Robert J. Pragnell
Chartered Structural and Civil Engineer
Chartered Building Surveyor

Structural Design Calculations

9 Sandy Brow, Widley

Loft conversion feasibility

Project No.: 632

Prepared by: RJP

Date: March 2026

Gyoury Self
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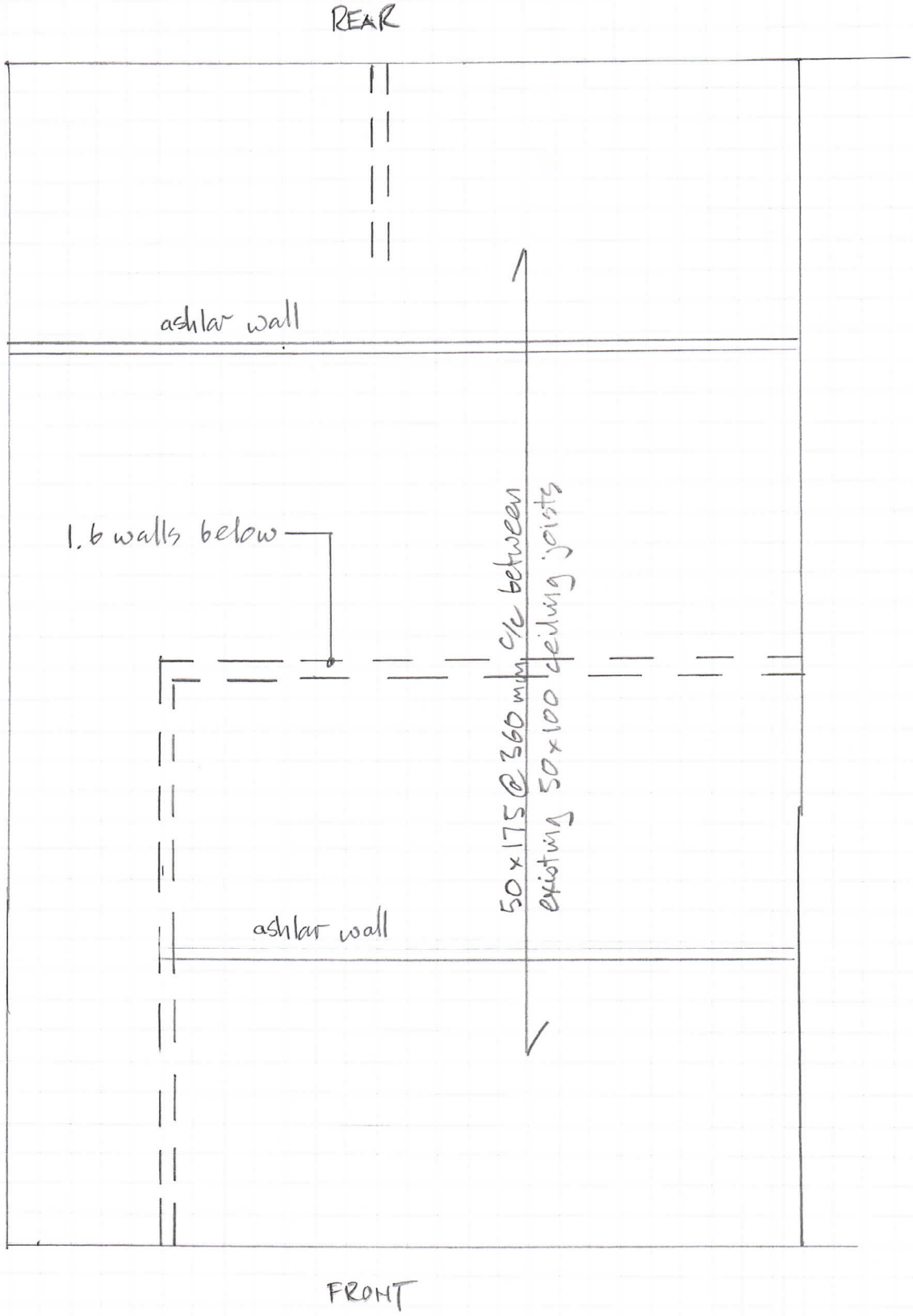
JOB TITLE		DATE
ITEM Design and Construction Notes	JOB NO.	SHEET NO. 01
PREPARED BY	CHECKED BY	

STANDARD LOADING (kN/m²)			OUTPUT (kN/m²)		
			Permanent	Variable	TOTAL
PITCHED ROOFS	TILES	0.65			
	BATTENS	0.10			
	RAFTERS	0.15			
		0.90 ON PLAN	**0.90**	**0.60**	**1.50**
ROOF SPACE	JOISTS +INSULATION	0.15			
	SOFFIT	0.15			
		0.30	0.30	0.25	0.55
ROOF + SPACE			**1.20**	**0.85**	**2.05**
FLAT ROOFS	CHIPPING + FELT	0.35			
	BOARD + JOISTS + FIRRING	0.30			
	SOFFIT + INSULATION	0.15			
		0.80	**0.80**	**0.75**	**1.55**
TIMBER FLOORS	BOARD + JOISTS	0.35			
	SOFFIT	0.15			
		0.50	**0.50**	**1.50**	**2.00**
	PARTITIONS	0.50	**0.50**		**0.50**
WALLS	**TIMBER STUD WALL - GENERAL**				
	PLASTERBOARD	0.15			
	STUDS	0.10			
	PLASTERBOARD	0.15			
		0.40	**0.40**		**0.40**
	TIMBER STUD WALL - HISTORIC				
	LATH + PLASTER	0.25			
	STUDS	0.10			
	LATH + PLASTER	0.25			
		0.60	**0.60**		**0.60**
	TIMBER STUD WALL- EXTERNAL				
	TILE	0.60			
	BATTEN + FELT + INSULATION	0.05			
	STUDS + BOARDING	0.20			
	PLASTERBOARD + SKIM	0.15			
		1.00	**1.00**		**1.00**
	CAVITY BLOCK-BLOCK WALLING				
	BLOCK 100mm	1.50			
	BLOCK 100mm	1.50			
	RENDER	0.50			
	PLASTER (ONE FACE)	0.30			
		3.80	**3.80**		**3.80**
	CAVITY BRICK-BLOCK WALLING				
	BRICK 103mm	2.00			
	BLOCK 100mm	1.50			
	PLASTER (ONE FACE)	0.30			
		3.80	**3.80**		**3.80**
	SOLID BRICK CONSTRUCTION				
	BRICK 102mm	2.00			
	PLASTER (TWO FACES)	0.50			
		2.50	**2.50**		**2.50**
	BRICK 215mm	4.20			
	PLASTER (TWO FACES)	0.50			
		4.70	**4.70**		**4.70**
	BRICK 330mm	6.50			
	PLASTER (TWO FACES)	0.50			
		7.00	**7.00**		**7.00**

Robert J. Pragnell Chartered Structural and Civil Engineer Chartered Building Surveyor	Job Title: 9 SANDY BROW		Date: MARCH 2026
	Item: PLAN OF ROOF SPACE	Job No: 632	Sheet No: 02
	Prepared by: RSP	Checked by:	



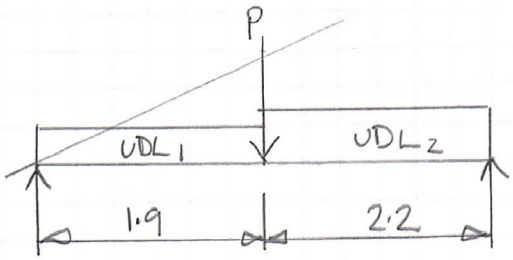
Sketch Sheet

Robert J. Pragnell Chartered Structural and Civil Engineer Chartered Building Surveyor	Job Title: 9 SANDY BROW		Date: MARCH 2026
	Item: OPTION ①	Job No: 632	Sheet No: 03
	Prepared by: RP	Checked by:	

Ref:	Calculations:	Output:

OPTION ①

Consider 50x175 joists supporting ashlar wall, which in turn supports dormer roof.



Joist spacing 360mm (16")

UDL1 - ceiling DL $0.15\ KN/m^2 \times 0.36 = 0.05\ KN/m$

IL $0.25\ KN/m^2 \times 0.36 = 0.1\ KN/m$

UDL2 - Floor DL $0.35\ KN/m^2 \times 0.36 = 0.13\ KN/m$

IL $1.5\ KN/m^2 \times 0.36 = 0.5\ KN/m$

P - dormer roof DL $0.80\ KN/m^2 \times \frac{2.0}{2} \times 0.36 = 0.3$

IL $0.75\ KN/m^2 \times \frac{2.0}{2} \times 0.36 = 0.3$

roof DL $0.90\ KN/m^2 \times \frac{1.9}{2} \times 0.36 = 0.3$

IL $0.75\ KN/m^2 \times \frac{1.9}{2} \times 0.36 = 0.3$

wall $0.90\ KN/m^2 \times 2.4 \times 0.36 = 0.8$

Σ DL 1.4 KN

IL 0.6 KN

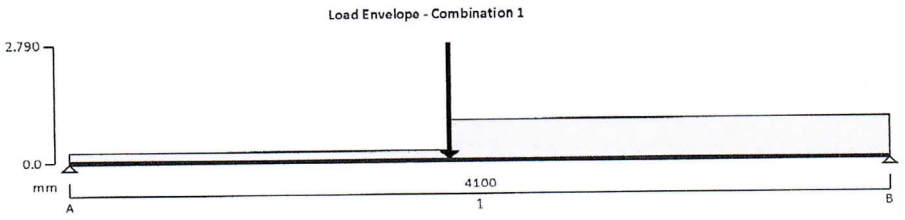
Robert J. Pragnell Chartered Structural and Civil Engineer Chartered Building Surveyor	Job Title: 9 SANDY BROW		Date: MARCH 2026
	Item: OPTION (1)	Job No: 632	Sheet No: 04
	Prepared by: RJP	Checked by:	

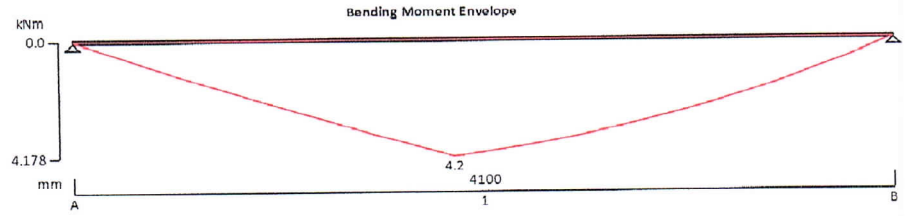
Ref:	Calculations:	Output:
	See computer print-out for analysis and design Joists Fail	

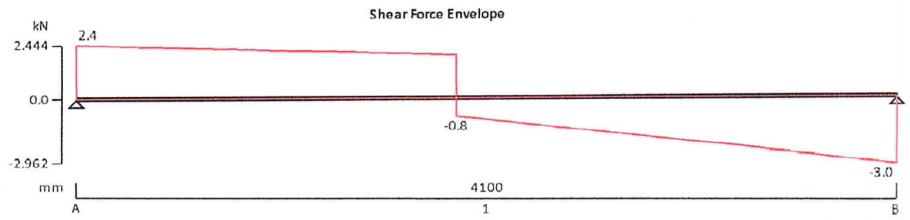
TIMBER BEAM ANALYSIS & DESIGN TO EN1995-1-1:2004

In accordance with EN1995-1-1:2004 + A2:2014 and Corrigendum No.1 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 1.7.05







Applied loading

Beam loads

Permanent partial UDL 0.050 kN/m from 0 mm to 1900 mm
Variable partial UDL 0.100 kN/m from 0 mm to 1900 mm
Permanent partial UDL 0.130 kN/m from 1900 mm to 4100 mm
Variable partial UDL 0.500 kN/m from 1900 mm to 4100 mm
Permanent point load 1.400 kN at 1900 mm
Variable point load 0.600 kN at 1900 mm
Permanent self weight of beam × 1

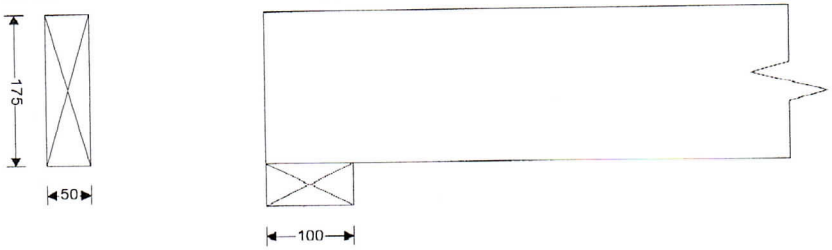
Load combinations

Load combination 1

Support A	Permanent × 1.35
	Variable × 1.50
Span 1	Permanent × 1.35
	Variable × 1.50
Support B	Permanent × 1.35
	Variable × 1.50

Analysis results

Maximum moment	M_{max} = **4.178** kNm	M_{min} = **0.000** kNm
Design moment	M = max(abs(M_{max}),abs(M_{min})) = **4.178** kNm	
Maximum shear	F_{max} = **2.444** kN	F_{min} = **-2.962** kN
Design shear	F = max(abs(F_{max}),abs(F_{min})) = **2.962** kN	
Total load on beam	W_{tot} = **5.406** kN	
Reactions at support A	R_{A_max} = **2.444** kN	R_{A_min} = **2.444** kN
Unfactored permanent load reaction at support A	$R_{A_Permanent}$ = **0.963** kN	
Unfactored variable load reaction at support A	$R_{A_Variable}$ = **0.763** kN	
Reactions at support B	R_{B_max} = **2.962** kN	R_{B_min} = **2.962** kN
Unfactored permanent load reaction at support B	$R_{B_Permanent}$ = **0.942** kN	
Unfactored variable load reaction at support B	$R_{B_Variable}$ = **1.127** kN	



Timber section details

Breadth of timber sections	b = **50** mm
Depth of timber sections	h = **175** mm
Number of timber sections in member	N = **1**
Overall breadth of timber member	b_b = N × b = **50** mm
Timber strength class - EN 338:2016 Table 1	**C24**

Member details

Load duration - cl.2.3.1.2	**Long-term**
Service class of timber - cl.2.3.1.3	**1**
Length of span	L_{s1} = **4100** mm
Length of bearing	L_b = **100** mm

Section properties

Cross sectional area of member	A = N × b × h = **8750** mm^2
Section modulus	W_y = N × b × h^2 / 6 = **255208** mm^3
	W_z = h × (N × b)^2 / 6 = **72917** mm^3
Second moment of area	I_y = N × b × h^3 / 12 = **22330729** mm^4
	I_z = h × (N × b)^3 / 12 = **1822917** mm^4
Radius of gyration	r_y = √(I_y / A) = **50.5** mm
	r_z = √(I_z / A) = **14.4** mm

Partial factor for material properties and resistances

Partial factor for material properties - Table 2.3	γ_M = **1.300**

Modification factors

Modification factor for load duration and moisture content - Table 3.1

k_{mod} = **0.700**

Deformation factor for service classes - Table 3.2 k_{def} = **0.600**

Depth factor for bending - exp.3.1	$k_{h.m}$ = **1.000**
Depth factor for tension - exp.3.1	$k_{h.t}$ = **1.000**
Bending stress re-distribution factor - cl.6.1.6(2)	k_m = **0.700**
Crack factor for shear resistance - cl.6.1.7(2)	k_{cr} = **0.670**
Load configuration factor - exp.6.4	$k_{c.90}$ = **1.000**
System strength factor - cl.6.6	k_{sys} = **1.000**
Lateral buckling factor - cl.6.3.3(5)	k_{crit} = **1.000**

Compression perpendicular to the grain - cl.6.1.5

Design compressive stress	$\sigma_{c.90.d} = R_{B_max} / (N \times b \times L_b)$ = **0.592** N/mm²
Design compressive strength	$f_{c.90.d} = k_{mod} \times k_{sys} \times k_{c.90} \times f_{c.90.k} / \gamma_M$ = **1.346** N/mm²
	$\sigma_{c.90.d} / f_{c.90.d}$ = **0.440**

PASS - Design compressive strength exceeds design compressive stress at bearing

Bending - cl 6.1.6

Design bending stress	$\sigma_{m.d} = M / W_y$ = **16.370** N/mm²
Design bending strength	$f_{m.d} = k_{h.m} \times k_{mod} \times k_{sys} \times k_{crit} \times f_{m.k} / \gamma_M$ = **12.923** N/mm²
	$\sigma_{m.d} / f_{m.d}$ = **1.267**

FAIL - Design bending stress exceeds design bending strength

Shear - cl.6.1.7

Applied shear stress	$\tau_d = 3 \times F / (2 \times k_{cr} \times A)$ = **0.758** N/mm²
Permissible shear stress	$f_{v.d} = k_{mod} \times k_{sys} \times f_{v.k} / \gamma_M$ = **2.154** N/mm²
	$\tau_d / f_{v.d}$ = **0.352**

PASS - Design shear strength exceeds design shear stress

Deflection - cl.7.2

Deflection limit	$\delta_{lim} = \min(14\text{ mm}, 0.004 \times L_{s1})$ = **14.000** mm
Instantaneous deflection due to permanent load	δ_{instG} = **10.325** mm
Final deflection due to permanent load	$\delta_{finG} = \delta_{instG} \times (1 + k_{def})$ = **16.521** mm
Instantaneous deflection due to variable load	δ_{instQ} = **8.578** mm
Factor for quasi-permanent variable action	ψ_2 = **0.3**
Final deflection due to variable load	$\delta_{finQ} = \delta_{instQ} \times (1 + \psi_2 \times k_{def})$ = **10.123** mm
Total final deflection	$\delta_{fin} = \delta_{finG} + \delta_{finQ}$ = **26.643** mm
	$\delta_{fin} / \delta_{lim}$ = **1.903**

FAIL - Total final deflection exceeds the deflection limit

Robert J. Pragnell
Chartered Structural and Civil Engineer
Chartered Building Surveyor

Job Title: 9 SANDY BROW		Date: MARCH 2026
Item: OPTION ②	Job No: 632	Sheet No: 08
Prepared by: RJP	Checked by:	

Ref:	Calculations:	Output:

OPTION ②

Consider 50 x 175 joists supporting ashlar wall, which in turn supports pitched roof with Velux windows, No dormer.

UDL, as option ① DL 0.05 KN/m

IL 0.1 KN/m

UDL2 as option ① DL 0.13 KN/m

IL 0.5 KN/m

P- pitched roof DL $1.05\ KN/m^2 \times \frac{5.9}{2} \times 0.36 = 1.1$

IL $0.60\ KN/m^2 \times \frac{5.9}{2} \times 0.36 = 0.6$

wall $= 0.8$

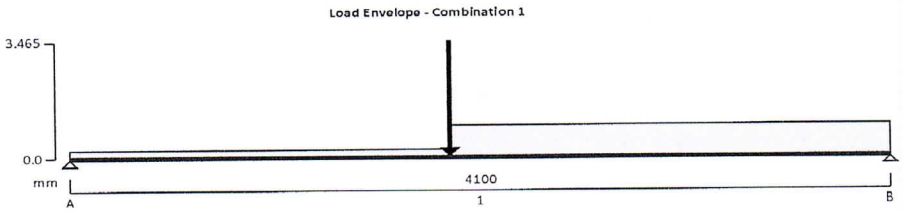
Σ DL 1.9 KN

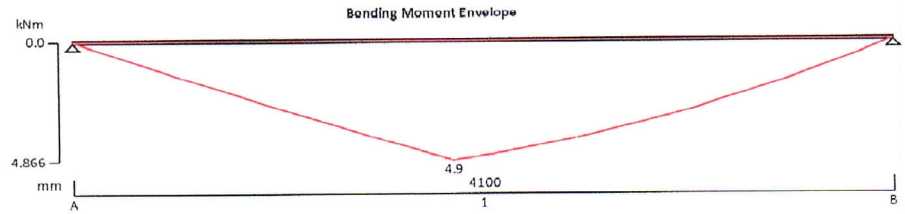
IL 0.6 KN

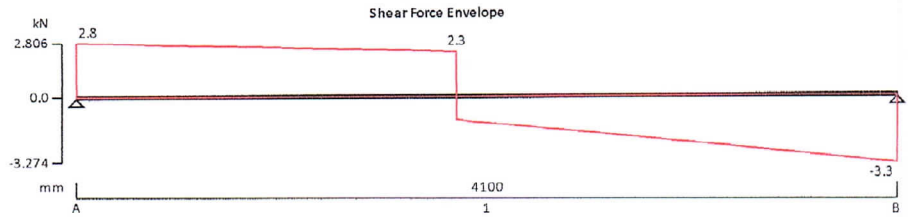
TIMBER BEAM ANALYSIS & DESIGN TO EN1995-1-1:2004

In accordance with EN1995-1-1:2004 + A2:2014 and Corrigendum No.1 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 1.7.05







Applied loading

Beam loads

Permanent partial UDL 0.050 kN/m from 0 mm to 1900 mm
Variable partial UDL 0.100 kN/m from 0 mm to 1900 mm
Permanent partial UDL 0.130 kN/m from 1900 mm to 4100 mm
Variable partial UDL 0.500 kN/m from 1900 mm to 4100 mm
Permanent point load 1.900 kN at 1900 mm
Variable point load 0.600 kN at 1900 mm
Permanent self weight of beam × 1

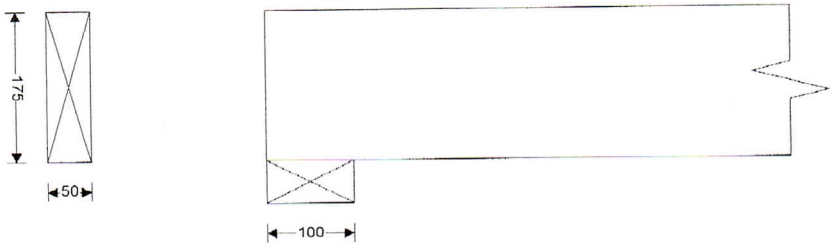
Load combinations

Load combination 1

Support A	Permanent × 1.35
	Variable × 1.50
Span 1	Permanent × 1.35
	Variable × 1.50
Support B	Permanent × 1.35
	Variable × 1.50

Analysis results

Maximum moment	M_{max} = **4.866** kNm	M_{min} = **0.000** kNm
Design moment	M = max(abs(M_{max}),abs(M_{min})) = **4.866** kNm	
Maximum shear	F_{max} = **2.806** kN	F_{min} = **-3.274** kN
Design shear	F = max(abs(F_{max}),abs(F_{min})) = **3.274** kN	
Total load on beam	W_{tot} = **6.081** kN	
Reactions at support A	R_{A_max} = **2.806** kN	R_{A_min} = **2.806** kN
Unfactored permanent load reaction at support A	$R_{A_Permanent}$ = **1.231** kN	
Unfactored variable load reaction at support A	$R_{A_Variable}$ = **0.763** kN	
Reactions at support B	R_{B_max} = **3.274** kN	R_{B_min} = **3.274** kN
Unfactored permanent load reaction at support B	$R_{B_Permanent}$ = **1.173** kN	
Unfactored variable load reaction at support B	$R_{B_Variable}$ = **1.127** kN	



Timber section details

Breadth of timber sections	b = **50** mm
Depth of timber sections	h = **175** mm
Number of timber sections in member	N = **1**
Overall breadth of timber member	b_b = N × b = **50** mm
Timber strength class - EN 338:2016 Table 1	**C24**

Member details

Load duration - cl.2.3.1.2	**Long-term**
Service class of timber - cl.2.3.1.3	**1**
Length of span	L_{s1} = **4100** mm
Length of bearing	L_b = **100** mm

Section properties

Cross sectional area of member	A = N × b × h = **8750** mm^2
Section modulus	W_y = N × b × h^2 / 6 = **255208** mm^3
	W_z = h × (N × b)^2 / 6 = **72917** mm^3
Second moment of area	I_y = N × b × h^3 / 12 = **22330729** mm^4
	I_z = h × (N × b)^3 / 12 = **1822917** mm^4
Radius of gyration	r_y = √(I_y / A) = **50.5** mm
	r_z = √(I_z / A) = **14.4** mm

Partial factor for material properties and resistances

Partial factor for material properties - Table 2.3	γ_M = **1.300**

Modification factors

Modification factor for load duration and moisture content - Table 3.1

k_{mod} = **0.700**

Deformation factor for service classes - Table 3.2 k_{def} = **0.600**

Depth factor for bending - exp.3.1	$k_{h.m}$ = **1.000**
Depth factor for tension - exp.3.1	$k_{h.t}$ = **1.000**
Bending stress re-distribution factor - cl.6.1.6(2)	k_m = **0.700**
Crack factor for shear resistance - cl.6.1.7(2)	k_{cr} = **0.670**
Load configuration factor - exp.6.4	$k_{c.90}$ = **1.000**
System strength factor - cl.6.6	k_{sys} = **1.000**
Lateral buckling factor - cl.6.3.3(5)	k_{crit} = **1.000**

Compression perpendicular to the grain - cl.6.1.5

Design compressive stress	$\sigma_{c.90.d} = R_{B_max} / (N \times b \times L_b)$ = **0.655** N/mm²
Design compressive strength	$f_{c.90.d} = k_{mod} \times k_{sys} \times k_{c.90} \times f_{c.90.k} / \gamma_M$ = **1.346** N/mm²
	$\sigma_{c.90.d} / f_{c.90.d}$ = **0.486**

PASS - Design compressive strength exceeds design compressive stress at bearing

Bending - cl 6.1.6

Design bending stress	$\sigma_{m.d} = M / W_y$ = **19.066** N/mm²
Design bending strength	$f_{m.d} = k_{h.m} \times k_{mod} \times k_{sys} \times k_{crit} \times f_{m.k} / \gamma_M$ = **12.923** N/mm²
	$\sigma_{m.d} / f_{m.d}$ = **1.475**

FAIL - Design bending stress exceeds design bending strength

Shear - cl.6.1.7

Applied shear stress	$\tau_d = 3 \times F / (2 \times k_{cr} \times A)$ = **0.838** N/mm²
Permissible shear stress	$f_{v.d} = k_{mod} \times k_{sys} \times f_{v.k} / \gamma_M$ = **2.154** N/mm²
	$\tau_d / f_{v.d}$ = **0.389**

PASS - Design shear strength exceeds design shear stress

Deflection - cl.7.2

Deflection limit	$\delta_{lim} = \min(14\text{ mm}, 0.004 \times L_{s1})$ = **14.000** mm
Instantaneous deflection due to permanent load	δ_{instG} = **13.328** mm
Final deflection due to permanent load	$\delta_{finG} = \delta_{instG} \times (1 + k_{def})$ = **21.326** mm
Instantaneous deflection due to variable load	δ_{instQ} = **8.578** mm
Factor for quasi-permanent variable action	ψ_2 = **0.3**
Final deflection due to variable load	$\delta_{finQ} = \delta_{instQ} \times (1 + \psi_2 \times k_{def})$ = **10.123** mm
Total final deflection	$\delta_{fin} = \delta_{finG} + \delta_{finQ}$ = **31.448** mm
	$\delta_{fin} / \delta_{lim}$ = **2.246**

FAIL - Total final deflection exceeds the deflection limit

Robert J. Pragnell Chartered Structural and Civil Engineer Chartered Building Surveyor	Job Title: 9 SANDY BROW		Date: MARCH 2026
	Item: OPTION (3)	Job No: 632	Sheet No: 12
	Prepared by: RJP	Checked by:	

Ref:	Calculations:	Output:

OPTION (3)

Consider 50x175 joists supporting Floor only

UDL as option (1) DL 0.05 KN/m

IL 0.1 KN/m

UDL_2 as option (1) DL 0.13 KN/m

IL 0.5 KN/m

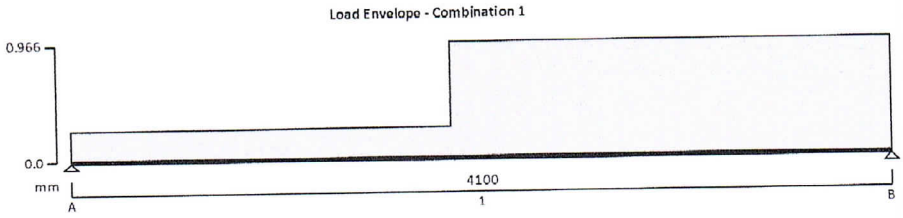
See computer print-out for analysis and design

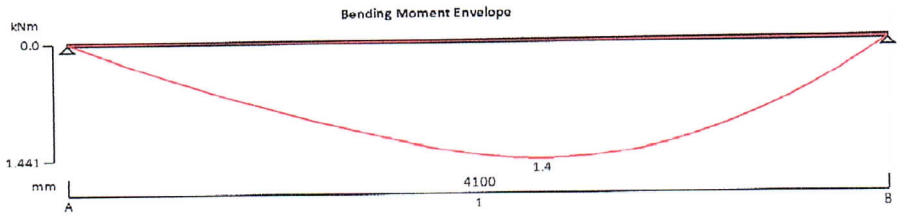
Joist works satisfactorily supporting Floor loading only.

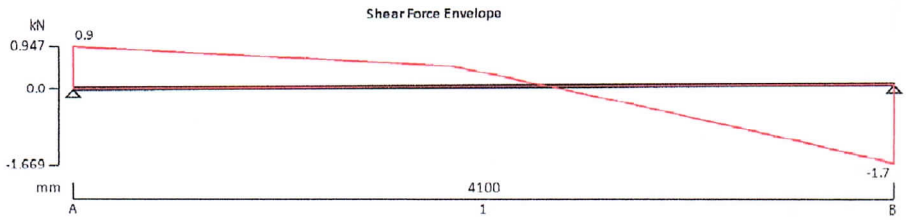
TIMBER BEAM ANALYSIS & DESIGN TO EN1995-1-1:2004

In accordance with EN1995-1-1:2004 + A2:2014 and Corrigendum No.1 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 1.7.05







Applied loading

Beam loads

Permanent partial UDL 0.050 kN/m from 0 mm to 1900 mm
Variable partial UDL 0.100 kN/m from 0 mm to 1900 mm
Permanent partial UDL 0.130 kN/m from 1900 mm to 4100 mm
Variable partial UDL 0.500 kN/m from 1900 mm to 4100 mm
Permanent self weight of beam × 1

Load combinations

Load combination 1

Support A	Permanent × 1.35
	Variable × 1.50
Span 1	Permanent × 1.35
	Variable × 1.50
Support B	Permanent × 1.35
	Variable × 1.50