STRUCTURAL CALCULATIONS

FOR

476 Garstang Road
Broughton PR3 5JB

PROPOSED ALTERATIONS
AND EXTENSION

STRUCTURAL ENGINEERS

ROBERT E. FRY & ASSOCIATES LTD.

45 Bridgeman Terrace
Wigan
WN1 1TT
Tel: (01942) 826020
Fax: (01942) 230816

PROJECT NO: 19192

Revision 0 – March 2020

By: Paul M. Bithell *I.Eng AMI.Struct.E AaPS*

Robert E Fry Associates Ltd
45 Bridgeman Terrace
Wigan, WN1 1TT
Tel: 01942-826020

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P.Bithell	March 2020				

BRIEF

To provide designs as requested for the proposed alterations and extension at the above property; no other structural aspects have been considered as it is assumed that these comply with Document A/Building Regulations:

The calculations are based on our interpretation of the drawings submitted and a number of assumptions have been made; these assumptions will need to be checked and confirmed on site and any variation which may affect the design should be brought to the attention of the Engineer for comment.

In line with the CDM Regulations 2015, we are obliged to inform the Client of the risks that may be encountered in the works and, wherever possible, risks have been eliminated from the design however it is not possible to remove all risks. The Client must take all reasonable steps to ensure that only competent contractors who are experienced and familiar with this type of work are employed; in addition, suitable arrangements must be in place to manage the works. Further information can be found at: www.hse.gov.uk/pubns/indg411.htm.

Your appointed Contractor must plan, manage and monitor the construction work under their control so that it is carried out without risks to health and safety and shall co-ordinate their activities with others involved with the project; they are required to prepare a construction phase plan.

Any work that is carried out prior to approval of the calculations/details shall be at the risk of the Client and their Contractor. The Engineer cannot be held responsible for any additional work that may be deemed necessary by the Local Authority or other statutory body after work has commenced prior to approval. The Client and/or Contractor must bear all the costs associated with any additional work.

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LOADINGS

MAIN ROOF

tiles	0.55			
felt/battens	0.05			
rafters, etc	0.15			
	0.75			
0.75 / cos 30° =	0.87			
framing, etc.	0.15			
insulation	0.05			
ceiling	0.15			
	1.22	**kN/m²**	**DEAD**	**say, 1.25 kN/m²**
roof/snow	**0.75**	**kN/m²**	**IMPOSED**	

DORMER ROOF

tiles	0.55			
felt/battens	0.05			
rafters, etc	0.15			
	0.75			
0.75 / cos 20° =	0.80			
insulation	0.05			
ceiling	0.15			
	1.00	**kN/m²**	**DEAD**	
roof/snow	**0.75**	**kN/m²**	**IMPOSED**	

GRD. FLOOR

finishes	0.15			
screed	1.80			
insulation	0.05			
pc floor	3.00			
	5.00	**kN/m²**	**DEAD**	
communal	**2.00**	**kN/m²**	**IMPOSED**	

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EXT. WALL	103 brick	2.18		
	insulation	0.05		
	100 block	1.39		
	1-plaster	0.15		
		3.77	**kN/m^2**	**DEAD**
DORMER WALL	render+board	0.55		
	insulation	0.05		
	framing	0.25		
	1-plaster	0.15		
		1.00	**kN/m^2**	**DEAD**

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LAYOUT

RAFTERS

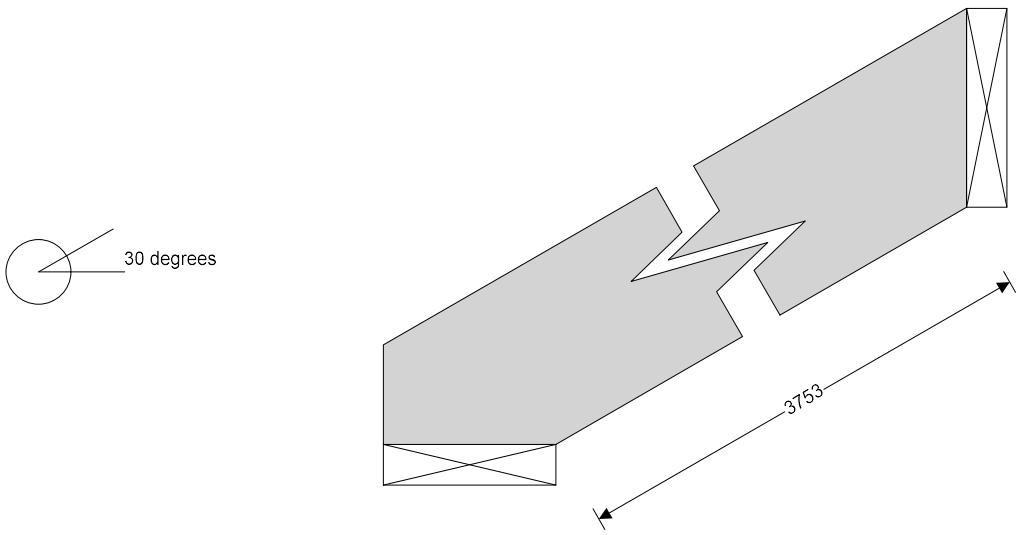
Adopt C16 timber rafters at 600mm centres; max. span = 3.25m (on plan) with a roof pitch of 30°

Loading, roof (d) = 1.25kN/m^2 and (i) = 0.75kN/m^2

→ **provide 47x200mm C16 rafters at 600mm centres throughout**

TIMBER RAFTER DESIGN (BS5268-2:2002)

TEDDS calculation version 1.0.03



Rafter details

Breadth of timber sections;	b = **47** mm;	Depth of timber sections;	h = **200** mm
Rafter spacing;	s = **600** mm;	Rafter span;	**Single span**
Clear length of span on slope;	L_{cl} = **3753** mm;	Rafter slope;	α = **30.0** deg
Timber strength class;	**C16**		

Section properties

Cross sectional area of rafter;	A = **9400** mm^2;	Section modulus;	Z = **313333** mm^3
Radius of gyration;	r = **58** mm;	Second moment of area;	I = **31333333** mm^4

Loading details

Rafter self weight;	F_j = **0.03** kN/m;	Dead load on slope;	F_d = **1.04** kN/m^2
Imposed snow load on plan;	F_u = **0.75** kN/m^2;	Imposed point load;	F_p = **0.90** kN

Modification factors

Section depth factor;	K_7 = **1.05**;	Load sharing factor;	K_8 = **1.10**

Consider long term load condition

Load duration factor; K_3 = **1.00**; Total UDL perp. to rafter; F = **0.565** kN/m

Notional bearing length; L_b = **9** mm; Effective span; L_{eff} = **3762** mm

Check bending stress

Permissible bending stress; σ_{m_adm} = **6.096** N/mm^2; Applied bending stress; σ_{m_max} = **3.191** N/mm^2

PASS - Applied bending stress within permissible limits

Check compressive stress parallel to grain

Permissible comp. stress; σ_{c_adm} = **4.636** N/mm^2; Applied compressive stress; σ_{c_max} = **0.392** N/mm^2

PASS - Applied compressive stress within permissible limits

Check combined bending and compressive stress parallel to grain

Combined loading check; **0.623 < 1**

PASS - Combined compressive and bending stresses are within permissible limits

Check shear stress

Permissible shear stress; τ_{adm} = **0.737** N/mm^2; Applied shear stress; τ_{max} = **0.170** N/mm^2

PASS - Applied shear stress within permissible limits

Check deflection

Permissible deflection; δ_{adm} = **11.286** mm; Total deflection; δ_{max} = **5.578** mm

PASS - Total deflection within permissible limits

Consider medium term load condition

Load duration factor; K_3 = **1.25**; Total UDL perp. to rafter; F = **0.903** kN/m

Notional bearing length; L_b = **15** mm; Effective span; L_{eff} = **3768** mm

Check bending stress

Permissible bending stress; σ_{m_adm} = **7.620** N/mm^2; Applied bending stress; σ_{m_max} = **5.112** N/mm^2

PASS - Applied bending stress within permissible limits

Check compressive stress parallel to grain

Permissible comp. stress; σ_{c_adm} = **5.420** N/mm^2; Applied compressive stress; σ_{c_max} = **0.627** N/mm^2

PASS - Applied compressive stress within permissible limits

Check combined bending and compressive stress parallel to grain

Combined loading check; **0.815 < 1**

PASS - Combined compressive and bending stresses are within permissible limits

Check shear stress

Permissible shear stress; τ_{adm} = **0.921** N/mm^2; Applied shear stress; τ_{max} = **0.271** N/mm^2

PASS - Applied shear stress within permissible limits

Check deflection

Permissible deflection; δ_{adm} = **11.303** mm; Total deflection; δ_{max} = **8.962** mm

PASS - Total deflection within permissible limits

Consider short term load condition

Load duration factor; K_3 = **1.50**; Total UDL perp. to rafter; F = **0.565** kN/m

Notional bearing length; L_b = **13** mm; Effective span; L_{eff} = **3766** mm

Check bending stress

Permissible bending stress; σ_{m_adm} = **9.144** N/mm^2; Applied bending stress; σ_{m_max} = **5.539** N/mm^2

PASS - Applied bending stress within permissible limits

Check compressive stress parallel to grain

Permissible comp. stress; σ_{c_adm} = **6.072** N/mm^2; Applied compressive stress; σ_{c_max} = **0.440** N/mm^2

PASS - Applied compressive stress within permissible limits

Check combined bending and compressive stress parallel to grain

Combined loading check; **0.695 < 1**

PASS - Combined compressive and bending stresses are within permissible limits

Check shear stress

Permissible shear stress; τ_{adm} = **1.106** N/mm^2; Applied shear stress; τ_{max} = **0.294** N/mm^2

PASS - Applied shear stress within permissible limits

Check deflection

Permissible deflection; δ_{adm} = **11.297** mm; Total deflection; δ_{max} = **8.913** mm

PASS - Total deflection within permissible limits

DORMER PURLIN

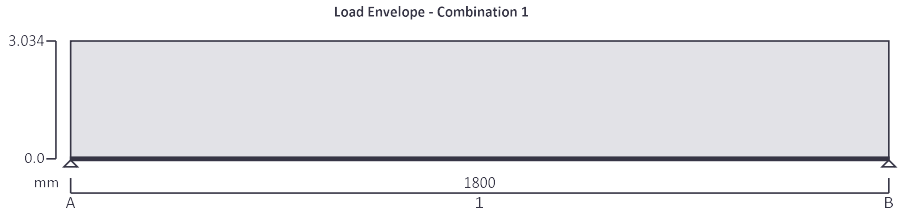
Adopt C16 timber, max. span = 1.80m (on plan), loading as follows

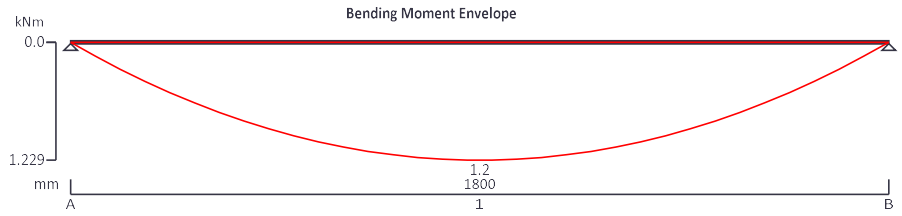
roof (d)	=	1.00# x (2.05 / 2)	=	1.03
roof (d)	=	1.25# x (1.20 / 2)	=	0.75
roof (i)	=	0.75# x [(2.05+1.20) / 2)]	=	1.22

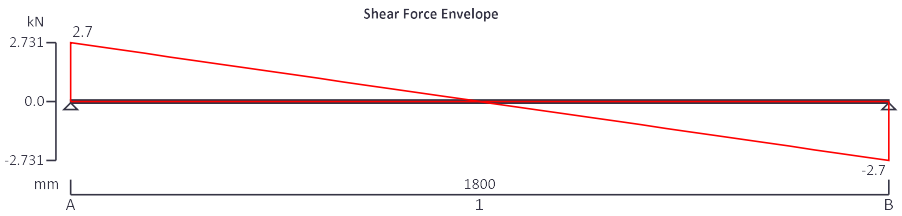
→ **(for detail) provide 47x200mm C16 purlin**

TIMBER BEAM ANALYSIS & DESIGN TO BS5268-2:2002

TEDDS calculation version 1.7.02







Applied loading

Beam loads

	Dead self weight of beam ´ 1
roof	Dead full UDL 1.030 kN/m
dormer	Dead full UDL 0.750 kN/m
r+d	Imposed full UDL 1.220 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 = **1.229** kNm;	Design shear;	F = **2.731** kN
Total load on beam;	W_{tot} = **5.461** kN		
Reactions at support A;	R_{A_max} = **2.731** kN;	R_{A_min} = **2.731** kN	
Unfactored dead load reaction at support A;	R_{A_Dead} = **1.633** kN		
Unfactored imposed load reaction at support A;	$R_{A\_Imposed}$ = **1.098** kN		
Reactions at support B;	R_{B_max} = **2.731** kN;	R_{B_min} = **2.731** kN	
Unfactored dead load reaction at support B;	R_{B_Dead} = **1.633** kN		
Unfactored imposed load reaction at support B;	$R_{B\_Imposed}$ = **1.098** kN		

Timber section details

Breadth of section;	b = **47** mm;	Depth of section;	h = **200** mm
Number of sections;	N = **1**;	Breadth of beam;	b_b = **47** mm
Timber strength class;	**C16**		

Member details

Service class of timber;	**1**;	Load duration;	**Medium term**
Length of span;	L_{s1} = **1800** mm		
Length of bearing;	L_b = **50** mm		

Lateral support - cl.2.10.8

Permiss.depth-to-breadth ratio; **5.00**; Actual depth-to-breadth ratio; **4.26**

PASS - Lateral support is adequate

Check bearing stress

Permissible bearing stress; σ_{c_adm} = **2.125** N/mm^2; Applied bearing stress; σ_{c_a} = **1.162** 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} = **6.927** N/mm^2; Applied bending stress; σ_{m_a} = **3.922** N/mm^2

PASS - Applied bending stress is less than permissible bending stress

Shear parallel to grain

Permissible shear stress; τ_{adm} = **0.838** N/mm^2; Applied shear stress; τ_a = **0.436** N/mm^2

PASS - Applied shear stress is less than permissible shear stress

Deflection

Permissible deflection; δ_{adm} = **5.400** mm; Total deflection; δ_a = **2.715** mm

PASS - Total deflection is less than permissible deflection

DORMER 'TRIMMERS'

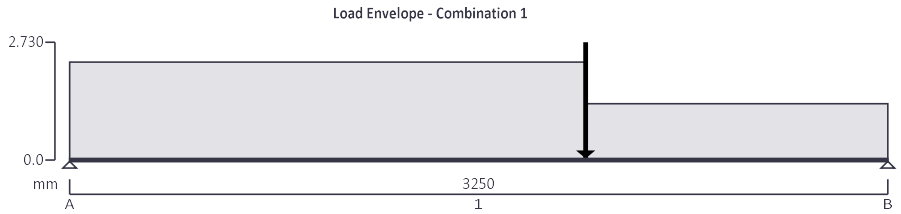
Adopt C16 timber, max. span = 3.25m (on plan); supports nominal loading from the main roof, reaction from purlin plus weight of dormer wall

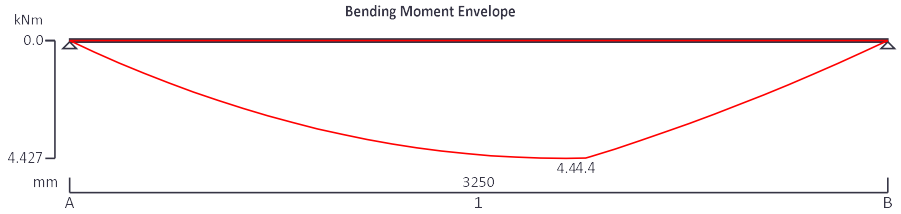
roof (d)	=	1.25# x (0.60 / 2)	=	0.38
roof (d)	=	0.75# x (0.62 / 2)	=	0.23
purlin (d)	=	from design	=	1.63kN
purlin (i)	=	from design	=	1.10kN
dormer (d)	=	1.00# x 1.33(2.35 / 2)	=	1.56kN/m partial

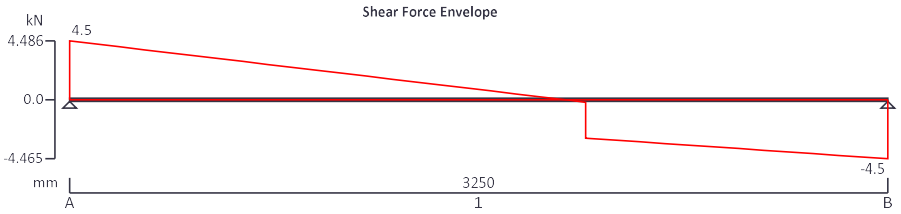
→ **provide 3-No. 47x200mm C16 rafters screwed together to form trimmers either side of dormer**

TIMBER BEAM ANALYSIS & DESIGN TO BS5268-2:2002

TEDDS calculation version 1.7.02







Applied loading

Beam loads

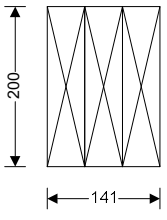
	Dead self weight of beam ´ 1
roof lower	Dead partial UDL 0.380 kN/m from 0 mm to 2050 mm
roof lower	Imposed partial UDL 0.230 kN/m from 0 mm to 2050 mm
roof upper	Dead partial UDL 0.750 kN/m from 2050 mm to 3250 mm
roof upper	Imposed partial UDL 0.450 kN/m from 2050 mm to 3250 mm
purlin	Dead point load 1.630 kN at 2050 mm
purlin	Imposed point load 1.100 kN at 2050 mm
dormer wall	Dead partial UDL 1.560 kN/m from 0 mm to 2050 mm

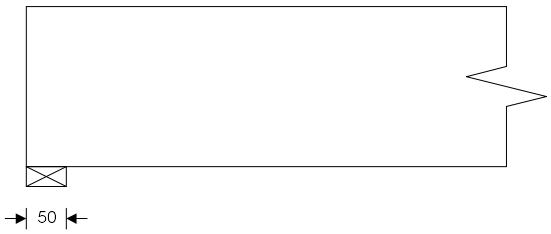
Load combinations

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 = **4.427** kNm;	Design shear;	F = **4.486** kN
Total load on beam;	W_{tot} = **8.951** kN		
Reactions at support A;	R_{A_max} = **4.486** kN;	R_{A_min} = **4.486** kN	
Unfactored dead load reaction at support A;	R_{A_Dead} = **3.657** kN		
Unfactored imposed load reaction at support A;	$R_{A\_Imposed}$ = **0.829** kN		
Reactions at support B;	R_{B_max} = **4.465** kN;	R_{B_min} = **4.465** kN	
Unfactored dead load reaction at support B;	R_{B_Dead} = **3.183** kN		
Unfactored imposed load reaction at support B;	$R_{B\_Imposed}$ = **1.283** kN		





Timber section details

Breadth of section;	b = **47** mm;	Depth of section;	h = **200** mm
Number of sections;	N = **3**;	Breadth of beam;	b_b = **141** mm
Timber strength class;	**C16**		

Member details

Service class of timber;	**1**;	Load duration;	**Medium term**

Length of span; L_{s1} = **3250** mm

Length of bearing; L_b = **50** mm

Lateral support - cl.2.10.8

Permiss.depth-to-breadth ratio; **5.00**; Actual depth-to-breadth ratio; **1.42**

PASS - Lateral support is adequate

Check bearing stress

Permissible bearing stress; σ_{c_adm} = **2.338** N/mm^2; Applied bearing stress; σ_{c_a} = **0.636** 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} = **7.620** N/mm^2; Applied bending stress; σ_{m_a} = **4.710** 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 = **0.239** N/mm^2

PASS - Applied shear stress is less than permissible shear stress

Deflection

Permissible deflection; δ_{adm} = **9.750** mm; Total deflection; δ_a = **7.493** mm

PASS - Total deflection is less than permissible deflection

RIDGE BEAM

Beam supports new roof construction and reaction from dormer trimmers only, no other loads considered; assume beam be restrained over its 6.00m span and limit deflection, under total dead & imposed, to 15mm (approx. span/360)

Loading: roof (d) = 1.25# x (6.50 / 2) = 4.06
roof (i) = 0.75# x (6.50 / 2) = 2.44

reaction (d) = 3.18 kN *applied at* 3.6m & 5.4m *from* R_A
reaction (i) = 1.28 kN *applied at* 3.6m & 5.4m *from* R_A

Reactions R_A = *33.20 kN ult. (d = 14.6kN & i = 8.0kN)*
R_B = *39.70 kN ult. (d = 17.8kN & i = 9.2kN)*

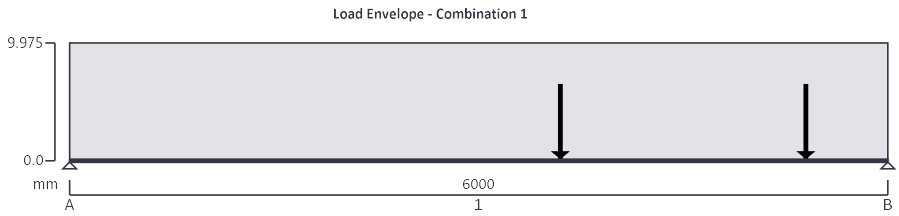
→ **adopt 305 x 102 x 28 UB (S275)**

beam weight approx. 170kgs; contractor/builder to consider handling issues during installation; ensure adequate propping of gable wall until beam – and roof – can be constructed the execution of the works

STEEL BEAM ANALYSIS & DESIGN (BS5950)

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

TEDDS calculation version 3.0.07



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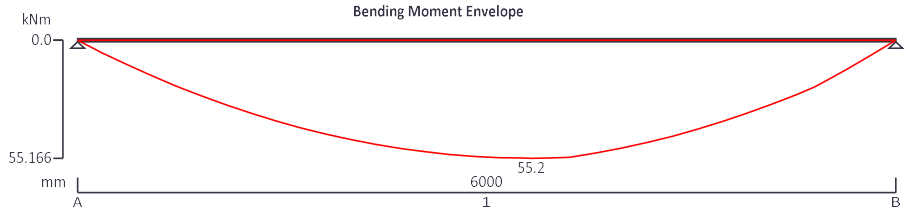
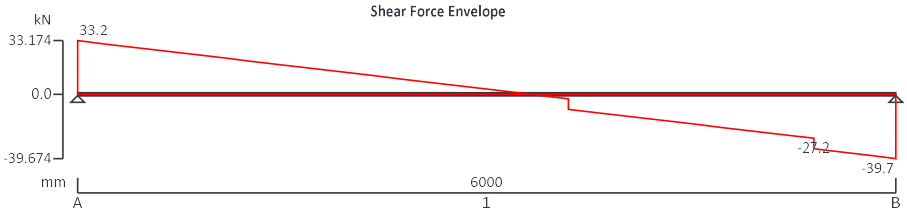




Support conditions

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

Applied loading

Beam loads	Dead self weight of beam × 1
	roof - Dead full UDL 4.06 kN/m
	roof - Imposed full UDL 2.44 kN/m
	dormer - Dead point load 3.18 kN at 3600 mm
	Imposed point load 1.28 kN at 3600 mm
	dormer - Dead point load 3.18 kN at 5400 mm
	Imposed point load 1.28 kN at 5400 mm

Load combinations

Load combination 1 - gravity	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} = **55.2** kNm;	M_{min} = **0** kNm
Maximum shear;	V_{max} = **33.2** kN;	V_{min} = **-39.7** kN
Deflection;	δ_{max} = **12.7** mm;	δ_{min} = **0** mm

Maximum reaction at support A; R_{A_max} = **33.2** kN; R_{A_min} = **33.2** kN
Unfactored dead load reaction at support A; R_{A_Dead} = **14.6** kN
Unfactored imposed load reaction at support A; $R_{A\_Imposed}$ = **8** kN
Maximum reaction at support B; R_{B_max} = **39.7** kN; R_{B_min} = **39.7** kN
Unfactored dead load reaction at support B; R_{B_Dead} = **17.8** kN
Unfactored imposed load reaction at support B; $R_{B\_Imposed}$ = **9.2** kN

Section details

Section type; **UB 305x102x28 (BS4-1)**; 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 = **39.7** kN; Design shear resistance; P_v = **305.6** kN

PASS - Design shear resistance exceeds design shear force

Moment capacity - Section 4.2.5

Design bending moment; M = **55.2** kNm; Moment capacity low shear; M_c = **110.8** kNm

PASS - Moment capacity exceeds design bending moment

Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

Limiting deflection δ_{lim} = **15** mm; Maximum deflection; δ = **12.661** mm

PASS - Maximum deflection does not exceed deflection limit

check beam bearings:

Reactions	R_A	=	**33.20 kN ult**	d = 14.6	i = 8.0
	R_B	=	**39.70 kN ult**	d = 17.8	i = 9.2

Worse case is R_B onto block wall/gable; adopt 100mm thick, 3.6N/mm^2, blockwork laid in M4 mortar throughout with normal manufacture and construction

→ **provide 300mm long x 100mm wide (C8/10) concrete padstone, 150mm deep, at bearings; beam to have 100mm 'seating' onto padstone/wall**

MASONRY BEARING DESIGN TO BS5628-1:2005

TEDDS calculation version 1.0.07

Masonry details

Masonry type;	**Aggregate concrete blocks (25% or less formed voids)**		
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} = **135** mm
Wall height;	h = **3000** mm;	Effective height of wall;	h_{ef} = **3000** mm

Bearing details

Beam spanning out of plane of wall

Width of bearing;	B = **102** mm;	Length of bearing;	l_b = **100** mm
Edge distance;	x_{edge} = **350** mm		

Loading details

Concentrated dead load;	G_k = **18** kN;	Concentrated imposed load;	Q_k = **9** kN
Design concentrated load;	F = **39.6** kN		

Masonry bearing type

Bearing type;	**Type 2** ;	Bearing safety factor;	γ_{bear} = **1.50**

Check design bearing without a spreader

Design bearing stress;	f_{ca} = **3.886** N/mm^2;	Allowable bearing stress;	f_{cp} = **1.500** N/mm^2

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

Spreader details

Length of spreader;	l_s = **300** mm;	Depth of spreader;	h_s = **150** mm
Edge distance;	s_{edge} = **251** mm		

Spreader bearing type

Bearing type;	**Type 2** ;	Bearing safety factor;	γ_{bear} = **1.50**

Check design bearing with a spreader

Loading acts at midpoint of spreader

Design bearing stress;	f_{ca} = **1.321** N/mm^2;	Allowable bearing stress;	f_{cp} = **1.500** 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} = **0.240** N/mm^2;	Allowable bearing stress;	f_{cp} = **0.680** N/mm^2

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

BEAM/LINTEL

Beam/lintel supports new roof construction, reaction from dormer trimmers and masonry over, no other loads considered; assume beam be unrestrained over its 3.95m span and limit deflection, under total dead & imposed, to 10mm (approx. span/360)

Loading:	roof (d)	=	1.25# x (6.50 / 4)	=	2.03
	roof (i)	=	0.75# x (6.50 / 4)	=	1.22
	brick (d)	=	2.18# x (0.45m)	=	0.98
	block (d)	=	1.59# x (0.45m)	=	0.72
	dormer (d)	=	1.00# x (2.35m)	=	2.35kN/m partial
	reaction (d)	=	3.66 kN	*applied at 2.45m from R_A*	
	reaction (i)	=	0.83 kN	*applied at 2.45m from R_A*	

Reactions	R_A	=	*20.30 kN ult.*	*(d = 11.4kN & i = 2.7kN)*
	R_B	=	*24.90 kN ult.*	*(d = 14.5kN & i = 2.9kN)*

→ **adopt 200 x 100 x 8.0mm thk RHS (S355) complete with 6mm thk ledger plate**

beam weight approx. 170kgs; contractor/builder to consider handling issues during installation; ensure adequate propping of gable wall until beam – and roof – can be constructed the execution of the works

Analysis for simple beam with torsion to BS 5950 & SCI-P-057

TEDDS calculation version 1.0.02

Span length & partial factors for loading

Span (mm)	Factors for moments & forces			Factors for deflection		
	γ_{fd}	γ_{fi}	γ_{fw}	γ_{dd}	γ_{di}	γ_{dw}
3950	**1.40**	**1.60**	**0.00**	**1.00**	**1.00**	**1.00**

Load descriptions

Loads are applied normal to the major principal axis (x-axis) of the member.

Ref.	Category	Description
1	**"Dead"**	**"self-wt"**
2	**"Dead"**	**"roof"**
3	**"Imposed"**	**"roof"**
4	**"Dead"**	**"blk"**
5	**"Dead"**	**"bwk"**
6	**"Dead"**	**"dormer walls"**
7	**"Imposed"**	**"dormer walls"**
8	**"Dead"**	**"dormer front"**

Loading data

Ref. #	Category	Type	Load kN/m	Position mm	Load kN/m	Position mm	Eccentricity mm
1	**"Dead"**	UDL	**1.0**	**0**	-	**3950**	**0**
2	**"Dead"**	UDL	**2.0**	**0**	-	**3950**	**0**
3	**"Imposed"**	UDL	**1.2**	**0**	-	**3950**	**0**
4	**"Dead"**	UDL	**1.0**	**0**	-	**3950**	**0**
5	**"Dead"**	UDL	**0.7**	**0**	-	**3950**	**200**
6	**"Dead"**	Point load	**3.7** kN	**2450**	-	-	**0**
7	**"Imposed"**	Point load	**0.8** kN	**2450**	-	-	**0**
8	**"Dead"**	UDL	**2.4**	**2450**	-	**3950**	**0**

Analysis results - entire span

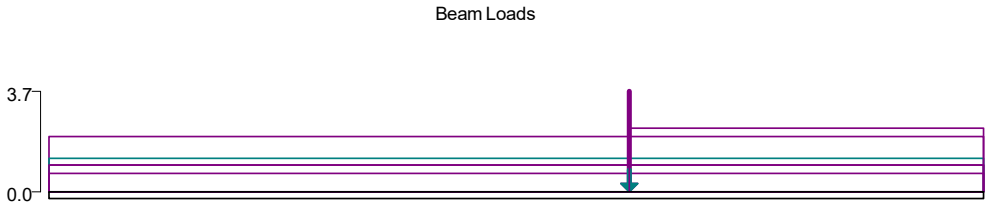
R_a	R_b	F_{vy}	M_x		T_q	Deflection: δEI_x	
kN (fac)	kN (fac)	kN (fac)	kNm (fac)	Sense	kNm (fac)	kNm^3	Direction
20.3	**24.9**	**24.9**	**24.1**	**"Sagging"**	**0.80**	**26.51**	**"Down"**

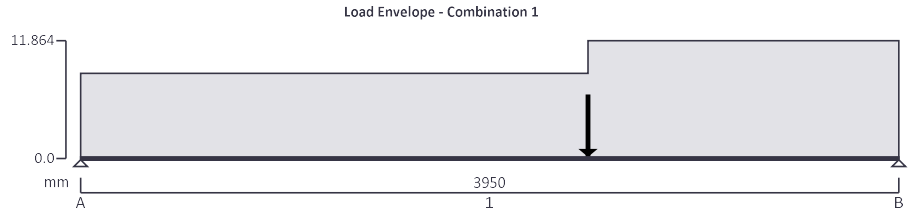
Unfactored support reactions

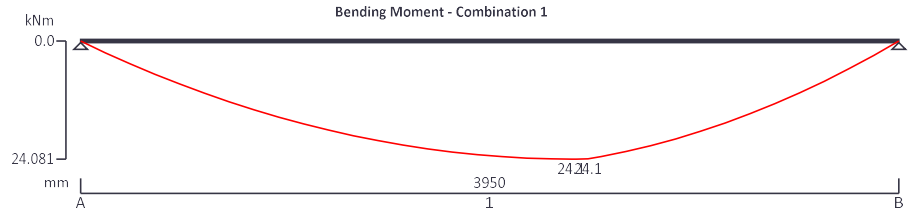
Support A;	Dead load; **-11.4** kN;	Live load; **-2.7** kN;	Wind load; **0.0** kN;
Support B;	Dead load; **-14.5** kN;	Live load; **-2.9** kN;	Wind load; **0.0** kN;

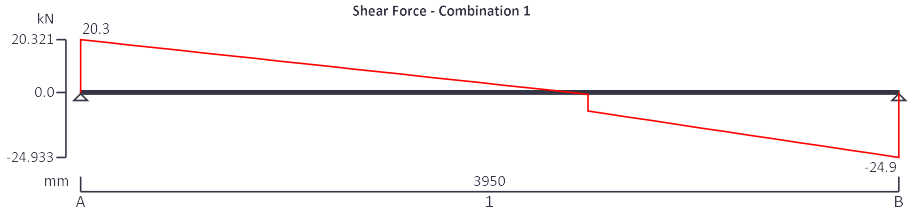
LTB segment results

Seg.	x_s mm	x_e mm	L_{LT} mm	M_{LT} kNm (fac)	M_{mLT2} kNm (fac)	M_{mLT3} kNm (fac)	M_{mLT4} kNm (fac)
1	**0**	**3950**	**3950**	**24.1**	**15.9**	**23.4**	**18.8**









Member design checks for simple beam with torsion to BS 5950 & SCI-P-057

Tedds calculation version 1.0.05

Summary

Span & restraint	L = **3950** mm	Torsion fixed & warping free each end.
Design load effects		F_{vy} = **24.9** kN; M_x = **24.1** kNm T_q = **0.80** kNm; torsion from uniformly distributed loads.
Material	Grade = **"S355"**	p_y = **355** N/mm^2
Section	**"RHS 200x100x8.0"**	**"Plastic"**

Check;	*Load*;	*Capacity*;	*Notes*;	*Result*;
Deflection;	δ_{y_max} = **5.8** mm;	δ_{lim} = **10.0** mm;	**Span / 360 or 10.0 mm**;	**Pass**
Twist angle	ϕ_{sls} = **0.01** deg	ϕ_{lim} = **2.00** deg	T_{qu} = **0.57** kNm	**Pass**
Shear;	F_{vy} = **24.9** kN;	P_{vy} = **635.5** kN;	**Low shear**;	**Pass**;
Moment;	M_x = **24.1** kNm;	M_{cx} = **95.2** kNm;	**Serviceability governs**;	**Pass**
LTB;	λ = **126**;	λ_{lim} = **263**;	**LTB check not req'd**; L_{E_LT} = **5140** mm;	**Pass**;
Overall buckling	Index; i_b = **0.229**	Limit = 1.0	σ_{byt} = **0** N/mm^2	**Pass**
Local capacity	σ_{bx} + σ_{byt} = **108** N/mm^2	p_y = **355** N/mm^2	σ_{bx} = **108** N/mm^2 σ_{byt} = **0** N/mm^2	**Pass**
Combined shear stresses	τ = **12** N/mm^2	p_v = **213** N/mm^2	τ_{bw} = **10** N/mm^2 τ_{vt} = **2** N/mm^2	**Pass**

;

check flange plate & welds:

Moment applied to plate M = 1.40 [(0.98 x 0.225) brickwork only
= 1.40 [0.22]
= **0.31 kNm/m**

Plate thickness required t_p = $(6M / bp_y)^{½}$ *where b = 1000mm & p_y = 275N/mm^2*

= $[(6 \times 0.31 \times 10^6) / (1000 \times 275)]^{½}$
= 2.60mm minimum

→ **provide 6mm 'flange' plate for detail**

Assume (conservatively) 70mm minimum lever-arm between welds, thus

Force in welds = (0.31×10^3) / 70mm
= 4.43 kN/m

Adopting 4mm fillet welds with a capacity of 0.62kN/mm, thus

Weld length required = 4.43 / 0.62
= 7.14mm/m *nominal*

→ **adopt 4mm FW's at 50mm hit/300mm miss along plate length**

check beam bearings:

Reactions	R_A	=	**20.30 kN ult**	d = 11.4	i = 2.7
	R_B	=	**24.90 kN ult**	d = 14.5	i = 2.9

Worse case is R_B onto block wall/rh-front; adopt 100mm thick, 3.6N/mm^2, blockwork laid in M4 mortar throughout with normal manufacture and construction

→ **provide 300mm long x 100mm wide (C8/10) concrete padstone, 150mm deep, at bearings; beam/lintel to have 225mm 'seating' onto padstone/wall**

MASONRY BEARING DESIGN TO BS5628-1:2005

TEDDS calculation version 1.0.07

Masonry details

Masonry type;	**Aggregate concrete blocks (25% or less formed voids)**		
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} = **135** mm
Wall height;	h = **3000** mm;	Effective height of wall;	h_{ef} = **3000** mm

Bearing details

Beam spanning in plane of wall

Width of bearing;	B = **100** mm;	Length of bearing;	l_b = **225** mm

Loading details

Concentrated dead load;	G_k = **15** kN;	Concentrated imposed load;	Q_k = **3** kN
Design concentrated load;	F = **24.9** kN		

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} = **1.108** N/mm^2; Allowable bearing stress; f_{cp} = **1.250** 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} = **0.175** N/mm^2; Allowable bearing stress; f_{cp} = **0.680** N/mm^2

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