PS1 FOR 40MM TOPHAT

for

BATTEN MANUFACTURERS LIMITED

At

NORTH ISLAND NEW ZEALAND

STRUCTURAL CALCULATIONS

March 2018

Project No. 18053

Prepared by:	Han Tong BE MEngSt	CPEng. sign off:	Franswa Jooste BE (Hons) M.IPENZ CPEng Int PE
Reviewed by:	Athir Mansoor BSc MEngSt	Approved by:	Graham Rundle BE M.IPENZ

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red co

adding 'enginuity' to building projects

Providing the services of:

Consulting Professional Engineers

Redco NZ Ltd
Redco House
470 Otumoetai Road
TAURANGA 3110
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Building Code Clause(s) B1, B2

PRODUCER STATEMENT – PS1 – DESIGN

(Guidance on use of Producer Statements (formerly page 2) is available at www.engineeringnz.org)

ISSUED BY: Redco NZ Ltd
(Design Firm)

TO: Batten Manufacturers Limited
(Owner/Developer)

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

IN RESPECT OF: Design of 40mm Tophat purlins, RB4055 & RB4075 (Redco Ref #18053) for various spans & wind speeds
(Description of Building Work)

AT: North Island New Zealand
(Address)

Town/City:…………………… **LOT** …………… **DP** …………… **SO** ……………
(Address)

We have been engaged by the owner/developer referred to above to provide:

Structural Engineering Design of RB4055 & RB4075 steel purlins as per Redco Calculation #18053
(Extent of Engagement)

services in respect of the requirements of Clause(s) B1, B2 of the Building Code for:

☐ All or ☑ Part only (as specified in the attachment to this statement), 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 B1/VM1 & AS1, B2/AS1 …or
(verification method/acceptable solution)

☐ Alternative solution as per the attached schedule……………………

The proposed building work covered by this producer statement is described on the drawings titled:

PS1 for 40mm Tophat ……………and numbered ……………;
together with the specification, and other documents set out in the schedule attached to this statement.

On behalf of the Design Firm, and subject to:
(i) Site verification of the following design assumptions N/A
(ii) All proprietary products meeting their performance specification requirements;

I believe on reasonable grounds that a) the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the attached schedule, will comply with the relevant provisions of the Building Code and that b), the persons who have undertaken the design have the necessary competency to do so. I also recommend the following level of construction monitoring/observation:

☐ CM1 ☑ CM2 ☐ CM3 ☐ CM4 ☐ CM5 (Engineering Categories) or ☐ as per agreement with owner/developer (Architectural)

I, Franzwa Jooste …………… am: ☑ CPEng 232746 # ☐ Reg Arch …………… #
(Name of Design Professional)

I am a member of: ☑ Engineering New Zealand ☐ NZIA and hold the following qualifications: BE (Hons), CMEngNZ, CPEng, IntPE
The Design Firm issuing this statement holds a current policy of Professional Indemnity Insurance no less than $200,000*.
The Design Firm is a member of ACENZ: ☐

SIGNED BY Franzwa Jooste ……………(Signature) Jooste
(Name of Design Professional)

ON BEHALF OF Redco NZ Ltd ……………Date 21/02/2018
(Design Firm)

Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Firm only. The total maximum amount of damages payable arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), 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.

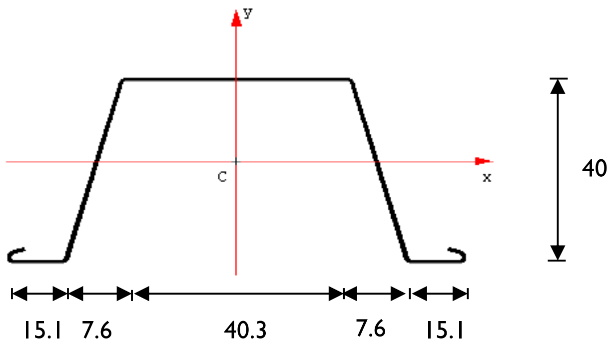
Client **Batten Manufacturers Limited** **23 Mar '18**

Project **PS1 for 40mm Tophat** Project No. **18053**

Design Summary (NZBC B1)

Description

RB4055 and RB4075 steel purlins are manufactured from 0.55mm and 0.75mm G550 Z275 . They have the following dimensions:



Compliance

The steel purlins 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 1170:2011 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 AS/NZS 1170:2011 .
• Steel purlins designed 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

RB4055 and RB4075 steel purlins can replace all sizes of timber prulin in Table 13.1 of NZS3604:2011 . Steel purlins must span over four supports (three continous spans)

Loading

• RB4055 and RB4075 steel purlins are designed to csupport lightweight roof with a maximum weight of 8kg/m².
• Designed for roof live load of 0.25kPa
•Designed for roof point load of 1.1kN (minimum sharing between 2 purlins)
• Designed for up to Extra High Wind (55 m/s)

Fixing

Substrate	**Recommended Fastener**
Timber (J5, Radiata pine)	2/12-11 x 40 screw fastener
Steel (0.55mm)	3/12-11 x 40mm screws for purlin @ 1200mm spacing in E.H wind zone
	2/12-11 x 40mm screws, 3 threads penetration minimum.

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NEW ZEALAND STEEL

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/m² (Z275) or 450g/m² (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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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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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	1st Coat			2nd Coat			3rd Coat			Total nominal DFT 3 (µm)
		Type	PRN 1	Nominal DFT 2 (µm)	Type	PRN1	Nominal DFT 2 (µm)	Type	PRN1	Nominal DFT 2 (µm)	
P1	Degrease, wash and dry	Acrylic dispersion paint		40	Acrylic dispersion paint4		40				80
P2		Galvanised iron acrylic primer		40	Acrylic dispersion paint4		40				80
P35		Etch primer		12	Acrylic elastomeric		350				362
P45	Sweep abrasive blast	Polyamide cured epoxy primer	C10	75	High build epoxy	13	200	Acrylic 2-pack	C33	50	325
P55								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

a) 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.
b) NZS 3404 Part 1, *Steel Structures Standard 2009;* Standards New Zealand.
c) 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.*
d) Clifton, G.C. and El Sarraf, R. *New Zealand Steelwork Corrosion Coatings Guide* (HERA Report R4-133) 2005.
e) Compliance Document for New Zealand Building Code – Clause E2 – External Moisture

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Table 2

Galvsteel™ durability statement

	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	1	2	3	3
5km to 50km from salt water	East coast of both islands, South coast of North Island and all harbours.		1	1	1	2	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

Summary Tables

Wind Speed	Spacings (mm) - Maxmimum Span (mm) For RB4075 Purlin			
	300 spacings	600 spacings	900 spacings	1200 spacings
EH (55 M/S)	1200	1000	800	700*
VH (50 M/S)	1200	1000	900	800
H (44 M/S)	1200	1100	1000	900
M (37 M/S)	1200	1200	1100	1000

Wind Speed	Spacings (mm) - Maxmimum Span (mm) For RB4055 Purlin			
	300 spacings	600 spacings	900 spacings	1200 spacings
EH (55 M/S)	1100	800	700	600
VH (50 M/S)	1100	900	800	700
H (44 M/S)	1100	1000	900	800
M (37 M/S)	1100	1000	1000	900

Notes:

- * Purlin span requires 3/12-11 x 40mm screws into 0.55mm (minimum) B.M.T steel substrate.

- All other purlin spans will have minimum 2/12-11 x 40mm screws into 0.55mm (minimum) B.M.T steel substrate or 40mm thick timber substrate.

- Purlins are designed for a roof with maximum pitch of 30 degrees.

- Purlins are designed to span continuously over minimum 4 supports (Triple spans).

- Maximum cantilever overhang for soffit takes 40% maximum supported span.

- Purlins are specifically designed to meet the critical loading combinations in AS/NZS1170:2011.

- The design is based on a local wind pressure, kl = 2.0

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4075 See Appendix D for effective length calculation

Spacing, s = 1200 mm Span, L = 700 mm L_e = 600 mm

Batten properties from CFSM - DSM - See Appendix A L_{e+} = 560 mm

ϕM_{bx+} = 0.186 kN.m (compression in legs) ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.85 kg/m ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.8 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.10 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.30 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

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

Wind speed = 55 m/s

$q_u(z)$ = 1.82 kPa combination factor, k_c = 0.9

$q_s(z)$ = 1.22 kPa Local factor, k_l = 2

C_{pt} = 0.63 or -1 NASH standard Part 1 a = 3.2 m

$W_{u(up)}$ = -1.82 kPa => -3.92 kN/m Average, k_l = 2

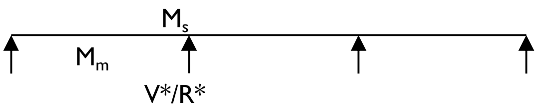
$W_{u(down)}$ = 1.14 kPa => 2.47 kN/m See appendix D for calculation

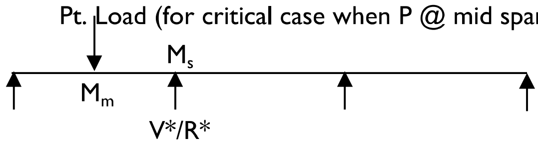
$W_{s(up)}$ = -1.22 kPa => -2.63 kN/m

$W_{s(down)}$ = 0.77 kPa => 1.65 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span) Pt. Load (for critical case when P @ mid span)





Bending moment, M	0.08	-0.10	X	W L^2	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	W L^4 / E I		0.015	X	P L^3 / E I
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.14		0.01		0.01	-0.01		-0.01	0.06		2%	4%	0%	OK
1.2G+1.5Q	0.58		0.02		0.02	-0.03		-0.03	0.25		8%	15%	2%	OK
$1.2G+1.5Q_p$	0.13	0.83	0.00	0.12	0.12	-0.01	-0.06	-0.06	0.88		42%	34%	6%	OK
$0.9G_{min} + W_{u(up)}$	-3.65		-0.14		-0.14	0.18		0.18	-1.58	-2.81	77%	62%	11%	OK
$1.2G_{max} + W_{u(down)}$	2.60		0.10		0.10	-0.13		-0.13	1.12		35%	68%	8%	OK

# of screws required in steel substrate = 3

Serviceability **# of screws required in timber substrate = 2**

Loadcase	Load		Deflections, Δ (mm)			Span ratio,	Limit	Check
	UDL	P	UDL	PL	Total	L/Δ (mm)		
G	0.10		0.1		0.1	13842	300	OK
Q	0.30	0.70	0.1	0.8	0.8	886	300	OK
$G + W_{s(up)}$	-2.52		-1.2		-1.2	573	150	OK
$W_{s(down)}$	1.65		0.8		0.8	873	150	OK

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4075 See Appendix D for effective length calculation

Spacing, s = 900 mm Span, L = 900 mm L_e = 750 mm

Batten properties from CFSM - DSM - See Appendix A L_{e+} = 720 mm

ϕM_{bx+} = 0.155 kN.m (compression in legs) ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.850 kg/m ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.08 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.23 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

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

Wind speed = 55 m/s

$q_u(z)$ = 1.82 kPa combination factor, k_c = 0.9

$q_s(z)$ = 1.22 kPa Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 a = 3.2 m

$W_{u(up)}$ = -1.82 kPa => -2.61 kN/m Average, kl = 1.8

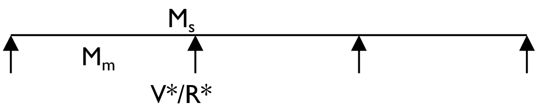
$W_{u(down)}$ = 1.14 kPa => 1.65 kN/m See appendix D for calculation

$W_{s(up)}$ = -1.22 kPa => -1.75 kN/m

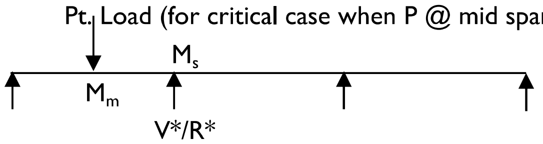
$W_{s(down)}$ = 0.77 kPa => 1.10 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	×	W L^2	0.20	-0.10	×	P L
Deflection, Δ		0.009	×	W L^4 / E I		0.015	×	P L^3 / E I
Shear Force, V*		0.617	×	W L		1.000	×	P
Hold down (up lift only), R*		1.100	×	W L		1.000	×	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.11		0.01		0.01	-0.01		-0.01	0.06		2%	6%	0%	OK
1.2G+1.5Q	0.43		0.03		0.03	-0.04		-0.04	0.24		10%	23%	2%	OK
$1.2G+1.5Q_p$	0.10	0.83	0.01	0.15	0.15	-0.01	-0.07	-0.08	0.88		53%	53%	6%	OK
$0.9G_{min} + W_{u(up)}$	-2.41		-0.16		-0.16	0.20		0.20	-1.34	-2.39	101%	67%	9%	OK
$1.2G_{max} + W_{u(down)}$	1.74		0.11		0.11	-0.14		-0.14	0.97		39%	91%	7%	OK

# of screws required in steel substrate = 2

Serviceability

# of screws required in timber substrate = 2

Loadcase	Load		Deflections, Δ (mm)			Span ratio,	Limit	Check
	UDL	P	UDL	PL	Total	L/Δ (mm)		
G	0.08		0.1		0.1	8459	300	OK
Q	0.23	0.70	0.3	1.7	1.7	536	300	OK
$G + W_{s(up)}$	-1.67		-2.2		-2.2	407	150	OK
$W_{s(down)}$	1.10		1.5		1.5	616	150	OK

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4075 See Appendix D for effective length calculation

Spacing, s = 600 mm Span, L = 1100 mm L_e = 900 mm

Batten properties from CFSM - DSM - See Appendix A L_{e+} = 880 mm

ϕM_{bx+} = 0.133 kN.m (compression in legs) ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.850 kg/m ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.06 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.15 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

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

Wind speed = 55 m/s

$q_u(z)$ = 1.82 kPa combination factor, k_c = 0.9

$q_s(z)$ = 1.22 kPa Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 a = 3.2 m

$W_{u(up)}$ = -1.82 kPa => -1.47 kN/m Average, kl = 1.5

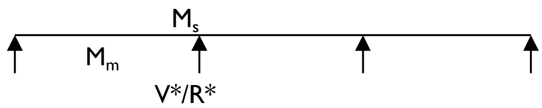
$W_{u(down)}$ = 1.14 kPa => 0.93 kN/m See appendix D for calculation

$W_{s(up)}$ = -1.22 kPa => -0.99 kN/m

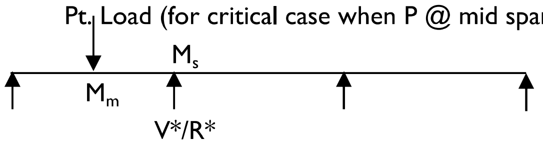
$W_{s(down)}$ = 0.77 kPa => 0.62 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	X	W L^2	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	W L^4 / E I		0.015	X	P L^3 / E I
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.08		0.01		0.01	-0.01		-0.01	0.05		3%	7%	0%	OK
1.2G+1.5Q	0.29		0.03		0.03	-0.04		-0.04	0.20		10%	27%	1%	OK
$1.2G+1.5Q_p$	0.07	0.83	0.01	0.18	0.19	-0.01	-0.09	-0.10	0.87		65%	74%	6%	OK
$0.9G_{min} + W_{u(up)}$	-1.34		-0.13		-0.13	0.16		0.16	-0.91	-1.62	97%	56%	6%	OK
$1.2G_{max} + W_{u(down)}$	0.99		0.10		0.10	-0.12		-0.12	0.67		33%	90%	5%	OK

# of screws required in steel substrate = 2

Serviceability

# of screws required in timber substrate = 1

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.06		0.2		0.2	6606	300	OK
Q	0.15	0.70	0.4	3.1	3.1	359	300	OK
$G + W_{s(up)}$	-0.93		-2.7		-2.7	401	150	OK
$W_{s(down)}$	0.62		1.8		1.8	600	150	OK

CALCULATIONS

Client: **Batten Manufacturers Limited** — **23 Mar '18**

Project: **PS1 for 40mm Tophat** — Project No. **18053**

Roof Purlins - RB4075 — See Appendix D for effective length calculation

Spacing, s = 300 mm — Span, L = 1200 mm — L_e = 1000 mm

Batten properties from CFSM - DSM - See Appendix A — L_{e+} = 960 mm

ϕM_{bx+} = 0.121 kN.m (compression in legs) — ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $\times 10^6 mm^4$ — E = 2.00E+05 MPa

SW = 0.850 kg/m — ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.03 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.08 kN/m

P = 1.10 kN => 0.37 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 3 NASH standard P1

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

Wind speed = 55 m/s

$q_u(z)$ = 1.82 kPa — combination factor, k_c = 0.9

$q_s(z)$ = 1.22 kPa — Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 — a = 3.2 m

$W_{u(up)}$ = -1.82 kPa => -0.74 kN/m — Average, kl = 1.5

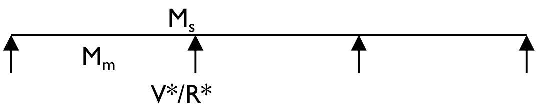
$W_{u(down)}$ = 1.14 kPa => 0.46 kN/m — See appendix D for calculation

$W_{s(up)}$ = -1.22 kPa => -0.49 kN/m

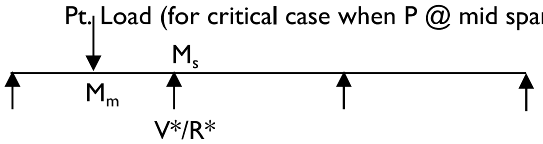
$W_{s(down)}$ = 0.77 kPa => 0.31 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	X	$W L^2$	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	$W L^4 / E I$		0.015	X	$P L^3 / E I$
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.04		0.01		0.01	-0.01		-0.01	0.03		2%	5%	0%	OK
1.2G+1.5Q	0.15		0.02		0.02	-0.02		-0.02	0.11		6%	18%	1%	OK
$1.2G+1.5Q_p$	0.04	0.55	0.00	0.13	0.14	-0.01	-0.07	-0.07	0.58		47%	59%	4%	OK
$0.9G_{min} + W_{u(up)}$	-0.67		-0.08		-0.08	0.10		0.10	-0.49	-0.88	64%	33%	3%	OK
$1.2G_{max} + W_{u(down)}$	0.50		0.06		0.06	-0.07		-0.07	0.37		20%	60%	3%	OK

# of screws required in steel substrate = 1

Serviceability

# of screws required in timber substrate = 1

Loadcase	Load		Deflections, Δ (mm)			Span ratio,	Limit	Check
	UDL	P	UDL	PL	Total	L/Δ (mm)		
G	0.03		0.1		0.1	8865	300	OK
Q	0.08	0.70	0.3	4.0	4.0	301	300	OK
$G + W_{s(up)}$	-0.46		-1.9		-1.9	623	150	OK
$W_{s(down)}$	0.31		1.3		1.3	924	150	OK

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4075 See Appendix D for effective length calculation

Spacing, s = 1200 mm Span, L = 800 mm L_e = 650 mm

Batten properties from CFSM - DSM - See Appendix A L_{e+} = 640 mm

ϕM_{bx+} = 0.174 kN.m (compression in legs) ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.850 kg/m ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.10 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.30 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = Very High (from NZS 3406:2011)

Wind speed = 50 m/s

$q_u(z)$ = 1.50 kPa combination factor, k_c = 0.9

$q_s(z)$ = 1.01 kPa Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 a = 3.2 m

$W_{u(up)}$ = -1.50 kPa => -3.24 kN/m Average, kl = 2.0

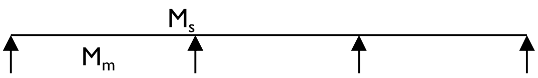
$W_{u(down)}$ = 0.95 kPa => 2.04 kN/m See appendix D for calculation

$W_{s(up)}$ = -1.01 kPa => -2.17 kN/m

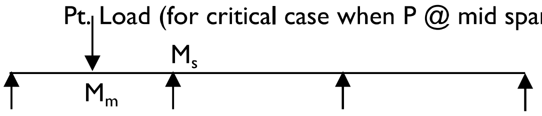
$W_{s(down)}$ = 0.63 kPa => 1.37 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	X	$W L^2$	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	$W L^4 / E I$		0.015	X	$P L^3 / E I$
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.14		0.01		0.01	-0.01		-0.01	0.07		2%	5%	0%	**OK**
1.2G+1.5Q	0.58		0.03		0.03	-0.04		-0.04	0.28		10%	21%	2%	**OK**
$1.2G+1.5Q_p$	0.13	0.83	0.01	0.13	0.14	-0.01	-0.07	-0.07	0.89		48%	43%	6%	**OK**
$0.9G_{min} + W_{u(up)}$	-2.97		-0.15		-0.15	0.19		0.19	-1.47	-2.61	87%	66%	10%	**OK**
$1.2G_{max} + W_{u(down)}$	2.17		0.11		0.11	-0.14		-0.14	1.07		38%	80%	7%	**OK**

# of screws required in steel substrate = 2

Serviceability **# of screws required in timber substrate =** 2

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.10		0.1		0.1	9273	300	**OK**
Q	0.30	0.70	0.2	1.2	1.2	678	300	**OK**
$G + W_{s(up)}$	-2.07		-1.7		-1.7	468	150	**OK**
$W_{s(down)}$	1.37		1.1		1.1	707	150	**OK**

Client: **Batten Manufacturers Limited** — **23 Mar '18**

Project: **PS1 for 40mm Tophat** — Project No. **18053**

Roof Purlins - RB4075 — See Appendix D for effective length calculation

Spacing, s = 900 mm — Span, L = 1000 mm — L_e = 800 mm

Batten properties from CFSM - DSM - See Appendix A — L_{e+} = 800 mm

ϕM_{bx+} = 0.146 kN.m (compression in legs) — ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $\times 10^6 mm^4$ — E = 2.00E+05 MPa

SW = 0.850 kg/m — ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.08 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.23 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = Very High (from NZS 3406:2011)

Wind speed = 50 m/s

$q_u(z)$ = 1.50 kPa — combination factor, k_c = 0.9

$q_s(z)$ = 1.01 kPa — Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 — a = 3.2 m

$W_{u(up)}$ = -1.50 kPa => -1.94 kN/m — Average, kl = 1.6

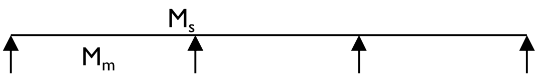
$W_{u(down)}$ = 0.95 kPa => 1.22 kN/m — See appendix D for calculation

$W_{s(up)}$ = -1.01 kPa => -1.30 kN/m

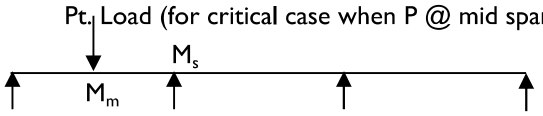
$W_{s(down)}$ = 0.63 kPa => 0.82 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	x	$W L^2$	0.20	-0.10	x	P L
Deflection, Δ		0.009	x	$W L^4 / E I$		0.015	x	$P L^3 / E I$
Shear Force, V*		0.617	x	W L		1.000	x	P
Hold down (up lift only), R*		1.100	x	W L		1.000	x	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.11		0.01		0.01	-0.01		-0.01	0.07		3%	7%	0%	OK
1.2G+1.5Q	0.43		0.03		0.03	-0.04		-0.04	0.27		12%	30%	2%	OK
$1.2G+1.5Q_p$	0.10	0.83	0.01	0.17	0.17	-0.01	-0.08	-0.09	0.88		60%	63%	6%	OK
$0.9G_{min} + W_{u(up)}$	-1.74		-0.14		-0.14	0.17		0.17	-1.07	-1.92	95%	60%	7%	OK
$1.2G_{max} + W_{u(down)}$	1.32		0.11		0.11	-0.13		-0.13	0.82		36%	90%	6%	OK

# of screws required in steel substrate = 2

Serviceability — **# of screws required in timber substrate = 2**

Loadcase	Load		Deflections, Δ (mm)			Span ratio,	Limit	Check
	UDL	P	UDL	PL	Total	L/Δ (mm)		
G	0.08		0.2		0.2	6166	300	OK
Q	0.23	0.70	0.5	2.3	2.3	434	300	OK
$G + W_{s(up)}$	-1.22		-2.5		-2.5	405	150	OK
$W_{s(down)}$	0.82		1.7		1.7	604	150	OK

CALCULATIONS

Client: **Batten Manufacturers Limited** — **23 Mar '18**

Project: **PS1 for 40mm Tophat** — Project No. **18053**

Roof Purlins - RB4075 — See Appendix D for effective length calculation

Spacing, s = 600 mm — Span, L = 1200 mm — L_e = 1000 mm

Batten properties from CFSM - DSM - See Appendix A — L_{e+} = 960 mm

ϕM_{bx+} = 0.121 kN.m (compression in legs) — ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $x10^6 mm^4$ — E = 2.00E+05 MPa

SW = 0.850 kg/m — ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.06 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.15 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = Very High (from NZS 3406:2011)

Wind speed = 50 m/s

$q_u(z)$ = 1.50 kPa — combination factor, k_c = 0.9

$q_s(z)$ = 1.01 kPa — Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 — a = 3.2 m

$W_{u(up)}$ = -1.50 kPa => -1.22 kN/m — Average, kl = 1.5

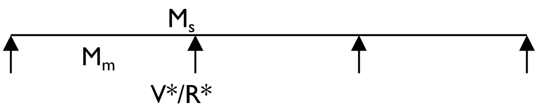
$W_{u(down)}$ = 0.95 kPa => 0.77 kN/m — See appendix D for calculation

$W_{s(up)}$ = -1.01 kPa => -0.81 kN/m

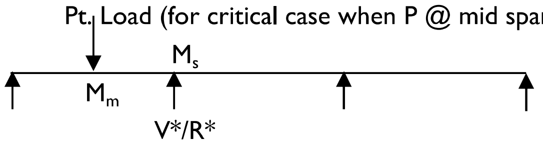
$W_{s(down)}$ = 0.63 kPa => 0.51 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	X	$W L^2$	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	$W L^4 / E I$		0.015	X	$P L^3 / E I$
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.08		0.01		0.01	-0.01		-0.01	0.06		3%	9%	0%	**OK**
1.2G+1.5Q	0.29		0.03		0.03	-0.04		-0.04	0.22		12%	35%	1%	**OK**
$1.2G+1.5Q_p$	0.07	0.83	0.01	0.20	0.21	-0.01	-0.10	-0.11	0.88		71%	90%	6%	**OK**
$0.9G_{min} + W_{u(up)}$	-1.08		-0.12		-0.12	0.16		0.16	-0.80	-1.43	103%	54%	5%	**OK**
$1.2G_{max} + W_{u(down)}$	0.83		0.10		0.10	-0.12		-0.12	0.62		33%	99%	4%	**OK**

# of screws required in steel substrate = 2

Serviceability

# of screws required in timber substrate = 1

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.06		0.2		0.2	5089	300	**OK**
Q	0.15	0.70	0.6	4.0	4.0	301	300	**OK**
$G + W_{s(up)}$	-0.76		-3.2		-3.2	378	150	**OK**
$W_{s(down)}$	0.51		2.1		2.1	559	150	**OK**

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4075 See Appendix D for effective length calculation

Spacing, s = 300 mm Span, L = 1200 mm L_e = 1000 mm

Batten properties from CFSM - DSM - See Appendix A L_{e+} = 960 mm

ϕM_{bx+} = 0.121 kN.m (compression in legs) ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.850 kg/m ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.03 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.08 kN/m

P = 1.10 kN => 0.37 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 3 NASH standard P1

Wind: Wind Zone = Very High (from NZS 3406:2011)

Wind speed = 50 m/s

$q_u(z)$ = 1.50 kPa combination factor, k_c = 0.9

$q_s(z)$ = 1.01 kPa Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 a = 3.2 m

$W_{u(up)}$ = -1.50 kPa => -0.61 kN/m Average, kl = 1.5

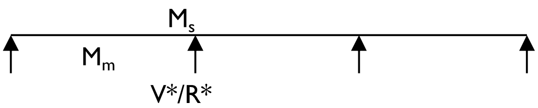
$W_{u(down)}$ = 0.95 kPa => 0.38 kN/m See appendix D for calculation

$W_{s(up)}$ = -1.01 kPa => -0.41 kN/m

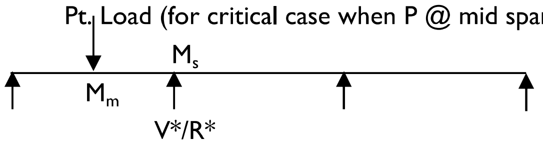
$W_{s(down)}$ = 0.63 kPa => 0.26 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



Bending moment, M	0.08	-0.10	X	$W L^2$	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	$W L^4 / E I$		0.015	X	$P L^3 / E I$
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.04		0.01		0.01	-0.01		-0.01	0.03		2%	5%	0%	OK
1.2G+1.5Q	0.15		0.02		0.02	-0.02		-0.02	0.11		6%	18%	1%	OK
$1.2G+1.5Q_P$	0.04	0.55	0.00	0.13	0.14	-0.01	-0.07	-0.07	0.58		47%	59%	4%	OK
$0.9G_{min} + W_{u(up)}$	-0.54		-0.06		-0.06	0.08		0.08	-0.40	-0.71	51%	27%	3%	OK
$1.2G_{max} + W_{u(down)}$	0.42		0.05		0.05	-0.06		-0.06	0.31		17%	50%	2%	OK

# of screws required in steel substrate = 1

Serviceability **# of screws required in timber substrate = 1**

Loadcase	Load		Deflections, Δ (mm)			Span ratio,	Limit	Check
	UDL	P	UDL	PL	Total	L/Δ (mm)		
G	0.03		0.1		0.1	8865	300	OK
Q	0.08	0.70	0.3	4.0	4.0	301	300	OK
$G + W_{s(up)}$	-0.37		-1.6		-1.6	765	150	OK
$W_{s(down)}$	0.26		1.1		1.1	1118	150	OK

adding 'enginuity' to building projects

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4075 See Appendix D for effective length calculation

Spacing, s = 1200 mm Span, L = 1000 mm L_e = 800 mm

Batten properties from CFSM - DSM - See Appendix A L_{e+} = 800 mm

ϕM_{bx+} = 0.146 kN.m (compression in legs) ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $x10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.850 kg/m ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.10 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.30 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = High (from NZS 3406:2011)

Wind speed = 44 m/s

$q_u(z)$ = 1.16 kPa combination factor, k_c = 0.9

$q_s(z)$ = 0.78 kPa Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 a = 3.2 m

$W_{u(up)}$ = -1.16 kPa => -2.01 kN/m Average, kl = 1.6

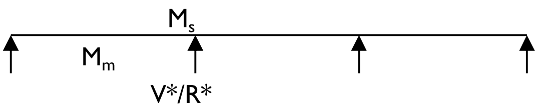
$W_{u(down)}$ = 0.73 kPa => 1.26 kN/m See appendix D for calculation

$W_{s(up)}$ = -0.78 kPa => -1.34 kN/m

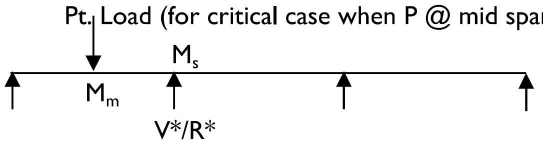
$W_{s(down)}$ = 0.49 kPa => 0.85 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



Bending moment, M	0.08	-0.10	x	$W L^2$	0.20	-0.10	x	P L
Deflection, Δ		0.009	x	$W L^4 / E I$		0.015	x	$P L^3 / E I$
Shear Force, V*		0.617	x	W L		1.000	x	P
Hold down (up lift only), R*		1.100	x	W L		1.000	x	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.14		0.01		0.01	-0.01		-0.01	0.09		4%	10%	1%	**OK**
1.2G+1.5Q	0.58		0.05		0.05	-0.06		-0.06	0.35		16%	39%	2%	**OK**
$1.2G+1.5Q_p$	0.13	0.83	0.01	0.17	0.18	-0.01	-0.08	-0.10	0.90		60%	65%	6%	**OK**
$0.9G_{min} + W_{u(up)}$	-1.74		-0.14		-0.14	0.17		0.17	-1.07	-1.91	95%	60%	7%	**OK**
$1.2G_{max} + W_{u(down)}$	1.39		0.11		0.11	-0.14		-0.14	0.86		38%	95%	6%	**OK**

# of screws required in steel substrate = 2

Serviceability

# of screws required in timber substrate = 2

Loadcase	Load		Deflections, Δ (mm)			Span ratio,	Limit	Check
	UDL	P	UDL	PL	Total	L/Δ (mm)		
G	0.10		0.2		0.2	4748	300	**OK**
Q	0.30	0.70	0.6	2.3	2.3	434	300	**OK**
$G + W_{s(up)}$	-1.24		-2.5		-2.5	399	150	**OK**
$W_{s(down)}$	0.85		1.7		1.7	585	150	**OK**

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4075 See Appendix D for effective length calculation

Spacing, s = 900 mm Span, L = 1100 mm L_e = 900 mm

Batten properties from CFSM - DSM - See Appendix A L_{e+} = 880 mm

ϕM_{bx+} = 0.133 kN.m (compression in legs) ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.850 kg/m ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.08 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.23 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = High (from NZS 3406:2011)

Wind speed = 44 m/s

$q_u(z)$ = 1.16 kPa combination factor, k_c = 0.9

$q_s(z)$ = 0.78 kPa Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 a = 3.2 m

$W_{u(up)}$ = -1.16 kPa => -1.41 kN/m Average, kl = 1.5

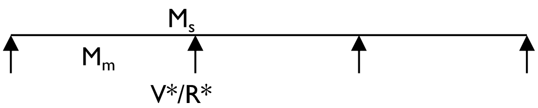
$W_{u(down)}$ = 0.73 kPa => 0.89 kN/m See appendix D for calculation

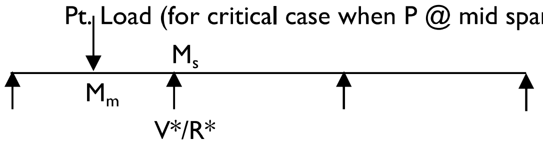
$W_{s(up)}$ = -0.78 kPa => -0.95 kN/m

$W_{s(down)}$ = 0.49 kPa => 0.60 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span) Pt. Load (for critical case when P @ mid span)





	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	×	$W L^2$	0.20	-0.10	×	P L
Deflection, Δ		0.009	×	$W L^4 / E I$		0.015	×	$P L^3 / E I$
Shear Force, V*		0.617	×	W L		1.000	×	P
Hold down (up lift only), R*		1.100	×	W L		1.000	×	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.11		0.01		0.01	-0.01		-0.01	0.07		4%	10%	0%	**OK**
1.2G+1.5Q	0.43		0.04		0.04	-0.05		-0.05	0.29		14%	39%	2%	**OK**
$1.2G+1.5Q_p$	0.10	0.83	0.01	0.18	0.19	-0.01	-0.09	-0.10	0.89		66%	77%	6%	**OK**
$0.9G_{min} + W_{u(up)}$	-1.21		-0.12		-0.12	0.15		0.15	-0.82	-1.46	88%	50%	6%	**OK**
$1.2G_{max} + W_{u(down)}$	0.99		0.10		0.10	-0.12		-0.12	0.67		33%	90%	5%	**OK**

# of screws required in steel substrate = 2

Serviceability

# of screws required in timber substrate = 1

Loadcase	Load		Deflections, Δ (mm)			Span ratio,	Limit	Check
	UDL	P	UDL	PL	Total	L/Δ (mm)		
G	0.08		0.2		0.2	4633	300	**OK**
Q	0.23	0.70	0.7	3.1	3.1	359	300	**OK**
$G + W_{s(up)}$	-0.87		-2.6		-2.6	430	150	**OK**
$W_{s(down)}$	0.60		1.8		1.8	625	150	**OK**

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4075 See Appendix D for effective length calculation

Spacing, s = 600 mm | Span, L = 1200 mm | L_e = 1000 mm

Batten properties from CFSM - DSM - See Appendix A | L_{e+} = 960 mm

ϕM_{bx+} = 0.121 kN.m (compression in legs) | ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $\times 10^6 mm^4$ | E = 2.00E+05 MPa

SW = 0.850 kg/m | ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.06 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.15 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = High (from NZS 3406:2011)

Wind speed = 44 m/s

$q_u(z)$ = 1.16 kPa | combination factor, k_c = 0.9

$q_s(z)$ = 0.78 kPa | Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 | a = 3.2 m

$W_{u(up)}$ = -1.16 kPa => -0.94 kN/m | Average, kl = 1.5

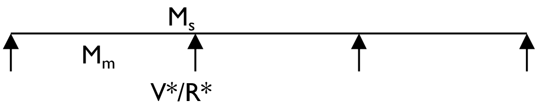
$W_{u(down)}$ = 0.73 kPa => 0.59 kN/m | See appendix D for calculation

$W_{s(up)}$ = -0.78 kPa => -0.63 kN/m

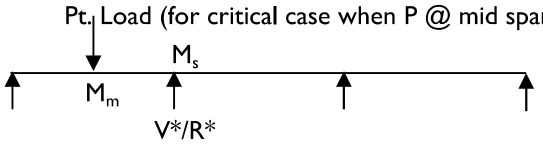
$W_{s(down)}$ = 0.49 kPa => 0.40 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



Bending moment, M	0.08	-0.10	X	$W L^2$	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	$W L^4 / E I$		0.015	X	$P L^3 / E I$
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.08		0.01		0.01	-0.01		-0.01	0.06		3%	9%	0%	OK
1.2G+1.5Q	0.29		0.03		0.03	-0.04		-0.04	0.22		12%	35%	1%	OK
$1.2G+1.5Q_p$	0.07	0.83	0.01	0.20	0.21	-0.01	-0.10	-0.11	0.88		71%	90%	6%	OK
$0.9G_{min} + W_{u(up)}$	-0.81		-0.09		-0.09	0.12		0.12	-0.60	-1.06	77%	40%	4%	OK
$1.2G_{max} + W_{u(down)}$	0.66		0.08		0.08	-0.10		-0.10	0.49		26%	79%	3%	OK

# of screws required in steel substrate = 1

Serviceability **# of screws required in timber substrate = 1**

Loadcase	Load		Deflections, Δ (mm)			Span ratio,	Limit	Check
	UDL	P	UDL	PL	Total	L/Δ (mm)		
G	0.06		0.2		0.2	5089	300	OK
Q	0.15	0.70	0.6	4.0	4.0	301	300	OK
$G + W_{s(up)}$	-0.57		-2.4		-2.4	499	150	OK
$W_{s(down)}$	0.40		1.7		1.7	722	150	OK

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4075 See Appendix D for effective length calculation

Spacing, s = 300 mm Span, L = 1200 mm L_e = 1000 mm

Batten properties from CFSM - DSM - See Appendix A L_{e+} = 960 mm

ϕM_{bx+} = 0.121 kN.m (compression in legs) ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.850 kg/m ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.03 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.08 kN/m

P = 1.10 kN => 0.37 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 3 NASH standard P1

Wind: Wind Zone = High (from NZS 3406:2011)

Wind speed = 44 m/s

$q_u(z)$ = 1.16 kPa combination factor, k_c = 0.9

$q_s(z)$ = 0.78 kPa Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 a = 3.2 m

$W_{u(up)}$ = -1.16 kPa => -0.47 kN/m Average, kl = 1.5

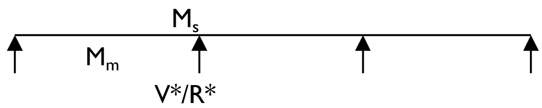
$W_{u(down)}$ = 0.73 kPa => 0.30 kN/m See appendix D for calculation

$W_{s(up)}$ = -0.78 kPa => -0.32 kN/m

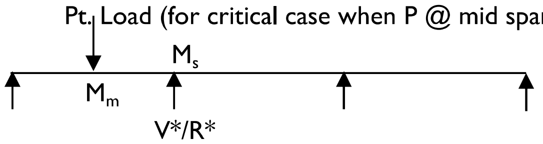
$W_{s(down)}$ = 0.49 kPa => 0.20 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL M_m	UDL M_s / coeff.		UDL term	Pt. M_m	Pt. M_s / coeff.		Pt. term
Bending moment, M	0.08	-0.10	X	$W L^2$	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	$W L^4 / E I$		0.015	X	$P L^3 / E I$
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load UDL	Load P	Mid span Moment UDL	Mid span Moment PL	Mid span Moment Total	M@support (kNm) UDL	M@support (kNm) PL	M@support (kNm) Total	V* kN	R* kN	% M Mid	% M Sup	%V Sup	Check
$1.35G_{max}$	0.04		0.01		0.01	-0.01		-0.01	0.03		2%	5%	0%	OK
1.2G+1.5Q	0.15		0.02		0.02	-0.02		-0.02	0.11		6%	18%	1%	OK
$1.2G+1.5Q_p$	0.04	0.55	0.00	0.13	0.14	-0.01	-0.07	-0.07	0.58		47%	59%	4%	OK
$0.9G_{min} + W_{u(up)}$	-0.40		-0.05		-0.05	0.06		0.06	-0.30	-0.53	38%	20%	2%	OK
$1.2G_{max} + W_{u(down)}$	0.34		0.04		0.04	-0.05		-0.05	0.25		13%	40%	2%	OK

# of screws required in steel substrate = 1

Serviceability **# of screws required in timber substrate = 1**

Loadcase	Load UDL	Load P	Deflections, Δ (mm) UDL	Deflections, Δ (mm) PL	Deflections, Δ (mm) Total	Span ratio, L/Δ (mm)	Limit	Check
G	0.03		0.1		0.1	8865	300	OK
Q	0.08	0.70	0.3	4.0	4.0	301	300	OK
$G + W_{s(up)}$	-0.28		-1.2		-1.2	1014	150	OK
$W_{s(down)}$	0.20		0.8		0.8	1444	150	OK

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4075 See Appendix D for effective length calculation

Spacing, s = 1200 mm Span, L = 1100 mm L_e = 900 mm

Batten properties from CFSM - DSM - See Appendix A L_{e+} = 880 mm

ϕM_{bx+} = 0.133 kN.m (compression in legs) ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $x10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.850 kg/m ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.10 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.30 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = Medium (from NZS 3406:2011)

Wind speed = 37 m/s

$q_u(z)$ = 0.82 kPa combination factor, k_c = 0.9

$q_s(z)$ = 0.55 kPa Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 a = 3.2 m

$W_{u(up)}$ = -0.82 kPa => -1.33 kN/m Average, kl = 1.5

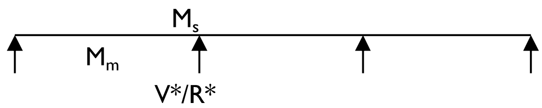
$W_{u(down)}$ = 0.52 kPa => 0.84 kN/m See appendix D for calculation

$W_{s(up)}$ = -0.55 kPa => -0.89 kN/m

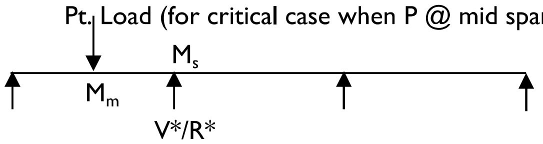
$W_{s(down)}$ = 0.35 kPa => 0.56 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	X	$W L^2$	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	$W L^4 / E I$		0.015	X	$P L^3 / E I$
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.14		0.01		0.01	-0.02		-0.02	0.10		5%	13%	1%	OK
1.2G+1.5Q	0.58		0.06		0.06	-0.07		-0.07	0.39		19%	52%	3%	OK
$1.2G+1.5Q_p$	0.13	0.83	0.01	0.18	0.19	-0.02	-0.09	-0.11	0.91		67%	80%	6%	OK
$0.9G_{min} + W_{u(up)}$	-1.06		-0.10		-0.10	0.13		0.13	-0.72	-1.28	77%	44%	5%	OK
$1.2G_{max} + W_{u(down)}$	0.96		0.09		0.09	-0.12		-0.12	0.65		32%	88%	4%	OK

# of screws required in steel substrate = 1

Serviceability **# of screws required in timber substrate = 1**

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.10		0.3		0.3	3567	300	OK
Q	0.30	0.70	0.9	3.1	3.1	359	300	OK
$G + W_{s(up)}$	-0.79		-2.3		-2.3	473	150	OK
$W_{s(down)}$	0.56		1.7		1.7	663	150	OK

Roof Purlins - RB4075 — See Appendix D for effective length calculation

Spacing, s = 900 mm — Span, L = 1200 mm — L_e = 1000 mm

Batten properties from CFSM - DSM - See Appendix A — L_{e+} = 960 mm

ϕM_{bx+} = 0.121 kN.m (compression in legs) — ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $\times 10^6 mm^4$ — E = 2.00E+05 MPa

SW = 0.850 kg/m — ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.08 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.23 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = Medium (from NZS 3406:2011)

Wind speed = 37 m/s

$q_u(z)$ = 0.82 kPa — combination factor, k_c = 0.9

$q_s(z)$ = 0.55 kPa — Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 — a = 3.2 m

$W_{u(up)}$ = -0.82 kPa => -1.00 kN/m — Average, kl = 1.5

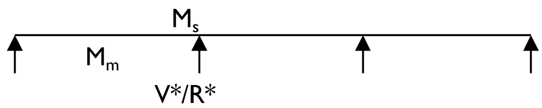
$W_{u(down)}$ = 0.52 kPa => 0.63 kN/m — See appendix D for calculation

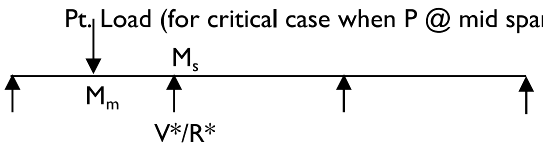
$W_{s(up)}$ = -0.55 kPa => -0.67 kN/m

$W_{s(down)}$ = 0.35 kPa => 0.42 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span) — Pt. Load (for critical case when P @ mid span)





	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	X	$W L^2$	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	$W L^4 / E I$		0.015	X	$P L^3 / E I$
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.11		0.01		0.01	-0.02		-0.02	0.08		4%	13%	1%	OK
1.2G+1.5Q	0.43		0.05		0.05	-0.06		-0.06	0.32		17%	52%	2%	OK
$1.2G+1.5Q_P$	0.10	0.83	0.01	0.20	0.21	-0.01	-0.10	-0.11	0.90		72%	93%	6%	OK
$0.9G_{min} + W_{u(up)}$	-0.80		-0.09		-0.09	0.11		0.11	-0.59	-1.05	76%	40%	4%	OK
$1.2G_{max} + W_{u(down)}$	0.73		0.08		0.08	-0.10		-0.10	0.54		29%	86%	4%	OK

# of screws required in steel substrate = 1

Serviceability — **# of screws required in timber substrate = 1**

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.08		0.3		0.3	3568	300	OK
Q	0.23	0.70	0.9	4.0	4.0	301	300	OK
$G + W_{s(up)}$	-0.59		-2.5		-2.5	487	150	OK
$W_{s(down)}$	0.42		1.8		1.8	681	150	OK

Roof Purlins - RB4075

See Appendix D for effective length calculation

Spacing, s = 600 mm | Span, L = 1200 mm | L_e = 1000 mm

Batten properties from CFSM - DSM - See Appendix A | L_{e+} = 960 mm

ϕM_{bx+} = 0.121 kN.m (compression in legs) | ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $\times 10^6 mm^4$ | E = 2.00E+05 MPa

SW = 0.850 kg/m | ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.06 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.15 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = Medium (from NZS 3406:2011)

Wind speed = 37 m/s

$q_u(z)$ = 0.82 kPa | combination factor, k_c = 0.9

$q_s(z)$ = 0.55 kPa | Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 | a = 3.2 m

$W_{u(up)}$ = -0.82 kPa => -0.67 kN/m | Average, kl = 1.5

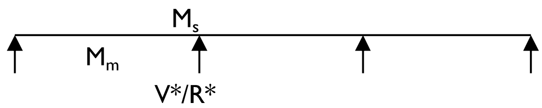
$W_{u(down)}$ = 0.52 kPa => 0.42 kN/m | See appendix D for calculation

$W_{s(up)}$ = -0.55 kPa => -0.45 kN/m

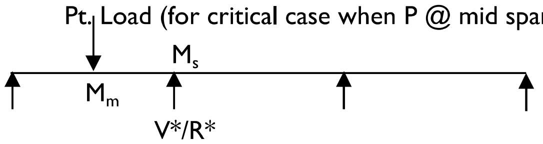
$W_{s(down)}$ = 0.35 kPa => 0.28 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	X	$W L^2$	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	$W L^4 / E I$		0.015	X	$P L^3 / E I$
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.08		0.01		0.01	-0.01		-0.01	0.06		3%	9%	0%	OK
1.2G+1.5Q	0.29		0.03		0.03	-0.04		-0.04	0.22		12%	35%	1%	OK
$1.2G+1.5Q_p$	0.07	0.83	0.01	0.20	0.21	-0.01	-0.10	-0.11	0.88		71%	90%	6%	OK
$0.9G_{min} + W_{u(up)}$	-0.53		-0.06		-0.06	0.08		0.08	-0.39	-0.70	50%	26%	3%	OK
$1.2G_{max} + W_{u(down)}$	0.49		0.06		0.06	-0.07		-0.07	0.36		19%	58%	2%	OK

# of screws required in steel substrate = 1

Serviceability

# of screws required in timber substrate = 1

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.06		0.2		0.2	5089	300	OK
Q	0.15	0.70	0.6	4.0	4.0	301	300	OK
$G + W_{s(up)}$	-0.39		-1.6		-1.6	736	150	OK
$W_{s(down)}$	0.28		1.2		1.2	1021	150	OK

Roof Purlins - RB4075 See Appendix D for effective length calculation

Spacing, s = 300 mm | Span, L = 1200 mm | L_e = 1000 mm

Batten properties from CFSM - DSM - See Appendix A | L_{e+} = 960 mm

ϕM_{bx+} = 0.121 kN.m (compression in legs) | ϕM_{bx-} = 0.29 kN.m (compression in flat)

I_x = 0.023 $\times 10^6 mm^4$ | E = 2.00E+05 MPa

SW = 0.850 kg/m | ϕV_{vx} = 14.8 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.03 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.08 kN/m

P = 1.10 kN => 0.37 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 3 NASH standard P1

Wind: Wind Zone = Medium (from NZS 3406:2011)

Wind speed = 37 m/s

$q_u(z)$ = 0.82 kPa | combination factor, k_c = 0.9

$q_s(z)$ = 0.55 kPa | Local factor, kl = 2

C_{pt} = 0.63 or -1.0 NASH standard Part 1 | a = 3.2 m

$W_{u(up)}$ = -0.82 kPa => -0.33 kN/m | Average, kl = 1.5

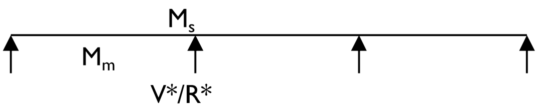
$W_{u(down)}$ = 0.52 kPa => 0.21 kN/m | See appendix D for calculation

$W_{s(up)}$ = -0.55 kPa => -0.22 kN/m

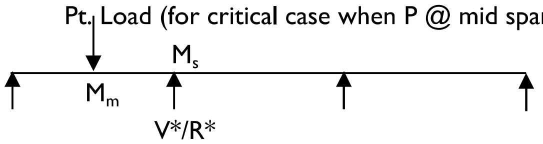
$W_{s(down)}$ = 0.35 kPa => 0.14 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	X	$W L^2$	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	$W L^4 / E I$		0.015	X	$P L^3 / E I$
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.04		0.01		0.01	-0.01		-0.01	0.03		2%	5%	0%	**OK**
1.2G+1.5Q	0.15		0.02		0.02	-0.02		-0.02	0.11		6%	18%	1%	**OK**
$1.2G+1.5Q_p$	0.04	0.55	0.00	0.13	0.14	-0.01	-0.07	-0.07	0.58		47%	59%	4%	**OK**
$0.9G_{min} + W_{u(up)}$	-0.27		-0.03		-0.03	0.04		0.04	-0.20	-0.35	25%	13%	1%	**OK**
$1.2G_{max} + W_{u(down)}$	0.25		0.03		0.03	-0.04		-0.04	0.18		10%	30%	1%	**OK**

# of screws required in steel substrate = 1

Serviceability

# of screws required in timber substrate = 1

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.03		0.1		0.1	8865	300	**OK**
Q	0.08	0.70	0.3	4.0	4.0	301	300	**OK**
$G + W_{s(up)}$	-0.19		-0.8		-0.8	1505	150	**OK**
$W_{s(down)}$	0.14		0.6		0.6	2042	150	**OK**

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 1200 mm Span, L = 600 mm L_e = 500 mm

Batten properties from CFSM - DSM - See Appendix B (0.8L) L_{e+} = 480 mm (0.8L)

ϕM_{bx+} = 0.156 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.63 kg/m ϕV_{vx} = 8.085 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.8 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.10 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.30 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

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} = 0.63 or -1 NASH standard Part 1

$W_{u(up)}$ = -1.82 kPa => -3.92 kN/m Local factor, k_l = 2

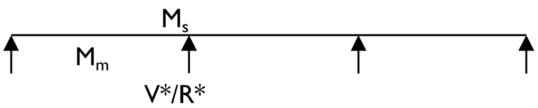
$W_{u(down)}$ = 1.14 kPa => 2.47 kN/m combination factor, k_c = 0.9

$W_{s(up)}$ = -1.22 kPa => -2.63 kN/m

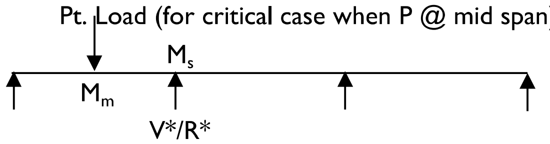
$W_{s(down)}$ = 0.77 kPa => 1.65 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	X	$W L^2$	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	$W L^4 / E I$		0.015	X	$P L^3 / E I$
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.14		0.00		0.00	0.00		0.00	0.05		2%	3%	1%	OK
1.2G+1.5Q	0.57		0.02		0.02	-0.02		-0.02	0.21		10%	13%	3%	OK
$1.2G+1.5Q_p$	0.12	0.83	0.00	0.10	0.10	0.00	-0.05	-0.05	0.87		60%	35%	11%	OK
$0.9G_{min} + W_{u(up)}$	-3.65		-0.11		-0.11	0.13		0.13	-1.35	-2.41	67%	77%	17%	OK
$1.2G_{max} + W_{u(down)}$	2.59		0.07		0.07	-0.09		-0.09	0.96		44%	60%	12%	OK

# of screws required in steel substrate = 2

Serviceability **# of screws required in timber substrate = 2**

Loadcase	Load		Deflections, Δ (mm)			Span ratio,	Limit	Check
	UDL	P	UDL	PL	Total	L/Δ (mm)		
G	0.10		0.0		0.0	19273	300	OK
Q	0.30	0.70	0.1	0.6	0.6	1035	300	OK
$G + W_{s(up)}$	-2.52		-0.8		-0.8	780	150	OK
$W_{s(down)}$	1.65		0.5		0.5	1190	150	OK

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 900 mm Span, L = 700 mm L_e = 600 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 560 mm (0.8L)

ϕM_{bx+} = 0.134 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $x10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.08 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.23 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

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} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -1.82 kPa => -2.94 kN/m Local factor, kl = 2

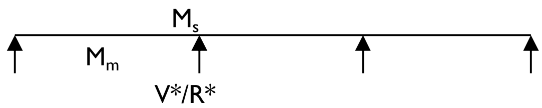
$W_{u(down)}$ = 1.14 kPa => 1.85 kN/m combination factor, kc = 0.9

$W_{s(up)}$ = -1.22 kPa => -1.97 kN/m

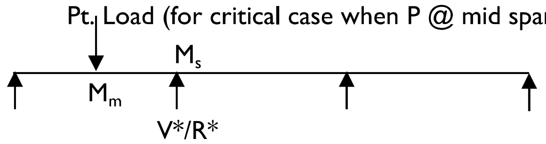
$W_{s(down)}$ = 0.77 kPa => 1.24 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	X	$W L^2$	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	$W L^4 / E I$		0.015	X	$P L^3 / E I$
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.11		0.00		0.00	-0.01		-0.01	0.05		2%	4%	1%	OK
1.2G+1.5Q	0.43		0.02		0.02	-0.02		-0.02	0.19		10%	16%	2%	OK
$1.2G+1.5Q_P$	0.09	0.83	0.00	0.12	0.12	0.00	-0.06	-0.06	0.87		70%	47%	11%	OK
$0.9G_{min} + W_{u(up)}$	-2.74		-0.11		-0.11	0.13		0.13	-1.18	-2.11	80%	79%	15%	OK
$1.2G_{max} + W_{u(down)}$	1.95		0.08		0.08	-0.10		-0.10	0.84		45%	71%	10%	OK

# of screws required in steel substrate = 2

Serviceability **# of screws required in timber substrate =** 2

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.08		0.0		0.0	15863	300	OK
Q	0.23	0.70	0.1	0.9	0.9	761	300	OK
$G + W_{s(up)}$	-1.89		-1.1		-1.1	656	150	OK
$W_{s(down)}$	1.24		0.7		0.7	999	150	OK

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 600 mm Span, L = 800 mm L_e = 650 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 640 mm (0.8L)

ϕM_{bx+} = 0.125 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.05 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.15 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

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} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -1.82 kPa => -1.96 kN/m Local factor, kl = 2

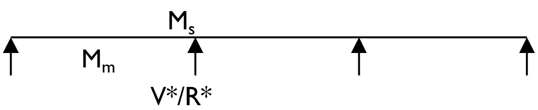
$W_{u(down)}$ = 1.14 kPa => 1.23 kN/m combination factor, kc = 0.9

$W_{s(up)}$ = -1.22 kPa => -1.31 kN/m

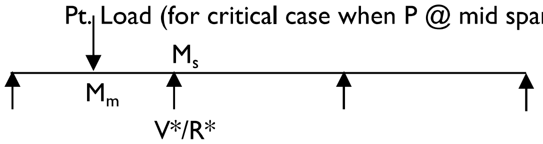
$W_{s(down)}$ = 0.77 kPa => 0.83 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	x	$W L^2$	0.20	-0.10	x	P L
Deflection, Δ		0.009	x	$W L^4 / E I$		0.015	x	$P L^3 / E I$
Shear Force, V*		0.617	x	W L		1.000	x	P
Hold down (up lift only), R*		1.100	x	W L		1.000	x	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.07		0.00		0.00	0.00		0.00	0.04		2%	4%	0%	**OK**
1.2G+1.5Q	0.29		0.01		0.01	-0.02		-0.02	0.14		9%	15%	2%	**OK**
$1.2G+1.5Q_p$	0.07	0.83	0.00	0.13	0.14	0.00	-0.07	-0.07	0.86		80%	56%	11%	**OK**
$0.9G_{min} + W_{u(up)}$	-1.83		-0.09		-0.09	0.12		0.12	-0.90	-1.61	75%	69%	11%	**OK**
$1.2G_{max} + W_{u(down)}$	1.30		0.07		0.07	-0.08		-0.08	0.64		39%	67%	8%	**OK**

# of screws required in steel substrate = 2

# of screws required in timber substrate = 1

Serviceability

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.05		0.1		0.1	15334	300	**OK**
Q	0.15	0.70	0.1	1.4	1.4	582	300	**OK**
$G + W_{s(up)}$	-1.26		-1.2		-1.2	660	150	**OK**
$W_{s(down)}$	0.83		0.8		0.8	1004	150	**OK**

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 300 mm Span, L = 1100 mm L_e = 900 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 880 mm (0.8L)

ϕM_{bx+} = 0.095 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.03 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.08 kN/m

P = 1.10 kN => 0.37 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 3 NASH standard P1

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} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -1.82 kPa => -0.98 kN/m Local factor, kl = 2

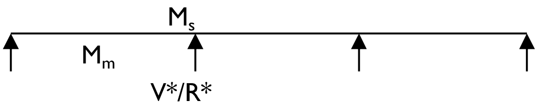
$W_{u(down)}$ = 1.14 kPa => 0.62 kN/m combination factor, kc = 0.9

$W_{s(up)}$ = -1.22 kPa => -0.66 kN/m

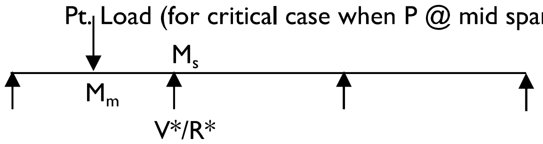
$W_{s(down)}$ = 0.77 kPa => 0.41 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	x	W L^2	0.20	-0.10	x	P L
Deflection, Δ		0.009	x	W L^4 / E I		0.015	x	P L^3 / E I
Shear Force, V*		0.617	x	W L		1.000	x	P
Hold down (up lift only), R*		1.100	x	W L		1.000	x	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.04		0.00		0.00	0.00		0.00	0.03		2%	5%	0%	**OK**
1.2G+1.5Q	0.15		0.01		0.01	-0.02		-0.02	0.10		8%	19%	1%	**OK**
$1.2G+1.5Q_p$	0.04	0.55	0.00	0.12	0.12	0.00	-0.06	-0.06	0.57		73%	68%	7%	**OK**
$0.9G_{min} + W_{u(up)}$	-0.91		-0.09		-0.09	0.11		0.11	-0.62	-1.10	93%	65%	8%	**OK**
$1.2G_{max} + W_{u(down)}$	0.65		0.06		0.06	-0.08		-0.08	0.44		37%	83%	5%	**OK**

# of screws required in steel substrate = 1

Serviceability

# of screws required in timber substrate = 1

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.03		0.1		0.1	10589	300	**OK**
Q	0.08	0.70	0.3	3.6	3.6	308	300	**OK**
$G + W_{s(up)}$	-0.63		-2.2		-2.2	510	150	**OK**
$W_{s(down)}$	0.41		1.4		1.4	773	150	**OK**

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 1200 mm Span, L = 700 mm L_e = 600 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 560 mm (0.8L)

ϕM_{bx+} = 0.134 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.10 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.30 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = Very High (from NZS 3406:2011)

Wind speed = 50 m/s

$q_u(z)$ = 1.50 kPa

$q_s(z)$ = 1.01 kPa

C_{pt} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -1.50 kPa => -3.24 kN/m Local factor, kl = 2

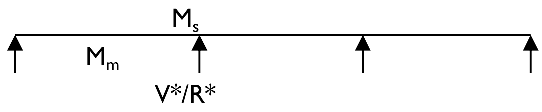
$W_{u(down)}$ = 0.95 kPa => 2.04 kN/m combination factor, kc = 0.9

$W_{s(up)}$ = -1.01 kPa => -2.17 kN/m

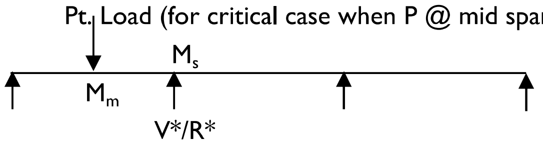
$W_{s(down)}$ = 0.63 kPa => 1.37 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	x	$W L^2$	0.20	-0.10	x	P L
Deflection, Δ		0.009	x	$W L^4 / E I$		0.015	x	$P L^3 / E I$
Shear Force, V*		0.617	x	W L		1.000	x	P
Hold down (up lift only), R*		1.100	x	W L		1.000	x	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.14		0.01		0.01	-0.01		-0.01	0.06		3%	5%	1%	**OK**
1.2G+1.5Q	0.57		0.02		0.02	-0.03		-0.03	0.25		13%	21%	3%	**OK**
$1.2G+1.5Q_p$	0.12	0.83	0.00	0.12	0.12	-0.01	-0.06	-0.06	0.88		71%	48%	11%	**OK**
$0.9G_{min} + W_{u(up)}$	-2.97		-0.12		-0.12	0.15		0.15	-1.28	-2.29	87%	86%	16%	**OK**
$1.2G_{max} + W_{u(down)}$	2.16		0.08		0.08	-0.11		-0.11	0.93		50%	79%	12%	**OK**

# of screws required in steel substrate = 2

Serviceability **# of screws required in timber substrate = 2**

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.10		0.1		0.1	12137	300	**OK**
Q	0.30	0.70	0.2	0.9	0.9	761	300	**OK**
$G + W_{s(up)}$	-2.07		-1.2		-1.2	600	150	**OK**
$W_{s(down)}$	1.37		0.8		0.8	907	150	**OK**

Roof Purlins - RB4055   See Appendix D for effective length calculation

Spacing, s = 900 mm   Span, L = 800 mm L_e = 650 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 640 mm (0.8L)

ϕM_{bx+} = 0.125 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.08 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.23 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = Very High (from NZS 3406:2011)

Wind speed = 50 m/s

$q_u(z)$ = 1.50 kPa

$q_s(z)$ = 1.01 kPa

C_{pt} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -1.50 kPa => -2.43 kN/m   Local factor, kl = 2

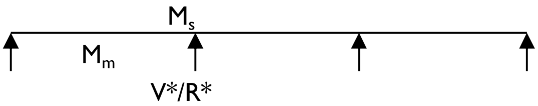
$W_{u(down)}$ = 0.95 kPa => 1.53 kN/m   combination factor, kc = 0.9

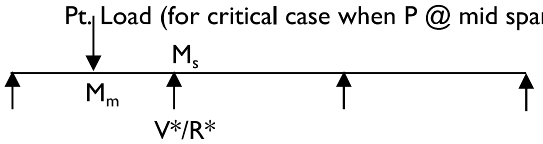
$W_{s(up)}$ = -1.01 kPa => -1.63 kN/m

$W_{s(down)}$ = 0.63 kPa => 1.03 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)   Pt. Load (for critical case when P @ mid span)





Bending moment, M	0.08	-0.10	x	W L^2	0.20	-0.10	x	P L
Deflection, Δ		0.009	x	W L^4 / E I		0.015	x	P L^3 / E I
Shear Force, V*		0.617	x	W L		1.000	x	P
Hold down (up lift only), R*		1.100	x	W L		1.000	x	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.11		0.01		0.01	-0.01		-0.01	0.05		3%	5%	1%	OK
1.2G+1.5Q	0.43		0.02		0.02	-0.03		-0.03	0.21		13%	22%	3%	OK
$1.2G+1.5Q_p$	0.09	0.83	0.00	0.13	0.14	-0.01	-0.07	-0.07	0.87		80%	58%	11%	OK
$0.9G_{min} + W_{u(up)}$	-2.23		-0.11		-0.11	0.14		0.14	-1.10	-1.96	91%	84%	14%	OK
$1.2G_{max} + W_{u(down)}$	1.62		0.08		0.08	-0.10		-0.10	0.80		49%	83%	10%	OK

# of screws required in steel substrate = 2

Serviceability

# of screws required in timber substrate = 2

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.08		0.1		0.1	10627	300	OK
Q	0.23	0.70	0.2	1.4	1.4	582	300	OK
$G + W_{s(up)}$	-1.55		-1.5		-1.5	536	150	OK
$W_{s(down)}$	1.03		1.0		1.0	810	150	OK

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 600 mm Span, L = 900 mm L_e = 750 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 720 mm (0.8L)

ϕM_{bx+} = 0.111 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.05 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.15 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = Very High (from NZS 3406:2011)

Wind speed = 50 m/s

$q_u(z)$ = 1.50 kPa

$q_s(z)$ = 1.01 kPa

C_{pt} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -1.50 kPa => -1.62 kN/m Local factor, kl = 2

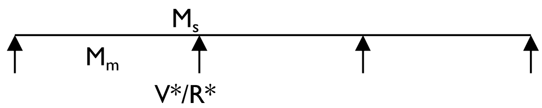
$W_{u(down)}$ = 0.95 kPa => 1.02 kN/m combination factor, kc = 0.9

$W_{s(up)}$ = -1.01 kPa => -1.09 kN/m

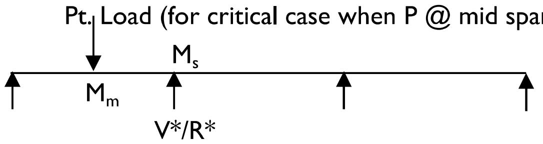
$W_{s(down)}$ = 0.63 kPa => 0.68 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	X	$W L^2$	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	$W L^4 / E I$		0.015	X	$P L^3 / E I$
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.07		0.00		0.00	-0.01		-0.01	0.04		3%	5%	1%	OK
1.2G+1.5Q	0.29		0.02		0.02	-0.02		-0.02	0.16		11%	21%	2%	OK
$1.2G+1.5Q_p$	0.07	0.83	0.00	0.15	0.15	-0.01	-0.07	-0.08	0.86		90%	72%	11%	OK
$0.9G_{min} + W_{u(up)}$	-1.49		-0.10		-0.10	0.12		0.12	-0.82	-1.47	87%	71%	10%	OK
$1.2G_{max} + W_{u(down)}$	1.09		0.07		0.07	-0.09		-0.09	0.60		41%	79%	7%	OK

# of screws required in steel substrate = 2

Serviceability

# of screws required in timber substrate = 1

Loadcase	Load		Deflections, Δ (mm)			Span ratio,	Limit	Check
	UDL	P	UDL	PL	Total	L/Δ (mm)		
G	0.05		0.1		0.1	10770	300	OK
Q	0.15	0.70	0.2	2.0	2.0	460	300	OK
$G + W_{s(up)}$	-1.03		-1.6		-1.6	566	150	OK
$W_{s(down)}$	0.68		1.1		1.1	853	150	OK

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 300 mm Span, L = 1100 mm L_e = 900 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 880 mm (0.8L)

ϕM_{bx+} = 0.095 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.03 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.08 kN/m

P = 1.10 kN => 0.37 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 3 NASH standard P1

Wind: Wind Zone = Very High (from NZS 3406:2011)

Wind speed = 50 m/s

$q_u(z)$ = 1.50 kPa

$q_s(z)$ = 1.01 kPa

C_{pt} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -1.50 kPa => -0.81 kN/m Local factor, kl = 2

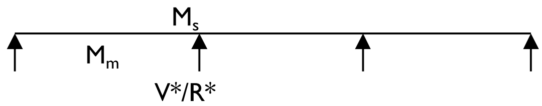
$W_{u(down)}$ = 0.95 kPa => 0.51 kN/m combination factor, kc = 0.9

$W_{s(up)}$ = -1.01 kPa => -0.54 kN/m

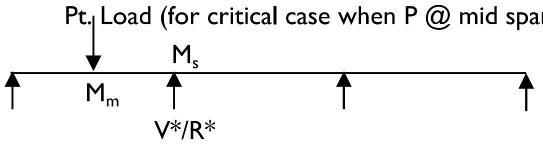
$W_{s(down)}$ = 0.63 kPa => 0.34 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	x	W L^2	0.20	-0.10	x	P L
Deflection, Δ		0.009	x	W L^4 / E I		0.015	x	P L^3 / E I
Shear Force, V*		0.617	x	W L		1.000	x	P
Hold down (up lift only), R*		1.100	x	W L		1.000	x	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.04		0.00		0.00	0.00		0.00	0.03		2%	5%	0%	**OK**
1.2G+1.5Q	0.15		0.01		0.01	-0.02		-0.02	0.10		8%	19%	1%	**OK**
$1.2G+1.5Q_p$	0.04	0.55	0.00	0.12	0.12	0.00	-0.06	-0.06	0.57		73%	68%	7%	**OK**
$0.9G_{min} + W_{u(up)}$	-0.74		-0.07		-0.07	0.09		0.09	-0.50	-0.90	76%	53%	6%	**OK**
$1.2G_{max} + W_{u(down)}$	0.55		0.05		0.05	-0.07		-0.07	0.37		31%	70%	5%	**OK**

# of screws required in steel substrate = 1

Serviceability **# of screws required in timber substrate = 1**

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.03		0.1		0.1	10589	300	**OK**
Q	0.08	0.70	0.3	3.6	3.6	308	300	**OK**
$G + W_{s(up)}$	-0.51		-1.8		-1.8	624	150	**OK**
$W_{s(down)}$	0.34		1.2		1.2	935	150	**OK**

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 1200 mm Span, L = 800 mm L_e = 650 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 640 mm (0.8L)

ϕM_{bx+} = 0.125 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.10 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.30 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = High (from NZS 3406:2011)

Wind speed = 44 m/s

$q_u(z)$ = 1.16 kPa

$q_s(z)$ = 0.78 kPa

C_{pt} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -1.16 kPa => -2.51 kN/m Local factor, kl = 2

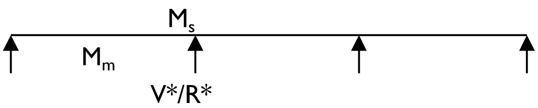
$W_{u(down)}$ = 0.73 kPa => 1.58 kN/m combination factor, kc = 0.9

$W_{s(up)}$ = -0.78 kPa => -1.68 kN/m

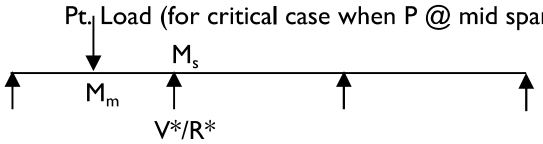
$W_{s(down)}$ = 0.49 kPa => 1.06 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	x	W L²	0.20	-0.10	x	P L
Deflection, Δ		0.009	x	W L⁴ / E I		0.015	x	P L³ / E I
Shear Force, V*		0.617	x	W L		1.000	x	P
Hold down (up lift only), R*		1.100	x	W L		1.000	x	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.14		0.01		0.01	-0.01		-0.01	0.07		4%	7%	1%	OK
1.2G+1.5Q	0.57		0.03		0.03	-0.04		-0.04	0.28		17%	29%	3%	OK
$1.2G+1.5Q_p$	0.12	0.83	0.01	0.13	0.14	-0.01	-0.07	-0.07	0.89		81%	59%	11%	OK
$0.9G_{min} + W_{u(up)}$	-2.24		-0.11		-0.11	0.14		0.14	-1.11	-1.97	92%	84%	14%	OK
$1.2G_{max} + W_{u(down)}$	1.70		0.09		0.09	-0.11		-0.11	0.84		51%	87%	10%	OK

# of screws required in steel substrate = 2

Serviceability

# of screws required in timber substrate = 2

Loadcase	Load		Deflections, Δ (mm)			Span ratio,	Limit	Check
	UDL	P	UDL	PL	Total	L/Δ (mm)		
G	0.10		0.1		0.1	8131	300	OK
Q	0.30	0.70	0.3	1.4	1.4	582	300	OK
$G + W_{s(up)}$	-1.58		-1.5		-1.5	526	150	OK
$W_{s(down)}$	1.06		1.0		1.0	784	150	OK

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 900 mm Span, L = 900 mm L_e = 750 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 720 mm (0.8L)

ϕM_{bx+} = 0.111 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.08 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.23 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = High (from NZS 3406:2011)

Wind speed = 44 m/s

$q_u(z)$ = 1.16 kPa

$q_s(z)$ = 0.78 kPa

C_{pt} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -1.16 kPa => -1.88 kN/m Local factor, kl = 2

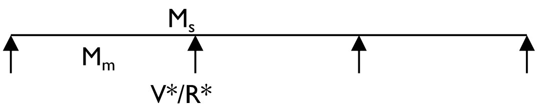
$W_{u(down)}$ = 0.73 kPa => 1.19 kN/m combination factor, kc = 0.9

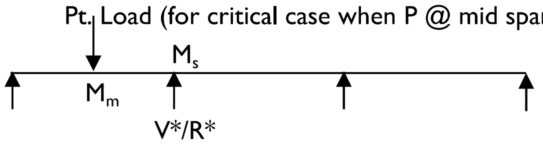
$W_{s(up)}$ = -0.78 kPa => -1.26 kN/m

$W_{s(down)}$ = 0.49 kPa => 0.79 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span) Pt. Load (for critical case when P @ mid span)





Bending moment, M	0.08	-0.10	X	W L²	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	W L⁴ / E I		0.015	X	P L³ / E I
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.11		0.01		0.01	-0.01		-0.01	0.06		4%	8%	1%	OK
1.2G+1.5Q	0.43		0.03		0.03	-0.03		-0.03	0.24		16%	31%	3%	OK
$1.2G+1.5Q_p$	0.09	0.83	0.01	0.15	0.15	-0.01	-0.07	-0.08	0.88		91%	74%	11%	OK
$0.9G_{min} + W_{u(up)}$	-1.68		-0.11		-0.11	0.14		0.14	-0.93	-1.66	98%	80%	12%	OK
$1.2G_{max} + W_{u(down)}$	1.28		0.08		0.08	-0.10		-0.10	0.71		49%	93%	9%	OK

# of screws required in steel substrate = 2

Serviceability **# of screws required in timber substrate = 1**

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.08		0.1		0.1	7463	300	OK
Q	0.23	0.70	0.3	2.0	2.0	460	300	OK
$G + W_{s(up)}$	-1.18		-1.8		-1.8	493	150	OK
$W_{s(down)}$	0.79		1.2		1.2	735	150	OK

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 600 mm Span, L = 1000 mm L_e = 800 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 800 mm (0.8L)

ϕM_{bx+} = 0.105 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

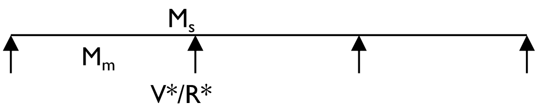
Dead	G =	0.08 kPa	=>	0.05 kN/m	(includes self weight of purlin)
	Q =	0.25 kPa	=>	0.15 kN/m	
	P =	1.10 kN	=>	0.55 kN	per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

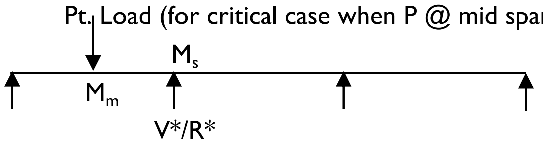
Wind:	Wind Zone =	High	(from NZS 3406:2011)			
	Wind speed =	44 m/s				
	$q_u(z)$ =	1.16 kPa				
	$q_s(z)$ =	0.78 kPa				
	C_{pt} =	0.63	or	-1.0 NASH standard Part 1		
	$W_{u(up)}$ =	-1.16 kPa	=>	-1.25 kN/m	Local factor, kl =	2
	$W_{u(down)}$ =	0.73 kPa	=>	0.79 kN/m	combination factor, kc =	0.9
	$W_{s(up)}$ =	-0.78 kPa	=>	-0.84 kN/m		
	$W_{s(down)}$ =	0.49 kPa	=>	0.53 kN/m		

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	x	$W L^2$	0.20	-0.10	x	P L
Deflection, Δ		0.009	x	$W L^4 / E I$		0.015	x	$P L^3 / E I$
Shear Force, V*		0.617	x	W L		1.000	x	P
Hold down (up lift only), R*		1.100	x	W L		1.000	x	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.07		0.01		0.01	-0.01		-0.01	0.05		3%	7%	1%	OK
1.2G+1.5Q	0.29		0.02		0.02	-0.03		-0.03	0.18		14%	28%	2%	OK
$1.2G+1.5Q_p$	0.07	0.83	0.01	0.17	0.17	-0.01	-0.08	-0.09	0.87		100%	85%	11%	OK
$0.9G_{min} + W_{u(up)}$	-1.12		-0.09		-0.09	0.11		0.11	-0.69	-1.23	85%	66%	9%	OK
$1.2G_{max} + W_{u(down)}$	0.86		0.07		0.07	-0.09		-0.09	0.53		40%	81%	7%	OK

# of screws required in steel substrate = 1

Serviceability **# of screws required in timber substrate = 1**

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.05		0.1		0.1	7851	300	OK
Q	0.15	0.70	0.4	2.7	2.7	373	300	OK
$G + W_{s(up)}$	-0.79		-1.8		-1.8	541	150	OK
$W_{s(down)}$	0.53		1.2		1.2	803	150	OK

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 300 mm Span, L = 1100 mm L_e = 900 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 880 mm (0.8L)

ϕM_{bx+} = 0.095 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.03 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.08 kN/m

P = 1.10 kN => 0.37 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 3 NASH standard P1

Wind: Wind Zone = High (from NZS 3406:2011)

Wind speed = 44 m/s

$q_u(z)$ = 1.16 kPa

$q_s(z)$ = 0.78 kPa

C_{pt} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -1.16 kPa => -0.63 kN/m Local factor, kl = 2

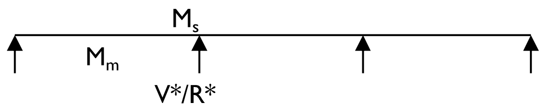
$W_{u(down)}$ = 0.73 kPa => 0.40 kN/m combination factor, kc = 0.9

$W_{s(up)}$ = -0.78 kPa => -0.42 kN/m

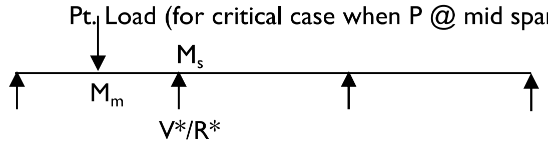
$W_{s(down)}$ = 0.49 kPa => 0.26 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



Bending moment, M	0.08	-0.10	x	$W L^2$	0.20	-0.10	x	P L
Deflection, Δ		0.009	x	$W L^4 / E I$		0.015	x	$P L^3 / E I$
Shear Force, V*		0.617	x	W L		1.000	x	P
Hold down (up lift only), R*		1.100	x	W L		1.000	x	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.04		0.00		0.00	0.00		0.00	0.03		2%	5%	0%	OK
1.2G+1.5Q	0.15		0.01		0.01	-0.02		-0.02	0.10		8%	19%	1%	OK
$1.2G+1.5Q_p$	0.04	0.55	0.00	0.12	0.12	0.00	-0.06	-0.06	0.57		73%	68%	7%	OK
$0.9G_{min} + W_{u(up)}$	-0.56		-0.05		-0.05	0.07		0.07	-0.38	-0.68	57%	40%	5%	OK
$1.2G_{max} + W_{u(down)}$	0.43		0.04		0.04	-0.05		-0.05	0.29		25%	55%	4%	OK

# of screws required in steel substrate = 1

Serviceability **# of screws required in timber substrate = 1**

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.03		0.1		0.1	10589	300	OK
Q	0.08	0.70	0.3	3.6	3.6	308	300	OK
$G + W_{s(up)}$	-0.39		-1.3		-1.3	819	150	OK
$W_{s(down)}$	0.26		0.9		0.9	1207	150	OK

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 1200 mm Span, L = 900 mm L_e = 750 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 720 mm (0.8L)

ϕM_{bx+} = 0.111 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.10 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.30 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = Medium (from NZS 3406:2011)

Wind speed = 37 m/s

$q_u(z)$ = 0.82 kPa

$q_s(z)$ = 0.55 kPa

C_{pt} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -0.82 kPa => -1.77 kN/m Local factor, kl = 2

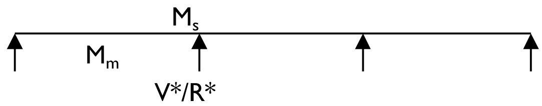
$W_{u(down)}$ = 0.52 kPa => 1.12 kN/m combination factor, kc = 0.9

$W_{s(up)}$ = -0.55 kPa => -1.19 kN/m

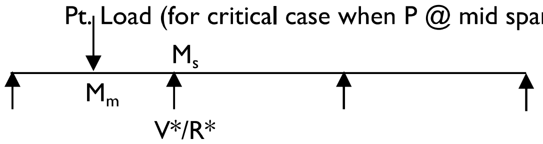
$W_{s(down)}$ = 0.35 kPa => 0.75 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



Bending moment, M	0.08	-0.10	x	$W L^2$	0.20	-0.10	x	P L
Deflection, Δ		0.009	x	$W L^4 / E I$		0.015	x	$P L^3 / E I$
Shear Force, V*		0.617	x	W L		1.000	x	P
Hold down (up lift only), R*		1.100	x	W L		1.000	x	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.14		0.01		0.01	-0.01		-0.01	0.08		5%	10%	1%	OK
1.2G+1.5Q	0.57		0.04		0.04	-0.05		-0.05	0.32		22%	42%	4%	OK
$1.2G+1.5Q_p$	0.12	0.83	0.01	0.15	0.16	-0.01	-0.07	-0.08	0.89		92%	76%	11%	OK
$0.9G_{min} + W_{u(up)}$	-1.50		-0.10		-0.10	0.12		0.12	-0.84	-1.49	88%	72%	10%	OK
$1.2G_{max} + W_{u(down)}$	1.24		0.08		0.08	-0.10		-0.10	0.69		47%	91%	9%	OK

# of screws required in steel substrate = 2

Serviceability **# of screws required in timber substrate =** 1

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.10		0.2		0.2	5710	300	OK
Q	0.30	0.70	0.5	2.0	2.0	460	300	OK
$G + W_{s(up)}$	-1.09		-1.7		-1.7	537	150	OK
$W_{s(down)}$	0.75		1.2		1.2	779	150	OK

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 900 mm Span, L = 1000 mm L_e = 800 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 800 mm (0.8L)

ϕM_{bx+} = 0.105 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.08 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.23 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = Medium (from NZS 3406:2011)

Wind speed = 37 m/s

$q_u(z)$ = 0.82 kPa

$q_s(z)$ = 0.55 kPa

C_{pt} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -0.82 kPa => -1.33 kN/m Local factor, kl = 2

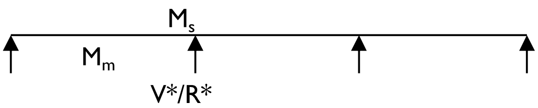
$W_{u(down)}$ = 0.52 kPa => 0.84 kN/m combination factor, kc = 0.9

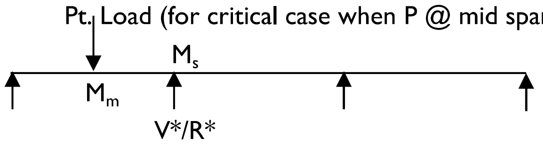
$W_{s(up)}$ = -0.55 kPa => -0.89 kN/m

$W_{s(down)}$ = 0.35 kPa => 0.56 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span) Pt. Load (for critical case when P @ mid span)





	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	x	$W L^2$	0.20	-0.10	x	P L
Deflection, Δ		0.009	x	$W L^4 / E I$		0.015	x	$P L^3 / E I$
Shear Force, V*		0.617	x	W L		1.000	x	P
Hold down (up lift only), R*		1.100	x	W L		1.000	x	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.11		0.01		0.01	-0.01		-0.01	0.07		5%	10%	1%	**OK**
1.2G+1.5Q	0.43		0.03		0.03	-0.04		-0.04	0.27		20%	41%	3%	**OK**
$1.2G+1.5Q_p$	0.09	0.83	0.01	0.17	0.17	-0.01	-0.08	-0.09	0.88		101%	88%	11%	**OK**
$0.9G_{min} + W_{u(up)}$	-1.13		-0.09		-0.09	0.11		0.11	-0.70	-1.24	86%	66%	9%	**OK**
$1.2G_{max} + W_{u(down)}$	0.93		0.07		0.07	-0.09		-0.09	0.58		44%	89%	7%	**OK**

# of screws required in steel substrate = 1

Serviceability **# of screws required in timber substrate = 1**

Loadcase	Load		Deflections, Δ (mm)			Span ratio,	Limit	Check
	UDL	P	UDL	PL	Total	L/Δ (mm)		
G	0.08		0.2		0.2	5441	300	**OK**
Q	0.23	0.70	0.5	2.7	2.7	373	300	**OK**
$G + W_{s(up)}$	-0.81		-1.9		-1.9	523	150	**OK**
$W_{s(down)}$	0.56		1.3		1.3	757	150	**OK**

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 600 mm Span, L = 1000 mm L_e = 800 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 800 mm (0.8L)

ϕM_{bx+} = 0.105 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.05 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.15 kN/m

P = 1.10 kN => 0.55 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 2 NASH standard P1

Wind: Wind Zone = Medium (from NZS 3406:2011)

Wind speed = 37 m/s

$q_u(z)$ = 0.82 kPa

$q_s(z)$ = 0.55 kPa

C_{pt} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -0.82 kPa => -0.89 kN/m Local factor, kl = 2

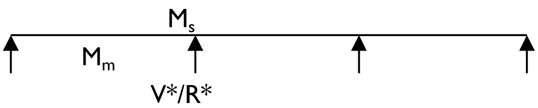
$W_{u(down)}$ = 0.52 kPa => 0.56 kN/m combination factor, kc = 0.9

$W_{s(up)}$ = -0.55 kPa => -0.59 kN/m

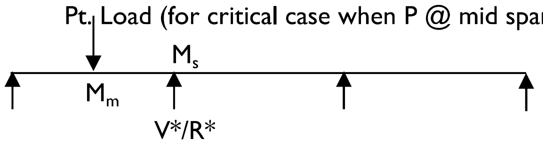
$W_{s(down)}$ = 0.35 kPa => 0.37 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span)



Pt. Load (for critical case when P @ mid span)



Bending moment, M	0.08	-0.10	X	W L²	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	W L⁴ / E I		0.015	X	P L³ / E I
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.07		0.01		0.01	-0.01		-0.01	0.05		3%	7%	1%	**OK**
1.2G+1.5Q	0.29		0.02		0.02	-0.03		-0.03	0.18		14%	28%	2%	**OK**
$1.2G+1.5Q_p$	0.07	0.83	0.01	0.17	0.17	-0.01	-0.08	-0.09	0.87		100%	85%	11%	**OK**
$0.9G_{min} + W_{u(up)}$	-0.75		-0.06		-0.06	0.08		0.08	-0.46	-0.83	57%	44%	6%	**OK**
$1.2G_{max} + W_{u(down)}$	0.62		0.05		0.05	-0.06		-0.06	0.38		29%	59%	5%	**OK**

# of screws required in steel substrate = 1

Serviceability **# of screws required in timber substrate = 1**

Loadcase	Load		Deflections, Δ (mm)			Span ratio, L/Δ (mm)	Limit	Check
	UDL	P	UDL	PL	Total			
G	0.05		0.1		0.1	7851	300	**OK**
Q	0.15	0.70	0.4	2.7	2.7	373	300	**OK**
$G + W_{s(up)}$	-0.54		-1.3		-1.3	787	150	**OK**
$W_{s(down)}$	0.37		0.9		0.9	1136	150	**OK**

Roof Purlins - RB4055 See Appendix D for effective length calculation

Spacing, s = 300 mm Span, L = 1100 mm L_e = 900 mm

Batten properties from CFSM - DSM - See Appendix B L_{e+} = 880 mm (0.8L)

ϕM_{bx+} = 0.095 kN.m (compression in legs) ϕM_{bx-} = 0.17 kN.m (compression in flat)

I_x = 0.020 $\times 10^6 mm^4$ E = 2.00E+05 MPa

SW = 0.630 kg/m ϕV_{vx} = 8.1 kN

ϕV_s = 1.32 kN single 12-11 x 40mm x T17 tek screw pull out capacity in 0.55 gauge steel - See Appendix C

Loading 1.80 kN single 12-11 x 40mm x T17 tek screw pull out capacity in timber - See Appendix C

Dead G = 0.08 kPa => 0.03 kN/m (includes self weight of purlin)

Q = 0.25 kPa => 0.08 kN/m

P = 1.10 kN => 0.37 kN per purlin

Assume roof cladding can span up to 600mm or share Pt. Load over minimum 2 purlins = 3 NASH standard P1

Wind: Wind Zone = Medium (from NZS 3406:2011)

Wind speed = 37 m/s

$q_u(z)$ = 0.82 kPa

$q_s(z)$ = 0.55 kPa

C_{pt} = 0.63 or -1.0 NASH standard Part 1

$W_{u(up)}$ = -0.82 kPa => -0.44 kN/m Local factor, kl = 2

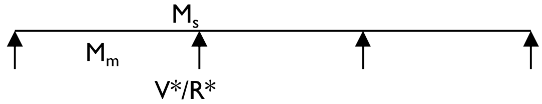
$W_{u(down)}$ = 0.52 kPa => 0.28 kN/m combination factor, kc = 0.9

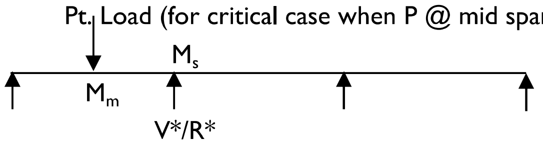
$W_{s(up)}$ = -0.55 kPa => -0.30 kN/m

$W_{s(down)}$ = 0.35 kPa => 0.19 kN/m

Load factors (3 continuous spans)

UDL (critical load in 1st span) Pt. Load (for critical case when P @ mid span)





	UDL				Pt. Load			
Bending moment, M	0.08	-0.10	X	W L^2	0.20	-0.10	X	P L
Deflection, Δ		0.009	X	W L^4 / E I		0.015	X	P L^3 / E I
Shear Force, V*		0.617	X	W L		1.000	X	P
Hold down (up lift only), R*		1.100	X	W L		1.000	X	P

Ultimate

Load case	Load		Mid span Moment			M@support (kNm)			V*	R*	% M		%V	Check
	UDL	P	UDL	PL	Total	UDL	PL	Total	kN	kN	Mid	Sup	Sup	
$1.35G_{max}$	0.04		0.00		0.00	0.00		0.00	0.03		2%	5%	0%	OK
1.2G+1.5Q	0.15		0.01		0.01	-0.02		-0.02	0.10		8%	19%	1%	OK
$1.2G+1.5Q_p$	0.04	0.55	0.00	0.12	0.12	0.00	-0.06	-0.06	0.57		73%	68%	7%	OK
$0.9G_{min} + W_{u(up)}$	-0.38		-0.04		-0.04	0.05		0.05	-0.26	-0.46	38%	27%	3%	OK
$1.2G_{max} + W_{u(down)}$	0.32		0.03		0.03	-0.04		-0.04	0.21		18%	40%	3%	OK

# of screws required in steel substrate = 1

Serviceability **# of screws required in timber substrate = 1**

Loadcase	Load		Deflections, Δ (mm)			Span ratio,	Limit	Check
	UDL	P	UDL	PL	Total	L/Δ (mm)		
G	0.03		0.1		0.1	10589	300	OK
Q	0.08	0.70	0.3	3.6	3.6	308	300	OK
$G + W_{s(up)}$	-0.27		-0.9		-0.9	1197	150	OK
$W_{s(down)}$	0.19		0.6		0.6	1707	150	OK

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PSI for 40mm Tophat** Project No. **18053**

APPENDIX A: RB4075 Purlin Design Capacity

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Flat)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031	$x10^6$ mm^4	A	90	mm^2		
I_{yy}	0.084	$x10^6$ mm^4	I_w	0.005	$x10^9$ mm^6		
y	20	mm	J	9.00	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.14	kNm
M_3	0.11	kNm (quarter point)
M_4	0.07	kNm (mid point)
M_5	0.04	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.67		
l_{ex}	500	mm	Roof fixing
l_{ey}	500	mm	
l_{ez}	500	mm	
M_y	0.85	kNm	
f_{oy}	7410	MPa	
f_{oz}	319	MPa	
M_o	8.27	kNm	
λ_b	0.32		
M_c	0.85	kNm	

AS/NZS 4600:2005 Clause 7.2.2.1 - General

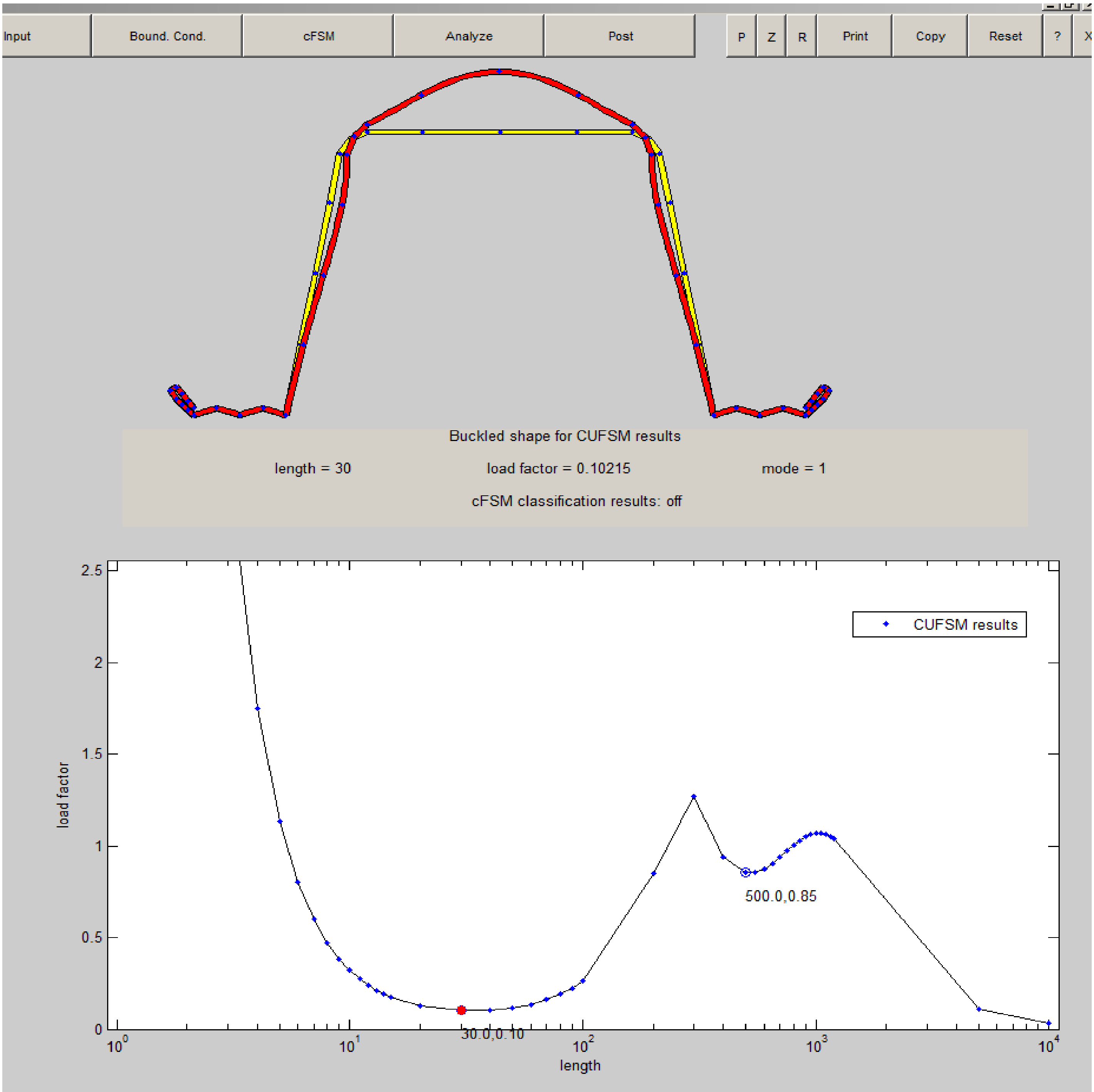
Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1554	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**



CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.32	kNm	(Local buckling is critical)
$\phi_b M_b$	0.29	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	8.27	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.85	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.85	kNm	
Z_f	1553.75	mm^3	0.1
f_{ol}	55.00	MPa	
M_{ol}	0.09	kNm	
λ_l	3.16		
M_{bl}	0.32	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.85	kNm	
Z_f	1553.75	mm^3	0.85
f_{od}	467.50	MPa	
M_{od}	0.73	kNm	
λ_d	1.08		
M_{bd}	0.63	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** — **23 Mar '18**

Project: **PS1 for 40mm Tophat** — Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031075	$x10^6$ mm^4	A	90	mm^2		
I_{yy}	0.084463	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	500	mm
l_{ey}	500	mm
l_{ez}	500	mm
M_y	0.85	kNm
f_{oy}	7410	MPa
f_{oz}	319	MPa
M_o	5.43	kNm
λ_b	0.40	
M_c	0.85	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

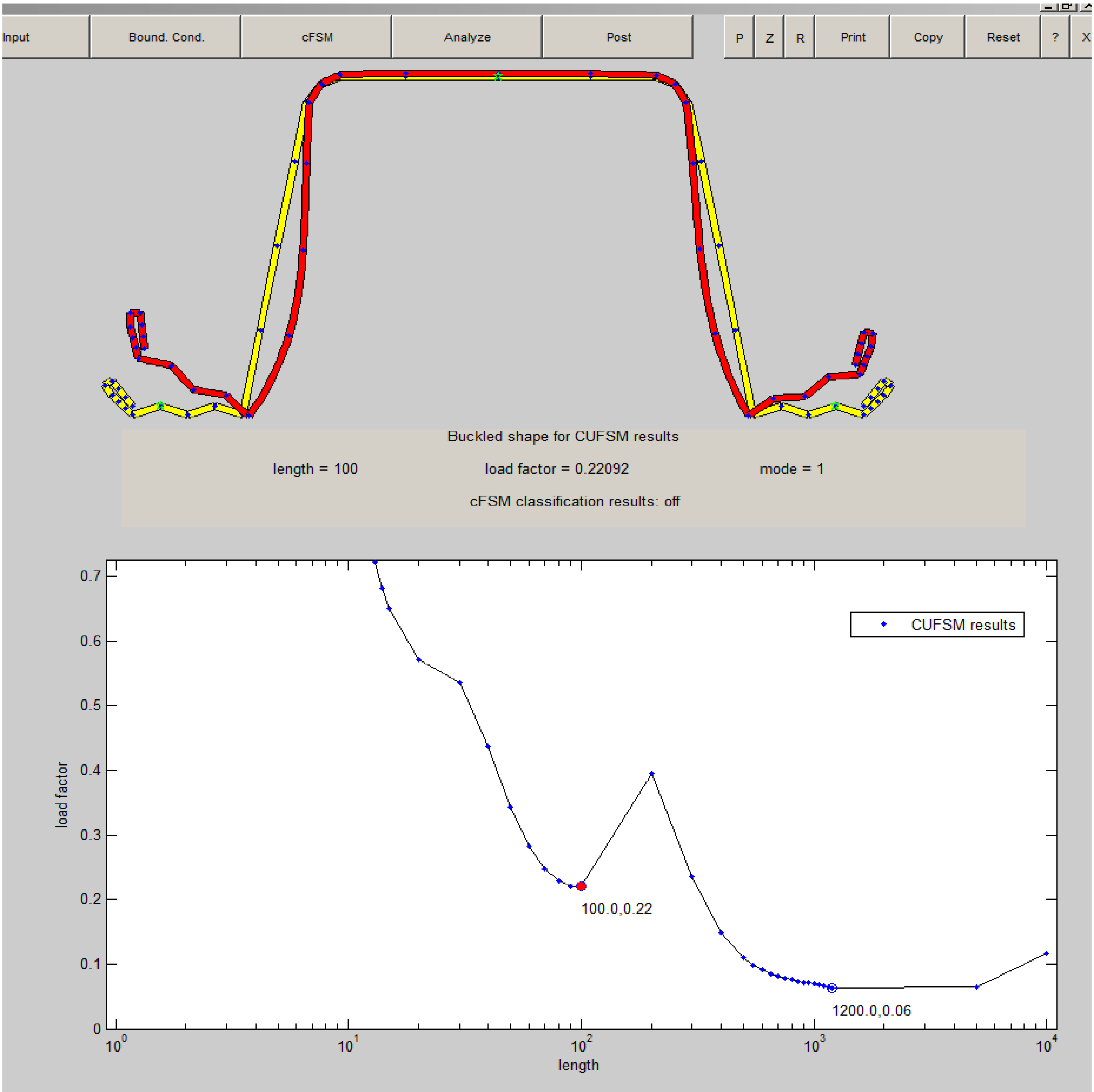
Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1554	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**



CALCULATIONS

ϕ_b	0.9		
M_b	0.24	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.217	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	5.43	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.85	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.85	kNm	Factor
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	2.13		
M_{bl}	0.43	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.85	kNm	Factor
Z_f	1553.75	mm^3	0.09093
f_{od}	50.01	MPa	
M_{od}	0.08	kNm	
λ_d	3.32		
M_{bd}	0.24	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** 23 Mar '18

Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031075	$x10^6$ mm^4	A	90	mm^2		
I_{yy}	0.084463	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	550	mm
l_{ey}	550	mm
l_{ez}	550	mm
M_y	0.85	kNm
f_{oy}	6124	MPa
f_{oz}	265	MPa
M_o	4.50	kNm
λ_b	0.44	
M_c	0.85	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1554	mm^3

ϕ_b	0.9		
M_b	0.22	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.200	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	4.50	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.85	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.85	kNm	
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	2.13		
M_{bl}	0.43	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.85	kNm	
Z_f	1553.75	mm^3	0.07685
f_{od}	42.27	MPa	
M_{od}	0.07	kNm	
λ_d	3.61		
M_{bd}	0.22	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** — **23 Mar '18**
Project: **PS1 for 40mm Tophat** — Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031075	$x10^6\ mm^4$	A	90	mm^2		
I_{yy}	0.084463	$x10^6\ mm^4$	I_w	0.00458	$x10^9\ mm^6$		
y	20	mm	J	9.0	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	600	mm
l_{ey}	600	mm
l_{ez}	600	mm
M_y	0.85	kNm
f_{oy}	5146	MPa
f_{oz}	224	MPa
M_o	3.79	kNm
λ_b	0.47	
M_c	0.85	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1554	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.21	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.186	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	3.79	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.85	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.85	kNm	Factor
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	2.13		
M_{bl}	0.43	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.85	kNm	Factor
Z_f	1553.75	mm^3	0.0659
f_{od}	36.25	MPa	
M_{od}	0.06	kNm	
λ_d	3.90		
M_{bd}	0.21	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031075	$\times 10^6$ mm^4	A	90	mm^2		
I_{yy}	0.084463	$\times 10^6$ mm^4	I_w	0.00458	$\times 10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max} 0.11 kNm
M_3 0.09 kNm (quarter point)
M_4 0.11 kNm (mid point)
M_5 0.09 kNm (three-quarter point)
Is it a cantlever or overhang where the free end is unbraced? No
C_b 1.10

l_{ex} 650 mm
l_{ey} 650 mm
l_{ez} 650 mm

M_y 0.85 kNm
f_{oy} 4385 MPa
f_{oz} 191 MPa
M_o 3.24 kNm

λ_b 0.51
M_c 0.85 kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E 200000 MPa
f_y 550 MPa
Z_f 1554 mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.19	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.174	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	3.24	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.85	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.85	kNm	Factor
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	2.13		
M_{bl}	0.43	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.85	kNm	Factor
Z_f	1553.75	mm^3	0.05721
f_{od}	31.47	MPa	
M_{od}	0.05	kNm	
λ_d	4.18		
M_{bd}	0.19	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa			
f_y	550	MPa						
I_{xx}	0.031075	$\times 10^6$ mm^4	A	90	mm^2			
I_{yy}	0.084463	$\times 10^6$ mm^4	I_w	0.00458	$\times 10^9$ mm^6			
y	20	mm	J	9.0	mm^4			
r_x	19	mm	x_o	0	mm		Centroid, x	42.8
r_y	31	mm	y_o	0	mm		Shear Cen	42.8
r_{o1}	36	mm						
$Z_{x,f}$	1554	mm^3						
$M_{x,y}$	0.85	kNm						

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	700	mm
l_{ey}	700	mm
l_{ez}	700	mm
M_y	0.85	kNm
f_{oy}	3781	MPa
f_{oz}	166	MPa
M_o	2.80	kNm
λ_b	0.55	
M_c	0.85	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1554	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.18	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.164	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	2.80	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.85	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.85	kNm	Factor
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	2.13		
M_{bl}	0.43	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.85	kNm	Factor
Z_f	1553.75	mm^3	0.05017
f_{od}	27.59	MPa	
M_{od}	0.04	kNm	
λ_d	4.46		
M_{bd}	0.18	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031075	$\times10^6$ mm^4	A	90	mm^2		
I_{yy}	0.084463	$\times10^6$ mm^4	I_w	0.00458	$\times10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max} 0.11 kNm

M_3 0.09 kNm (quarter point)

M_4 0.11 kNm (mid point)

M_5 0.09 kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b 1.10

l_{ex} 750 mm

l_{ey} 750 mm

l_{ez} 750 mm

M_y 0.85 kNm

f_{oy} 3293 MPa

f_{oz} 145 MPa

M_o 2.44 kNm

λ_b 0.59

M_c 0.85 kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E 200000 MPa

f_y 550 MPa

Z_f 1554 mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.17	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.155	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	2.44	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.85	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.85	kNm	Factor
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	2.13		
M_{bl}	0.43	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.85	kNm	Factor
Z_f	1553.75	mm^3	0.0444
f_{od}	24.43	MPa	
M_{od}	0.04	kNm	
λ_d	4.75		
M_{bd}	0.17	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** 23 Mar '18
Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031075	$x10^6\ mm^4$	A	90	mm^2		
I_{yy}	0.084463	$x10^6\ mm^4$	I_w	0.00458	$x10^9\ mm^6$		
y	20	mm	J	9.0	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max} 0.11 kNm
M_3 0.09 kNm (quarter point)
M_4 0.11 kNm (mid point)
M_5 0.09 kNm (three-quarter point)
Is it a cantlever or overhang where the free end is unbraced? No
C_b 1.10

l_{ex} 800 mm
l_{ey} 800 mm
l_{ez} 800 mm

M_y 0.85 kNm
f_{oy} 2895 MPa
f_{oz} 128 MPa
M_o 2.15 kNm

λ_b 0.63
M_c 0.84 kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E 200000 MPa
f_y 550 MPa
Z_f 1554 mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PSI for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.16	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.146	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	2.15	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.84	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.84	kNm	
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	2.12		
M_{bl}	0.43	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.85	kNm	
Z_f	1553.75	mm^3	0.03962
f_{od}	21.79	MPa	
M_{od}	0.03	kNm	
λ_d	5.02		
M_{bd}	0.16	kNm	

CALCULATIONS

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031075	$x10^6$ mm^4	A	90	mm^2		
I_{yy}	0.084463	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	850	mm
l_{ey}	850	mm
l_{ez}	850	mm
M_y	0.85	kNm
f_{oy}	2564	MPa
f_{oz}	115	MPa
M_o	1.91	kNm
λ_b	0.67	
M_c	0.83	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1554	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.15	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.139	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.91	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.83	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.83	kNm	
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	2.10		
M_{bl}	0.42	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.85	kNm	
Z_f	1553.75	mm^3	0.03561
f_{od}	19.59	MPa	
M_{od}	0.03	kNm	
λ_d	5.30		
M_{bd}	0.15	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**
Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031075	$\times 10^6$ mm^4	A	90	mm^2		
I_{yy}	0.084463	$\times 10^6$ mm^4	I_w	0.00458	$\times 10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	900	mm
l_{ey}	900	mm
l_{ez}	900	mm
M_y	0.85	kNm
f_{oy}	2287	MPa
f_{oz}	103	MPa
M_o	1.71	kNm
λ_b	0.71	
M_c	0.82	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1554	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PSI for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.15	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.133	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.71	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.82	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.82	kNm	Factor
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	2.09		
M_{bl}	0.42	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.85	kNm	Factor
Z_f	1553.75	mm^3	0.03222
f_{od}	17.72	MPa	
M_{od}	0.03	kNm	
λ_d	5.57		
M_{bd}	0.15	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** — **23 Mar '18**

Project: **PS1 for 40mm Tophat** — Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000 MPa	G	80000 MPa		
f_y	550 MPa				
I_{xx}	0.031075 $\times10^6$ mm^4	A	90 mm^2		
I_{yy}	0.084463 $\times10^6$ mm^4	I_w	0.00458 $\times10^9$ mm^6		
y	20 mm	J	9.0 mm^4		
r_x	19 mm	x_o	0 mm	Centroid, x	42.8
r_y	31 mm	y_o	0 mm	Shear Cen	42.8
r_{o1}	36 mm				
$Z_{x,f}$	1554 mm^3				
$M_{x,y}$	0.85 kNm				

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max} 0.11 kNm
M_3 0.09 kNm (quarter point)
M_4 0.11 kNm (mid point)
M_5 0.09 kNm (three-quarter point)
Is it a cantlever or overhang where the free end is unbraced? No
C_b 1.10

l_{ex} 950 mm
l_{ey} 950 mm
l_{ez} 950 mm

M_y 0.85 kNm
f_{oy} 2053 MPa
f_{oz} 93 MPa
M_o 1.54 kNm

λ_b 0.74
M_c 0.80 kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E 200000 MPa
f_y 550 MPa
Z_f 1554 mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.14	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.127	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.54	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.80	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.80	kNm	
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	2.07		
M_{bl}	0.41	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.85	kNm	
Z_f	1553.75	mm^3	0.02932
f_{od}	16.13	MPa	
M_{od}	0.03	kNm	
λ_d	5.84		
M_{bd}	0.14	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031075	$\times 10^6$ mm^4	A	90	mm^2		
I_{yy}	0.084463	$\times 10^6$ mm^4	I_w	0.00458	$\times 10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	1000	mm
l_{ey}	1000	mm
l_{ez}	1000	mm
M_y	0.85	kNm
f_{oy}	1852	MPa
f_{oz}	84	MPa
M_o	1.40	kNm
λ_b	0.78	
M_c	0.79	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1554	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.13	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.121	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.40	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.79	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.79	kNm	
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	2.05		
M_{bl}	0.41	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.85	kNm	
Z_f	1553.75	mm^3	0.02684
f_{od}	14.76	MPa	
M_{od}	0.02	kNm	
λ_d	6.10		
M_{bd}	0.13	kNm	

CALCULATIONS

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031075	$x10^6$ mm^4	A	90	mm^2		
I_{yy}	0.084463	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	1050	mm
l_{ey}	1050	mm
l_{ez}	1050	mm
M_y	0.85	kNm
f_{oy}	1680	MPa
f_{oz}	77	MPa
M_o	1.27	kNm
λ_b	0.82	
M_c	0.77	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1554	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.13	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.117	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.27	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.77	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.77	kNm	Factor
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	2.03		
M_{bl}	0.40	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.85	kNm	Factor
Z_f	1553.75	mm^3	0.02469
f_{od}	13.58	MPa	
M_{od}	0.02	kNm	
λ_d	6.36		
M_{bd}	0.13	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** | **23 Mar '18**

Project: **PS1 for 40mm Tophat** | Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031075	$x10^6$ mm^4	A	90	mm^2		
I_{yy}	0.084463	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	1100	mm
l_{ey}	1100	mm
l_{ez}	1100	mm
M_y	0.85	kNm
f_{oy}	1531	MPa
f_{oz}	71	MPa
M_o	1.16	kNm
λ_b	0.86	
M_c	0.76	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1554	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **23 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.12	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.112	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.16	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.76	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.76	kNm	
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	2.01		
M_{bl}	0.40	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.85	kNm	
Z_f	1553.75	mm^3	0.02282
f_{od}	12.55	MPa	
M_{od}	0.02	kNm	
λ_d	6.62		
M_{bd}	0.12	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** — **23 Mar '18**

Project: **PSI for 40mm Tophat** — Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031075	$x10^6$ mm^4	A	90	mm^2		
I_{yy}	0.084463	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	1150	mm
l_{ey}	1150	mm
l_{ez}	1150	mm
M_y	0.85	kNm
f_{oy}	1401	MPa
f_{oz}	65	MPa
M_o	1.07	kNm
λ_b	0.89	
M_c	0.74	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1554	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** — **23 Mar '18**

Project: **PS1 for 40mm Tophat** — Project No. **18053**

ϕ_b	0.9		
M_b	0.12	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.108	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.07	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.74	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.74	kNm	Factor
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	1.98		
M_{bl}	0.39	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.85	kNm	Factor
Z_f	1553.75	mm^3	0.02118
f_{od}	11.65	MPa	
M_{od}	0.02	kNm	
λ_d	6.87		
M_{bd}	0.12	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** — **23 Mar '18**
Project: **PS1 for 40mm Tophat** — Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (Compression in Legs)

Section RB4075

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.031075	$x10^6$ mm^4	A	90	mm^2		
I_{yy}	0.084463	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	19	mm	x_o	0	mm	Centroid, x	42.8
r_y	31	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	36	mm					
$Z_{x,f}$	1554	mm^3					
$M_{x,y}$	0.85	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	1200	mm
l_{ey}	1200	mm
l_{ez}	1200	mm
M_y	0.85	kNm
f_{oy}	1286	MPa
f_{oz}	61	MPa
M_o	0.99	kNm
λ_b	0.93	
M_c	0.72	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1554	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** — **23 Mar '18**

Project: **PS1 for 40mm Tophat** — Project No. **18053**

ϕ_b	0.9		
M_b	0.12	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.105	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	0.99	kNm	(From nominal member capacity calculation)
M_y	0.85	kNm	
M_{be}	0.72	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.72	kNm	
Z_f	1553.75	mm^3	0.22
f_{ol}	121.00	MPa	
M_{ol}	0.19	kNm	
λ_l	1.96		
M_{bl}	0.38	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.85	kNm	
Z_f	1553.75	mm^3	0.01974
f_{od}	10.86	MPa	
M_{od}	0.02	kNm	
λ_d	7.12		
M_{bd}	0.12	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

APPENDIX B: RB4055 Purlin Design Capacity

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the flat)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.023	$x10^6$ mm^4	A	90	mm^2		
I_{yy}	0.062	$x10^6$ mm^4	I_w	0.005	$x10^9$ mm^6		
y	20.0	mm	J	9.00	mm^4		
r_x	16	mm	x_o	0	mm	Centroid, x	42.8
r_y	26	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	31	mm					
$Z_{x,f}$	1140	mm^3					
$M_{x,y}$	0.63	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.14	kNm
M_3	0.11	kNm (quarter point)
M_4	0.07	kNm (mid point)
M_5	0.04	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.67		
l_{ex}	500	mm	Roof fixing
l_{ey}	500	mm	
l_{ez}	500	mm	
M_y	0.63	kNm	
f_{oy}	5430	MPa	
f_{oz}	435	MPa	
M_o	7.08	kNm	
λ_b	0.30		
M_c	0.63	kNm	

AS/NZS 4600:2005 Clause 7.2.2.1 - General

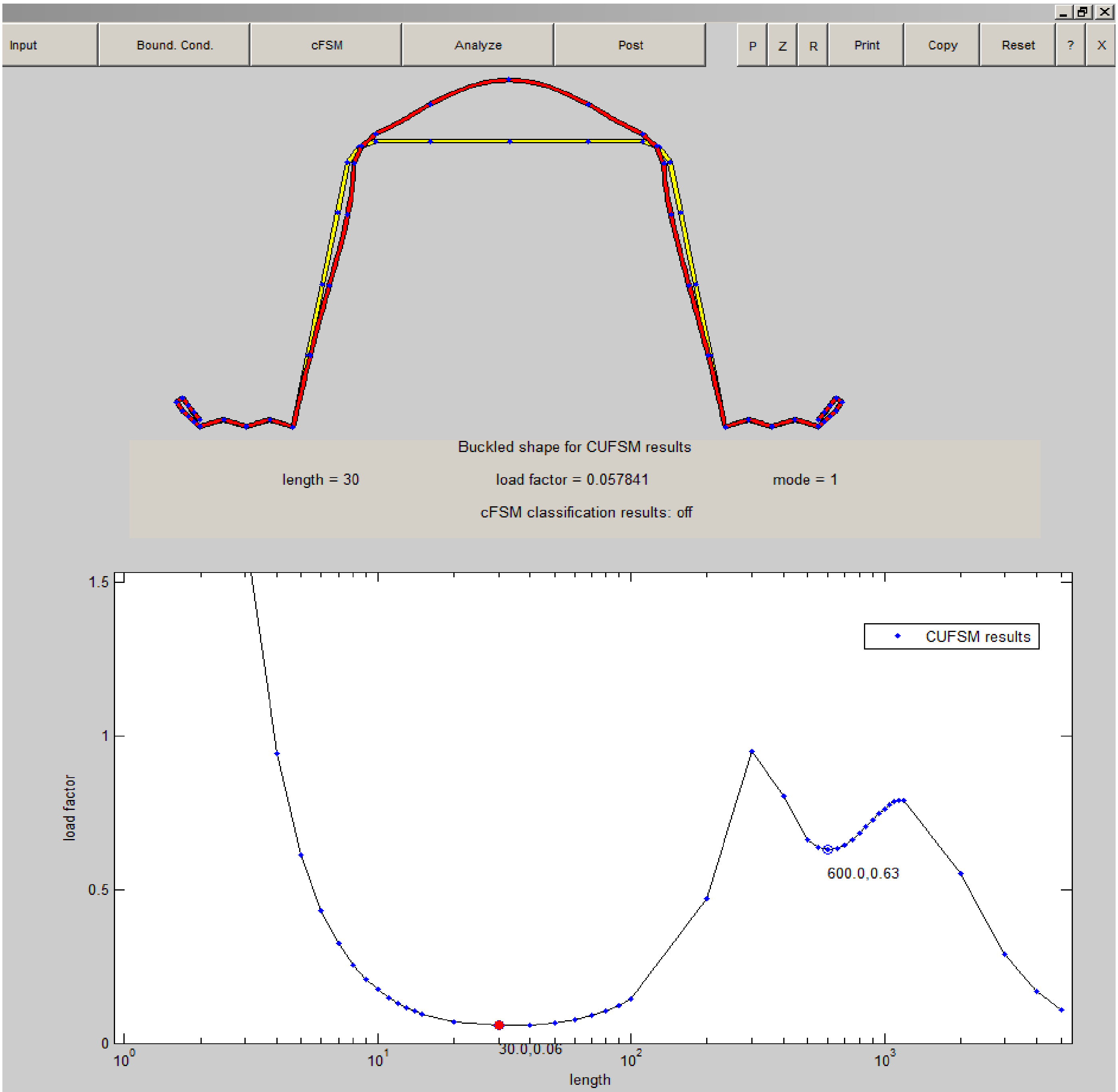
Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**



CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PSI for 40mm Tophat** Project No. **18053**

ϕ_b	0.9	
M_b	0.19 kNm	(Local buckling is critical)
$\phi_b M_b$	0.17 kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550 MPa	
M_o	7.08 kNm	(From nominal member capacity calculation)
M_y	0.63 kNm	
M_{be}	0.63 kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

		Factor
M_{be}	0.63 kNm	
Z_f	1140 mm^3	0.058
f_{ol}	31.90 MPa	
M_{ol}	0.04 kNm	
λ_l	4.15	
M_{bl}	0.19 kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

		Factor
M_y	0.63 kNm	
Z_f	1140 mm^3	0.663
f_{od}	364.65 MPa	
M_{od}	0.42 kNm	
λ_d	1.23	
M_{bd}	0.42 kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa			
f_y	550	MPa						
I_{xx}	0.0228	$\times 10^6$ mm^4	A	90	mm^2			
I_{yy}	0.0619	$\times 10^6$ mm^4	I_w	0.00458	$\times 10^9$ mm^6			
y	20	mm	J	9.0	mm^4			
r_x	16	mm	x_o	0	mm		Centroid, x	42.8
r_y	26	mm	y_o	0	mm		Shear Cen	42.8
r_{o1}	31	mm						
$Z_{x,f}$	1140	mm^3						
$M_{x,y}$	0.63	kNm						

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	500	mm
l_{ey}	500	mm
l_{ez}	500	mm
M_y	0.63	kNm
f_{oy}	5430	MPa
f_{oz}	435	MPa
M_o	4.65	kNm
λ_b	0.37	
M_c	0.63	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

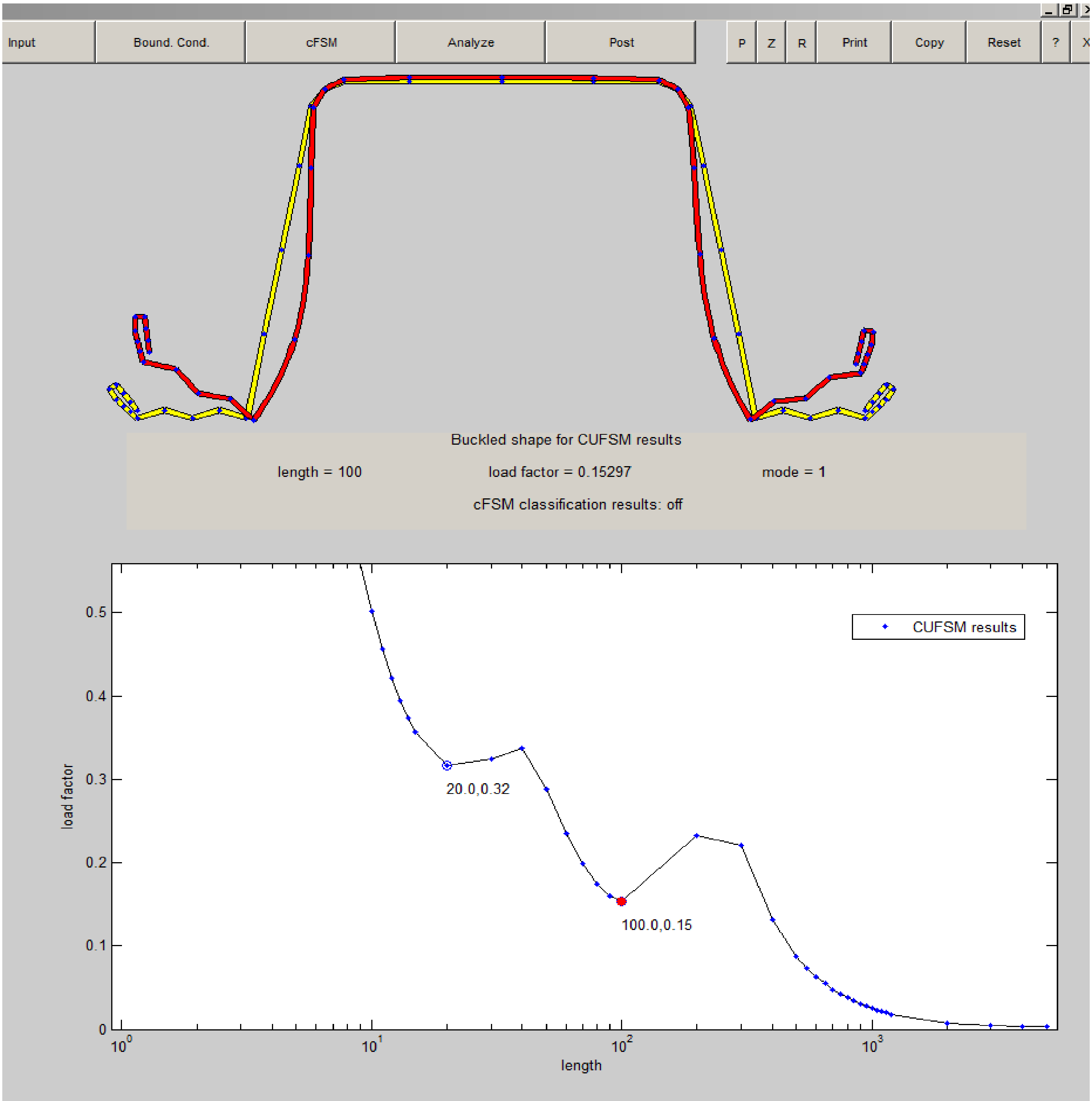
Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**



CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.17	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.156	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	4.65	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.63	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.63	kNm	Factor
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.56		
M_{bl}	0.27	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.63	kNm	Factor
Z_f	1140	mm^3	0.0873
f_{od}	48.02	MPa	
M_{od}	0.05	kNm	
λ_d	3.38		
M_{bd}	0.17	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PSI for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.0228	$\times 10^6$ mm^4	A	90	mm^2		
I_{yy}	0.0619	$\times 10^6$ mm^4	I_w	0.00458	$\times 10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	16	mm	x_o	0	mm	Centroid, x	42.8
r_y	26	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	31	mm					
$Z_{x,f}$	1140	mm^3					
$M_{x,y}$	0.63	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	550	mm
l_{ey}	550	mm
l_{ez}	550	mm
M_y	0.63	kNm
f_{oy}	4488	MPa
f_{oz}	361	MPa
M_o	3.85	kNm
λ_b	0.40	
M_c	0.63	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.16	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.144	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	3.85	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.63	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.63	kNm	Factor
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.56		
M_{bl}	0.27	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.63	kNm	Factor
Z_f	1140	mm^3	0.0736
f_{od}	40.48	MPa	
M_{od}	0.05	kNm	
λ_d	3.69		
M_{bd}	0.16	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** | **22 Mar '18**

Project: **PS1 for 40mm Tophat** | Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.0228	$x10^6$ mm^4	A	90	mm^2		
I_{yy}	0.0619	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	16	mm	x_o	0	mm	Centroid, x	42.8
r_y	26	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	31	mm					
$Z_{x,f}$	1140	mm^3					
$M_{x,y}$	0.63	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	600	mm
l_{ey}	600	mm
l_{ez}	600	mm
M_y	0.63	kNm
f_{oy}	3771	MPa
f_{oz}	305	MPa
M_o	3.24	kNm
λ_b	0.44	
M_c	0.63	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.15	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.134	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	3.24	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.63	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.63	kNm	Factor
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.56		
M_{bl}	0.27	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.63	kNm	Factor
Z_f	1140	mm^3	0.0629
f_{od}	34.60	MPa	
M_{od}	0.04	kNm	
λ_d	3.99		
M_{bd}	0.15	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PSI for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.0228	$\times 10^6$ mm^4	A	90	mm^2		
I_{yy}	0.0619	$\times 10^6$ mm^4	I_w	0.00458	$\times 10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	16	mm	x_o	0	mm	Centroid, x	42.8
r_y	26	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	31	mm					
$Z_{x,f}$	1140	mm^3					
$M_{x,y}$	0.63	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	650	mm
l_{ey}	650	mm
l_{ez}	650	mm
M_y	0.63	kNm
f_{oy}	3213	MPa
f_{oz}	261	MPa
M_o	2.77	kNm
λ_b	0.48	
M_c	0.63	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** — **22 Mar '18**

Project: **PS1 for 40mm Tophat** — Project No. **18053**

ϕ_b	0.9		
M_b	0.14	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.125	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	2.77	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.63	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.63	kNm	
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.56		
M_{bl}	0.27	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.63	kNm	
Z_f	1140	mm^3	0.0546
f_{od}	30.03	MPa	
M_{od}	0.03	kNm	
λ_d	4.28		
M_{bd}	0.14	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.0228	$x10^6\ mm^4$	A	90	mm^2		
I_{yy}	0.0619	$x10^6\ mm^4$	I_w	0.00458	$x10^9\ mm^6$		
y	20	mm	J	9.0	mm^4		
r_x	16	mm	x_o	0	mm	Centroid, x	42.8
r_y	26	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	31	mm					
$Z_{x,f}$	1140	mm^3					
$M_{x,y}$	0.63	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	700	mm
l_{ey}	700	mm
l_{ez}	700	mm
M_y	0.63	kNm
f_{oy}	2771	MPa
f_{oz}	226	MPa
M_o	2.40	kNm
λ_b	0.51	
M_c	0.63	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

ϕ_b	0.9		
M_b	0.13	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.117	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	2.40	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.63	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.63	kNm	
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.56		
M_{bl}	0.27	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.63	kNm	
Z_f	1140	mm^3	0.0478
f_{od}	26.29	MPa	
M_{od}	0.03	kNm	
λ_d	4.57		
M_{bd}	0.13	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PSI for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.0228	$x10^6$ mm^4	A	90	mm^2		
I_{yy}	0.0619	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	16	mm	x_o	0	mm	Centroid, x	42.8
r_y	26	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	31	mm					
$Z_{x,f}$	1140	mm^3					
$M_{x,y}$	0.63	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	750	mm
l_{ey}	750	mm
l_{ez}	750	mm
M_y	0.63	kNm
f_{oy}	2414	MPa
f_{oz}	198	MPa
M_o	2.09	kNm
λ_b	0.55	
M_c	0.63	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PSI for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.12	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.111	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	2.09	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.63	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.63	kNm	
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.56		
M_{bl}	0.27	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.63	kNm	
Z_f	1140	mm^3	0.0422
f_{od}	23.21	MPa	
M_{od}	0.03	kNm	
λ_d	4.87		
M_{bd}	0.12	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** — **22 Mar '18**

Project: **PSI for 40mm Tophat** — Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.0228	$x10^6\ mm^4$	A	90	mm^2		
I_{yy}	0.0619	$x10^6\ mm^4$	I_w	0.00458	$x10^9\ mm^6$		
y	20	mm	J	9.0	mm^4		
r_x	16	mm	x_o	0	mm	Centroid, x	42.8
r_y	26	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	31	mm					
$Z_{x,f}$	1140	mm^3					
$M_{x,y}$	0.63	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	800	mm
l_{ey}	800	mm
l_{ez}	800	mm
M_y	0.63	kNm
f_{oy}	2121	MPa
f_{oz}	175	MPa
M_o	1.84	kNm
λ_b	0.58	
M_c	0.63	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** — **22 Mar '18**

Project: **PS1 for 40mm Tophat** — Project No. **18053**

ϕ_b	0.9		
M_b	0.12	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.105	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.84	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.63	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.63	kNm	Factor
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.56		
M_{bl}	0.27	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.63	kNm	Factor
Z_f	1140	mm^3	0.0376
f_{od}	20.68	MPa	
M_{od}	0.02	kNm	
λ_d	5.16		
M_{bd}	0.12	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa			
f_y	550	MPa						
I_{xx}	0.0228	$\times10^6$ mm^4	A	90	mm^2			
I_{yy}	0.0619	$\times10^6$ mm^4	I_w	0.00458	$\times10^9$ mm^6			
y	20	mm	J	9.0	mm^4			
r_x	16	mm	x_o	0	mm		Centroid, x	42.8
r_y	26	mm	y_o	0	mm		Shear Cen	42.8
r_{o1}	31	mm						
$Z_{x,f}$	1140	mm^3						
$M_{x,y}$	0.63	kNm						

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	850	mm
l_{ey}	850	mm
l_{ez}	850	mm
M_y	0.63	kNm
f_{oy}	1879	MPa
f_{oz}	156	MPa
M_o	1.64	kNm
λ_b	0.62	
M_c	0.62	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.11	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.099	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.64	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.62	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.62	kNm	Factor
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.55		
M_{bl}	0.27	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.63	kNm	Factor
Z_f	1140	mm^3	0.0337
f_{od}	18.54	MPa	
M_{od}	0.02	kNm	
λ_d	5.45		
M_{bd}	0.11	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** 22 Mar '18
Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa			
f_y	550	MPa						
I_{xx}	0.0228	$x10^6$ mm^4	A	90	mm^2			
I_{yy}	0.0619	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6			
y	20	mm	J	9.0	mm^4			
r_x	16	mm	x_o	0	mm		Centroid, x	42.8
r_y	26	mm	y_o	0	mm		Shear Cen	42.8
r_{o1}	31	mm						
$Z_{x,f}$	1140	mm^3						
$M_{x,y}$	0.63	kNm						

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	900	mm
l_{ey}	900	mm
l_{ez}	900	mm
M_y	0.63	kNm
f_{oy}	1676	MPa
f_{oz}	140	MPa
M_o	1.47	kNm
λ_b	0.65	
M_c	0.61	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.11	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.095	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.47	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.61	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.61	kNm	
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.53		
M_{bl}	0.27	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.63	kNm	
Z_f	1140	mm^3	0.0304
f_{od}	16.72	MPa	
M_{od}	0.02	kNm	
λ_d	5.74		
M_{bd}	0.11	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa			
f_y	550	MPa						
I_{xx}	0.0228	$x10^6$ mm^4	A	90	mm^2			
I_{yy}	0.0619	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6			
y	20	mm	J	9.0	mm^4			
r_x	16	mm	x_o	0	mm		Centroid, x	42.8
r_y	26	mm	y_o	0	mm		Shear Cen	42.8
r_{o1}	31	mm						
$Z_{x,f}$	1140	mm^3						
$M_{x,y}$	0.63	kNm						

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	950	mm
l_{ey}	950	mm
l_{ez}	950	mm
M_y	0.63	kNm
f_{oy}	1504	MPa
f_{oz}	127	MPa
M_o	1.32	kNm
λ_b	0.69	
M_c	0.60	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**
Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.10	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.090	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.32	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.60	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.60	kNm	Factor
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.51		
M_{bl}	0.27	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.63	kNm	Factor
Z_f	1140	mm^3	0.02755
f_{od}	15.15	MPa	
M_{od}	0.02	kNm	
λ_d	6.02		
M_{bd}	0.10	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PSI for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.0228	$\times 10^6$ mm^4	A	90	mm^2		
I_{yy}	0.0619	$\times 10^6$ mm^4	I_w	0.00458	$\times 10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	16	mm	x_o	0	mm	Centroid, x	42.8
r_y	26	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	31	mm					
$Z_{x,f}$	1140	mm^3					
$M_{x,y}$	0.63	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	1000	mm
l_{ey}	1000	mm
l_{ez}	1000	mm
M_y	0.63	kNm
f_{oy}	1358	MPa
f_{oz}	115	MPa
M_o	1.20	kNm
λ_b	0.72	
M_c	0.59	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.10	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.086	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.20	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.60	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.60	kNm	Factor
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.49		
M_{bl}	0.27	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.63	kNm	Factor
Z_f	1140	mm^3	0.0251
f_{od}	13.81	MPa	
M_{od}	0.02	kNm	
λ_d	6.31		
M_{bd}	0.10	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.0228	$x10^6$ mm^4	A	90	mm^2		
I_{yy}	0.0619	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	16	mm	x_o	0	mm	Centroid, x	42.8
r_y	26	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	31	mm					
$Z_{x,f}$	1140	mm^3					
$M_{x,y}$	0.63	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	1050	mm
l_{ey}	1050	mm
l_{ez}	1050	mm
M_y	0.63	kNm
f_{oy}	1231	MPa
f_{oz}	105	MPa
M_o	1.09	kNm
λ_b	0.76	
M_c	0.58	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited**   **22 Mar '18**

Project: **PS1 for 40mm Tophat**   Project No. **18053**

ϕ_b	0.9		
M_b	0.09	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.083	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.09	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.59	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.59	kNm	
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.47		
M_{bl}	0.26	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.63	kNm	
Z_f	1140	mm^3	0.023
f_{od}	12.65	MPa	
M_{od}	0.01	kNm	
λ_d	6.59		
M_{bd}	0.09	kNm	

CALCULATIONS

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa		
f_y	550	MPa					
I_{xx}	0.0228	$x10^6$ mm^4	A	90	mm^2		
I_{yy}	0.0619	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6		
y	20	mm	J	9.0	mm^4		
r_x	16	mm	x_o	0	mm	Centroid, x	42.8
r_y	26	mm	y_o	0	mm	Shear Cen	42.8
r_{o1}	31	mm					
$Z_{x,f}$	1140	mm^3					
$M_{x,y}$	0.63	kNm					

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	1100	mm
l_{ey}	1100	mm
l_{ez}	1100	mm
M_y	0.63	kNm
f_{oy}	1122	MPa
f_{oz}	97	MPa
M_o	1.00	kNm
λ_b	0.79	
M_c	0.57	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.09	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.080	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	1.00	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.57	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

			Factor
M_{be}	0.57	kNm	
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.45		
M_{bl}	0.26	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

			Factor
M_y	0.63	kNm	
Z_f	1140	mm^3	0.0212
f_{od}	11.66	MPa	
M_{od}	0.01	kNm	
λ_d	6.87		
M_{bd}	0.09	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** — **22 Mar '18**

Project: **PSI for 40mm Tophat** — Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa			
f_y	550	MPa						
I_{xx}	0.0228	$\times 10^6$ mm^4	A	90	mm^2			
I_{yy}	0.0619	$\times 10^6$ mm^4	I_w	0.00458	$\times 10^9$ mm^6			
y	20	mm	J	9.0	mm^4			
r_x	16	mm	x_o	0	mm		Centroid, x	42.8
r_y	26	mm	y_o	0	mm		Shear Cen	42.8
r_{o1}	31	mm						
$Z_{x,f}$	1140	mm^3						
$M_{x,y}$	0.63	kNm						

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	1150	mm
l_{ey}	1150	mm
l_{ez}	1150	mm
M_y	0.63	kNm
f_{oy}	1027	MPa
f_{oz}	89	MPa
M_o	0.92	kNm
λ_b	0.83	
M_c	0.56	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PSI for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.08	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.076	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	0.92	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.56	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.56	kNm	Factor
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.42		
M_{bl}	0.26	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.63	kNm	Factor
Z_f	1140	mm^3	0.0195
f_{od}	10.73	MPa	
M_{od}	0.01	kNm	
λ_d	7.16		
M_{bd}	0.08	kNm	

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

Direct Strength Method to AS/NZS 4600:2005 Section 7

AS/NZS 4600:2005 Clause 7.2.2 - Design of members subject to bending (compression in the lips)

Section RB4055

AS/NZS 4600:2005 Clause 3.3.3.2.1 - Open section members

E	200000	MPa	G	80000	MPa			
f_y	550	MPa						
I_{xx}	0.0228	$x10^6$ mm^4	A	90	mm^2			
I_{yy}	0.0619	$x10^6$ mm^4	I_w	0.00458	$x10^9$ mm^6			
y	20	mm	J	9.0	mm^4			
r_x	16	mm	x_o	0	mm		Centroid, x	42.8
r_y	26	mm	y_o	0	mm		Shear Cen	42.8
r_{o1}	31	mm						
$Z_{x,f}$	1140	mm^3						
$M_{x,y}$	0.63	kNm						

AS/NZS 4600:2005 Clause 3.3.3.2.1(a)(i) - Elastic buckling moment for singly-, doubly- and point symmetric sections

M_{max}	0.11	kNm
M_3	0.09	kNm (quarter point)
M_4	0.11	kNm (mid point)
M_5	0.09	kNm (three-quarter point)

Is it a cantlever or overhang where the free end is unbraced? No

C_b	1.10	
l_{ex}	1200	mm
l_{ey}	1200	mm
l_{ez}	1200	mm
M_y	0.63	kNm
f_{oy}	943	MPa
f_{oz}	83	MPa
M_o	0.84	kNm
λ_b	0.86	
M_c	0.55	kNm

AS/NZS 4600:2005 Clause 7.2.2.1 - General

Does member meet geometric requirements of Clause 7.1.2? Yes

E	200000	MPa
f_y	550	MPa
Z_f	1140	mm^3

CALCULATIONS

Client: **Batten Manufacturers Limited** **22 Mar '18**

Project: **PS1 for 40mm Tophat** Project No. **18053**

ϕ_b	0.9		
M_b	0.08	kNm	(Distortional buckling is critical)
$\phi_b M_b$	0.074	kNm	

AS/NZS 4600:2005 Clause 7.2.2.2 - Lateral Torsional buckling

f_y	550	MPa	
M_o	0.84	kNm	(From nominal member capacity calculation)
M_y	0.63	kNm	
M_{be}	0.55	kNm	

AS/NZS 4600:2005 Clause 7.2.2.3 - Local buckling

M_{be}	0.55	kNm	Factor
Z_f	1140	mm^3	0.153
f_{ol}	84.15	MPa	
M_{ol}	0.10	kNm	
λ_l	2.40		
M_{bl}	0.25	kNm	

AS/NZS 4600:2005 Clause 7.2.2.4 - Distortional buckling

M_y	0.63	kNm	Factor
Z_f	1140	mm^3	0.0181
f_{od}	9.96	MPa	
M_{od}	0.01	kNm	
λ_d	7.43		
M_{bd}	0.08	kNm	

APPENDIX C: PULL OUT CAPACITY of ST12-11x40 SCREWS

According AS/NZS 4600 Section 8.2
coefficient of variation of structural characteristics (V_{sc}) for screws pull out tests are calculated as follow.

ST 12-11 x 40 screw fixing in 0.55 BMT

sample	N (kN)	$\lvert x_i - \bar{x} \rvert$	$(x_i - \bar{x})^2$
1	1.43	0.03	0.9×10^{-3}
2	R_{min} = 1.37	0.03	0.9×10^{-3}
3	1.38	0.02	0.4×10^{-3}
4	1.41	0.01	0.1×10^{-3}
5	1.42	0.02	0.4×10^{-3}
	$\bar{x} = 1.40$		$\Sigma = 2.7 \times 10^{-3}$

standard deviation

$$\sigma = \sqrt{\frac{\Sigma (x_i - \bar{x})^2}{n}} = \sqrt{\frac{2.7 \times 10^{-3}}{5}} = 0.0232$$

$$V_{sc} = \frac{\sigma}{\bar{x}} =$$

$$V_{sc} = \frac{\sigma}{\bar{x}} = \frac{0.0232}{1.40} \times 100\% = 1.66\%$$

Interpolate from Table 8.2.3 $k_t = \left[\frac{1.66}{5} \times (1.13 - 1.0)\right] + 1.0$
$= 1.04$

$$R_d = \frac{R_{min}}{k_t} = \frac{1.37}{1.04} = \underline{1.32\,kN} \text{ / screw}$$

Client: **BATTEN MANUFACTURERS LIMITED** **Mar-18**

Project: **PSI FOR 40MM TOPHAT** Project No. **18053**

2 x SXT 12 - 11 x 40 screws fixing in timber

Sample	N(kN)	$\lvert x_i - \bar{x} \rvert$	$(x_i - \bar{x})^2$
1	4.57	0.11	0.0121
2	4.98	0.30	0.0900
3	R_{min} = 4.27	0.41	0.1681
4	4.40	0.28	0.0784
5	5.16	0.48	0.2304
	$\bar{x}$ = 4.68		Σ = 0.5790

$$\sigma = \sqrt{\frac{0.5790}{5}} = 0.34$$

$$V_{sc} = \frac{0.34}{4.68} \times 100\% = 7.26\%$$

Interpolate from Table 8.2.3

$$k_t = \left[\frac{1.28 - 1.13}{5} \times (7.26 - 5)\right] + 1.13$$

$$= 1.20$$

$$R_d = \frac{4.27}{1.20} = \underline{3.6 \text{ kN}} / \underline{2 \text{ screws}}$$

or $\underline{1.8 \text{ kN} / \text{screw}}$

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CERTIFICATE OF TEST REPORT

MTL Report No.	J51417/1 Page 1 of 3 Pages	Order No.	Neil Lilley	Date Tested	16/02/2018
Client Name	Konnect Shop				
Attention	Mr. Neil Lilley				
Comparative Load Tests					
Test Equipment	Shimadzu Universal Grade 1 Testing Machine Model REH 50, Serial # 72666. Calibration Due June 2018				

RESULTS

Test 1 – 2 x Screws

0.55 BMT Roof Battern
Truss Pine Timber 40mm x 90mm
Screw: Steeltite ST12 – 11 x 40 CL5

Sample	Max Force (N)	(Kg)	Failure Location
1	5.08	518	Metal Battern
2	5.18	528	Metal Battern
3	5.16	526	Metal Battern
4	5.14	524	Metal Battern
5	5.29	539	Metal Battern
Average	**5.17**	**527**	–

Test 2 – 2 x Screws

0.75 BMT Roof Battern
Truss Pine Timber 40mm x 90mm
Screw: Steeltite ST12 – 11 x 40 CL5

Sample	Max Force (N)	(Kg)	Failure Location
1	4.57	466	Metal Battern
2	4.98	508	Metal Battern
3	4.27	435	Metal Battern
4	4.40	449	Metal Battern
5	5.16	526	Metal Battern
Average	**4.68**	**477**	--

Test 3 – Single screw pull out of single battern (Metal Only)

0.55 BMT Roof Battern
Screw: Steeltite ST12 – 11 x 40 CL5

Sample	Max Force (N)	(Kg)
1	1.43	146
2	1.37	140
3	1.38	141
4	1.41	144
5	1.42	145
Average	**1.40**	**143**

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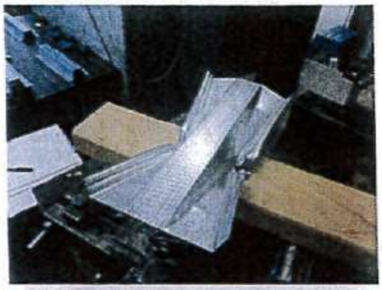
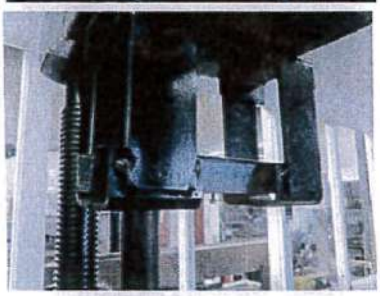
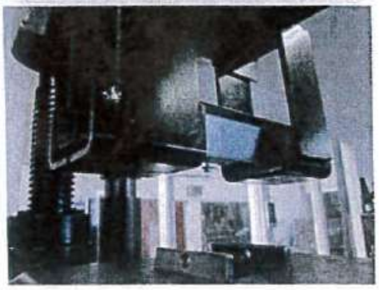
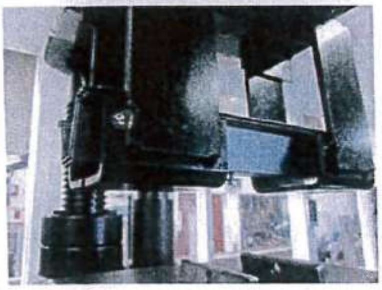
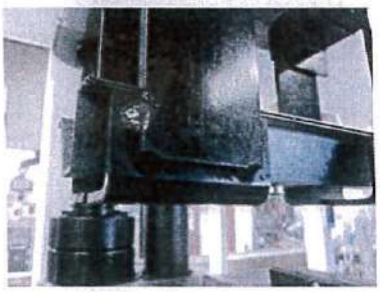
MTL Report No.	J51417/1 Page 3 of 3 Pages	Order No.	Neil Lilley	Date Tested	16/02/2018

This report applies only to the sample/s as tested.

Tested By	Jim Saunders
Date Reported	22/02/2018
Checked By	(signature)

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

Approved Signatory (signature) J. SAUNDERS

APPENDIX D: DETERMINE CRITICAL DESIGN LOAD VS MEMBER CAPACITY

* The following example identifies critical design moment produced by different load combinations and compared them to purlin member capacity

* According to Appendix A & B, sagging moment capacities (compression in flat) are limited by local buckling (effective member span does not has an effect to member bending capacity)

* The critical design load combinations vs member capacity are found in end span of three continous span model. From bending moment shape of critical design load combination, the effective length of the member in bending is found to be approximately 80% of purlin span.

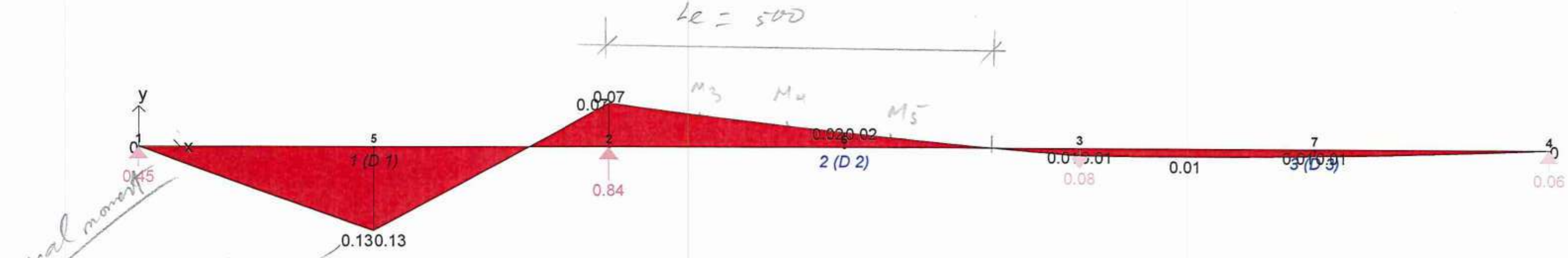
$M^* = 0.07$ kN.m

$M_3 = 3/4 \times 0.07 = 0.053$ kN.m

$M_4 = 1/2 \times 0.07 = 0.035$ kN.m

$M_5 = 1/4 \times 0.07 = 0.018$ kN.m

$M^* = 0.07$ kN.m



|| Moment due to UDL = 0.08 wL^2
|| Moment due to Pt = 0.2 PL

$$C_b = \frac{12.5 M^*}{2.5M^* + 3M_3 + 4M_4 + 3M_5} = \frac{12.5 \times 0.07}{2.5 \times 0.07 + 3 \times 0.053 + 4 \times 0.035 + 3 \times 0.018}$$

$= 1.66$

Plot View - Static Case: 1.2G+1.5Q1 Mz' (kN-m)

$M^* = 0.05$ kN.m

$L_e = 600$

$M^* = 0.05$ kN.m

$M_3 = 3/4\, M^* = 0.038$ kN.m

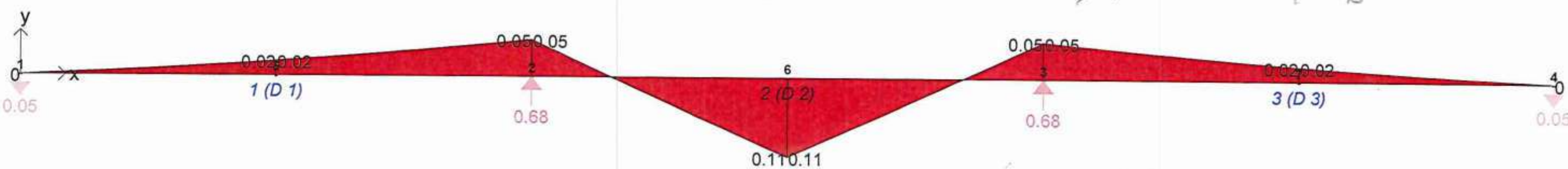
$M_4 = 1/2\, M^* = 0.025$ kN.m

$M_5 = 1/4\, M^* = 0.013$ kN.m

$C_b = 1.65$

$\phi M_b = 0.127$ kN.m $> M^*$

$\frac{M^*}{\phi M_b} = 39\%$



Plot View - Static Case: 1.2G+1.5Q2 Mz' (kN-m)

$M^* \simeq M_4 = 0.11$ kN.m

$M_3 \simeq M_5 \simeq 0.09$ kN.m

For RB4055 purlin

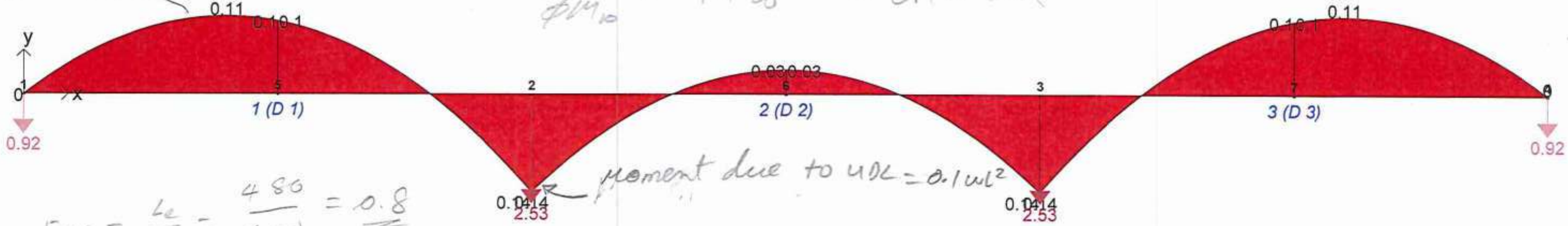
$M^* = 0.11$ kN.m

$L_e = 480$mm

$\phi M_b = 0.148$ kN.m $> M^*$ – critical

$\frac{M^*}{\phi M_b} = 74\%$ – critical

critical moment due to UDL = $0.08\,wL^2$



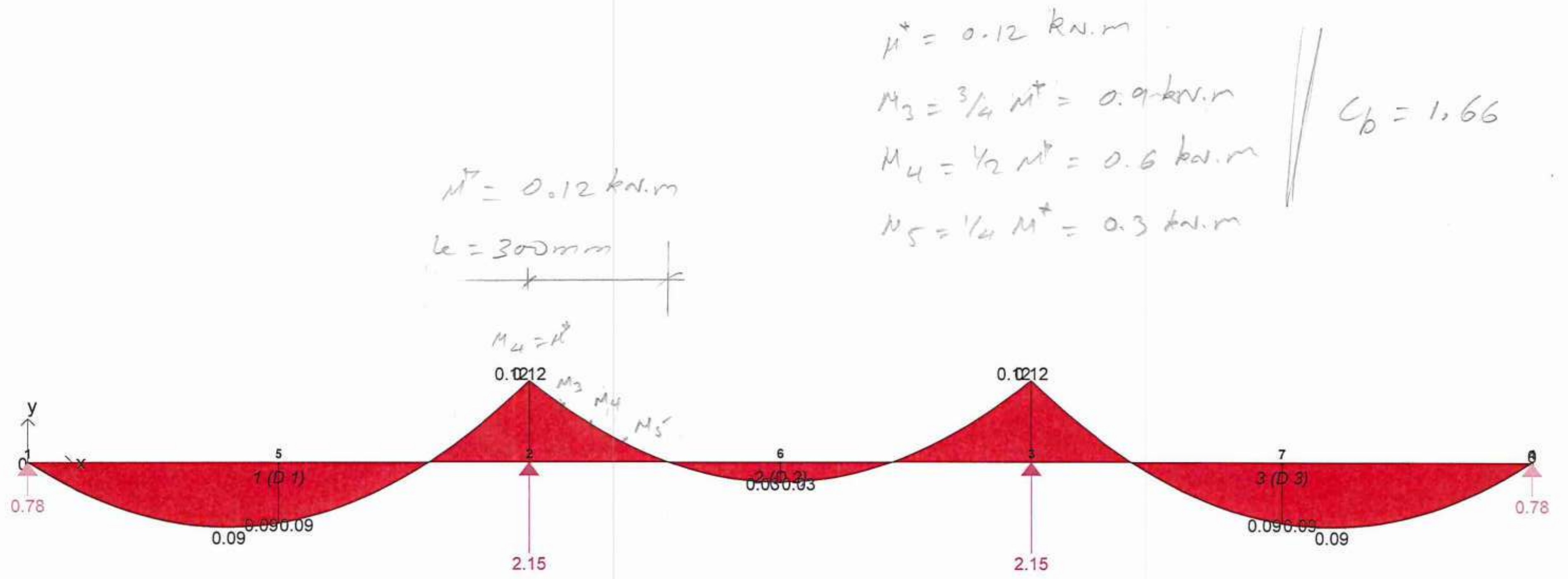
moment due to UDL = $0.1\,wL^2$

For $= \frac{L_e}{L} = \frac{480}{600} = 0.8$

$$C_b = \frac{12.5 \times 0.11}{2.5 \times 0.11 + 3 \times 0.09 + 4 \times 0.11 + 3 \times 0.09}$$

$= 1.1$

Plot View - Static Case: 0.9G+Wu Mz' (kN-m)



Plot View - Static Case: 1.2G+Wd Mz' (kN-m)