in a stacked condition and free of corrosion prior to installation.
- d) Structural building elements must be clean, with no corrosion, clear of debris and dry, prior to installation of external and internal linings.
- f) During storage and erection the material should be kept as dry as possible and the building closed in as soon as practical to limit exposure to the elements, particularly in marine or geothermal environments.
- g) Contact between dissimilar metals must be avoided (e.g. between copper and galvanised).
- h) Structural building elements should be carried and not dragged when being moved.

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Galvsteel™ and Axxis® durability statement

4. Environment.

Initially the macroclimate in which the building is situated needs to be determined. Table 2 is broken down into broad geographical regions of New Zealand. Within the regions the corrosivity is further defined by the distance to the nearest coast, harbour or estuary.

For aggressive industrial environments either externally or internally, or buildings subject to heavy geothermal influence, expected corrosion rates and recommended coatings will need to be determined on a case by case basis using *New Zealand Steelwork Corrosion Coatings Guide* HERA Report R4-133:2005 [d].

5. Building Types

This statement classifies six different building situations where structural steel may be used (N.B. one building may contain more than one of these situations);

a) Residential/Dry

Steelwork located in a dry internal environment, with an effective thermal break between external cladding and the structure, such as a fully enclosed office, an apartment building or a domestic house. This includes structures that are lined with building wrap and have internally controlled environments such as commercial shops and malls.

b) Internal

Steelwork located in a damp or humid environment, with no effective thermal break between the external cladding and structure. For structures such as storage sheds, garages and workshops which are typically closed when not in use. These structures are distinguished in the following two cases;

• Damp

Steelwork located in a damp internal environment where condensation may occur, where the structure may be in an open sunny location (i.e. when the structure is exposed to the sun and not under any form of cover). This is for structures such as exhibition halls, vehicle depots and warehouses.

• High Humidity

Steelwork located in an internal high humidity environment with some pollution, where the structure may be in a humid and shaded location (i.e. when the shed is under a tree shaded from the sun). This is for structures such as food processing plants, breweries and dairies. Steel in subfloor spaces is included in this building type.

c) Open Front

Steelwork located near permanent openings (such as near doors or windows that remain open under operating conditions), and may be exposed to the prevailing winds. For structures such as open front lean-to, gable structure closed in on three sides or warehouses with large openings. This building type has two cases, which are only applicable to the internal steelwork close to the openings as defined in Section 5.5 of reference [d].

• Protected

Structures that are protected from the wind coming off the closest sea.

• Open

Structures that are open and exposed to the prevailing wind coming off the closest sea.

d) Awning

Steelwork that is exposed to the wind but is protected from the rain located in an open sided structure such as carports or structures closed in on one side only. The equivalent reference [b] designation is "Sheltered". The corrosion rate of this building type and that of "Open Front; Open" are identical.

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Galvsteel™ and Axxis® durability statement

6. Coating Systems

The following coating systems are referenced in Table 2 of this document, alternative solutions are also available and may be identified by reference to HERA Report R4-133:2005 [d], or AS/NZS2312:2002 [c] or by discussions with paint suppliers or coatings specialists.

Table 1

System	Surface Preparation	1 st Coat			2 nd Coat			3 rd Coat			Total nominal DFT ³ (µm)
		Type	PRN ¹	Nominal DFT ² (µm)	Type	PRN ¹	Nominal DFT ² (µm)	Type	PRN ¹	Nominal DFT ² (µm)	
P1	Degrease, wash and dry	Acrylic dispersion paint		40	Acrylic dispersion paint ⁴		40				80
P2		Galvanised iron acrylic primer		40	Acrylic dispersion paint ⁴		40				80
P3 ⁵		Etch primer		12	Acrylic elastomeric		350				362
P4 ⁵	Sweep abrasive blast	Polyamide cured epoxy primer	C10	75	High build epoxy	13	200	Acrylic 2-pack	C33	50	325
P5 ⁵								Polyurethane gloss	C26	50	325

Notes on Table 1

¹PRN: Paint reference number as given in appendix C of reference [c].

²DFT; coating dry film thickness.

³The total nominal DFT does not include the galvanised coating thickness.

⁴Contact the coating supplier for feedback on the appropriate acrylic paint for its intended use. For example, for internal high humidity locations it is recommended to use acrylic enamel at the specified nominal DFT.

⁵P3, P4 and P5 coatings must be applied by a professional coating applicator to achieve the required durability performance.

7. Maintenance

Maintenance is necessary when the galvanised coating ceases to provide sacrificial protection to the steel base, or where the appearance is no longer aesthetically acceptable.

Rust staining or the growth of rust spots usually indicates the breakdown of galvanised coating. At the first sign of breakdown, the surface should be treated with an appropriate maintenance coating system. All maintenance should be carried out in accordance with AS/NZS 2312:2002 (Incorporating Amendment No. 1) [c] and HERA Report R4-133:2005 [d].

Regular inspections of the steel work and maintenance at the first signs of a problem will extend the durability of the sections.

8. Recommended coating systems to achieve 50 year durability.

Table 2 shows the recommended coating system to achieve 50 year durability for the different building conditions in the various marine environments throughout New Zealand.

9. References

- El Sarraf, R. and Hicks, S. – *Extending the Durability Performance of Galvsteel™ using a Protective Coating System*, (HERA) Structural Systems Technical Report SSTR-001 2008.
- NZS 3404 Part 1, *Steel Structures Standard 2009*; Standards New Zealand.
- AS/NZS 2312:2002 (Inc Incorporating Amendment No. 1), *Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings*.
- Clifton, G.C. and El Sarraf, R. *New Zealand Steelwork Corrosion Coatings Guide* (HERA Report R4-133) 2005.
- Compliance Document for New Zealand Building Code – Clause E2 – External Moisture

Galvsteel™ durability statement

Table 2

	Location	Characterised by	Residential /Dry	Internal		Open front		Awning
				Damp	High humidity	Protected	Open	
Within 200m of breaking surf	West coast, South Island	Heavy salt deposits, almost constant smell of salt spray in the air.	1	3	4	4	4	4
Within 100m of breaking surf	West coast, North Island		1	3	4	4	4	4
Within 50m of breaking surf	Other coasts		1	3	4	4	4	4
200m up to 500m or more inland from breaking surf. In the immediate vicinity of calm salt water such as harbour foreshores	West coast, South Island	Medium salt deposits. Frequent smell of salt in the air.	1	3	4	4	4	4
50m up to 500m or more inland from breaking surf. In the immediate vicinity of calm salt water such as harbour foreshores.	All other coasts		1	1	3	4	4	4
500m to 1km from breaking surf. In the immediate vicinity of calm salt water such as estuaries.	West coast of both islands and South coast of South Island.	Little salt deposits, occasional smell of salt in the air.	1	1	3	4	4	4
500m to 1km from breaking surf. In the immediate vicinity of calm salt water such as estuaries.	East coast of both islands, South coast of North Island and all harbours.		1	1	3	3	4	4
1km to 20 km from salt water	West coast of both islands and South coast of South Island	Minor salt deposits, no smell of salt in the air.	1	1	3	4	4	4
1km to 5km from salt water	East coast of both islands, South coast of North Island and all harbours.		1	1	2	3	4	4
20km to 50km from salt water.	West coast of both islands and South coast of South Island	No marine influence.	1	1	2	3	3	3
5km to 50km from salt water	East coast of both islands, South coast of North Island and all harbours.		1	1	2	3	3	3
Inland more than 50km from salt water.	Both islands		1	1	1	1	1	1

Note: all environments may be extended inland by prevailing winds and local conditions.

Key	
1	Z275
2	Z450 or Z275 and one of the paint systems P1 – P5 applied when new.
3	Z275 and one of (P3, P4 or P5) applied when new, <u>or</u> P1 or P2 applied when new and recoated every 15 years.
4	Z275 and one of (P3, P4 or P5) applied when new and then recoated every 15 years

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3.0 SUPPORTING CALCULATIONS

3.1 BATTENS AT 1200mm

Ceiling battens

Battenman CB35 ceiling battens

Spacing, $s = 600$ mm

Span, $L = 1200$ mm

Batten properties from ColdSteel (see attached output for details):

$\phi M_{b+ve} = 0.23$ kNm (compression in legs) $\phi M_{b+ve} = 0.26$ kNm (compression in flat)

$I_x = 0.013 \times 10^6$ mm⁴

$E = 200$ MPa

$SW = 0.54$ kg/m

Loading

Dead $G_{max} = 0.17$ kPa $\Rightarrow 0.11$ kN/m (includes self weight of batten)

$G_{min} = 0.07$ kPa $\Rightarrow 0.04$ kN/m

$P_G = 9.00$ kg $\Rightarrow 0.09$ kN

Wind: Wind Zone = **Extra high** (from NZS 3406:2011)

Wind speed = **55** m/s

$q_u(z) = 1.82$ kPa

$q_s(z) = 1.22$ kPa

$C_{pt} = 0.2$ or **-0.3**

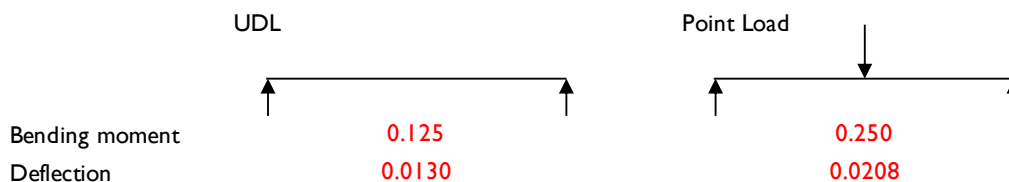
$W_{u(up)} = -0.54$ kPa $\Rightarrow -0.33$ kN/m

$W_{u(down)} = 0.36$ kPa $\Rightarrow 0.22$ kN/m

$W_{s(up)} = -0.36$ kPa $\Rightarrow -0.22$ kN/m

$W_{s(down)} = 0.24$ kPa $\Rightarrow 0.15$ kN/m

Load factors



Ultimate

Loadcase	Load (kN/m, kN)		Moment, M* (kNm)			Capacity, ϕM (kNm)	Check
	w	P	UDL	PL	Total		
$1.35G_{max}$	0.15	0.12	0.022	0.036	0.058	0.257	OK
$0.9G_{min} + W_{u(up)}$	-0.29	0.00	-0.043	0.000	-0.043	0.230	OK
$1.2G_{max} + W_{u(down)}$	0.35	0.11	0.052	0.032	0.084	0.257	OK

Serviceability

Loadcase	Load (kN/m, kN)		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	w	P	UDL	PL	Total			
G	0.11	0.09	1.1	1.2	2.3	512	500	OK
$G_{min} + W_{s(up)}$	-0.18	0.00	-1.8	0.0	-1.8	651	200	OK
$G_{max} + W_{s(down)}$	0.25	0.09	2.6	1.2	3.9	311	200	OK

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3.3 Cold Steel/ NZS 4600 Section Properties and Capacity

Results of Analysis by ColdSteel/4600, Version 1.23, 20 October 2006

28/11/2011 4:04:55 p.m.

CS-1202

Member ID: Member 1
 Section Class: Lipped Hat
 Section Designation: Frameman CB35
 Material Grade: G550

Governing Load Factor and Mode

No failure mode applicable

Units

Length: Metres
 Force: Kilonewtons
 Mass: Kilograms

Input Parameters

- Design actions come first-order elastic structural analysis.
 - Thin-walled theory is used for calculation of cross-section properties.
 - Rounded corners are used for calculation of torsional section properties.
 - Shear centre and warping constant are calculated on-the-fly.
 - Principal (x-y) axes are used.
 - Phi-factors from AS/NZS 4600:1996 are used in design calculations.
 - Mcx calculated using Clause 3.3.3.2(a) for bending strength check.
 - Mox (C=1) calculated using Clause 3.3.3.2(a) for combined actions strength check.
 - Mox calculated using Clause 3.3.3.2(a) for bending strength check.
 - Mox (C=1) calculated using Clause 3.3.3.2(a) for combined actions strength check.
 - Axial compression force (N*) is assumed to pass through effective section centroid
 - Noc calculated using the given effective lengths (Lex, Ley, Lez)
 - The possibility of torsional or torsional-flexural buckling in compression is considered
 - Distortional buckling strength in compression is considered if relevant (Clause 3.4.6)
 - Distortional buckling stress in compression (if relevant) is calculated using simple analytical model
 - Distortional buckling stress in bending about x-axis (if relevant) is calculated using simple analytical model
 - Distortional buckling stress in bending about y-axis (if relevant) is calculated using simple analytical model

2E8 kPa = E, Elastic modulus
 8E7 kPa = G, Shear modulus
 550000 kPa = fy, Yield stress
 550000 kPa = fu, Ultimate tensile strength
 7850 kg/m3 = rho, Mass density
 2.4 m = Lx, Actual member length for bending about x-axis
 2.4 m = Ly, Actual member length for bending about y-axis
 0.2 m = Lebx, Beam effective length for buckling about x-axis
 0.2 m = Leby, Beam effective length for buckling about y-axis
 0.2 m = Lebz, Beam effective length for buckling about z-axis
 0.2 m = Lecx, Column effective length for buckling about x-axis
 0.2 m = Lecy, Column effective length for buckling about y-axis
 0.2 m = Lecz, Column effective length for buckling about z-axis
 1 = kt, Tension factor
 0 m = Brem, Equivalent removed width
 0.1 m = Lb, Bearing length
 0.1 m = c, Bearing parameter
 0.1 m = e, Bearing parameter
 1 = CmX (Mox), coefficient for calculation of buckling moment Mox (Clause 3.3.3.2(a))
 1 = CMy (Moy), coefficient for calculation of buckling moment Moy (Clause 3.3.3.2(a))
 1 = CmX, Moment modification factor (combined tension/compression & bending)
 1 = CMy, Moment modification factor (combined tension/compression & bending)
 0 kN = N*, Design axial force (tension positive)
 0 kNm = Mx*, Design bending moment about x-axis
 0 kNm = My*, Design bending moment about y-axis
 0 kN = Vx*, Design shear force in direction of x-axis
 0 kN = Vy*, Design shear force in direction of y-axis
 0 kN = Rx*, Design bearing force in direction of x-axis
 0 kN = Ry*, Design bearing force in direction of y-axis

Overload Factors for all Limit States

[-] = LF (Nty) (Yielding in tension, Clause 3.2.1, Eq. 3.2.1(1))
 [-] = LF (Ntu) (Fracture in tension, Clause 3.2.1, Eq. 3.2.1(2))
 [-] = LF (Msx) (Section capacity in bending about x-axis, Clause 3.3.2(a))
 [-] = LF (Msy) (Section capacity in bending about y-axis, Clause 3.3.2(a))
 [-] = LF (Mblx) (Lateral buckling about x-axis, Clause 3.3.2(b))
 [-] = LF (Mby) (Lateral buckling about y-axis, Clause 3.3.2(b))
 [-] = LF (Mbdx) (Distortional buckling about x-axis, Clause 3.3.3.3)
 [-] = LF (Mbdy) (Distortional buckling about y-axis, Clause 3.3.3.3)
 [-] = LF (Mbrx) (R-Factor, Clause 3.3.3.4)
 [-] = LF (Vvx) (Shear in x-axis direction, Clause 3.3.4)
 [-] = LF (Vvy) (Shear in y-axis direction, Clause 3.3.4)
 [-] = LF (Vvx+Msy) (Combined shear and bending, Clause 3.3.5)
 [-] = LF (Vvy+Msx) (Combined shear and bending, Clause 3.3.5)
 [-] = LF (Rbx) (Bearing in x-axis direction, Clause 3.3.6)
 [-] = LF (Rby) (Bearing in y-axis direction, Clause 3.3.6)
 [-] = LF (Rbx+Msy) (Bearing and bending, Clause 3.3.7)
 [-] = LF (Rby+Msx) (Bearing and bending, Clause 3.3.7)

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[-]	= LF (Ns) (Section capacity in compression, Clause 3.4.1(a))
[-]	= LF (Ncft) (Flexural or flexural-torsional buckling capacity in compression, Clause 3.4.1)
[-]	= LF (Ncd) (Distortional buckling capacity in compression, Clause 3.4.6)
[-]	= LF (Mx+My+Nc, Combined compression and bending, Clause 3.5.1(a))
[-]	= LF (Mx+My+Nc, Combined compression and bending, Clause 3.5.1(b))
[-]	= LF (Mx+My+Nc, Combined compression and bending, Clause 3.5.1, $N^*/\phi N_c \leq 0.15$)
[-]	= LF (Mx+My+Nt, Combined tension and bending, Clause 3.5.2(a))
[-]	= LF (Mx+My+Nt, Combined tension and bending, Clause 3.5.2(b))

Nominal Capacities

37.9181 kN	= Nty, Tension yield
32.2304 kN	= Ntu, Tension fracture
0.32637 kNm	= Msx+, Section capacity in bending
0.285608 kNm	= Msx-, Section capacity in bending
0.460368 kNm	= Msy+, Section capacity in bending
0.460368 kNm	= Msy-, Section capacity in bending
0.323798 kNm	= Mblx+(C), Member capacity in bending using actual Cb or Cm (Lateral buckling)
0.285608 kNm	= Mblx-(C), Member capacity in bending using actual Cb or Cm (Lateral buckling)
0.460368 kNm	= Mbly+(C), Member capacity in bending using actual Cb or Cm (Lateral buckling)
0.460368 kNm	= Mbly-(C), Member capacity in bending using actual Cb or Cm (Lateral buckling)
0.323798 kNm	= Mblx+(C=1), Member capacity in bending using Cb or Cm = 1.0 (Lateral buckling)
0.285608 kNm	= Mblx-(C=1), Member capacity in bending using Cb or Cm = 1.0 (Lateral buckling)
0.460368 kNm	= Mbly+(C=1), Member capacity in bending using Cb or Cm = 1.0 (Lateral buckling)
0.460368 kNm	= Mbly-(C=1), Member capacity in bending using Cb or Cm = 1.0 (Lateral buckling)
0.4517 kNm	= Msfx+, Section yield capacity of the full section
0.374041 kNm	= Msfx-, Section yield capacity of the full section
0.581033 kNm	= Msfy+, Section yield capacity of the full section
0.581033 kNm	= Msfy-, Section yield capacity of the full section
8.07325 kN	= Vvx, Shear capacity for shear force in x-axis direction
6.68223 kN	= Vvy, Shear capacity for shear force in y-axis direction
[-] kN	= Rbx, Bearing capacity for bearing force in x-axis direction
7.43955 kN	= Rby, Bearing capacity for bearing force in y-axis direction
19.6449 kN	= Ns, Section capacity in compression
16.3721 kN	= Ncft, Member capacity in compression (flexural or flexural-torsional buckling)
15.7452 kN	= Ncd, Member capacity in compression (distortional buckling)
0.257087 kNm	= Mbdx+, Member capacity in bending (Distortional buckling)
[-] kNm	= Mbdx-, Member capacity in bending (Distortional buckling)
0.383521 kNm	= Mbdy+, Member capacity in bending (Distortional buckling)
0.383521 kNm	= Mbdy-, Member capacity in bending (Distortional buckling)
[-] kNm	= Mbrx+, Member capacity in bending (R-factor method)
[-] kNm	= Mbrx-, Member capacity in bending (R-factor method)

Design Capacities

34.1263 kN	= ϕN_{ty}	($\phi = 0.90$)
29.0074 kN	= ϕN_{tu}	($\phi = 0.90$)
0.310051 kNm	= ϕM_{sx+}	($\phi = 0.95$)
0.271328 kNm	= ϕM_{sx-}	($\phi = 0.95$)
0.437349 kNm	= ϕM_{sy+}	($\phi = 0.95$)
0.437349 kNm	= ϕM_{sy-}	($\phi = 0.95$)
0.291418 kNm	= $\phi M_{bx+(C)}$	($\phi = 0.90$)
0.257048 kNm	= $\phi M_{bx-(C)}$	($\phi = 0.90$)
0.414331 kNm	= $\phi M_{by+(C)}$	($\phi = 0.90$)
0.414331 kNm	= $\phi M_{by-(C)}$	($\phi = 0.90$)
0.291418 kNm	= $\phi M_{bx+(C=1)}$	($\phi = 0.90$)
0.257048 kNm	= $\phi M_{bx-(C=1)}$	($\phi = 0.90$)
0.414331 kNm	= $\phi M_{by+(C=1)}$	($\phi = 0.90$)
0.414331 kNm	= $\phi M_{by-(C=1)}$	($\phi = 0.90$)
0.429115 kNm	= ϕM_{sfx+}	($\phi = 0.95$)
0.355339 kNm	= ϕM_{sfx-}	($\phi = 0.95$)
0.551982 kNm	= ϕM_{sfy+}	($\phi = 0.95$)
0.551982 kNm	= ϕM_{sfy-}	($\phi = 0.95$)
7.26593 kN	= ϕV_{vx}	($\phi = 0.90$)
6.01401 kN	= ϕV_{vy}	($\phi = 0.90$)
[-] kN	= ϕR_{bx}	($\phi = 0.75$)
5.57966 kN	= ϕR_{by}	($\phi = 0.75$)
16.6982 kN	= ϕN_s	($\phi = 0.85$)
13.9163 kN	= ϕN_{cft}	($\phi = 0.85$)
13.3834 kN	= ϕN_{cd}	($\phi = 0.85$)
0.231378 kNm	= ϕM_{bdx+}	($\phi = 0.90$)
[-] kNm	= ϕM_{bdx-}	($\phi = 0.90$)
0.345169 kNm	= ϕM_{bdy+}	($\phi = 0.90$)
0.345169 kNm	= ϕM_{bdy-}	($\phi = 0.90$)
[-] kNm	= ϕM_{brx+}	($\phi = 0.90$)
[-] kNm	= ϕM_{brx-}	($\phi = 0.90$)

Cross-Sectional Dimensions

0.0005 m	= Thickness (t)
0.035 m	= Overall depth (D)
0.04 m	= Width (B)
0.015 m	= Flange width (F)
0.008 m	= Lip stiffener length (L)
0.0005 m	= Internal radius (R)
16 deg	= Angle of web from vertical (degrees)
290 deg	= Angle of flange stiffener from vertical (degrees)

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Properties of Full Section

0.137884 m	= Wf, Feed width
6.8942E-5 m2	= A (full section)
6.8942E-5 m2	= A (net section)
0 m	= xc, x-ordinate of centroid (full section)
0.0188958 m	= yc, y-ordinate of centroid (full section)
0 m	= xo, x-ordinate of shear centre (referred to principal axes)
0.02839 m	= yo, y-ordinate of shear centre (referred to principal axes)
1.30206E-8 m4	= Ix (full section)
4.20929E-8 m4	= Iy (full section)
0 m4	= Ixy (full section)
0 deg	= Inclination of principal axes (full section)
0.0137427 m	= rx (full section), radius of gyration
0.0247094 m	= ry (full section), radius of gyration
-0.0398447 m	= Extreme negative x-ordinate (full section)
0.0398447 m	= Extreme positive x-ordinate (full section)
-0.0191458 m	= Extreme negative y-ordinate (full section)
0.0158542 m	= Extreme positive y-ordinate (full section)
8.21273E-7 m3	= Zx+, Full section modulus (yield at extreme positive y-ordinate)
6.80075E-7 m3	= Zx-, Full section modulus (yield at extreme negative y-ordinate)
1.05642E-6 m3	= Zy+, Full section modulus (yield at extreme positive x-ordinate)
1.05642E-6 m3	= Zy-, Full section modulus (yield at extreme negative x-ordinate)
5.74517E-12 m4	= J, torsion constant (full section)
0.0400643 m	= rol (full section)
-0.0870193 m	= betax, monosymmetry parameter (referred to principal axes)
0 m	= betay, monosymmetry parameter (referred to principal axes)
1.69021E-12 m6	= Iw, warping constant (full section)
0.541195 kg/m	= Mass per unit length
0.276768 m	= Profile distance
0.511402 m2/kg	= Profile surface area (Area/Mass)

Properties of Effective Section

3.57181E-5 m2	= Ae(fy) Effective area for uniform stress fy
4.04897E-5 m2	= Ae(fn) Effective area for uniform stress fn
1.19036E-8 m4	= Iex+, effective 2nd moment of area (x+ bending, extreme fibre at yield)
9.79156E-9 m4	= Iex-, effective 2nd moment of area (x- bending, extreme fibre at yield)
3.62226E-8 m4	= Iey+, effective 2nd moment of area (y+ bending, extreme fibre at yield)
3.62226E-8 m4	= Iey-, effective 2nd moment of area (y- bending, extreme fibre at yield)
5.934E-7 m3	= Zex+, effective section modulus at yield (x+ bending)
5.19288E-7 m3	= Zex-, effective section modulus at yield (x- bending)
8.37032E-7 m3	= Zey+, effective section modulus at yield (y+ bending)
8.37032E-7 m3	= Zey-, effective section modulus at yield (y- bending)

Miscellaneous Parameters

9.32001E6 kPa	= fox, Elastic buckling stress for buckling about principal x-axis
3.01297E7 kPa	= foy, Elastic buckling stress for buckling about principal y-axis
757877 kPa	= foz, Elastic buckling stress for torsional buckling about z-axis
748307 kPa	= foc, Elastic buckling stress
404353 kPa	= fn, Inelastic buckling stress
642.541 kN	= Nox, Elastic flexural buckling load about x-axis (used for moment amplification)
2077.2 kN	= Noy, Elastic flexural buckling load about y-axis (used for moment amplification)
0.958704 kNm	= Mox+, Elastic lateral buckling moment for positive bending about x-axis (using actual Cb/Cm
)	
181.715 kNm	= Mox-, Elastic lateral buckling moment for negative bending about x-axis (using actual Cb/Cm
)	
7.3409 kNm	= Moy+, Elastic lateral buckling moment for positive bending about y-axis (using actual Cb/Cm
)	
7.3409 kNm	= Moy-, Elastic lateral buckling moment for negative bending about y-axis (using actual Cb/Cm
)	
0.958704 kNm	= Molx+, Elastic lateral buckling moment for positive bending about x-axis (using Cb/Cm = 1.0
)	
181.715 kNm	= Molx-, Elastic lateral buckling moment for negative bending about x-axis (using Cb/Cm = 1.0
)	
7.3409 kNm	= Moly+, Elastic lateral buckling moment for positive bending about y-axis (using Cb/Cm = 1.0
)	
7.3409 kNm	= Moly-, Elastic lateral buckling moment for negative bending about y-axis (using Cb/Cm = 1.0
)	
0 m	= x-ordinate of C(full)->C(effective) (fy)
-0.00231893 m	= y-ordinate of C(full)->C(effective) (fy)
0 m	= x-ordinate of C(full)->C(effective) (fn)
-0.00230393 m	= y-ordinate of C(full)->C(effective) (fn)
1.30206E-8 m4	= Ie_Mx+, Effective second moment of area for design Mx*
6.80075E-7 m3	= Ze_Mx+, Effective section modulus for design Mx*
4.20929E-8 m4	= Ie_My+, Effective second moment of area for design My*
1.05642E-6 m3	= Ze_My+, Effective section modulus for design My*
169793 kPa	= f0dc, Distortional buckling stress in pure compression
391839 kPa	= f0dx+, Distortional buckling stress in bending
-] kPa	= f0dx-, Distortional buckling stress in bending
353179 kPa	= f0dy+, Distortional buckling stress in bending
353179 kPa	= f0dy-, Distortional buckling stress in bending