15 WILLOW GROVE

SOUTH CERNEY

Structural Calculations

Document reference: 22.132-CR01

Revision: B

Barsby Structural Consultants Ltd
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Calculation Report Ref. 22.132-CR01

Contents

Appendices

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Introduction

Barsby Structural Consultants have been appointed by Mr & Mrs Carter to carry out structural calculations and drawings suitable for construction and building regulations approval for 15 Willow Grove, South Cerney.

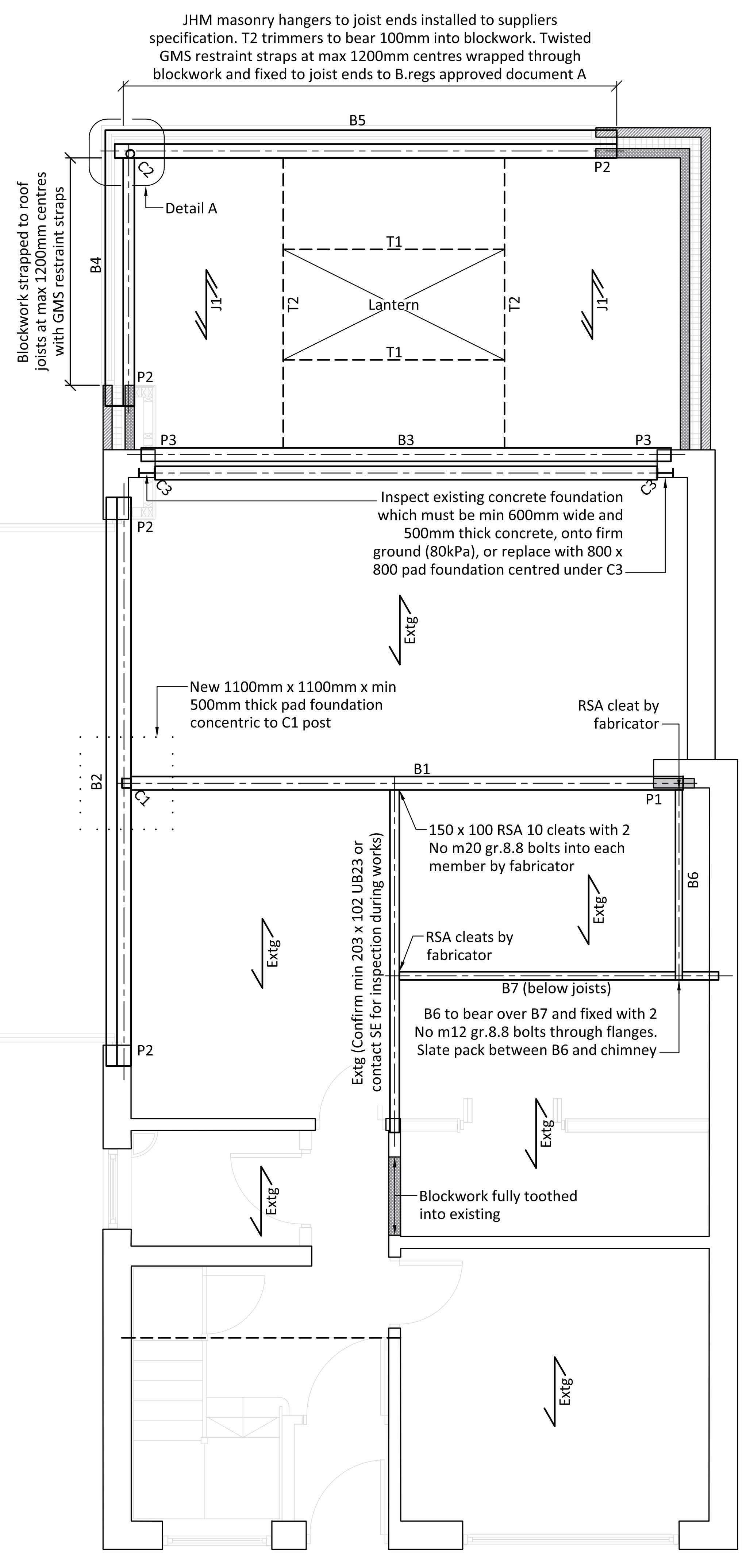
The scope of works is to design trimming steelwork and timber to support the existing dormer bungalow structure and permit a number of ground floor wall removals and bi-fold openings. In addition, a single storey flat roof extension to be designed to the rear of the existing with corner glazing and steel post (post positions is to be agreed with the Architect).

Designers Risk Assessment

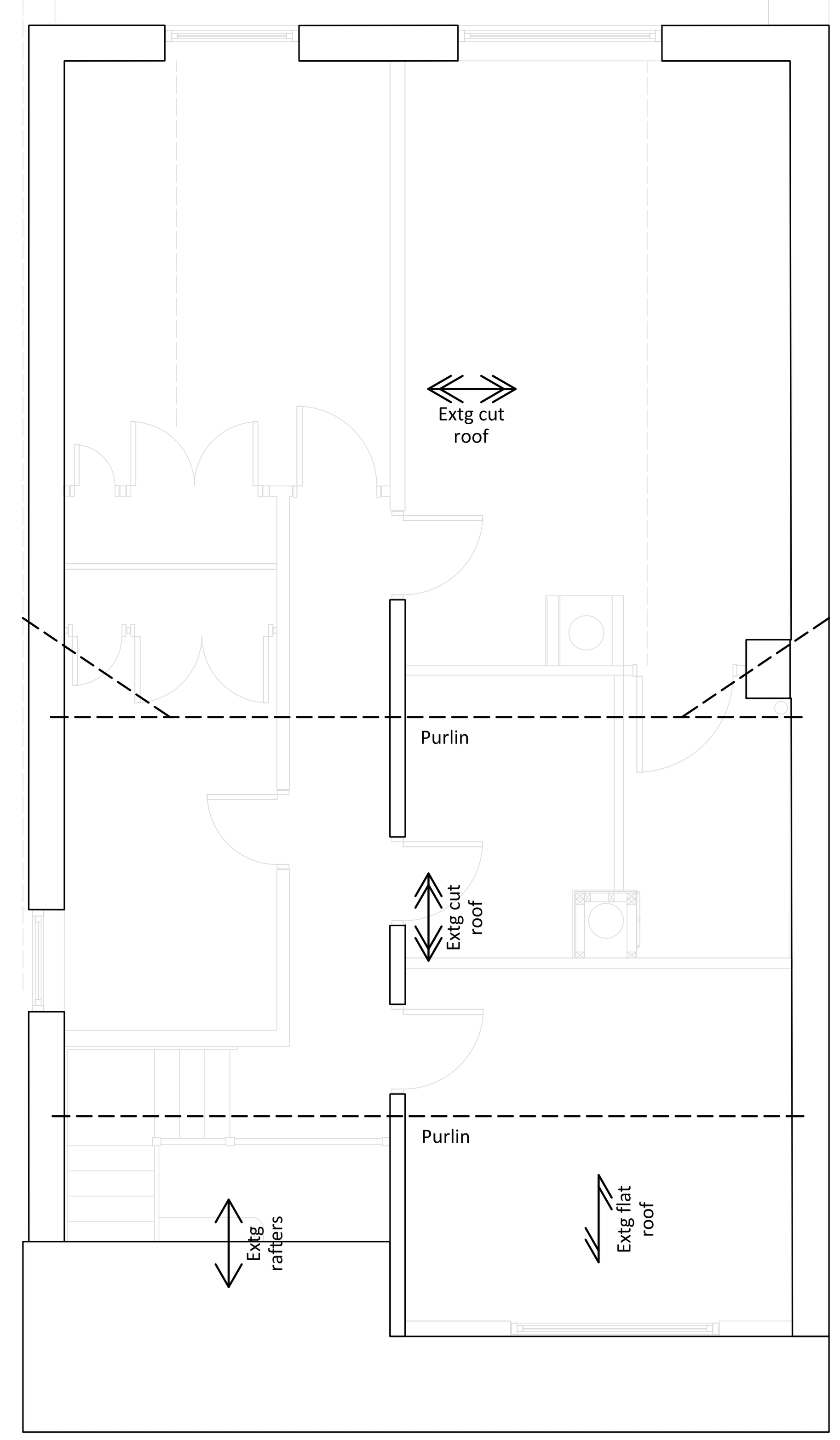
A risk assessment for this project has been carried out in accordance with CDM regulations 2015, to identify unusual hazards associated with the design; those are risks that are not standard risks associated with construction projects. Standard construction risks are not assessed, as Barsby Structural Consultants Ltd assumes a competent contractor is appointed to carry out the works. The Unusual risks have been assessed for severity and probability, and mitigating measures are described in the measures taken column. Where residual risks are greater than a low rating, these are highlighted on the project drawings.

Description	Severity	Likelihood	Risk Rating	Measures taken	Residual Risk Rating
None identified					

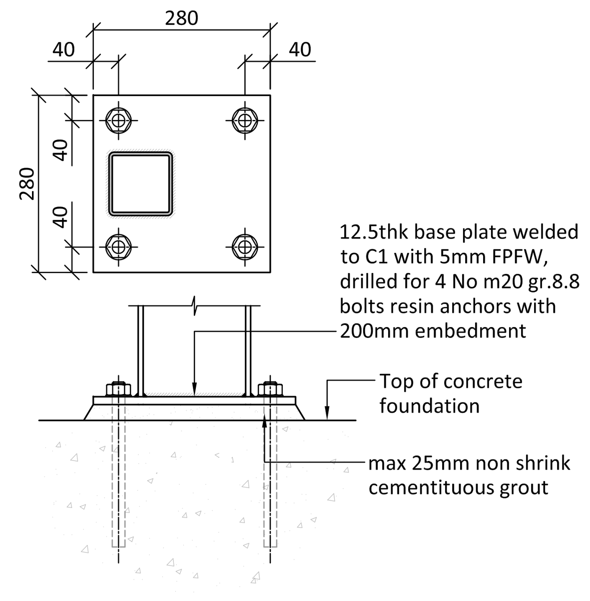
Appendix A - Drawings



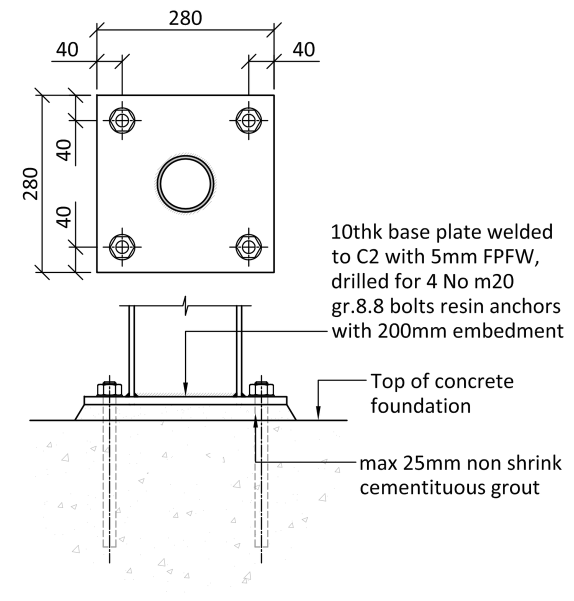
Ground Floor Showing Structure Over
scale 1:50



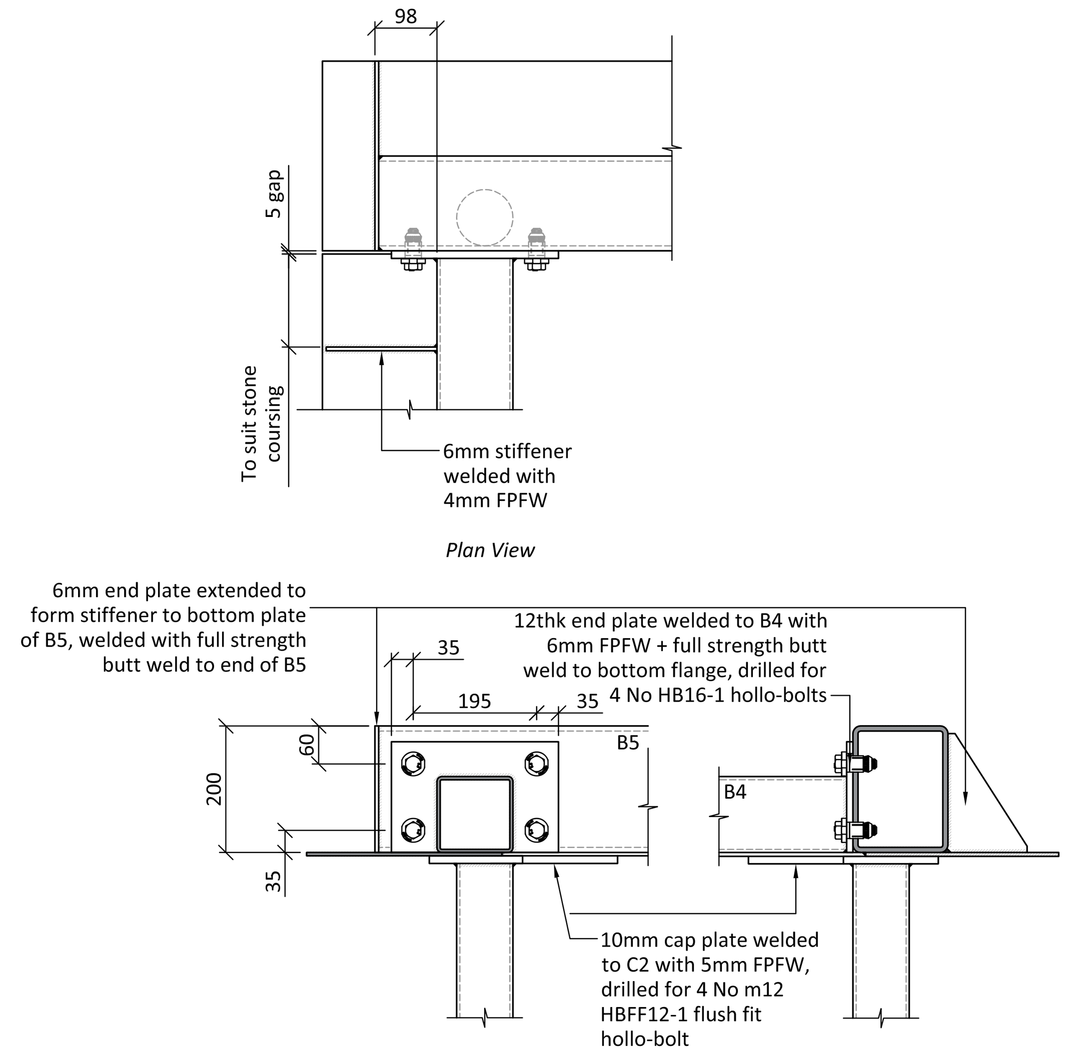
First Floor Showing Structure Over
scale 1:50

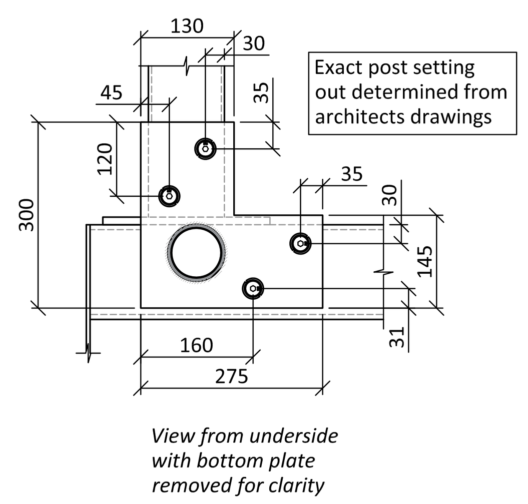


C1 baseplate
scale 1:10

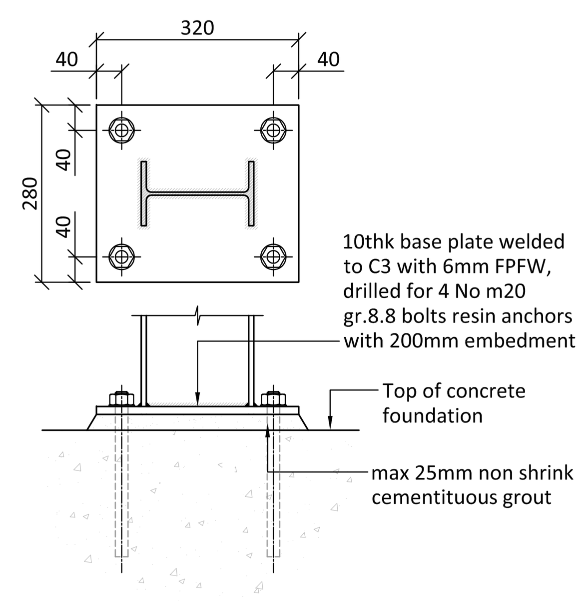


C2 baseplate
scale 1:10

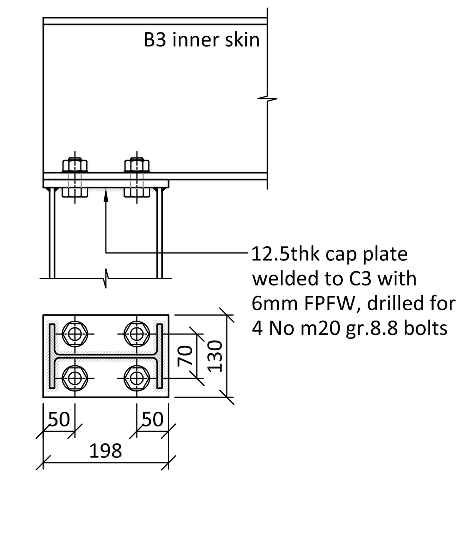




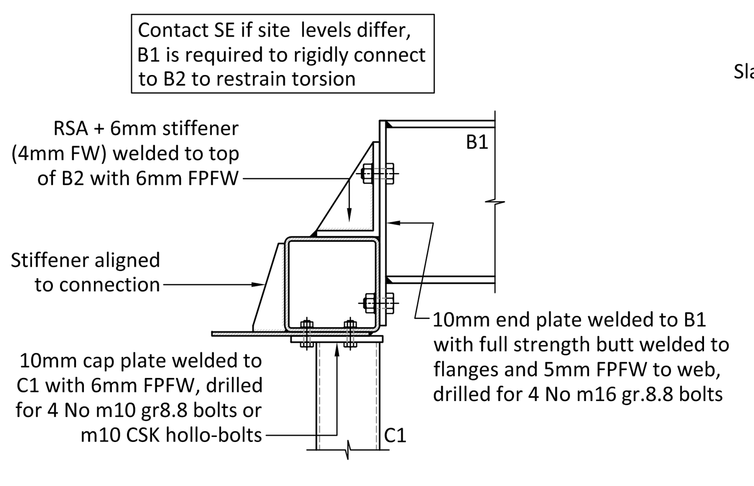
Detail A
scale 1:10



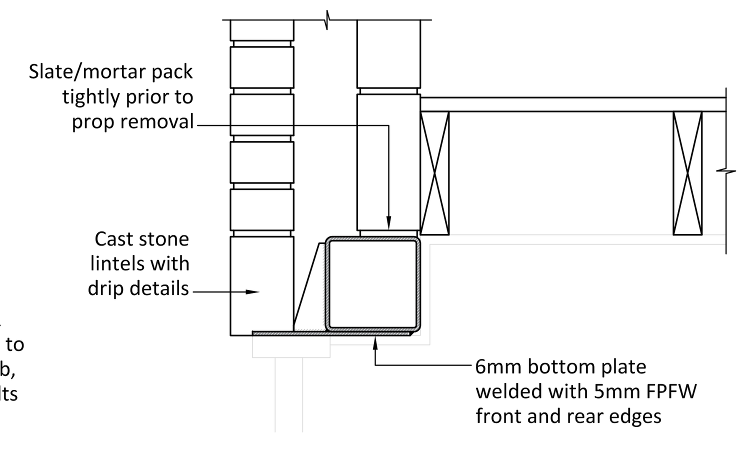
C3 baseplate
scale 1:10



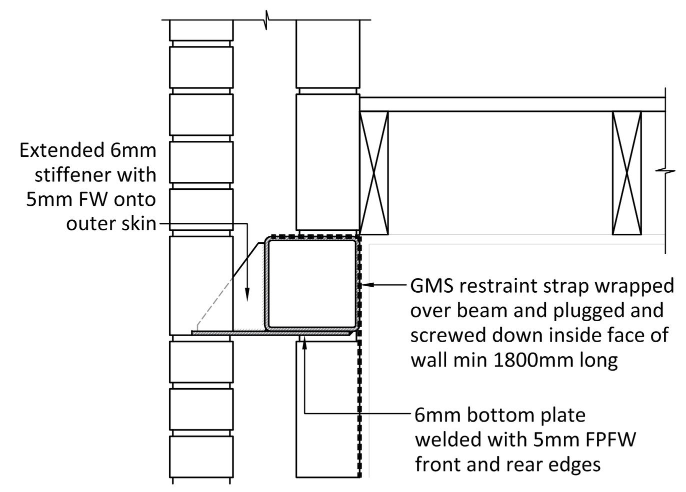
C3 to B3 connection
scale 1:10



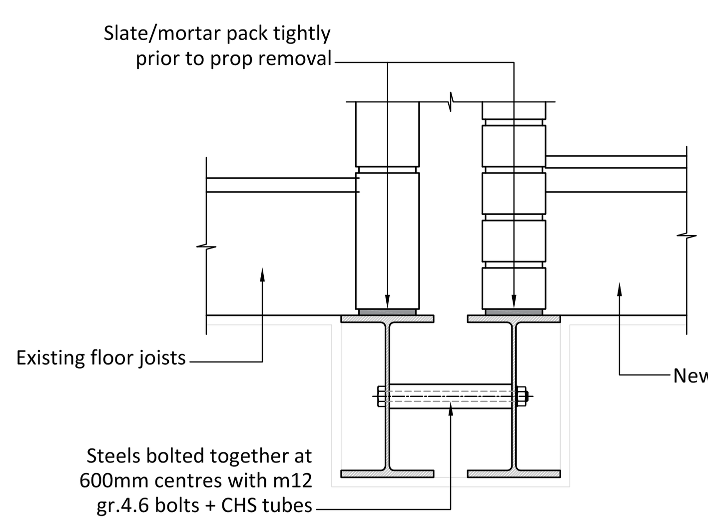
B1, B2 and C1 connection
scale 1:10



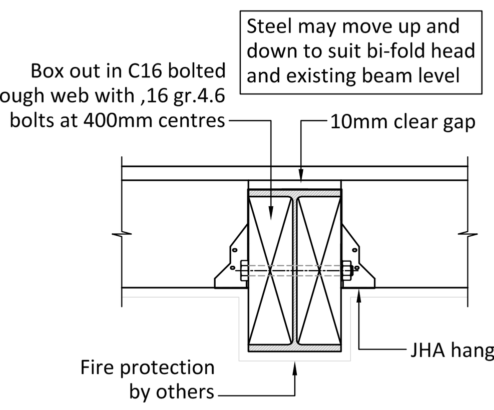
Typical Section Through B2/B4/B5
scale 1:10



P2 bearing (typical)
scale 1:10



Section Through B3
scale 1:10



Section Through B1
scale 1:10

Legend

- Steel beam (size as noted in key)
- Crank in steel beam (full strength butt weld)
- Steel column (size as noted in key)
- Timber beam (size as noted in key)
- Rafter (size as noted on key)
- Flat roof joist (size as noted on key)
- Floor joist (size as noted on plan)
- Trussed rafters by supplier
- Timber post (size as noted in key)
- Blockwork inner skin
- Brickwork
- Stone/ recon stone
- Non load-bearing partitions by others
- Studwork wall (size and spacing as noted in member key)
- Pre-stressed lintel with min 150mm bearings (size as noted on member key)
- Padstone (size as noted on member key)

Member Key

J1 - 195 x 45 C16 joists at max 600mm centres
T1 - 2 No 195 x 45 C16 trimmer
T2 - 2 No 195 x 70 C24 trimmer
B1 - 254 x 146 UB 43
B2 - 150 x 150 SHS6.3 + 6mm bottom plate (see typical section)
B3 - 2 No 254 x 146 UB37
B4 - 120 x 120 SHS 5 + 6mm bottom plate (see typical section)
B5 - 200 x 150 RHS 8 + 6mm bottom plate (see typical section)
B6 - 127 x 76 UB13 at tip of chimney stack above first floor level
B7 - 152 x 89 UB16 downstand below ceiling level
C1 - 100 x 100 SHS 10 post
C2 - 88.9 CHS 5 post
C3 - 178 x 102 UB19 post
P1 - Steel to bear 300mm onto 440 x 100 x 215dp PPC padstone.
P2 - Steel to bear 225mm onto masonry, including bottom plate onto outer skin (see typical detail).

General Notes:

1. Do not scale from the drawing; all dimensions and setting out to either be confirmed by the Architect or by measuring on site.
2. The copyright in this drawing belongs to Barsby Structural Consultants Ltd; the details contained within this drawing can not be used for any other project other than the project stated in the title block.
3. It is the responsibility of the contractor to review the drawing and notify the Structural Engineer of any discrepancies prior to commencing works.
4. All dimensions are in mm u.n.o.
5. This drawing may be subject to planning, building regulations application, party wall agreement. Should this be the case, all works carried out prior to approval are at the contractors/clients risk.

Steelwork notes:

1. These are **not** setting out drawings - steelwork setting out to be determined by the fabricator from site measurement or the Architects drawings.
2. No holes are to be drilled through the steelwork unless agreed with the Structural Engineer.
3. All steelwork to be CE marked in accordance with BS EN 1090-1 & 2. All steelwork to be Execution Class 2.
4. All open sections to be grade S275JR in accordance with BS EN10025-2
5. All hollow sections to be grade S355JOH in accordance with BS EN10210-1
6. All bolts to be m20 grade 8.8; sheradized for internal use, or hot spun galvanised for external use.
7. All fillet welds to be 8mm full profile fillet welds u.n.o
8. Corrosion protection.
   - 8.1. Hidden steelwork; to Corus system B3, with shop applied zinc phosphate epoxy primer 80μm. If in contact with external masonry and additional 2 coats of high build bituminous paint to be applied
   - 8.2. External steelwork; to Corus system B12 hot dip galvanised to BE EN ISO 1461 to 85μm

Timber notes:

1. All softwood timber to be fsC certified stamped grade C16, All hardwood timber to be fsC certified stamped grade D30 to BS 5268 u.n.o, with maximum moisture content of 20% internal use and 40% external use.
2. All fixings into softwood to be galvanised
3. All fixings into hardwood to be stainless steel
4. All nails to be in accordance with BS 1202-1. pre drilling to be maximum of 0.8 x nail diameter
5. All screws to be in accordance with BS 1202. pre drilled holes to be maximum of 0.5 x screw shank diameter
6. All bolts to be grade 4.6 with oversized washers. Toothed plate connectors to be used between adjoining timber surfaces.
7. All notches and holes within timbers to be in accordance with the Building Regulations current version

Masonry notes:

1. All masonry to be in accordance with BS EN 5628-1 and 3.
2. Brickwork to be minimum compressive strength of 20N/mm², with frogs facing upwards.
3. Blockwork to be minimum compressive strength 7.3n/mm² u.n.o.
4. Engineering brickwork to be minimum compressive strength 50N/mm² u.n.o.
5. Below DPC mortar to be designation class (ii).
6. Above DPC mortar to be designation class (iii).
7. Internal blockwork to have movement joints in accordance with the suppliers specification but at a maximum of 6m, unless shrinkage cracking is deemed acceptable.

Foundation notes:

1. All excavations to be inspection by the Building Control Officer (BCO) prior to pouring concrete
3. Assumed bearing pressure 80kPa, to be approved by BCO for site soil conditions
4. Concrete to be poured on the same day of excavation. If this is not possible, the base of the excavation is to be reduced 200mm immediately prior to pouring concrete the following day. The contractor is responsible for making sure excavations are not left open overnight.
5. Excavations to be clear and free of debris prior to pouring concrete.
6. All below ground mass fill concrete to be FND3 u.n.o
7. All below ground reinforced concrete to be RC32/40 u.n.o

BSC
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Drawing Status:
ISSUED FOR CONSTRUCTION

Project:
15 WILLOW GROVE
SOUTH CERNEY

Title:
GENERAL ARRANGEMENT AND DETAILS

Scale:	Date:	Drawn:
as shown at A1	16/11/22	MPB

Drawing Number:	Revison:
22.132-1000	B

CDM Risk Schedule:

The client is responsible for ensuring those who undertake the work are suitably experience and competent.
In addition to usual hazards expected with the work covered by this drawing, the following unusual risks have been highlighted risk through assessment. The work must be planned and executed to account for these risks during construction, operation,maintenance, decommissioning and demolition

Reference	Risk description
1	There are no unusual risks identified for this drawing

Date	Description	Rev.
16/11/22	Chimney support added	B
25/10/22	First issue	A

Appendix B - Calculations

Title:	15 WILLOW GROVE, SOUTH CERNEY		
Ref. 22.132	By: MB	Date:	20/10/2022

BSC
BARSBY STRUCTURAL CONSULTANTS

Loading sheet 1

	ROOF (40 DEG)	
1No	Interlocking Concrete Tiles	0.55
1No	Felt + Battens	0.05
145mm	Timber @ 400c/c	0.11
40Pitch	Imposed,R2 - Pitch between 30-60 degrees = 0.75[(60-a)/30] (Small ro.....	0.50
	Total GK (Pitch Corrected)	0.93 kN/m2
	Total Qk	0.5 kN/m2
	ATTIC	
300mm	Insulation	0.12
150mm	Timber @ 400c/c	0.12
1No	12thk Plasterboard/Skim	0.12
1No	Imposed,RS2 - Roof Space with access.....	0.25
	Total Gk	0.35 kN/m2
	Total Qk	0.25 kN/m2
	ROOF(30 DEG)	
1No	Interlocking Concrete Tiles	0.55
1No	Felt + Battens	0.05
145mm	Timber @ 400c/c	0.11
30Pitch	Imposed,R2 - Pitch between 30-60 degrees = 0.75[(60-a)/30] (Small ro.....	0.75
	Total GK (Pitch Corrected)	0.82 kN/m2
	Total Qk	0.75 kN/m2
	FLOOR	
1No	Carpet & Underlay	0.05
22mm	Chipboard/OSB board	0.16
170mm	Timber @ 400c/c	0.13
1No	12thk Plasterboard/Skim	0.12
1No	Imposed,A1 - All usages within self-contained single family dwelling.....	1.50
	Total Gk	0.46 kN/m2
	Total Qk	1.5 kN/m2
	BLOCKWORK	
100mm	Block (Medium)	1.40
	Total Gk	1.4 kN/m2
	Total Qk	0 kN/m2
	BRADSTONE	
100mm	Stone (Sandstone)	2.40
	Total Gk	2.4 kN/m2
	Total Qk	0 kN/m2

Title:	15 WILLOW GROVE, SOUTH CERNEY		
Ref. 22.132	By: MB	Date:	20/10/2022

BSC
BARSBY STRUCTURAL CONSULTANTS

Loading sheet 1

	FLAT ROOF	
1No	Felt + Chippings	0.35
19mm	Chipboard/OSB board	0.14
1No	Felt + Battens	0.05
195mm	Timber @ 400c/c	0.15
170mm	Insulation	0.07
1No	12thk Plasterboard/Skim	0.12
0Pitch	Imposed,R1 - Pitch less than 30 degrees (small roof).....	0.75
	Total Gk	0.87 kN/m2
	Total Qk	0.75 kN/m2

Title:	15 WILLOW GROVE, SOUTH CERNEY		
Ref. 22.132	By: MB	Date:	16/11/2022

BSC
BARSBY STRUCTURAL CONSULTANTS

Beam ref	Beam Load Rundown		kN/m (SLS)
	UDL = Uniformly distrubuted load DL = Partially Distributed load PL = Point Load		
PURLIN			
	2600mm x ROOF (40 DEG)		
	2600mm x ROOF (40 DEG)		
	1600mm x ATTIC		
	1600mm x ATTIC		
UDL	Total Gk/Qk		2.99/1.7
EXTG BEAM			
	2500mm x BLOCKWORK		
0	Total Gk/Qk		3.5/0
PURLIN	4.7kN/m - Distributed		
PURLIN	2.7kN/m - Distributed		
DL	Total Gk/Qk	From 0mm for 2200mm	4.7/2.7
PL	From B7 Gk = 4.3kN at 1570 mm		
PL	From B7 Qk = 6.1kN at 1570 mm		
B1			
	3500mm x FLOOR		
	3500mm x FLOOR		
DL	Total Gk/Qk	From 0mm for 2800mm	1.61/5.25
PL	From EXTG BEAM Gk = 9.1kN at 2800 mm		
PL	From EXTG BEAM Qk = 4.5kN at 2800 mm		
	2750mm x FLOOR		
	2750mm x FLOOR		
DL	Total Gk/Qk	From 2800mm for 2850mm	1.27/4.12
B2 INNER			
	3400mm x ROOF(30 DEG)		
	3400mm x ROOF(30 DEG)		
	2000mm x ATTIC		
	2000mm x ATTIC		
	1800mm x BLOCKWORK		
UDL	Total Gk/Qk		6.04/3.05
B2 OUTER			
	2000mm x BRADSTONE		
UDL	Total Gk/Qk		4.8/0
B3 INNER MAX	1650mm x FLOOR		

Title:	15 WILLOW GROVE, SOUTH CERNEY		
Ref. 22.132	By: MB	Date: 16/11/2022	

BSC
BARSBY STRUCTURAL CONSULTANTS

Beam ref	Beam Load Rundown	kN/m (SLS)
	UDL = Uniformly distrubuted load	
	DL = Partially Distributed load	
	PL = Point Load	
	1650mm x FLOOR	
	3450mm x BLOCKWORK	
UDL	Total Gk/Qk	5.59/2.47
PL	From EXTG BEAM Gk = 8kN at 2900 mm	
B3 INNER		
MIN	1650mm x FLOOR	
	1650mm x FLOOR	
	1800mm x BLOCKWORK	
UDL	Total Gk/Qk	3.28/2.47
B3 OUTER		
MAX	3450mm x BRADSTONE	
	1650mm x FLAT ROOF	
	1650mm x FLAT ROOF	
UDL	Total Gk/Qk	9.73/1.23
B3 OUTER		
MIN	1800mm x BRADSTONE	
	1650mm x FLAT ROOF	
	1650mm x FLAT ROOF	
UDL	Total Gk/Qk	5.77/1.23
B4 INNER		
	900mm x BLOCKWORK	
UDL	Total Gk/Qk	1.26/0
B4 OUTER		
	1050mm x BRADSTONE	
UDL	Total Gk/Qk	2.52/0
B5 INNER		
	1650mm x FLAT ROOF	
	1650mm x FLAT ROOF	
	900mm x BLOCKWORK	
UDL	Total Gk/Qk	2.71/1.23
B5 OUTER		
	1050mm x BRADSTONE	
UDL	Total Gk/Qk	2.52/0

Title:	15 WILLOW GROVE, SOUTH CERNEY		
Ref. 22.132	By: MB	Date:	16/11/2022

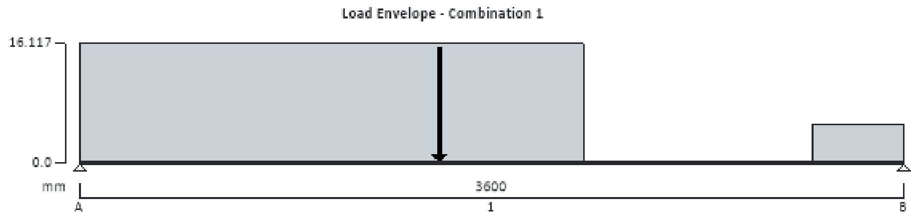
BSC
BARSBY STRUCTURAL CONSULTANTS

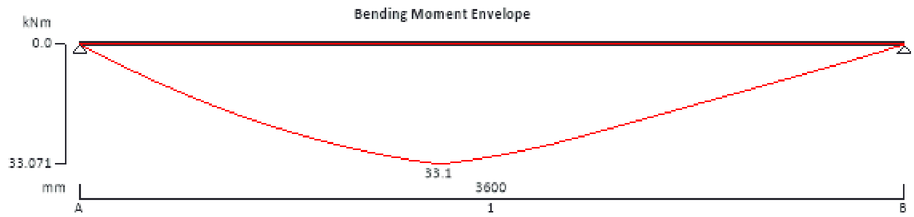
Beam ref	**Beam Load Rundown**	**kN/m (SLS)**
	UDL = Uniformly distrubuted load	
	DL = Partially Distributed load	
	PL = Point Load	
T1		
	1100mm x FLAT ROOF	
	1100mm x FLAT ROOF	
UDL	Total Gk/Qk	0.96/0.82
T2		
	600mm x FLAT ROOF	
	600mm x FLAT ROOF	
UDL	Total Gk/Qk	0.52/0.44
PL	From T1 Gk = 1.2kN at 1000 mm	
PL	From T1 Qk = 1.1kN at 1000 mm	
PL	From T1 Gk = 1.2kN at 2200 mm	
PL	From T1 Qk = 1.1kN at 2200 mm	
B5		
	4000mm x FLOOR	
	4000mm x FLOOR	
UDL	Total Gk/Qk	1.85/6
B6		
PL	From CHIMNEY Gk = 18.9kN at 300 mm	
	1750mm x FLOOR	
	1750mm x FLOOR	
UDL	Total Gk/Qk	0.80/2.62
B7		
	2400mm x FLOOR	
	2400mm x FLOOR	
UDL	Total Gk/Qk	1.11/3.6
PL	From CHIMNEY = kN at mm	

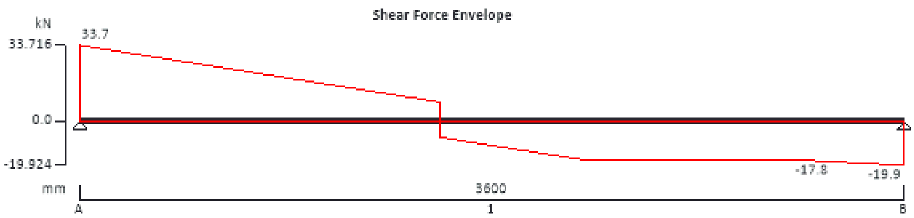
STEEL BEAM ANALYSIS & DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

TEDDS calculation version 3.0.07







Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

Beam loads	Dead self weight of beam × 1
	Dead partial UDL 3.5 kN/m from 0 mm to 2200 mm
	Dead partial UDL 3.5 kN/m from 3200 mm to 3600 mm
	Dead partial UDL 4.7 kN/m from 0 mm to 2200 mm
	Imposed partial UDL 2.7 kN/m from 0 mm to 2200 mm
	Dead point load 4.3 kN at 1570 mm
	Imposed point load 6.1 kN at 1570 mm

Load combinations

Load combination 1	Support A	Dead × 1.40
		Imposed × 1.60
		Dead × 1.40

Barsby Structural Consultants Ltd	Project: 15 WILLOW GROVE, SOUTH CERNEY				Job no.: 22.132	
	Calcs for				Start page no./Revision: 2	
	Calcs by: MB	Calcs date: 16/11/2022	Checked by	Checked date	Approved by	Approved date

		Imposed × 1.60
	Support B	Dead × 1.40
		Imposed × 1.60

Analysis results

Maximum moment	M_{max} = **33.1** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **33.7** kN	V_{min} = **-19.9** kN
Deflection	δ_{max} = **6.2** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **33.7** kN	R_{A_min} = **33.7** kN
Unfactored dead load reaction at support A	R_{A_Dead} = **15.4** kN	
Unfactored imposed load reaction at support A	$R_{A\_Imposed}$ = **7.6** kN	
Maximum reaction at support B	R_{B_max} = **19.9** kN	R_{B_min} = **19.9** kN
Unfactored dead load reaction at support B	R_{B_Dead} = **9.1** kN	
Unfactored imposed load reaction at support B	$R_{B\_Imposed}$ = **4.5** kN	

Section details

Section type — **UKB 203x102x23 (Tata Steel Advance)**

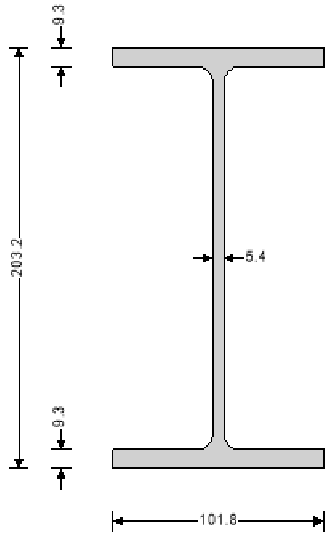
Steel grade — **S275**

From table 9: Design strength p_y

Thickness of element — max(T, t) = **9.3** mm

Design strength — p_y = **275** N/mm^2

Modulus of elasticity — E = **205000** N/mm^2



Lateral restraint

Span 1 has lateral restraint at supports only

Effective length factors

Effective length factor in major axis — K_x = **1.00**

Effective length factor in minor axis — K_y = **1.00**

Effective length factor for lateral-torsional buckling — $K_{LT.A}$ = **1.00**

$K_{LT.B}$ = **1.00**

Classification of cross sections - Section 3.5

$\varepsilon = \sqrt{[275 \text{ N/mm}^2 / p_y]}$ = **1.00**

Internal compression parts - Table 11

Depth of section — d = **169.4** mm

$d / t = 31.4 \times \varepsilon <= 80 \times \varepsilon$ — Class 1 plastic

Outstand flanges - Table 11

Width of section — b = B / 2 = **50.9** mm

$b / T = 5.5 \times \varepsilon <= 9 \times \varepsilon$ — Class 1 plastic

Section is class 1 plastic

Shear capacity - Section 4.2.3

Design shear force — F_v = max(abs(V_{max}), abs(V_{min})) = **33.7** kN

$d / t < 70 \times \varepsilon$

Web does not need to be checked for shear buckling

Shear area — $A_v = t \times D$ = **1097** mm^2

Design shear resistance — $P_v = 0.6 \times p_y \times A_v$ = **181.1** kN

PASS - Design shear resistance exceeds design shear force

Moment capacity - Section 4.2.5

Design bending moment — M = max(abs(M_{s1_max}), abs(M_{s1_min})) = **33.1** kNm

Moment capacity low shear - cl.4.2.5.2 — $M_c = \min(p_y \times S_{xx}, 1.2 \times p_y \times Z_{xx})$ = **64.4** kNm

Effective length for lateral-torsional buckling - Section 4.3.5

Effective length for lateral torsional buckling — $L_E = 1.0 \times L_{s1}$ = **3600** mm

Slenderness ratio — $\lambda = L_E / r_{yy}$ = **152.482**

Equivalent slenderness - Section 4.3.6.7

Buckling parameter — u = **0.888**

Torsional index — x = **22.460**

Slenderness factor — $v = 1 / [1 + 0.05 \times (\lambda / x)^2]^{0.25}$ = **0.742**

Ratio - cl.4.3.6.9 — β_W = **1.000**

Equivalent slenderness - cl.4.3.6.7 — $\lambda_{LT} = u \times v \times \lambda \times \sqrt{[\beta_W]}$ = **100.432**

Limiting slenderness - Annex B.2.2 — $\lambda_{L0} = 0.4 \times (\pi^2 \times E / p_y)^{0.5}$ = **34.310**

$\lambda_{LT} > \lambda_{L0}$ - Allowance should be made for lateral-torsional buckling

Bending strength - Section 4.3.6.5

Robertson constant — α_{LT} = **7.0**

Perry factor — $\eta_{LT} = \max(\alpha_{LT} \times (\lambda_{LT} - \lambda_{L0}) / 1000, 0)$ = **0.463**

Euler stress — $p_E = \pi^2 \times E / \lambda_{LT}^2$ = **200.6** N/mm^2

$\phi_{LT} = (p_y + (\eta_{LT} + 1) \times p_E) / 2$ = **284.2** N/mm^2

Bending strength - Annex B.2.1 — $p_b = p_E \times p_y / (\phi_{LT} + (\phi_{LT}^2 - p_E \times p_y)^{0.5})$ = **124.2** N/mm^2

Equivalent uniform moment factor - Section 4.3.6.6

Moment at quarter point of segment — M_2 = **23.8** kNm

Moment at centre-line of segment — M_3 = **31** kNm

Moment at three quarter point of segment — M_4 = **16.4** kNm

Maximum moment in segment — M_{abs} = **33.1** kNm

Maximum moment governing buckling resistance — $M_{LT} = M_{abs}$ = **33.1** kNm

Equivalent uniform moment factor for lateral-torsional buckling

$m_{LT} = \max(0.2 + (0.15 \times M_2 + 0.5 \times M_3 + 0.15 \times M_4) / M_{abs}, 0.44)$ = **0.850**

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment — $M_b = p_b \times S_{xx}$ = **29.1** kNm

M_b / m_{LT} = **34.2** kNm

PASS - Buckling resistance moment exceeds design bending moment

Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

Limiting deflection $\delta_{lim} = L_{s1} / 360 =$ **10** mm

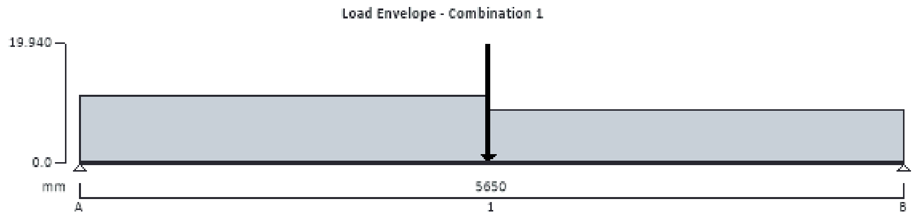
Maximum deflection span 1 $\delta = max(abs(\delta_{max}), abs(\delta_{min})) =$ **6.191** mm

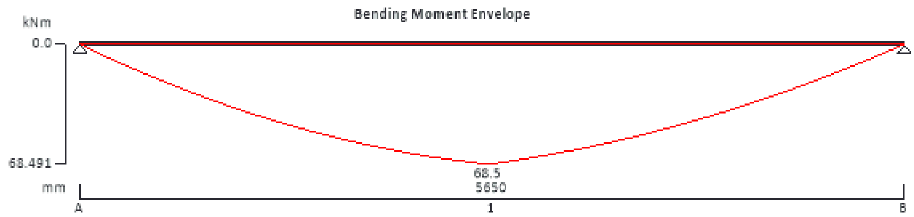
PASS - Maximum deflection does not exceed deflection limit

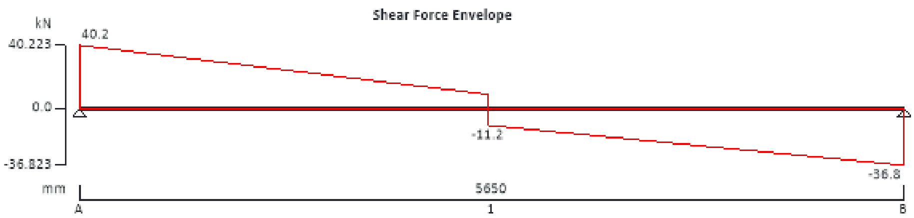
STEEL BEAM ANALYSIS & DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

TEDDS calculation version 3.0.07







Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

Beam loads	Dead self weight of beam × 1
	Dead partial UDL 1.62 kN/m from 0 mm to 2800 mm
	Imposed partial UDL 5.25 kN/m from 0 mm to 2800 mm
	Dead point load 9.1 kN at 2800 mm
	Imposed point load 4.5 kN at 2800 mm
	Dead partial UDL 1.27 kN/m from 2800 mm to 5650 mm
	Imposed partial UDL 4.13 kN/m from 2800 mm to 5650 mm

Load combinations

Load combination 1	Support A	Dead × 1.40
		Imposed × 1.60
		Dead × 1.40

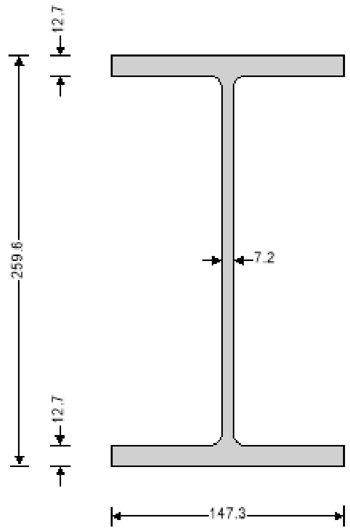
		Imposed × 1.60
	Support B	Dead × 1.40
		Imposed × 1.60

Analysis results

Maximum moment	M_{max} = **68.5** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **40.2** kN	V_{min} = **-36.8** kN
Deflection	δ_{max} = **10.3** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **40.2** kN	R_{A_min} = **40.2** kN
Unfactored dead load reaction at support A	R_{A_Dead} = **10.1** kN	
Unfactored imposed load reaction at support A	$R_{A\_Imposed}$ = **16.3** kN	
Maximum reaction at support B	R_{B_max} = **36.8** kN	R_{B_min} = **36.8** kN
Unfactored dead load reaction at support B	R_{B_Dead} = **9.5** kN	
Unfactored imposed load reaction at support B	$R_{B\_Imposed}$ = **14.7** kN	

Section details

Section type **UKB 254x146x43 (Tata Steel Advance)** Steel grade **S275**



Classification of cross sections - Section 3.5

Tensile strain coefficient ε = **1.00** Section classification **Plastic**

Shear capacity - Section 4.2.3

Design shear force F_v = **40.2** kN Design shear resistance P_v = **308.4** kN

PASS - Design shear resistance exceeds design shear force

Moment capacity - Section 4.2.5

Design bending moment M = **68.5** kNm Moment capacity low shear M_c = **155.7** kNm

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment M_b = **68.9** kNm M_b / m_{LT} = **77.2** kNm

PASS - Buckling resistance moment exceeds design bending moment

Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

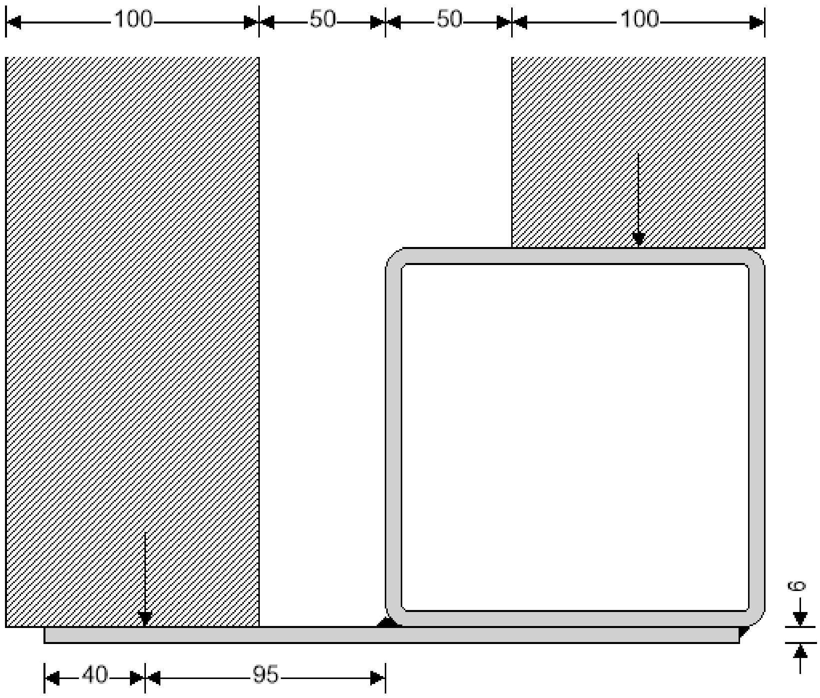
Limiting deflection δ_{lim} = **15.694** mm Maximum deflection δ = **10.285** mm

PASS - Maximum deflection does not exceed deflection limit

STEEL MASONRY SUPPORT

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

Tedds calculation version 1.0.05



Steel member details

Torsion beam	SHS 150x150x6.3	Masonry support angle	plate
Steel grade of support angle	User	Design strength support angle	p_{ysb} = **355** N/mm^2
Modulus of elasticity	E = 205000 N/mm^2	Constant	ε = **0.880**
Length of plate beyond beam	l_h = **135** mm	Total length of plate	l_{plate} = **275** mm
Thickness of plate	t_{sb} = **6** mm	Width of main beam	B_{mb} = **150** mm
Area of plate	A_{sbu} = **1650.0** mm^2	Dist weld position to CoG	c_{yysb} = **-3** mm

Supported materials detail

Density mas. main beam	$\rho_{m,mb}$ = **21.0** kN/m^3	Width masonry main beam	b_{mmb} = **100** mm
Height masonry main beam	h_{mmb} = **1900** mm		
Ecc. of main beam material	e_{mb} = **50** mm		
Add dead force main beam	P_{Gaddmb} = **3.5** kN/m	Add live force main beam	P_{Qaddmb} = **3.1** kN/m
Density mas. support beam	$\rho_{m,sb}$ = **24.0** kN/m^3	Width masonry support beam	b_{msb} = **100** mm
Height masonry support beam	h_{msb} = **2100** mm		
Add dead force support beam	P_{Gaddsb} = **0.0** kN/m	Add live force support beam	P_{Qaddsb} = **2.0** kN/m

Geometry

Cavity width	c = **100** mm	Supported width of masonry	d_m = **85** mm

Biaxial stress effects in the plate (SCI-P-110)

Max overall bending moment	M_x = **27.6** kNm	Dist to NA combined section	$y_{e,all}$ = **25** mm
Second moment of area	$I_{xx,all}$ = **1910** cm^4	Elastic section modulus	$Z_{xx,all}$ = **338.82** cm^3
Section modulus of plate	$Z_{xx,plate}$ = **6.00** cm^3/m	Eccentricity on support beam	e_1 = **95** mm
Force on support plate	P_1 = **10.3** kN/m	Bending at heel	$M_{x,plate}$ = **1.0** kNm/m
Moment capacity of plate	M_c = **2.6** kNm/m		

PASS - Design strength exceeds stress at heel

Long stress overall bending σ_1 = **81.4** N/mm^2 Von Mises curve constant c_{fp} = **695.9** N/mm^2

Trans bending stress ratio limit α_{ts} = **0.967** Trans bending stress ratio α_{ls} = **0.381**

PASS - Transverse bending stress ratio less than allowable limit

Deflection at toe

Unfact force on plate P_{1SLS} = **7.0** kN/m Distance from weld to load a_m = **95** mm

Load resultant to edge of plate b_m = **40** mm Weld to load pos as ratio a_l = **0.704**

Effect second mnt of inertia I_{eff_def} = **18000** mm^4/m Deflection at toe δ = **0.89** mm

Deflection limit δ_{lim} = **1.85** mm

PASS - Deflection is within specified criteria

Weld details - assume a full length weld and that the plate acts as a propped cantilever with the prop at the weld position and the fixed end at the centre of the torsion beam

Leg length of weld s_{weld} = **4** mm Throat size of weld a_{weld} = **2.8** mm

Shear force at weld position R_A = **29.7** kN/m Max possible force in plate R_p = **607.1** kN

Long shear beam/plate R_l = **418.7** kN/m Horizontal shear beam/plate R_h = **194.9** kN/m

Resultant weld force R_{weld} = **0.463** kN/mm Strength of weld (Table 37) p_{weld} = **220.0** N/mm^2

Capacity of full length weld $p_{c,weld}$ = **0.622** kN/mm

$1/\sqrt{(2)} \times s_{weld}$

Torsional loading ULS

Loading support beam w_{1ULS} = **10.26** kN/m Loading of main beam w_{2ULS} = **15.41** kN/m

Self weight of support beam w_{3ULS} = **0.18** kN/m

Torsional loading SLS

Loading support beam w_{1SLS} = **7.04** kN/m Loading of main beam w_{2SLS} = **10.57** kN/m

Self weight of support beam w_{3SLS} = **0.13** kN/m

Eccentricities

Distance of shear centre e_{0mb} = **0** mm Ecc of support beam masonry e_{1mb} = **175** mm

Ecc of main beam masonry e_{2mb} = **-25** mm Ecc of support beam e_{3mb} = **73** mm

Torsional effects

Applied torque T_{qULS} = **1.42** kNm/m Torsional moment (ULS) T_q = **4.13** kNm

Applied torque (SLS) T_{qSLS} = **0.98** kNm/m Torsional moment (SLS) T_{qu} = **2.83** kNm

STEEL BEAM TORSION DESIGN

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

Tedds calculation version 2.0.03

Section details

Section type SHS 150x150x6.3 Steel grade S355

Design stength $p_{yw} = p_y$ = **355** N/mm^2 Constant ε = **0.880**

Geometry - Beam unrestrained against lateral-torsional buckling between supports.

Effective span L = **2900** mm

Length of segment LTB L_{LT} = **2900** mm Effective length for LTB L_{E_LT} = **2030** mm

Loading - Torsional loading comprises only full-length uniformly distributed load(s)

Internal forces & moments on member under factored loading for uls design

Applied shear force F_{vy} = **38.0** kN Maximum bending moment $M_{LT} = M_x$ = **27.58** kNm

Applied torque T_q = **4.13** kNm Minor axis bending moment M_y = 0 kNm

Compression force F_c = 0 kN

Equivalent uniform moment factors

EUM factor (Cl.4.3.6.6 & T18) m_{LT} = **1.000**

Torsional deflection analysis

Beam is torsion fixed at each end. (as defined in SCI-P-057 section 2.1.6)

Max torque (at supports) T_o = **2.06** kNm   Avg torque support & CL T_{av} = **1.03** kNm

Max. angle of twist (midspan) ϕ = **0.001** rads

Section classification

b_x / t = **20.8** d_x / t = **20.8**

b_y / t = **20.8** d_y / t = **20.8**

r_{1sx} = **0.000** r_{1sy} = **0.000**

r_{2s} = **0.000**

Section classification is plastic

Shear capacity (parallel to y-axis)

Design shear force F_{vy} = **38.0** kN   Design shear resist (cl. 4.2.3) P_{vy} = **381.1** kN

Pass - Shear

Moment capacity (x-axis)

Design bending moment M_x = **27.6** kNm   Mnt cap low shear (cl. 4.2.5.1) M_{cx} = **68.1** kNm

Pass - Moment capacity exceeds design bending moment

Lateral torsional buckling

LT buckling check not required for this section (cl. 4.6.3.1)

Buckling resistance moment $M_b = M_{cx}$ = **68.1** kNm

LT buckling check not required for this section

Buckling under combined bending & torsion - SCI-P-057 section 2.3

For simplicity, a conservative check is applied using the maximum stresses due to each of the separate load effects, even though these do not necessarily all occur at the same section along the member.

Max angle of twist ϕ = **0.001** rads   Induced minor axis moment M_{yt} = **0.03** kNm

Norm stress corner due to M_{yt} σ_{byt} = **0** N/mm^2 Interaction index i_b = **0.41**

Pass - Combined bending and torsion check satisfied

Local capacity under combined bending & torsion

For simplicity, a conservative check is applied using the maximum stresses due to each of the separate load effects, even though these do not necessarily all occur at the same section along the member.

Max. direct stress due to M_x $\sigma_{bx} = M_x / Z_x$ = **169** N/mm^2

Combined stress - eqn 2.22 $\sigma_{bx} + \sigma_{byt}$ = **169** N/mm^2 Design strength p_y = **355** N/mm^2

Pass - Local capacity

Combined shear stresses SCI-P-057 section 2.3

For simplicity, a conservative check is applied using the maximum shear stresses due to each of the separate load effects, even though these do not necessarily all occur at the same section along the member.

Max. shear stress bending τ_{bw} = **24** N/mm^2 Max. shear stresses torsion τ_t = **9** N/mm^2

Amplified shear stress torsion τ_{vt} = **10** N/mm^2 Combined shear bend & tors τ = **34** N/mm^2

Shear strength p_v = **213** N/mm^2

Pass - Combined shear stresses

Twist check

Total applied torque (unfact) T_{qu} = **2.83** kNm

Max twist under sls loading ϕ_{sls} = **0.04** degs   Lever arm for defl due to twist h_δ = **200** mm

Deflection due to twist $\delta_{h.sls}$ = **0.1** mm   Deflection limit $\delta_{h.lim}$ = **1** mm

Pass - Deflection due to twist

Deflection

Maximum y-axis deflection δ_{y_max} = **6.6** mm

Deflection limit - cl. 2.5.2 δ_{lim} = **8.1** mm

Pass - Deflection within specified limit

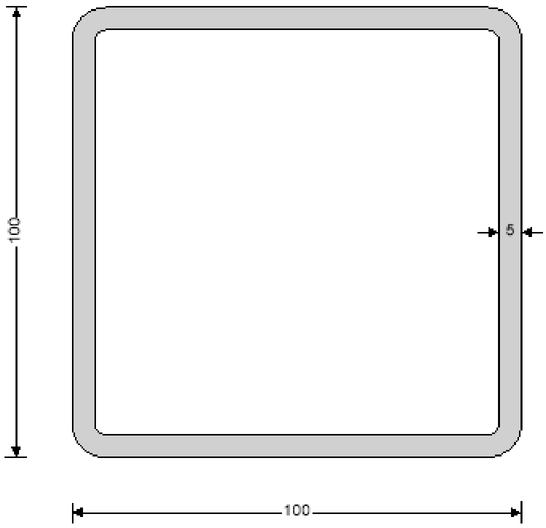
STEEL MEMBER DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

TEDDS calculation version 3.0.07

Section details

Section type **SHS 100x100x5.0 (Tata Steel Celsius (Gr355 Gr420 Gr460))** Steel grade **S355**



Classification of cross sections - Section 3.5

Tensile strain coefficient ε = **0.88** Section classification **Semi-compact**

Moment capacity - Section 4.2.5

Design bending moment M = **10** kNm Moment capacity low shear M_c = **23.6** kNm

Buckling resistance moment - Section 4.3.6.4

Bending strength p_b = **355** N/mm^2 Buckling resistance moment M_b = **23.6** kNm

PASS - Moment capacity exceeds design bending moment

Compression members - Section 4.7

Design compression force F_c = **107** kN Compression resistance P_{cx} = **415.3** kN

PASS - Compression resistance exceeds design compression force

Design compression force F_c = **107** kN Compression resistance P_{cy} = **415.3** kN

PASS - Compression resistance exceeds design compression force

Compression members with moments - Section 4.8.3

Comp.and bending check $F_c / (A \times p_y) + M / M_c$ = **0.585**

PASS - Combined bending and compression check is satisfied

Member buckling resistance - cl.4.8.3.3.3

Buckling resistance checks $F_c / P_{cx} + m_x \times M / M_c \times (1 + 0.5 \times F_c / P_{cx})$ = **0.737**

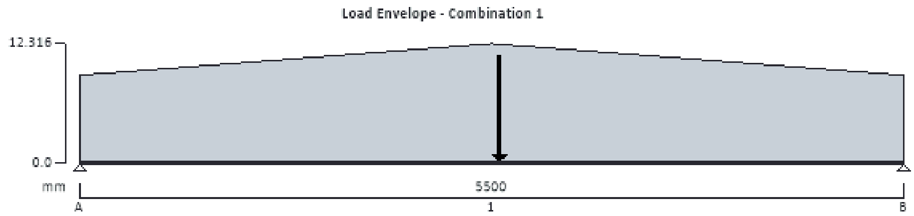
$F_c / P_{cy} + 0.5 \times m_{LT} \times M_{LT} / M_{cx}$ = **0.385**

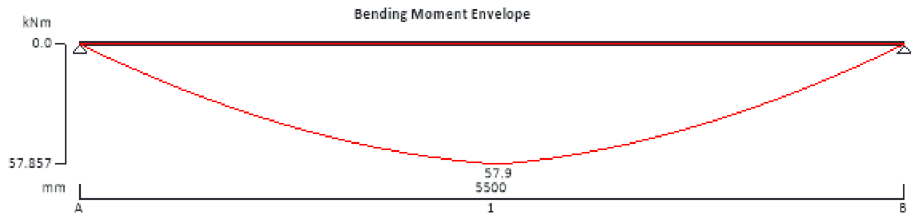
PASS - Member buckling resistance checks are satisfied

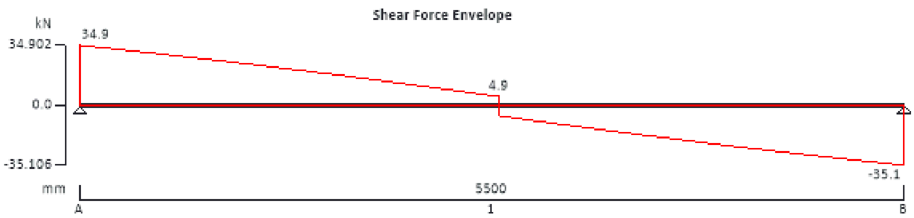
STEEL BEAM ANALYSIS & DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

TEDDS calculation version 3.0.07







Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

Beam loads	Dead self weight of beam × 1
	Dead partial VDL 3.28 kN/m at 0 mm to 5.6 kN/m at 2750 mm
	Dead partial VDL 5.6 kN/m at 2750 mm to 3.28 kN/m at 5500 mm
	Dead point load 8 kN at 2800 mm
	Imposed full UDL 2.48 kN/m

Load combinations

Load combination 1	Support A	Dead × 1.40
		Imposed × 1.60
		Dead × 1.40
		Imposed × 1.60
	Support B	Dead × 1.40

BSC BARSBY STRUCTURAL CONSULTANTS Barsby Structural Consultants Ltd	Project 15 WILLOW GROVE, SOUTH CERNEY				Job no. 22.132	
	Calcs for B3 INNER				Start page no./Revision 2	
	Calcs by MB	Calcs date 21/10/2022	Checked by	Checked date	Approved by	Approved date

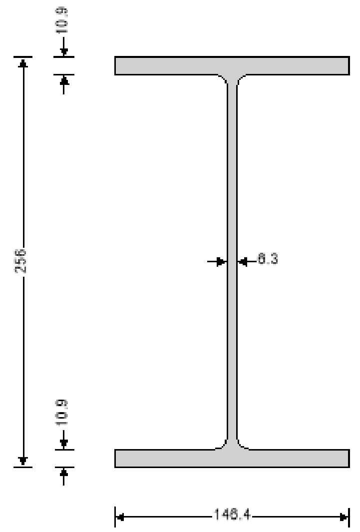
Imposed × 1.60

Analysis results

Maximum moment	M_{max} = **57.9** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **34.9** kN	V_{min} = **-35.1** kN
Deflection	δ_{max} = **10.4** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **34.9** kN	R_{A_min} = **34.9** kN
Unfactored dead load reaction at support A	R_{A_Dead} = **17.1** kN	
Unfactored imposed load reaction at support A	$R_{A\_Imposed}$ = **6.8** kN	
Maximum reaction at support B	R_{B_max} = **35.1** kN	R_{B_min} = **35.1** kN
Unfactored dead load reaction at support B	R_{B_Dead} = **17.3** kN	
Unfactored imposed load reaction at support B	$R_{B\_Imposed}$ = **6.8** kN	

Section details

Section type **UKB 254x146x37 (Tata Steel Advance)** Steel grade **S275**



Classification of cross sections - Section 3.5

Tensile strain coefficient ε = **1.00** Section classification **Plastic**

Shear capacity - Section 4.2.3

Design shear force F_v = **35.1** kN Design shear resistance P_v = **266.1** kN

PASS - Design shear resistance exceeds design shear force

Moment capacity - Section 4.2.5

Design bending moment M = **57.9** kNm Moment capacity low shear M_c = **132.9** kNm

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment M_b = **55.6** kNm M_b / m_{LT} = **61.8** kNm

PASS - Buckling resistance moment exceeds design bending moment

Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

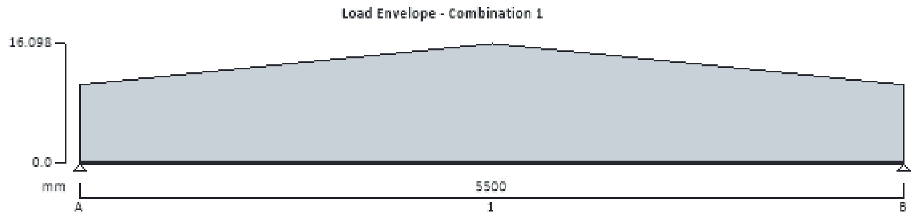
Limiting deflection δ_{lim} = **15.278** mm Maximum deflection δ = **10.428** mm

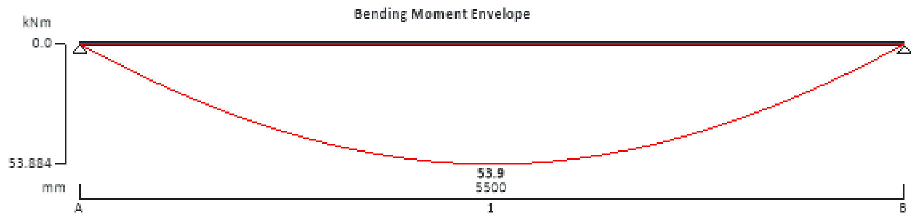
PASS - Maximum deflection does not exceed deflection limit

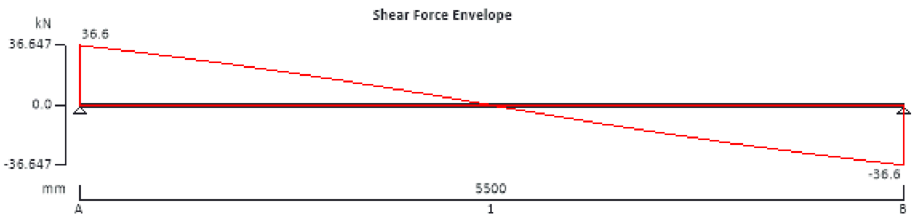
STEEL BEAM ANALYSIS & DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

TEDDS calculation version 3.0.07







Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

Beam loads	Dead self weight of beam × 1
	Dead partial VDL 5.77 kN/m at 0 mm to 9.73 kN/m at 2750 mm
	Dead partial VDL 9.73 kN/m at 2750 mm to 5.77 kN/m at 5500 mm
	Imposed full UDL 1.23 kN/m

Load combinations

Load combination 1	Support A	Dead × 1.40
		Imposed × 1.60
		Dead × 1.40
		Imposed × 1.60
	Support B	Dead × 1.40
		Imposed × 1.60

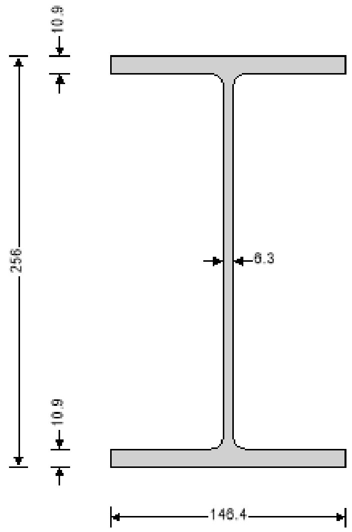
BSC BARSBY STRUCTURAL CONSULTANTS	Project				Job no.	
	15 WILLOW GROVE, SOUTH CERNEY				22.132	
	Calcs for				Start page no./Revision	
	B3 OUTER				2	
Barsby Structural Consultants Ltd	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	MB	21/10/2022				

Analysis results

Maximum moment	M_{max} = **53.9** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **36.6** kN	V_{min} = **-36.6** kN
Deflection	δ_{max} = **10.4** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **36.6** kN	R_{A_min} = **36.6** kN
Unfactored dead load reaction at support A	R_{A_Dead} = **22.3** kN	
Unfactored imposed load reaction at support A	$R_{A\_Imposed}$ = **3.4** kN	
Maximum reaction at support B	R_{B_max} = **36.6** kN	R_{B_min} = **36.6** kN
Unfactored dead load reaction at support B	R_{B_Dead} = **22.3** kN	
Unfactored imposed load reaction at support B	$R_{B\_Imposed}$ = **3.4** kN	

Section details

Section type **UKB 254x146x37 (Tata Steel Advance)** Steel grade **S275**



Classification of cross sections - Section 3.5

Tensile strain coefficient ε = **1.00** Section classification **Plastic**

Shear capacity - Section 4.2.3

Design shear force F_v = **36.6** kN Design shear resistance P_v = **266.1** kN

PASS - Design shear resistance exceeds design shear force

Moment capacity - Section 4.2.5

Design bending moment M = **53.9** kNm Moment capacity low shear M_c = **132.9** kNm

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment M_b = **55.6** kNm M_b / m_{LT} = **60.5** kNm

PASS - Buckling resistance moment exceeds design bending moment

Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

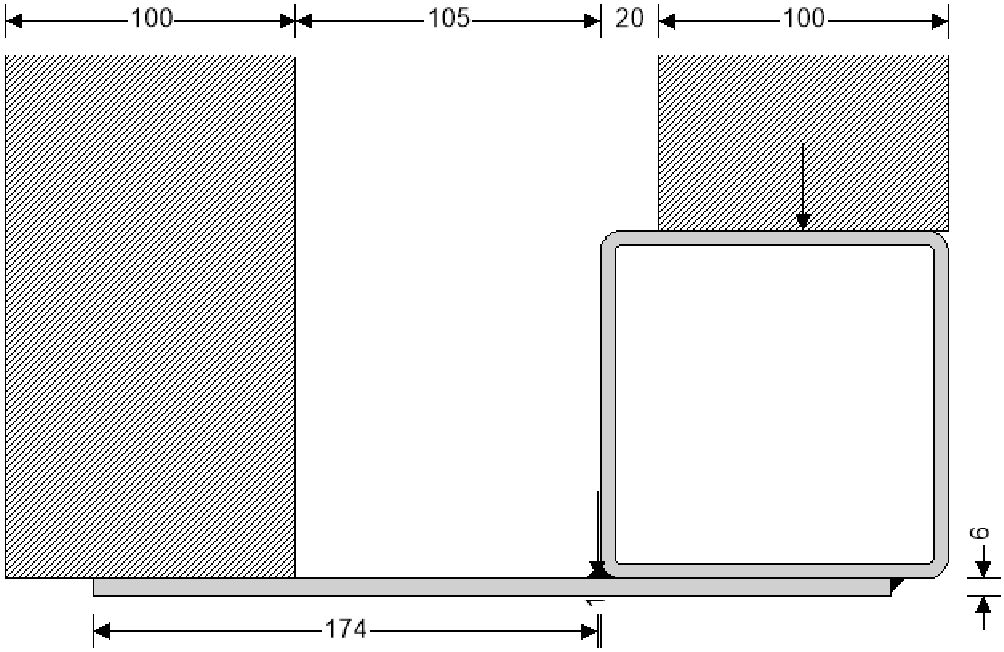
Limiting deflection δ_{lim} = **15.278** mm Maximum deflection δ = **10.39** mm

PASS - Maximum deflection does not exceed deflection limit

STEEL MASONRY SUPPORT

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

Tedds calculation version 1.0.05



Steel member details

Torsion beam	SHS 120x120x5.0	Masonry support angle	plate
Steel grade of support angle	User	Design strength support angle	p_{ysb} = **355** N/mm^2
Modulus of elasticity	E = 205000 N/mm^2	Constant	ε = **0.880**
Length of plate beyond beam	l_h = **175** mm	Total length of plate	l_{plate} = **275** mm
Thickness of plate	t_{sb} = **6** mm	Width of main beam	B_{mb} = **120** mm
Area of plate	A_{sbu} = **1650.0** mm^2	Dist weld position to CoG	c_{yysb} = **38** mm

Supported materials detail

Density mas. main beam	$\rho_{m,mb}$ = **9.0** kN/m^3	Width masonry main beam	b_{mmb} = **100** mm
Height masonry main beam	h_{mmb} = **900** mm		
Ecc. of main beam material	e_{mb} = **20** mm		
Add dead force main beam	P_{Gaddmb} = **0.0** kN/m	Add live force main beam	P_{Qaddmb} = **0.0** kN/m
Density mas. support beam	$\rho_{m,sb}$ = **24.0** kN/m^3	Width masonry support beam	b_{msb} = **100** mm
Height masonry support beam	h_{msb} = **1050** mm		
Add dead force support beam	P_{Gaddsb} = **2.0** kN/m	Add live force support beam	P_{Qaddsb} = **0.0** kN/m

Geometry

Cavity width	c = **125** mm	Supported width of masonry	d_m = **70** mm

Biaxial stress effects in the plate (SCI-P-110)

Max overall bending moment	M_x = **6.7** kNm	Dist to NA combined section	$y_{e,all}$ = **26** mm
Second moment of area	$I_{xx,all}$ = **877** cm^4	Elastic section modulus	$Z_{xx,all}$ = **222.05** cm^3
Section modulus of plate	$Z_{xx,plate}$ = **6.00** cm^3/m	Eccentricity on support beam	e_1 = **1** mm
Force on support plate	P_1 = **6.3** kN/m	Bending at heel	$M_{x,plate}$ = **0.0** kNm/m
Moment capacity of plate	M_c = **2.6** kNm/m		

PASS - Design strength exceeds stress at heel

Long stress overall bending σ_1 = **30.0** N/mm^2 | Von Mises curve constant c_{fp} = **708.1** N/mm^2

Trans bending stress ratio limit α_{ts} = **0.996** | Trans bending stress ratio α_{ls} = **0.002**

PASS - Transverse bending stress ratio less than allowable limit

Deflection at toe

Unfact force on plate P_{1SLS} = **4.5** kN/m | Distance from weld to load a_m = **1** mm

Load resultant to edge of plate b_m = **174** mm | Weld to load pos as ratio a_l = **0.006**

Effect second mnt of inertia I_{eff_def} = **18000** mm^4/m | Deflection at toe δ = **0.00** mm

Deflection limit δ_{lim} = **1.56** mm

PASS - Deflection is within specified criteria

Construction stage biaxial stress effects in the plate

Eccentricity on support beam e_{1c} = **155** mm | Force on support plate P_{1c} = **4.0** kN/m

Bending at heel $M_{x,platec}$ = **0.6** kNm/m

PASS - Design strength exceeds stress at heel

Trans bending stress ratio α_{lsc} = **0.245**

PASS - Transverse bending stress ratio less than allowable limit

Construction stage deflection at toe

Unfact force on plate P_{1cSLS} = **2.9** kN/m | Dist from weld to load pos a_{mc} = **155** mm

Load resultant to edge of plate b_{mc} = **20** mm | Weld to load pos as ratio a_{lc} = **0.886**

Deflection at toe δ_c = **1.16** mm

PASS - Deflection is within specified criteria

Weld details - assume a full length weld and that the plate acts as a propped cantilever with the prop at the weld position and the fixed end at the centre of the torsion beam

Leg length of weld s_{weld} = **5** mm | Throat size of weld a_{weld} = **3.5** mm

Shear force at weld position R_A = **8.9** kN/m | Max possible force in plate R_p = **628.4** kN

Long shear beam/plate R_l = **483.3** kN/m | Horizontal shear beam/plate R_h = **1.2** kN/m

Resultant weld force R_{weld} = **0.483** kN/mm | Strength of weld (Table 37) p_{weld} = **220.0** N/mm^2

Capacity of full length weld $p_{c,weld}$ = **0.778** kN/mm

$1/\sqrt{(2)} \times s_{weld}$

Torsional loading ULS

Loading support beam w_{1ULS} = **6.33** kN/m | Loading of main beam w_{2ULS} = **1.13** kN/m

Self weight of support beam w_{3ULS} = **0.18** kN/m

Torsional loading SLS

Loading support beam w_{1SLS} = **4.52** kN/m | Loading of main beam w_{2SLS} = **0.81** kN/m

Self weight of support beam w_{3SLS} = **0.13** kN/m

Eccentricities

Distance of shear centre e_{0mb} = **0** mm | Ecc of support beam masonry e_{1mb} = **215** mm

Ecc of main beam masonry e_{2mb} = **-10** mm | Ecc of support beam e_{3mb} = **98** mm

Torsional effects

Applied torque T_{qULS} = **1.37** kNm/m | Torsional moment (ULS) T_q = **3.55** kNm

Applied torque (SLS) T_{qSLS} = **0.98** kNm/m | Torsional moment (SLS) T_{qu} = **2.54** kNm

STEEL BEAM TORSION DESIGN

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

Tedds calculation version 2.0.03

Barsby Structural Consultants Ltd	Project: 15 WILLOW GROVE, SOUTH CERNEY				Job no.: 22.132	
	Calcs for: B4				Start page no./Revision: 3	
	Calcs by: MB	Calcs date: 24/10/2022	Checked by	Checked date	Approved by	Approved date

Section details

Section type SHS 120x120x5.0 Steel grade S275

Design stength $p_{yw} = p_y =$ **275** N/mm^2 Constant $\varepsilon =$ **1.000**

Geometry - Beam unrestrained against lateral-torsional buckling between supports.

Effective span L = **2600** mm

Length of segment LTB $L_{LT} =$ **2600** mm Effective length for LTB $L_{E\_LT} =$ **2600** mm

Loading - Torsional loading comprises only full-length uniformly distributed load(s)

Internal forces & moments on member under factored loading for uls design

Applied shear force $F_{vy} =$ **10.3** kN Maximum bending moment $M_{LT} = M_x =$ **6.67** kNm

Applied torque $T_q =$ **3.55** kNm Minor axis bending moment $M_y = 0$ kNm

Compression force $F_c = 0$ kN

Equivalent uniform moment factors

EUM factor (Cl.4.3.6.6 & T18) $m_{LT} =$ **1.000**

Torsional deflection analysis

Beam is torsion fixed at each end. (as defined in SCI-P-057 section 2.1.6)

Max torque (at supports) $T_o =$ **1.78** kNm Avg torque support & CL $T_{av} =$ **0.89** kNm

Max. angle of twist (midspan) $\phi =$ **0.002** rads

Section classification

$b_x / t =$ **21.0** $d_x / t =$ **21.0**

$b_y / t =$ **21.0** $d_y / t =$ **21.0**

$r_{1sx} =$ **0.000** $r_{1sy} =$ **0.000**

$r_{2s} =$ **0.000**

Section classification is plastic

Shear capacity (parallel to y-axis)

Design shear force $F_{vy} =$ **10.3** kN Design shear resist (cl. 4.2.3) $P_{vy} =$ **187.5** kN

Pass - Shear

Moment capacity (x-axis)

Design bending moment $M_x =$ **6.7** kNm Mnt cap low shear (cl. 4.2.5.1) $M_{cx} =$ **26.8** kNm

Pass - Moment capacity exceeds design bending moment

Lateral torsional buckling

LT buckling check not required for this section (cl. 4.6.3.1)

Buckling resistance moment $M_b = M_{cx} =$ **26.8** kNm

LT buckling check not required for this section

Buckling under combined bending & torsion - SCI-P-057 section 2.3

For simplicity, a conservative check is applied using the maximum stresses due to each of the separate load effects, even though these do not necessarily all occur at the same section along the member.

Max angle of twist $\phi =$ **0.002** rads Induced minor axis moment $M_{yt} =$ **0.01** kNm

Norm stress corner due to M_{yt} $\sigma_{byt} =$ **0** N/mm^2 Interaction index $i_b =$ **0.25**

Pass - Combined bending and torsion check satisfied

Local capacity under combined bending & torsion

For simplicity, a conservative check is applied using the maximum stresses due to each of the separate load effects, even though these do not necessarily all occur at the same section along the member.

Max. direct stress due to M_x $\sigma_{bx} = M_x / Z_x =$ **80** N/mm^2

Combined stress - eqn 2.22 $\sigma_{bx} + \sigma_{byt} =$ **81** N/mm^2 Design strength $p_y =$ **275** N/mm^2

Pass - Local capacity

Combined shear stresses SCI-P-057 section 2.3

For simplicity, a conservative check is applied using the maximum shear stresses due to each of the separate load effects, even though these do not necessarily all occur at the same section along the member.

Max. shear stress bending τ_{bw} = **10** N/mm^2 Max. shear stresses torsion τ_t = **15** N/mm^2

Amplified shear stress torsion τ_{vt} = **16** N/mm^2 Combined shear bend & tors τ = **26** N/mm^2

Shear strength p_v = **165** N/mm^2

Pass - Combined shear stresses

Twist check

Total applied torque (unfact) T_{qu} = **2.54** kNm

Max twist under sls loading ϕ_{sls} = **0.08** degs Lever arm for defl due to twist h_δ = **225** mm

Deflection due to twist $\delta_{h.sls}$ = **0.3** mm Deflection limit $\delta_{h.lim}$ = **2** mm

Pass - Deflection due to twist

Deflection

Maximum y-axis deflection δ_{y_max} = **3.3** mm Deflection limit - cl. 2.5.2 δ_{lim} = **10.4** mm

Pass - Deflection within specified limit

Barsby Structural Consultants Ltd	Project: 15 WILLOW GROVE, SOUTH CERNEY				Job no.: 22.132	
	Calcs for: B5				Start page no./Revision: 1	
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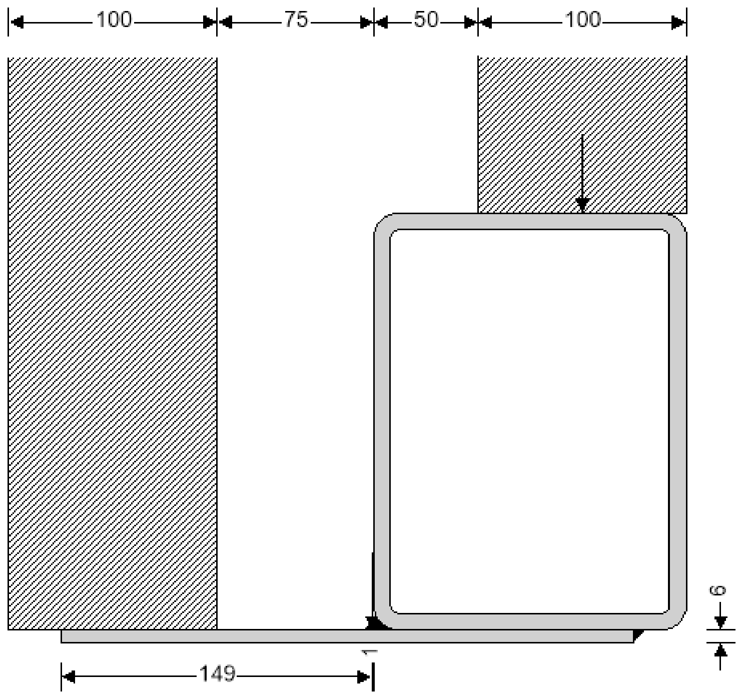
STEEL MASONRY SUPPORT

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

Tedds calculation version 1.0.05



Steel member details

Torsion beam	RHS 200x150x8.0	Masonry support angle	plate
Steel grade of support angle	User	Design strength support angle	p_{ysb} = **355** N/mm^2
Modulus of elasticity	E = 205000 N/mm^2	Constant	ε = **0.880**
Length of plate beyond beam	l_h = **150** mm	Total length of plate	l_{plate} = **275** mm
Thickness of plate	t_{sb} = **6** mm	Width of main beam	B_{mb} = **150** mm
Area of plate	A_{sbu} = **1650.0** mm^2	Dist weld position to CoG	c_{yysb} = **12** mm

Supported materials detail

Density mas. main beam	$\rho_{m,mb}$ = **9.0** kN/m^3	Width masonry main beam	b_{mmb} = **100** mm
Height masonry main beam	h_{mmb} = **900** mm		
Ecc. of main beam material	e_{mb} = **50** mm		
Add dead force main beam	P_{Gaddmb} = **1.5** kN/m	Add live force main beam	P_{Qaddmb} = **1.2** kN/m
Density mas. support beam	$\rho_{m,sb}$ = **24.0** kN/m^3	Width masonry support beam	b_{msb} = **100** mm
Height masonry support beam	h_{msb} = **1050** mm		
Add dead force support beam	P_{Gaddsb} = **2.0** kN/m	Add live force support beam	P_{Qaddsb} = **0.0** kN/m

Geometry

Cavity width	c = **125** mm	Supported width of masonry	d_m = **75** mm

Biaxial stress effects in the plate (SCI-P-110)

Max overall bending moment	M_x = **41.4** kNm	Dist to NA combined section	$y_{e,all}$ = **25** mm
Second moment of area	$I_{xx,all}$ = **4305** cm^4	Elastic section modulus	$Z_{xx,all}$ = **528.45** cm^3
Section modulus of plate	$Z_{xx,plate}$ = **6.00** cm^3/m	Eccentricity on support beam	e_1 = **1** mm
Force on support plate	P_1 = **6.3** kN/m	Bending at heel	$M_{x,plate}$ = **0.0** kNm/m
Moment capacity of plate	M_c = **2.6** kNm/m		

PASS - Design strength exceeds stress at heel

Long stress overall bending σ_1 = **78.3** N/mm^2 Von Mises curve constant c_{fp} = **696.9** N/mm^2

Trans bending stress ratio limit α_{ts} = **0.969** Trans bending stress ratio α_{ls} = **0.002**

PASS - Transverse bending stress ratio less than allowable limit

Deflection at toe

Unfact force on plate P_{1SLS} = **4.5** kN/m Distance from weld to load a_m = **1** mm

Load resultant to edge of plate b_m = **149** mm Weld to load pos as ratio a_l = **0.007**

Effect second mnt of inertia I_{eff_def} = **18000** mm^4/m Deflection at toe δ = **0.00** mm

Deflection limit δ_{lim} = **1.60** mm

PASS - Deflection is within specified criteria

Construction stage biaxial stress effects in the plate

Eccentricity on support beam e_{1c} = **125** mm Force on support plate P_{1c} = **4.0** kN/m

Bending at heel $M_{x,platec}$ = **0.5** kNm/m

PASS - Design strength exceeds stress at heel

Trans bending stress ratio α_{lsc} = **0.197**

PASS - Transverse bending stress ratio less than allowable limit

Construction stage deflection at toe

Unfact force on plate P_{1cSLS} = **2.9** kN/m Dist from weld to load pos a_{mc} = **125** mm

Load resultant to edge of plate b_{mc} = **25** mm Weld to load pos as ratio a_{lc} = **0.833**

Deflection at toe δ_c = **0.66** mm

PASS - Deflection is within specified criteria

Weld details - assume a full length weld and that the plate acts as a propped cantilever with the prop at the weld position and the fixed end at the centre of the torsion beam

Leg length of weld s_{weld} = **5** mm Throat size of weld a_{weld} = **3.5** mm

Shear force at weld position R_A = **8.9** kN/m Max possible force in plate R_p = **639.0** kN

Long shear beam/plate R_l = **245.8** kN/m Horizontal shear beam/plate R_h = **1.2** kN/m

Resultant weld force R_{weld} = **0.246** kN/mm Strength of weld (Table 37) p_{weld} = **220.0** N/mm^2

Capacity of full length weld $p_{c,weld}$ = **0.778** kN/mm

$1/\sqrt{(2)} \times s_{weld}$

Torsional loading ULS

Loading support beam w_{1ULS} = **6.33** kN/m Loading of main beam w_{2ULS} = **5.15** kN/m

Self weight of support beam w_{3ULS} = **0.18** kN/m

Torsional loading SLS

Loading support beam w_{1SLS} = **4.52** kN/m Loading of main beam w_{2SLS} = **3.50** kN/m

Self weight of support beam w_{3SLS} = **0.13** kN/m

Eccentricities

Distance of shear centre e_{0mb} = **0** mm Ecc of support beam masonry e_{1mb} = **200** mm

Ecc of main beam masonry e_{2mb} = **-25** mm Ecc of support beam e_{3mb} = **87** mm

Torsional effects

Applied torque T_{qULS} = **1.15** kNm/m Torsional moment (ULS) T_q = **5.99** kNm

Applied torque (SLS) T_{qSLS} = **0.83** kNm/m Torsional moment (SLS) T_{qu} = **4.30** kNm

STEEL BEAM TORSION DESIGN

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

Tedds calculation version 2.0.03

Section details

Section type	RHS 200x150x8.0	Steel grade	S275
Design stength	$p_{yw} = p_y =$ **275** N/mm^2	Constant	$\varepsilon =$ **1.000**

Geometry - Beam unrestrained against lateral-torsional buckling between supports.

Effective span	$L =$ **5200** mm		
Length of segment LTB	$L_{LT} =$ **5200** mm	Effective length for LTB	$L_{E\_LT} =$ **5200** mm

Loading - Torsional loading comprises only full-length uniformly distributed load(s)

Internal forces & moments on member under factored loading for uls design

Applied shear force	$F_{vy} =$ **31.8** kN	Maximum bending moment	$M_{LT} = M_x =$ **41.36** kNm
Applied torque	$T_q =$ **5.99** kNm	Minor axis bending moment	$M_y = 0$ kNm
Compression force	$F_c = 0$ kN		

Equivalent uniform moment factors

EUM factor (Cl.4.3.6.6 & T18) $m_{LT} =$ **1.000**

Torsional deflection analysis

Beam is torsion fixed at each end. (as defined in SCI-P-057 section 2.1.6)

Max torque (at supports)	$T_o =$ **3.00** kNm	Avg torque support & CL	$T_{av} =$ **1.50** kNm
Max. angle of twist (midspan)	$\phi =$ **0.001** rads		

Section classification

	$b_x / t =$ **15.8**		$d_x / t =$ **22.0**
	$b_y / t =$ **22.0**		$d_y / t =$ **15.8**
	$r_{1sx} =$ **0.000**		$r_{1sy} =$ **0.000**
	$r_{2s} =$ **0.000**		

Section classification is plastic

Shear capacity (parallel to y-axis)

Design shear force	$F_{vy} =$ **31.8** kN	Design shear resist (cl. 4.2.3)	$P_{vy} =$ **497.4** kN

Pass - Shear

Moment capacity (x-axis)

Design bending moment	$M_x =$ **41.4** kNm	Mnt cap low shear (cl. 4.2.5.1)	$M_{cx} =$ **98.1** kNm

Pass - Moment capacity exceeds design bending moment

Lateral torsional buckling

Effective length for LTB	$L_{E\_LT} =$ **5200** mm		
Slenderness ratio - cl 4.3.6.5	$\lambda =$ **87**		$D / B =$ **1.3**

LTB check not required

Buckling resistance mnt $M_b = M_{cx} =$ **98.1** kNm

Buckling under combined bending & torsion - SCI-P-057 section 2.3

For simplicity, a conservative check is applied using the maximum stresses due to each of the separate load effects, even though these do not necessarily all occur at the same section along the member.

Max angle of twist	$\phi =$ **0.001** rads	Induced minor axis moment	$M_{yt} =$ **0.06** kNm
Norm stress corner due to M_{yt}	$\sigma_{byt} =$ **0** N/mm^2	Interaction index	$i_b =$ **0.42**

Pass - Combined bending and torsion check satisfied

Local capacity under combined bending & torsion

For simplicity, a conservative check is applied using the maximum stresses due to each of the separate load effects, even though these do not necessarily all occur at the same section along the member.

Max. direct stress due to M_x $\sigma_{bx} = M_x / Z_x =$ **139** N/mm^2

Combined stress - eqn 2.22	$\sigma_{bx} + \sigma_{byt}$ = **139** N/mm^2	Design strength	p_y = **275** N/mm^2

Pass - Local capacity

Combined shear stresses SCI-P-057 section 2.3

For simplicity, a conservative check is applied using the maximum shear stresses due to each of the separate load effects, even though these do not necessarily all occur at the same section along the member.

Max. shear stress bending	τ_{bw} = **12** N/mm^2	Max. shear stresses torsion	τ_t = **8** N/mm^2
Amplified shear stress torsion	τ_{vt} = **9** N/mm^2	Combined shear bend & tors	τ = **21** N/mm^2
Shear strength	p_v = **165** N/mm^2		

Pass - Combined shear stresses

Twist check

Total applied torque (unfact)	T_{qu} = **4.30** kNm		
Max twist under sls loading	ϕ_{sls} = **0.06** degs	Lever arm for defl due to twist	h_δ = **225** mm
Deflection due to twist	$\delta_{h.sls}$ = **0.2** mm	Deflection limit	$\delta_{h.lim}$ = **2** mm

Pass - Deflection due to twist

Deflection

Maximum y-axis deflection	δ_{y_max} = **13.4** mm	Deflection limit - cl. 2.5.2	δ_{lim} = **14.0** mm

Pass - Deflection within specified limit

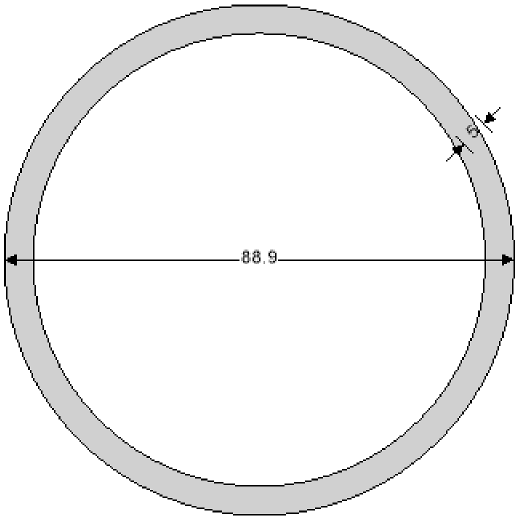
STEEL MEMBER DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

TEDDS calculation version 3.0.07

Section details

Section type **CHS 88.9x5.0 (Tata Steel Celsius (Gr355 Gr420 Gr460))** Steel grade **S355**



Classification of cross sections - Section 3.5

Tensile strain coefficient ε = **0.88** Section classification **Semi-compact**

Moment capacity - Section 4.2.5

Design bending moment M = **4** kNm Moment capacity low shear M_c = **11.2** kNm

PASS - Moment capacity exceeds design bending moment

Compression members - Section 4.7

Design compression force F_c = **33** kN Compression resistance P_{cx} = **161.4** kN

PASS - Compression resistance exceeds design compression force

Design compression force F_c = **33** kN Compression resistance P_{cy} = **161.4** kN

PASS - Compression resistance exceeds design compression force

Compression members with moments - Section 4.8.3

Comp.and bending check $F_c / (A \times p_y) + M / M_c$ = **0.429**

PASS - Combined bending and compression check is satisfied

Member buckling resistance - cl.4.8.3.3.3

Buckling resistance checks $F_c / P_{cx} + m_x \times M / M_c \times (1 + 0.5 \times F_c / P_{cx})$ = **0.600**

$F_c / P_{cy} + 0.5 \times m_{LT} \times M_{LT} / M_{cx}$ = **0.312**

PASS - Member buckling resistance checks are satisfied

Barsby Structural Consultants Ltd	Project: 15 WILLOW GROVE, SOUTH CERNEY				Job no.: 22.132	
	Calcs for: P1				Start page no./Revision: 1	
	Calcs by: MB	Calcs date: 21/10/2022	Checked by	Checked date	Approved by	Approved date

MASONRY BEARING DESIGN TO BS5628-1:2005

TEDDS calculation version 1.0.08

Masonry details

Masonry type **Autoclaved aerated concrete blocks**

Compressive strength p_{unit} = **3.6** N/mm^2 Mortar designation **iii**

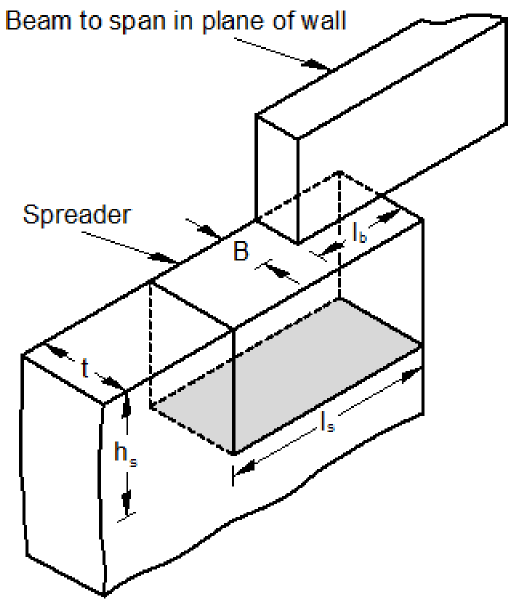
Least horiz dim of units l_{unit} = **100** mm Height of units h_{unit} = **215** mm

Masonry units **Category II** Construction control **Normal**

Partial safety factor γ_m = **3.5** Characteristic strength f_k = **3.5** N/mm^2

Leaf thickness t = **100** mm Effective wall thickness t_{ef} = **133** mm

Wall height h = **2400** mm Effective height of wall h_{ef} = **2400** mm



Bearing details

Beam spanning in plane of wall

Width of bearing B = **100** mm Length of bearing l_b = **300** mm

Loading details

Concentrated dead load G_k = **13** kN Concentrated imposed load Q_k = **16** kN

Design concentrated load F = **43.8** kN

Distributed dead load g_k = **0.0** kN/m Distributed imposed load q_k = **0.0** kN/m

Design distributed load f = **0.0** kN/m

Masonry bearing type

Bearing type **Type 1** Bearing safety factor γ_{bear} = **1.25**

Check design bearing without a spreader

Design bearing stress f_{ca} = **1.460** N/mm^2 Allowable bearing stress f_{cp} = **1.250** N/mm^2

FAIL - Design bearing stress exceeds allowable bearing stress, use a spreader

Spreader details

Length of spreader l_s = **440** mm Depth of spreader h_s = **215** mm

Edge distance S_{edge} = **0** mm

Spreader bearing type

Bearing type **Type 3** Bearing safety factor γ_{bear} = **2.00**

Check design bearing with a spreader

Loading acts eccentrically within middle third – triangular stress distribution

Design bearing stress f_{ca} = **1.946** N/mm^2 Allowable bearing stress f_{cp} = **2.000** N/mm^2

PASS - Allowable bearing stress exceeds design bearing stress

Check design bearing at 0.4 × h below the bearing level

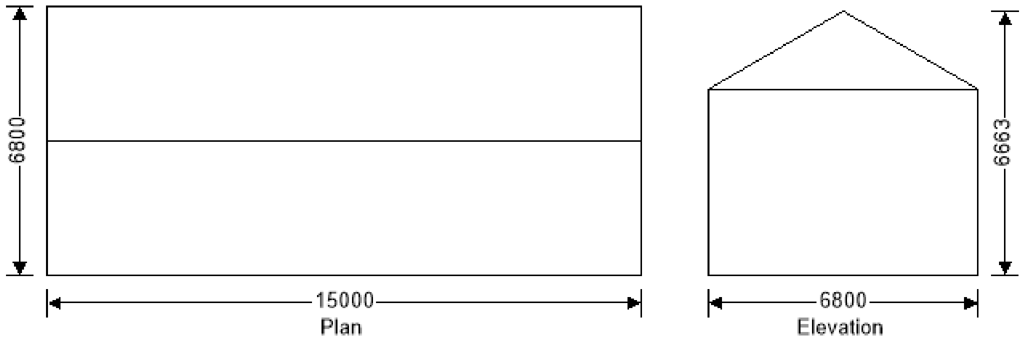
Design bearing stress f_{ca} = **0.348** N/mm^2 Allowable bearing stress f_{cp} = **0.835** N/mm^2

PASS - Allowable bearing stress at 0.4 × h below bearing level exceeds design bearing stress

WIND LOADING (BS6399)

In accordance with BS6399

Tedds calculation version 3.0.18



Building data

Type of roof	Duopitch		
Length of building	L = **15000** mm	Width of building	W = **6800** mm
Pitch of roof	α_0 = **30.0** deg		
Reference height	H_r = **6663** mm		

Dynamic classification

Building type factor (table 1)	K_b = **0.5**	Dynamic augmentation factor (1.6.1)	C_r = **0.01**

Site wind speed

Location	Oxford	Basic wind speed	V_b = **19.7** m/s
Site altitude	Δ_S = **90** m	Upwind dist from sea to site	d_{sea} = **110** km
Direction factor	S_d =**0.85**	Seasonal factor	S_s = **1.00**
Probability factor	S_p = **1.00**	Critical gap between buidlings	g = **5000** mm
Topography not significant			
Altitude factor	S_a = **1.09**	Site wind speed	V_s = **18.3** m/s
Terrain category	Country		
Displacement height	H_d = 0mm		

The velocity pressure for the windward face of the building with a 0 degree wind is to be considered as 1 part as the height h is less than b (cl.2.2.3.2)

Dynamic pressure - windward wall - Wind 0 deg

Reference height	H_e = **4700** mm		
Fetch factor (Table 22)	S_c = **0.866**	Turbulence factor (Table 22)	S_t = **0.194**
Gust peak factor	g_t = **3.44**	Terrain and building factor	S_b = **1.44**
Effective wind speed	V_e = **26.4** m/s	Dynamic pressure	q_s = **0.426** kN/m^2

Dynamic pressure - roof

Reference height	H_e = **6663** mm		
Fetch factor (Table 22)	S_c = **0.921**	Turbulence factor (Table 22)	S_t = **0.187**
Gust peak factor	g_t = **3.44**	Terrain and building factor	S_b = **1.51**
Effective wind speed	V_e = **27.7** m/s	Dynamic pressure	q_s = **0.469** kN/m^2

Size effect factors

Diag dim for gablewall	a_{eg} = **8.3** m	Exte size effect factor	C_{aeg} = **0.962**
Diag dim for side wall	a_{es} = **15.7** m	Exte size effect factor	C_{aes} = **0.914**
Diag dim for roof	a_{er} = **15.5** m	Exte size effect factor	C_{aer} = **0.915**
Volume for int size effect	V_i = **0.1** m^3	Diag dim for int size effect	a_i = **5.0** m

Internal size effect factor C_{ai} = **1.000**

Pressures and forces

Net pressure $p = q_s \times c_{pe} \times C_{ae} - q_s \times c_{pi} \times C_{ai}$

Net force $F_w = p \times A_{ref}$

Roof load case 1 - Wind 0, c_{pi} 0.20, $-c_{pe}$

Zone	Ext pressure coefficient, c_{pe}	Dynamic pressure, q_s (kN/m^2)	External size factor, C_{ae}	Net Pressure, p (kN/m^2)	Area, A_{ref} (m^2)	Net force, F_w (kN)
A (-ve)	-0.50	0.47	0.915	-0.31	20.51	-6.32
B (-ve)	-0.50	0.47	0.915	-0.31	2.58	-0.79
C (-ve)	-0.20	0.47	0.915	-0.18	35.81	-6.43
E (-ve)	-0.90	0.47	0.915	-0.48	20.51	-9.83
F (-ve)	-0.50	0.47	0.915	-0.31	2.58	-0.79
G (-ve)	-0.50	0.47	0.915	-0.31	35.81	-11.03

Total vertical net force $F_{w,v}$ = **-30.48** kN Total horizontal net force $F_{w,h}$ = **4.06** kN

Walls load case 1 - Wind 0, c_{pi} 0.20, $-c_{pe}$

Zone	Ext pressure coefficient, c_{pe}	Dynamic pressure, q_s (kN/m^2)	External size factor, C_{ae}	Net Pressure, p (kN/m^2)	Area, A_{ref} (m^2)	Net force, F_w (kN)
A	-1.45	0.47	0.962	-0.75	14.58	-10.90
B	-0.85	0.47	0.962	-0.48	24.06	-11.48
w	0.81	0.43	0.914	0.23	70.50	16.31
l	-0.50	0.43	0.914	-0.28	70.50	-19.74

Overall loading

Leeward force overall F_l = **-19.7** kN Windward force overall F_w = **16.3** kN

Overall loading overall $F_{w,w}$ = **34.4** kN

Roof load case 2 - Wind 0, c_{pi} -0.3, $+c_{pe}$

Zone	Ext pressure coefficient, c_{pe}	Dynamic pressure, q_s (kN/m^2)	External size factor, C_{ae}	Net Pressure, p (kN/m^2)	Area, A_{ref} (m^2)	Net force, F_w (kN)
A (+ve)	0.80	0.47	0.915	0.48	20.51	9.91
B (+ve)	0.50	0.47	0.915	0.35	2.58	0.91
C (+ve)	0.40	0.47	0.915	0.31	35.81	11.17
E (+ve)	-0.90	0.47	0.915	-0.25	20.51	-5.03
F (+ve)	-0.50	0.47	0.915	-0.07	2.58	-0.19
G (+ve)	-0.50	0.47	0.915	-0.07	35.81	-2.64

Total vertical net force $F_{w,v}$ = **12.25** kN Total horizontal net force $F_{w,h}$ = **14.93** kN

Walls load case 2 - Wind 0, c_{pi} -0.3, $+c_{pe}$

BSC BARSBY STRUCTURAL CONSULTANTS	Project				Job no.	
	15 WILLOW GROVE, SOUTH CERNEY				22.132	
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	WIND LOADING				3	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
Barsby Structural Consultants Ltd	MB	21/10/2022				

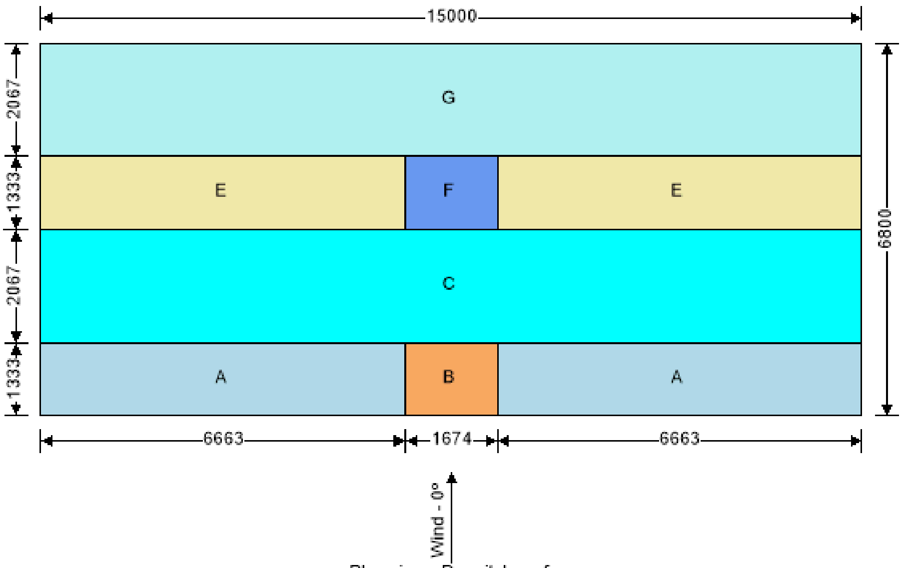
Zone	Ext pressure coefficient, c_{pe}	Dynamic pressure, q_s (kN/m^2)	External size factor, C_{ae}	Net Pressure, p (kN/m^2)	Area, A_{ref} (m^2)	Net force, F_w (kN)
A	-1.45	0.47	0.962	-0.51	14.58	-7.48
B	-0.85	0.47	0.962	-0.24	24.06	-5.84
w	0.81	0.43	0.914	0.44	70.50	31.34
l	-0.50	0.43	0.914	-0.07	70.50	-4.71

Overall loading

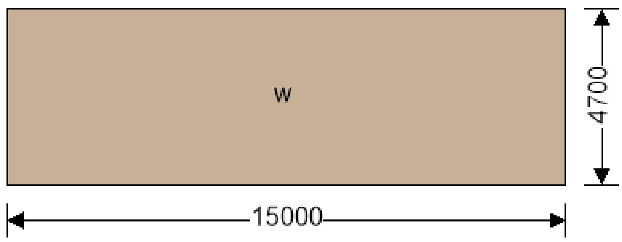
Leeward force overall F_l = **-4.7** kN

Windward force overall F_w = **31.3** kN

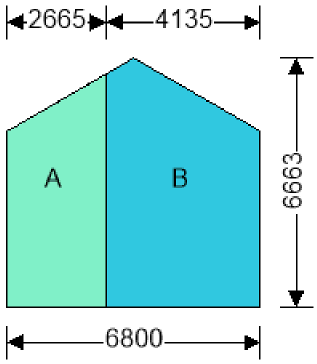
Overall loading overall $F_{w,w}$ = **43.7** kN



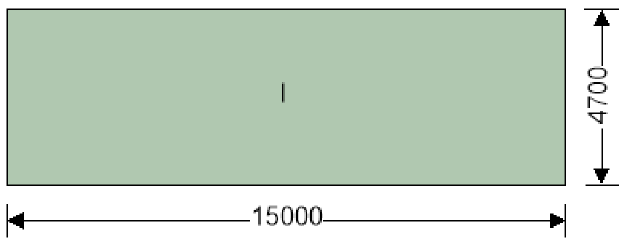
Plan view - Duopitch roof



Windward face



Side face



Leeward face

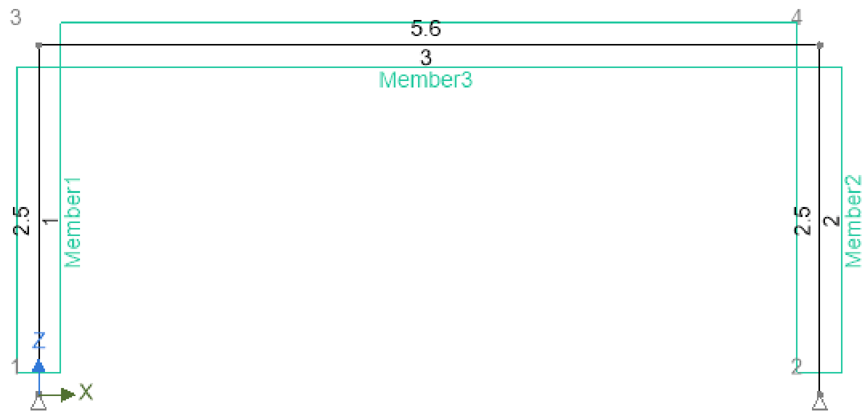
Barsby Structural Consultants Ltd	Project: 15 WILLOW GROVE, SOUTH CERNEY				Job no.: 22.132	
	Calcs for: B3 + C3 SWAY FRAME ANALYSIS				Start page no./Revision: 1	
	Calcs by: MB	Calcs date: 21/10/2022	Checked by	Checked date	Approved by	Approved date

ANALYSIS

Tedds calculation version 1.0.37

Geometry

Geometry (m) - Steel (BS5950)



Materials

Name	Density (kg/m³)	Youngs Modulus kN/mm²	Shear Modulus kN/mm²	Thermal Coefficient °C⁻¹
Steel (BS5950)	7850	205	78.8	0.000012

Sections

Name	Area	Moment of inertia		Shear area parallel to	
		Major	Minor	Minor	Major
	(cm²)	(cm⁴)	(cm⁴)	(cm²)	(cm²)
UB 254x146x37	47.2	5536.8	570.6	16.1	28.7
UB 178x102x19	24.3	1356	136.7	8.5	14.4

Nodes

Node	Co-ordinates		Freedom			Coordinate system		Spring		
	X (m)	Z (m)	X	Z	Rot.	Name	Angle (°)	X (kN/m)	Z (kN/m)	Rot. kNm/°
1	0	0	Fixed	Fixed	Free		0	0	0	0
2	5.6	0	Fixed	Fixed	Free		0	0	0	0
3	0	2.5	Free	Free	Free		0	0	0	0
4	5.6	2.5	Free	Free	Free		0	0	0	0

Elements

Element	Length (m)	Nodes		Section	Material	Releases			Rotated
		Start	End			Start moment	End moment	Axial	
1	2.5	1	3	UB 178x102x19	Steel (BS5950)	Fixed	Fixed	Fixed	
2	2.5	2	4	UB 178x102x19	Steel (BS5950)	Fixed	Fixed	Fixed	
3	5.6	3	4	UB 254x146x37	Steel (BS5950)	Fixed	Fixed	Fixed	

Members

Name	Elements	
	Start	End
Member1	1	1

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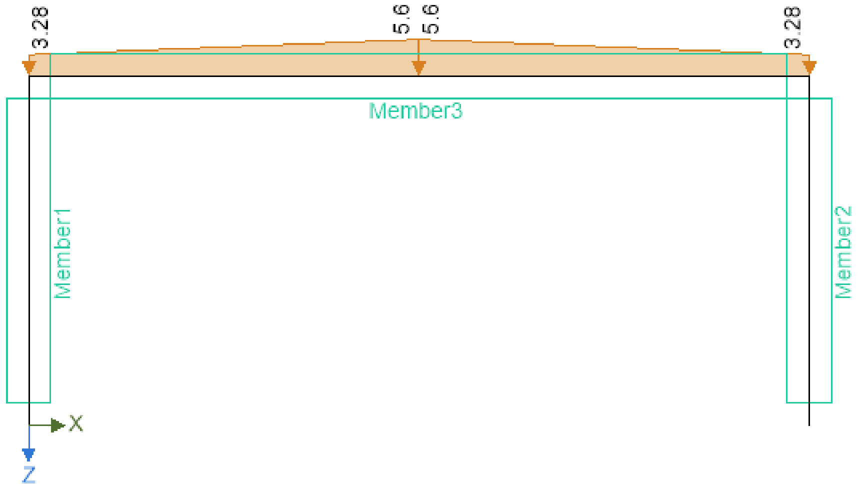
Name	Elements	
	Start	End
Member2	2	2
Member3	3	3

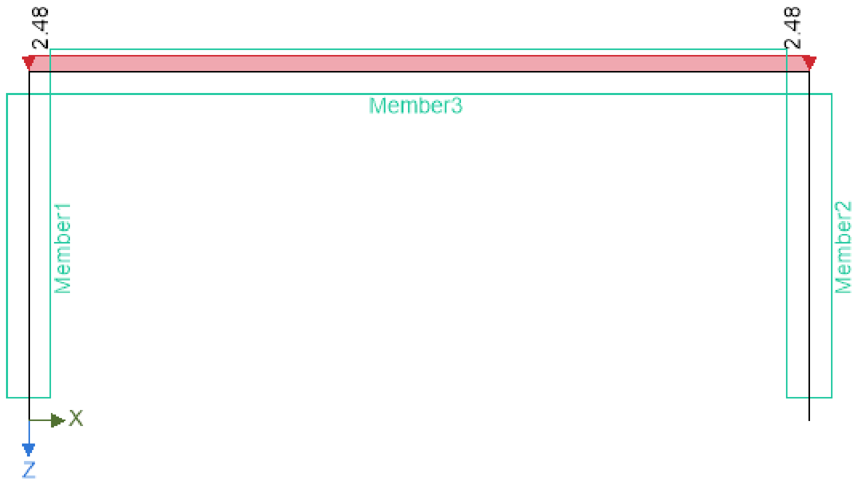
Loading

Self weight included

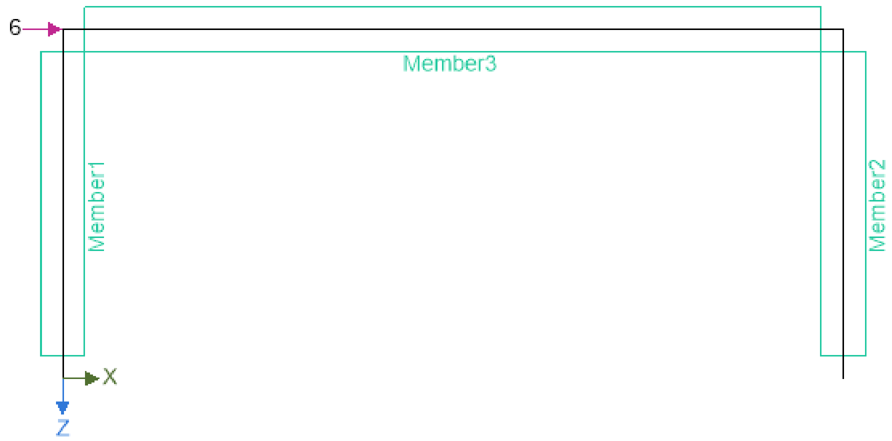
Permanent - Loading (kN/m)



Imposed - Loading (kN/m)



Wind - Loading (kN)



Load combination factors

Load combination	Self Weight	Permanent	Imposed	Wind
1.4D + 1.6I + 1.6RI (Strength)	1.40	1.40	1.60	
1.0D + 1.0I + 1.0RI (Service)	1.00	1.00	1.00	
1.2D + 1.2I + 1.2RI + 1.2W (Strength)	1.20	1.20	1.20	1.20
1.0D + 1.0I + 1.0RI + 1.0W (Service)	1.00	1.00	1.00	1.00
1.0D + 1.4W (Strength)	1.00	1.00		1.40

Node loads

Node	Load case	Force X (kN)	Force Z (kN)	Moment (kNm)
3	Wind	6	0	0

Member Loads

Member	Load case	Load Type	Orientation	Description
Member3	Permanent	VDL	GlobalZ	3.28 kN/m at 0 m to 5.6 kN/m at 2.8 m
Member3	Permanent	VDL	GlobalZ	5.6 kN/m at 2.8 m to 3.28 kN/m at 5.6 m
Member3	Imposed	UDL	GlobalZ	2.48 kN/m

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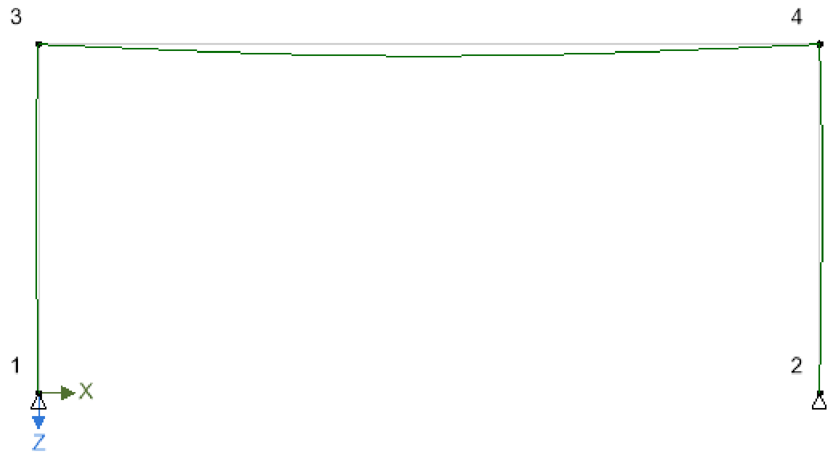
	Calcs for B3 + C3 SWAY FRAME ANALYSIS				Start page no./Revision 4	
	Calcs by MB	Calcs date 21/10/2022	Checked by	Checked date	Approved by	Approved date

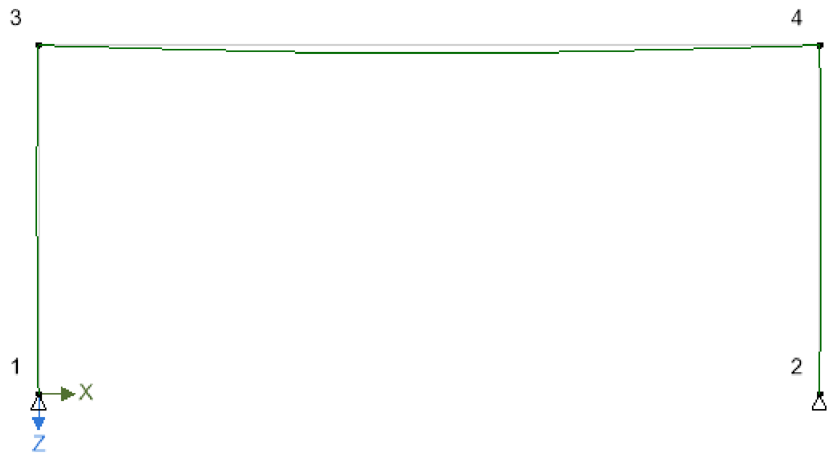
Results

Total deflection

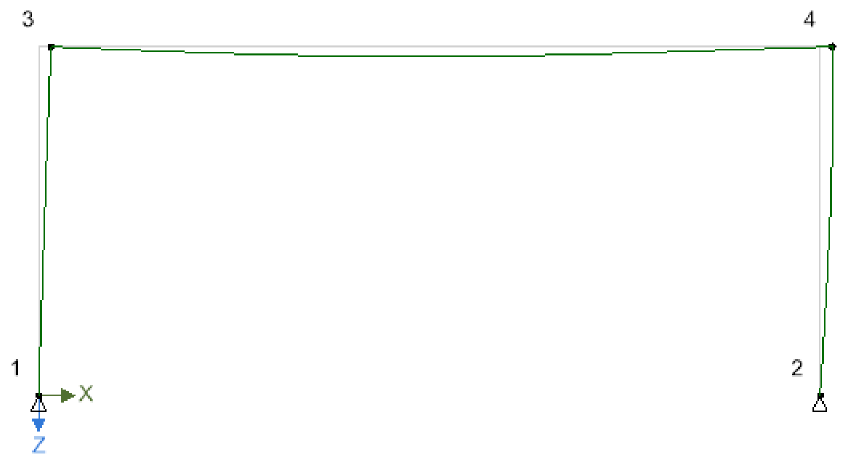
1.4D + 1.6I + 1.6RI (Strength) - Total deflection



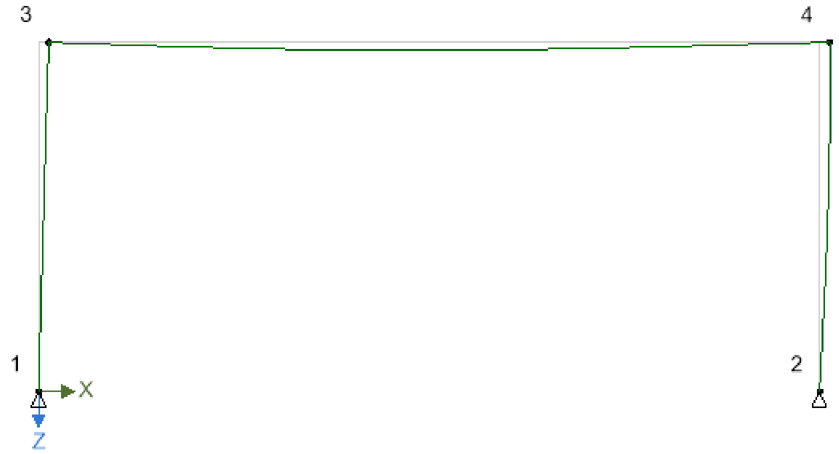
1.0D + 1.0I + 1.0RI (Service) - Total deflection



1.2D + 1.2I + 1.2RI + 1.2W (Strength) - Total deflection



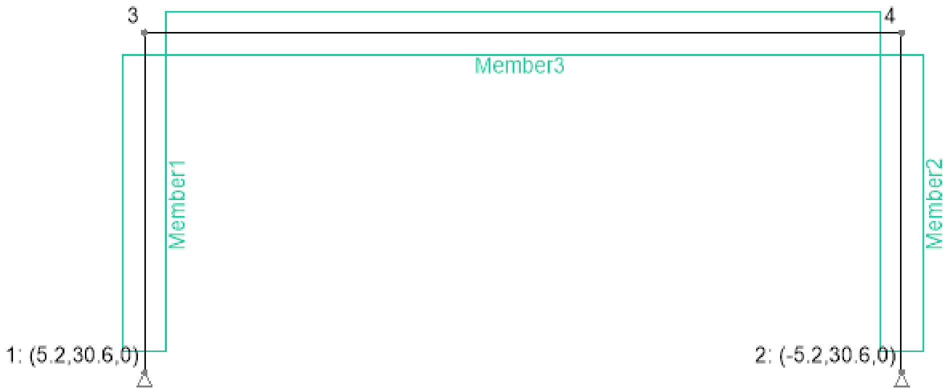
1.0D + 1.0I + 1.0RI + 1.0W (Service) - Total deflection



1.0D + 1.4W (Strength) - Total deflection

Reactions

1.4D + 1.6I + 1.6RI (Strength) - Local node reactions - Node: (Horiz (kN), Vert (kN), Mom (kNm))



Project				Job no.	
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MB	21/10/2022				

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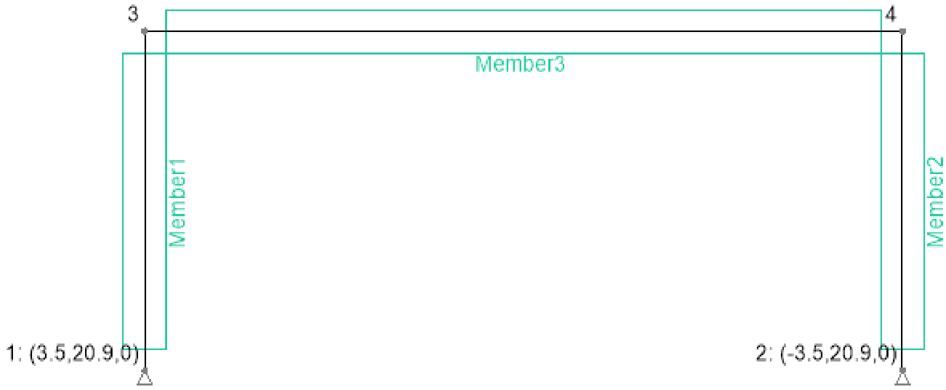
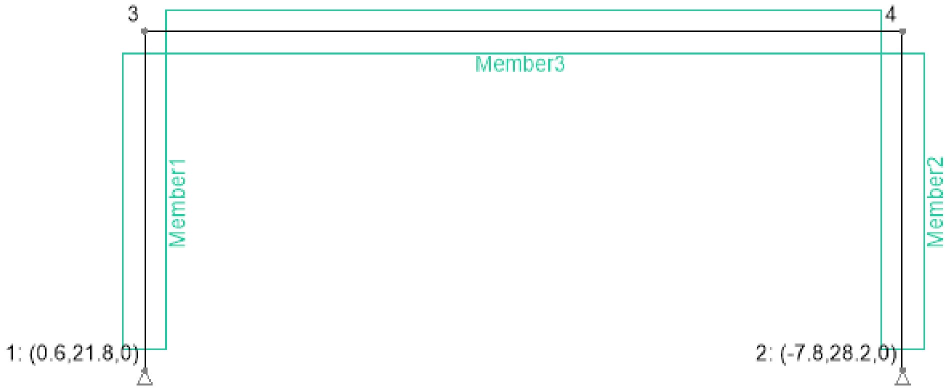
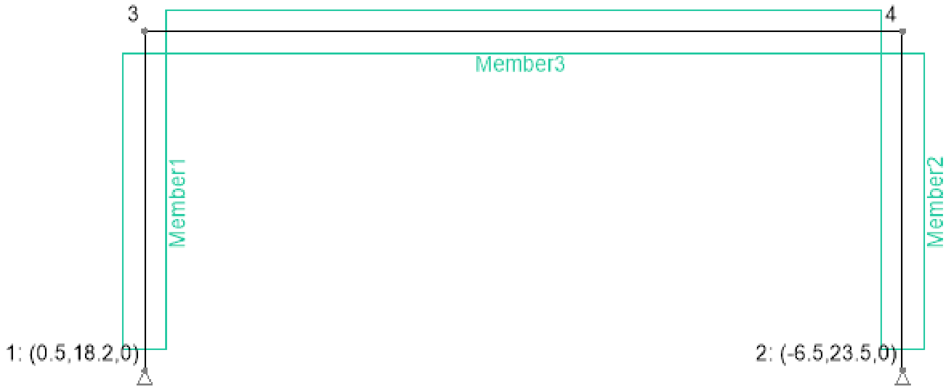
1.0D + 1.0I + 1.0RI (Service) - Local node reactions - Node: (Horiz (kN), Vert (kN), Mom (kNm))



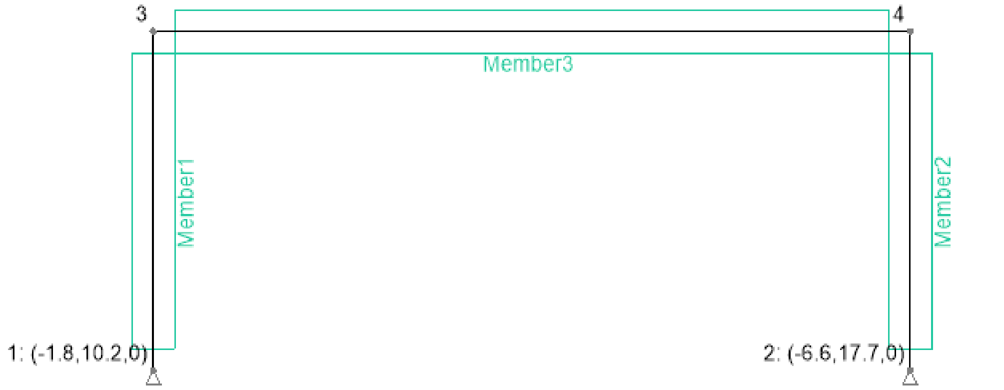
1.2D + 1.2I + 1.2RI + 1.2W (Strength) - Local node reactions - Node: (Horiz (kN), Vert (kN), Mom (kNm))



1.0D + 1.0I + 1.0RI + 1.0W (Service) - Local node reactions - Node: (Horiz (kN), Vert (kN), Mom (kNm))

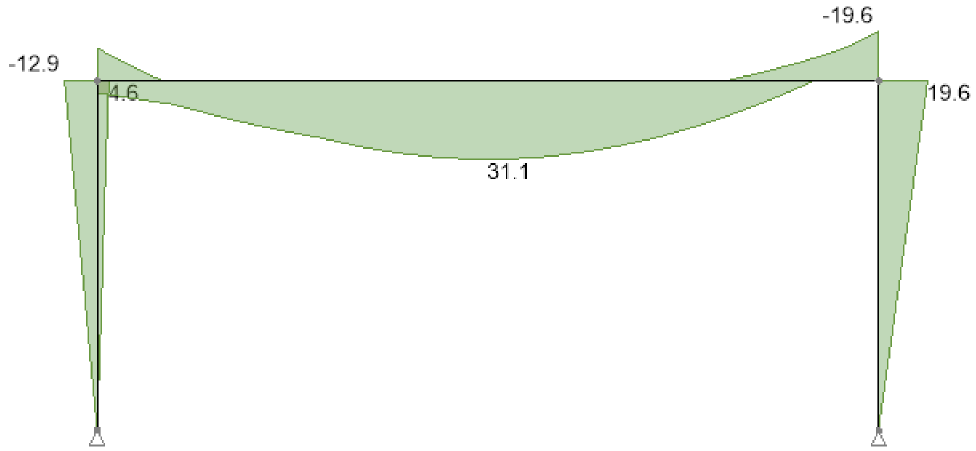


1.0D + 1.4W (Strength) - Local node reactions - Node: (Horiz (kN), Vert (kN), Mom (kNm))

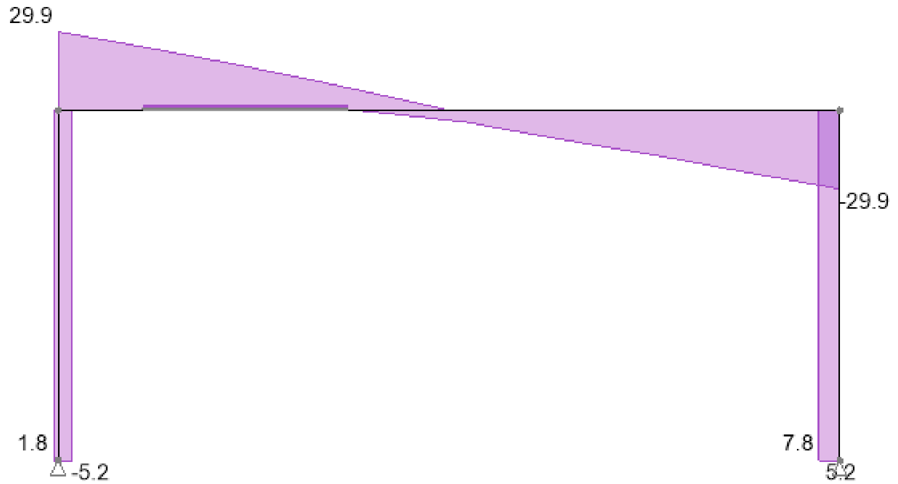


Forces

Strength combinations - Moment envelope (kNm)



Strength combinations - Shear envelope (kN)



BSC BARSBY STRUCTURAL CONSULTANTS Barsby Structural Consultants Ltd	Project 15 WILLOW GROVE, SOUTH CERNEY				Job no. 22.132	
	Calcs for B3 + C3 SWAY FRAME ANALYSIS				Start page no./Revision 8	
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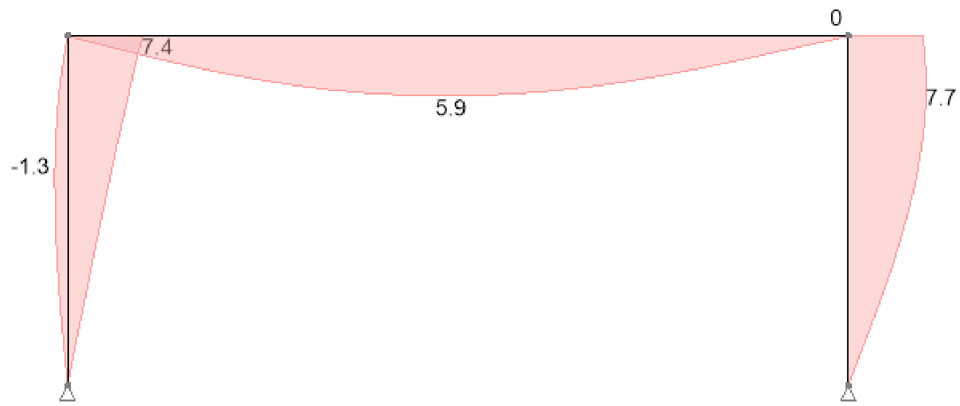
Strength combinations - Axial force envelope (kN)

Service combinations - Deflection envelope (mm)



TIMBER JOIST DESIGN (BS5268-2:2002)

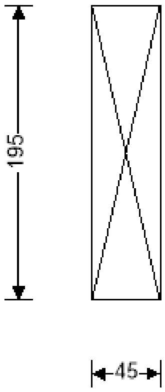
Tedds calculation version 1.1.04

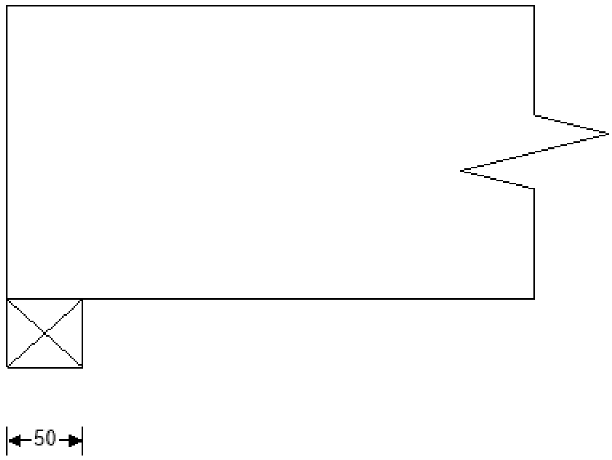
Joist details

Joist breadth b = **45** mm
Joist depth h = **195** mm
Joist spacing s = **600** mm
Service class of timber **2**
Timber strength class **C16**

Span details

Number of spans N_{span} = **1**
Length of bearing L_b = **50** mm
Clear length of span L_{s1} = **3300** mm





Section properties

Second moment of area I = **27805781** mm^4
Section modulus Z = **285188** mm^3

Loading details

Joist self weight F_{swt} = **0.03** kN/m
Dead load F_{d_udl} = **0.90** kN/m^2
Imposed UDL(Medium term) F_{i_udl} = **0.75** kN/m^2
Imposed point load (Short) F_{i_pt} = **0.90** kN

Consider medium term loads

Design bending moment M = **1.384** kNm
Design shear force V = **1.678** kN
Design support reaction R = **1.678** kN
Design deflection δ = **6.760** mm

Check bending stress

Permissible bending stress σ_{m_adm} = **7.641** N/mm^2
Applied bending stress σ_{m_max} = **4.853** N/mm^2

PASS - Applied bending stress within permissible limits

Check shear stress

Permissible shear stress τ_{adm} = **0.921** N/mm^2 Applied shear stress τ_{max} = **0.287** N/mm^2

PASS - Applied shear stress within permissible limits

Check bearing stress

Permissible bearing stress σ_{c_adm} = **3.025** N/mm^2 Applied bearing stress σ_{c_max} = **0.746** N/mm^2

PASS - Applied bearing stress within permissible limits

Check deflection

Permissible deflection δ_{adm} = **9.900** mm Actual deflection δ = **6.760** mm

PASS - Actual deflection within permissible limits

Consider short term loads

Design bending moment M = **1.514** kNm Design shear force V = **1.835** kN

Design support reaction R = **1.835** kN Design deflection δ = **6.706** mm

Check bending stress

Permissible bending stress σ_{m_adm} = **9.169** N/mm^2 Applied bending stress σ_{m_max} = **5.308** N/mm^2

PASS - Applied bending stress within permissible limits

Check shear stress

Permissible shear stress τ_{adm} = **1.106** N/mm^2 Applied shear stress τ_{max} = **0.314** N/mm^2

PASS - Applied shear stress within permissible limits

Check bearing stress

Permissible bearing stress σ_{c_adm} = **3.630** N/mm^2 Applied bearing stress σ_{c_max} = **0.816** N/mm^2

PASS - Applied bearing stress within permissible limits

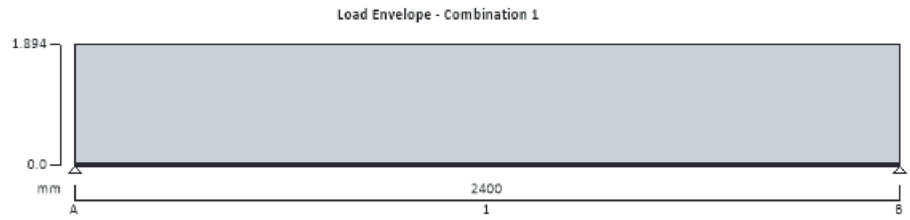
Check deflection

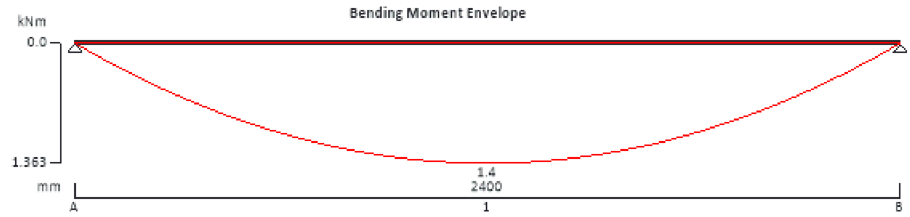
Permissible deflection δ_{adm} = **9.900** mm Actual deflection δ = **6.706** mm

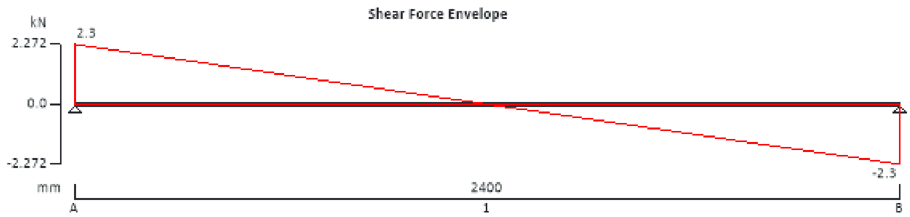
PASS - Actual deflection within permissible limits

TIMBER BEAM ANALYSIS & DESIGN TO BS5268-2:2002

TEDDS calculation version 1.7.02







Applied loading

Beam loads

Dead self weight of beam × 1
Dead full UDL 1.000 kN/m
Imposed full UDL 0.830 kN/m

Load combinations

Load combination 1	Support A	Dead × 1.00
		Imposed × 1.00
	Span 1	Dead × 1.00
		Imposed × 1.00
	Support B	Dead × 1.00
		Imposed × 1.00

Analysis results

Design moment	M = **1.363** kNm	Design shear	F = **2.272** kN
Total load on beam	W_{tot} = **4.545** kN		
Reactions at support A	R_{A_max} = **2.272** kN	R_{A_min} = **2.272** kN	

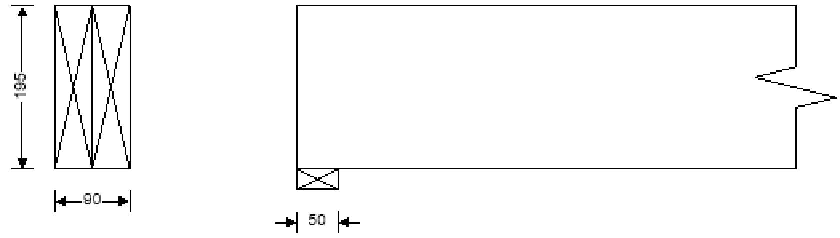
Unfactored dead load reaction at support A R_{A_Dead} = **1.276** kN

Unfactored imposed load reaction at support A $R_{A\_Imposed}$ = **0.996** kN

Reactions at support B R_{B_max} = **2.272** kN R_{B_min} = **2.272** kN

Unfactored dead load reaction at support B R_{B_Dead} = **1.276** kN

Unfactored imposed load reaction at support B $R_{B\_Imposed}$ = **0.996** kN



Timber section details

Breadth of section	b = **45** mm	Depth of section	h = **195** mm
Number of sections	N = **2**	Breadth of beam	b_b = **90** mm
Timber strength class	**C16**		

Member details

Service class of timber	**2**	Load duration	**Medium term**
Length of span	L_{s1} = **2400** mm		
Length of bearing	L_b = **50** mm		

Lateral support - cl.2.10.8

Permiss.depth-to-breadth ratio **4.00** Actual depth-to-breadth ratio **2.17**

PASS - Lateral support is adequate

Check bearing stress

Permissible bearing stress σ_{c_adm} = **3.025** N/mm^2 Applied bearing stress σ_{c_a} = **0.505** N/mm^2

PASS - Applied compressive stress is less than permissible compressive stress at bearing

Bending parallel to grain

Permissible bending stress σ_{m_adm} = **7.641** N/mm^2 Applied bending stress σ_{m_a} = **2.390** N/mm^2

PASS - Applied bending stress is less than permissible bending stress

Shear parallel to grain

Permissible shear stress τ_{adm} = **0.921** N/mm^2 Applied shear stress τ_a = **0.194** N/mm^2

PASS - Applied shear stress is less than permissible shear stress

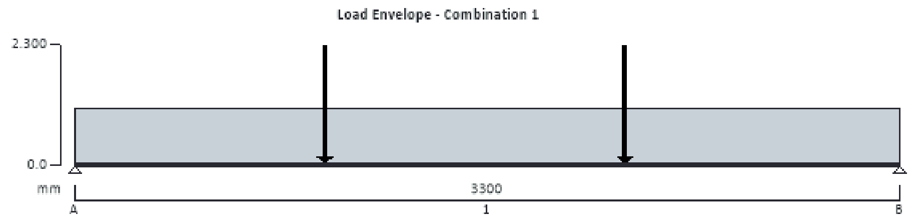
Deflection

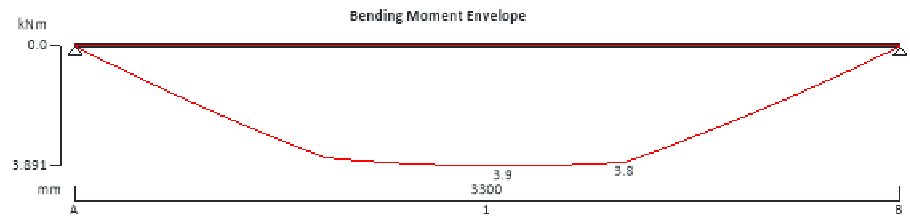
Permissible deflection δ_{adm} = **4.800** mm Total deflection δ_a = **2.450** mm

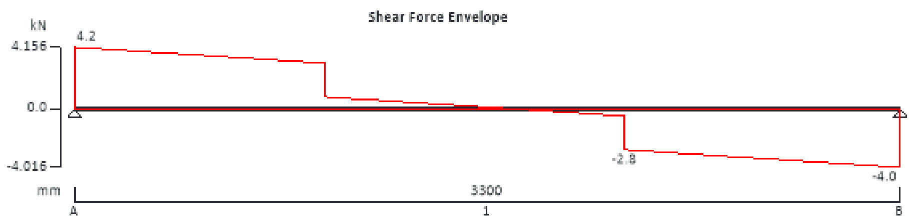
PASS - Total deflection is less than permissible deflection

TIMBER BEAM ANALYSIS & DESIGN TO BS5268-2:2002

TEDDS calculation version 1.7.02







Applied loading

Beam loads

Dead self weight of beam × 1
Dead full UDL 0.520 kN/m
Imposed full UDL 0.450 kN/m
Dead point load 1.200 kN at 1000 mm
Imposed point load 1.100 kN at 1000 mm
Dead point load 1.200 kN at 2200 mm
Imposed point load 1.100 kN at 2200 mm

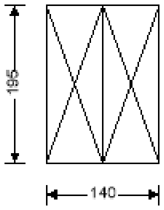
Load combinations

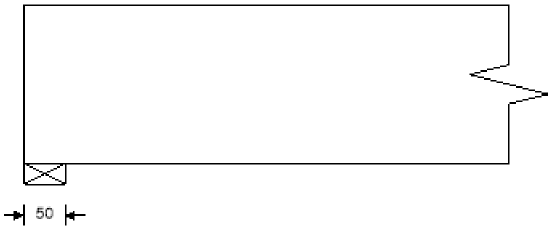
Load combination 1	Support A	Dead × 1.00
		Imposed × 1.00
	Span 1	Dead × 1.00
		Imposed × 1.00
	Support B	Dead × 1.00
		Imposed × 1.00

Analysis results

Design moment M = **3.891** kNm Design shear F = **4.156** kN

Total load on beam	W_{tot} = **8.172** kN		
Reactions at support A	R_{A_max} = **4.156** kN	R_{A_min} = **4.156** kN	
Unfactored dead load reaction at support A	R_{A_Dead} = **2.280** kN		
Unfactored imposed load reaction at support A	$R_{A\_Imposed}$ = **1.876** kN		
Reactions at support B	R_{B_max} = **4.016** kN	R_{B_min} = **4.016** kN	
Unfactored dead load reaction at support B	R_{B_Dead} = **2.207** kN		
Unfactored imposed load reaction at support B	$R_{B\_Imposed}$ = **1.809** kN		





Timber section details

Breadth of section	b = **70** mm	Depth of section	h = **195** mm
Number of sections	N = **2**	Breadth of beam	b_b = **140** mm
Timber strength class	**C24**		

Member details

Service class of timber	**2**	Load duration	**Medium term**
Length of span	L_{s1} = **3300** mm		
Length of bearing	L_b = **50** mm		

Lateral support - cl.2.10.8

Permiss.depth-to-breadth ratio	**4.00**	Actual depth-to-breadth ratio	**1.39**

PASS - Lateral support is adequate

Check bearing stress

Permissible bearing stress	σ_{c_adm} = **3.300** N/mm^2	Applied bearing stress	σ_{c_a} = **0.594** N/mm^2

PASS - Applied compressive stress is less than permissible compressive stress at bearing

Bending parallel to grain

Permissible bending stress	σ_{m_adm} = **10.813** N/mm^2	Applied bending stress	σ_{m_a} = **4.385** N/mm^2

PASS - Applied bending stress is less than permissible bending stress

Shear parallel to grain

Permissible shear stress	τ_{adm} = **0.976** N/mm^2	Applied shear stress	τ_a = **0.228** N/mm^2

PASS - Applied shear stress is less than permissible shear stress

Deflection

Permissible deflection	δ_{adm} = **9.900** mm	Total deflection	δ_a = **6.688** mm

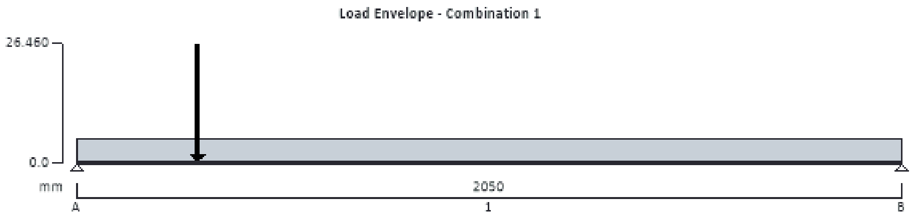
PASS - Total deflection is less than permissible deflection

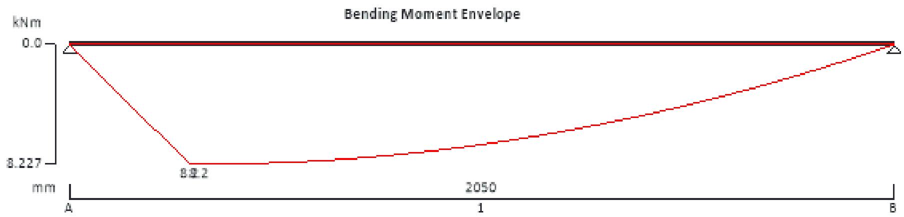
BSC BARSBY STRUCTURAL CONSULTANTS	Project 15 WILLOW GROVE, SOUTH CERNEY				Job no. 22.132	
	Calcs for B6				Start page no./Revision 1	
Barsby Structural Consultants Ltd	Calcs by MB	Calcs date 16/11/2022	Checked by	Checked date	Approved by	Approved date

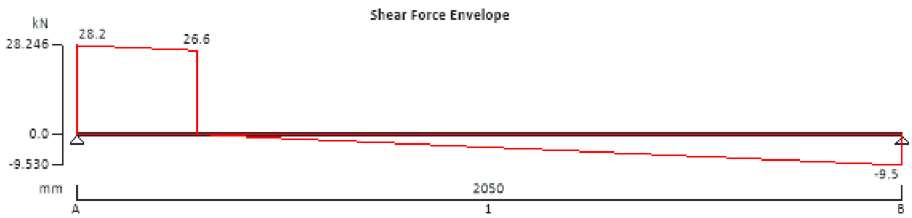
STEEL BEAM ANALYSIS & DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

TEDDS calculation version 3.0.07







Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

Beam loads	Dead self weight of beam × 1
	Dead full UDL 0.81 kN/m
	Imposed full UDL 2.63 kN/m
	Dead point load 18.9 kN at 300 mm

Load combinations

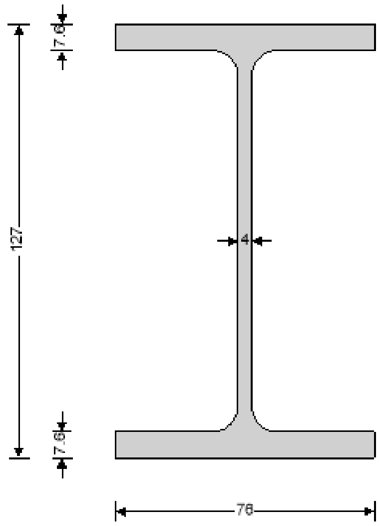
Load combination 1	Support A	Dead × 1.40
		Imposed × 1.60
		Dead × 1.40
		Imposed × 1.60
	Support B	Dead × 1.40
		Imposed × 1.60

Analysis results

Maximum moment	M_{max} = **8.2** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **28.2** kN	V_{min} = **-9.5** kN
Deflection	δ_{max} = **2.4** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **28.2** kN	R_{A_min} = **28.2** kN
Unfactored dead load reaction at support A	R_{A_Dead} = **17.1** kN	
Unfactored imposed load reaction at support A	$R_{A\_Imposed}$ = **2.7** kN	
Maximum reaction at support B	R_{B_max} = **9.5** kN	R_{B_min} = **9.5** kN
Unfactored dead load reaction at support B	R_{B_Dead} = **3.7** kN	
Unfactored imposed load reaction at support B	$R_{B\_Imposed}$ = **2.7** kN	

Section details

Section type **UKB 127x76x13 (Tata Steel Advance)** Steel grade **S275**



Classification of cross sections - Section 3.5

Tensile strain coefficient ε = **1.00** Section classification **Plastic**

Shear capacity - Section 4.2.3

Design shear force F_v = **28.2** kN Design shear resistance P_v = **83.8** kN

PASS - Design shear resistance exceeds design shear force

Moment capacity - Section 4.2.5

Design bending moment M = **8.2** kNm Moment capacity low shear M_c = **23.1** kNm

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment M_b = **15.1** kNm M_b / m_{LT} = **17.9** kNm

PASS - Buckling resistance moment exceeds design bending moment

Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

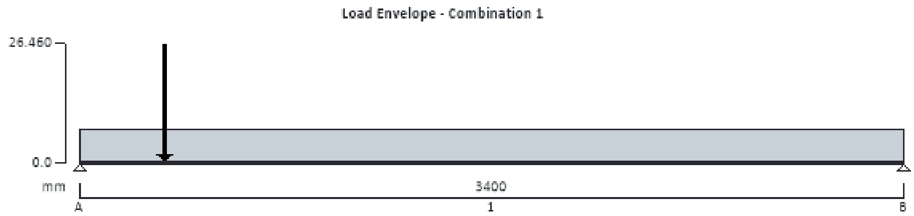
Limiting deflection δ_{lim} = **5.694** mm Maximum deflection δ = **2.365** mm

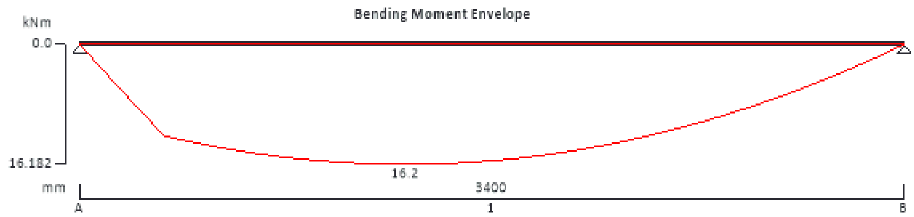
PASS - Maximum deflection does not exceed deflection limit

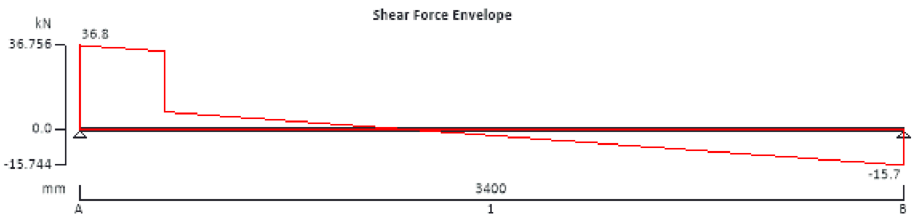
STEEL BEAM ANALYSIS & DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

TEDDS calculation version 3.0.07







Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

Beam loads	Dead self weight of beam × 1
	Dead full UDL 1.2 kN/m
	Imposed full UDL 3.6 kN/m
	Dead point load 18.9 kN at 350 mm

Load combinations

Load combination 1	Support A	Dead × 1.40
		Imposed × 1.60
		Dead × 1.40
		Imposed × 1.60
	Support B	Dead × 1.40
		Imposed × 1.60

Project				Job no.	
15 WILLOW GROVE, SOUTH CERNEY				22.132	
Calcs for				Start page no./Revision	
B7				2	
Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
MB	16/11/2022				

BSC
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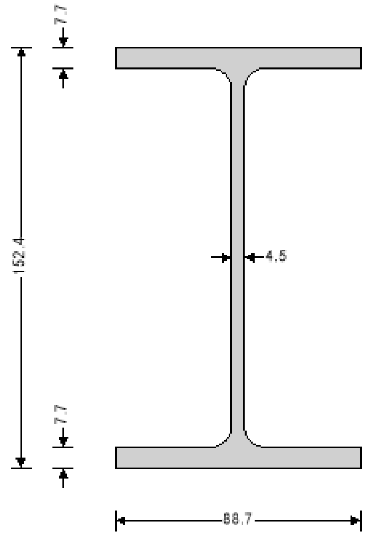
Analysis results

Maximum moment	M_{max} = **16.2** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **36.8** kN	V_{min} = **-15.7** kN
Deflection	δ_{max} = **7.8** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **36.8** kN	R_{A_min} = **36.8** kN
Unfactored dead load reaction at support A	R_{A_Dead} = **19.3** kN	
Unfactored imposed load reaction at support A	$R_{A\_Imposed}$ = **6.1** kN	
Maximum reaction at support B	R_{B_max} = **15.7** kN	R_{B_min} = **15.7** kN
Unfactored dead load reaction at support B	R_{B_Dead} = **4.3** kN	
Unfactored imposed load reaction at support B	$R_{B\_Imposed}$ = **6.1** kN	

Section details

Section type **UKB 152x89x16 (Tata Steel Advance)** Steel grade **S275**



Classification of cross sections - Section 3.5

Tensile strain coefficient ε = **1.00** Section classification **Plastic**

Shear capacity - Section 4.2.3

Design shear force F_v = **36.8** kN Design shear resistance P_v = **113.2** kN

PASS - Design shear resistance exceeds design shear force

Moment capacity - Section 4.2.5

Design bending moment M = **16.2** kNm Moment capacity low shear M_c = **33.9** kNm

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment M_b = **15.5** kNm M_b / m_{LT} = **16.8** kNm

PASS - Buckling resistance moment exceeds design bending moment

Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

Limiting deflection δ_{lim} = **9.444** mm Maximum deflection δ = **7.842** mm

PASS - Maximum deflection does not exceed deflection limit