STRUCTURAL CALCULATIONS

FOR

476 Garstang Road
Broughton PR3 5JB

PROPOSED ALTERATIONS
AND EXTENSION

STRUCTURAL ENGINEERS

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PROJECT NO: 191929

Revision 0 – January 2020

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

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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	0.10		
		0.70		
	0.70 / cos 35° =	0.85		
	insulation	0.05		
	ceiling	0.15		
		1.05	**kN/m²**	**DEAD**
	roof/snow	0.75		
	ceiling	0.25		
		1.00	**kN/m²**	**IMPOSED**
1st FLOOR	boards	0.20		
	joists	0.15		
	ceiling	0.15		
	partitions	0.25		
		0.75	**kN/m²**	**DEAD**
	communal	**2.00**	**kN/m²**	**IMPOSED**
EXT. WALL	render	0.50		
	215 brick	4.36		
	1-plaster	0.25		
		5.11	**kN/m²**	**DEAD**

REFA Robert E Fry Associates Ltd 45 Bridgeman Terrace Wigan, WN1 1TT Tel: 01942-826020	Project **476 Garstang road, Broughton**				Job Ref. **19192**	
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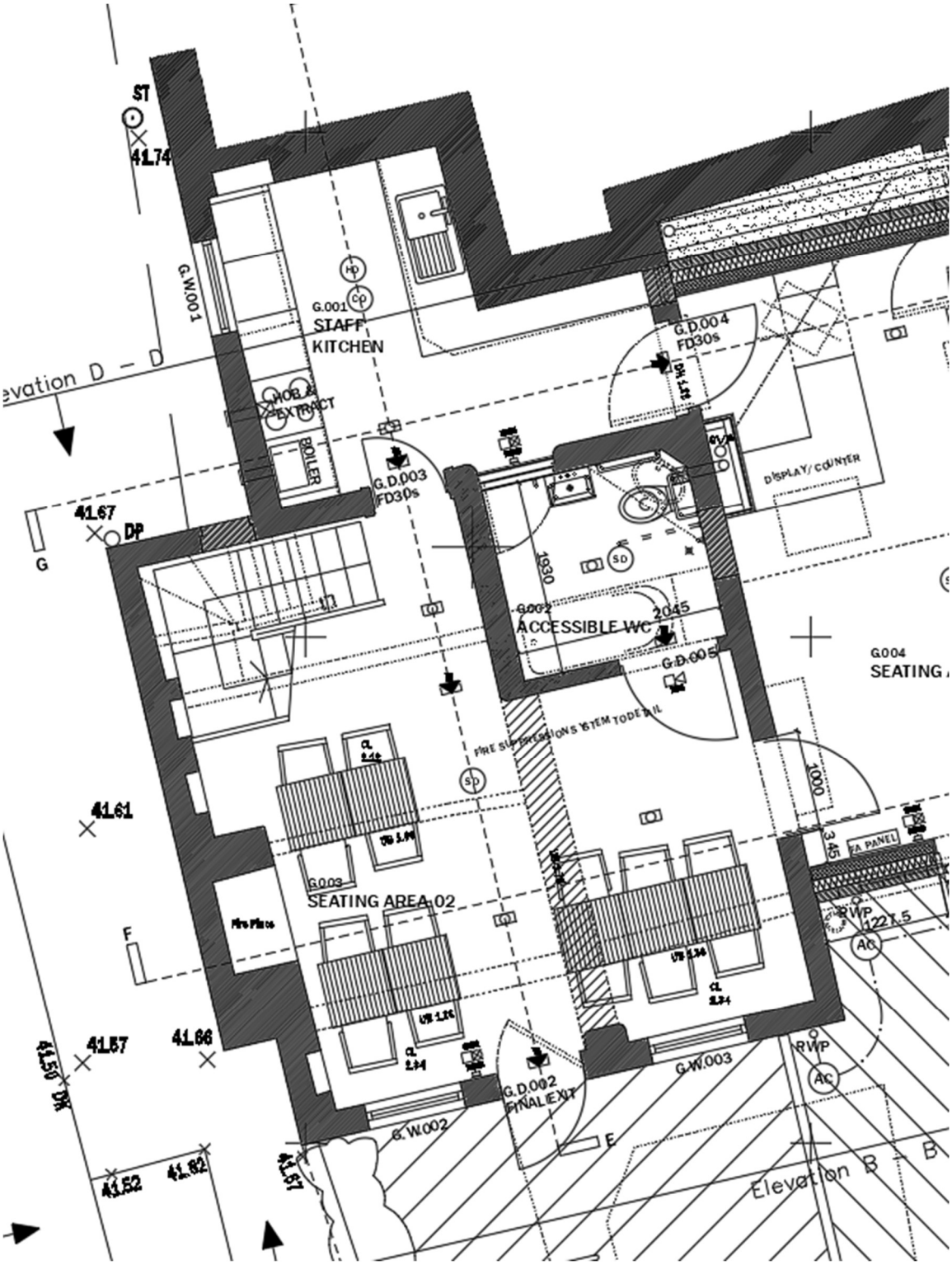
LAYOUT



EXISTING TIMBER BEAMS

Assess loading – and reactions – to existing timber beams to the front of the property; beams support main roof (no ceiling) and nominal loading from low level lean-to roof over plus self-weight of brick wall, new timber 1st floor will span parallel with the beams and will not be considered.

Beams span 2.85m (left) and 2.15m (right) over the proposed seating area.

Loading:	roofs (d)	=	1.05# x [(1.30+1.10) / 2]	=	1.26
	roofs (i)	=	0.75# x [(1.30+1.10) / 2]	=	0.90
	wall (d)	=	5.11# x 1.55m	=	7.92
	self-wt (d)	=	say,	=	0.50
Applied loading,	dead	=	(1.26+7.92+0.50)	=	9.68 kN/m
	imposed	=	(0.90)	=	0.90 kN/m
Beam reactions:	left-side(d)	=	9.68 x (2.85 / 2)	=	13.79 kN
	left-side (i)	=	0.90 x (2.85 / 2)	=	1.28 kN
	right-side(d)	=	9.68 x (2.15 / 2)	=	10.41 kN
	right-side (i)	=	0.90 x (2.15 / 2)	=	0.97 kN
Total reaction (to new beam)		=	13.79+10.41	=	24.50 kN (d)
		=	1.28+ 0.97	=	2.25 kN (i)

NEW FLOOR BEAM

Beam supports new 1st floor construction plus reactions from existing timber beams only.

Assume beam to be unrestrained over its span and limit deflection, under total dead & imposed, 10mm; max. span = 3.60m

Loading:	floor (d)	=	0.75# x [(2.85+2.15) / 2]	= 1.88
	floor (i)	=	2.00# x [(2.85+2.15) / 2]	= 5.00
	reaction (d)	=	24.50 kN	*applied at 1.00m from R_A*
	reaction (i)	=	2.25 kN	*applied at 1.00m from R_A*

Reactions R_A = *47.60 kN ult.* *(d = 21.9kN & i = 10.6kN)*

R_B = *30.80 kN ult.* *(d = 11.0kN & i = 9.6kN)*

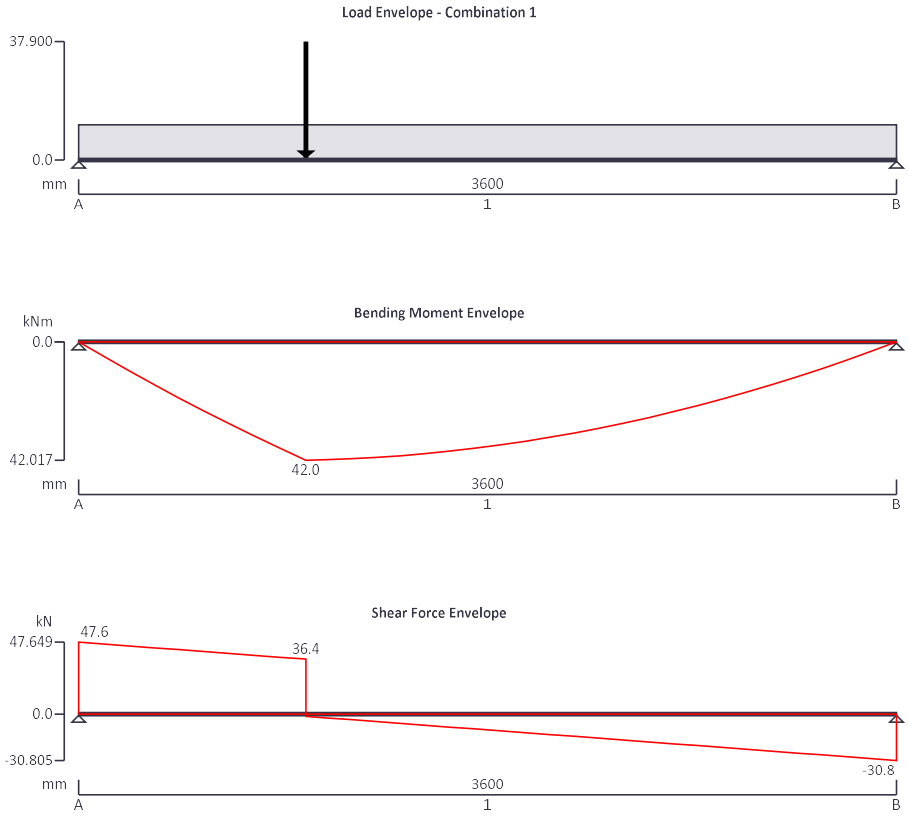
→ **for detail, adopt 203 x 203 x 46 UC (S275)**

beam weight approx. 180kgs; contractor/builder to consider handling issues during installation; ensure adequate propping of walls, floors, etc. during 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



Support conditions

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

Applied loading

Beam loads	Dead self weight of beam ´ 1
	floor - Dead full UDL 1.88 kN/m
	floor - Imposed full UDL 5 kN/m
	ex. beams - Dead point load 24.5 kN at 1000 mm
	ex. beams - Imposed point load 2.25 kN at 1000 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} = **42** kNm;	M_{min} = **0** kNm
Maximum shear;	V_{max} = **47.6** kN;	V_{min} = **-30.8** kN
Deflection;	δ_{max} = **3.8** mm;	δ_{min} = **0** mm
Maximum reaction at support A;	R_{A_max} = **47.6** kN;	R_{A_min} = **47.6** kN
Unfactored dead load reaction at support A;	R_{A_Dead} = **21.9** kN	
Unfactored imposed load reaction at support A;	$R_{A\_Imposed}$ = **10.6** kN	
Maximum reaction at support B;	R_{B_max} = **30.8** kN;	R_{B_min} = **30.8** kN
Unfactored dead load reaction at support B;	R_{B_Dead} = **11** kN	
Unfactored imposed load reaction at support B;	$R_{B\_Imposed}$ = **9.6** kN	

Section details

Section type; **UC 203x203x46 (BS4-1)**; Steel grade; **S275**

Classification of cross sections - Section 3.5

Tensile strain coefficient; ε = **1.00**; Section classification; **Compact**

S

hear capacity - Section 4.2.3

Design shear force; F_v = **47.6** kN; Design shear resistance; P_v = **241.4** kN

PASS - Design shear resistance exceeds design shear force

Moment capacity - Section 4.2.5

Design bending moment; M = **42** kNm; Moment capacity low shear; M_c = **136.8** kNm

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment; M_b = **102.4** kNm; M_b / m_{LT} = **118.8** 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} = **10** mm; Maximum deflection; δ = **3.81** mm

PASS - Maximum deflection does not exceed deflection limit

check beam bearings:

Reactions	R_A	=	**47.60 kN ult**	d = 21.9	i = 10.6
	R_B	=	**30.80 kN ult**	d = 11.0	i = 9.6

Assume 103mm thick, 20.0N/mm^2, clay brickwork laid in M4 mortar throughout with normal manufacture and construction

Consider bearing onto front pier:

→ **provide 440mm long x 100mm wide (C8/10) concrete padstone, 215mm deep, at bearing**

MASONRY BEARING DESIGN TO BS5628-1:2005

TEDDS calculation version 1.0.07

Masonry details

Masonry type;	**Clay or calcium silicate bricks**		
Compressive strength;	p_{unit} = **20.0** N/mm^2;	Mortar designation;	**iii**
Masonry units;	**Category II**;	Construction control;	**Normal**
Partial safety factor;	γ_m = **3.5**;	Characteristic strength;	f_k = **5.0** N/mm^2
Leaf thickness;	t = **440** mm;	Effective wall thickness;	t_{ef} = **440** 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 = **203** mm; Length of bearing; l_b = **100** mm

Loading details

Concentrated dead load; G_k = **22** kN; Concentrated imposed load; Q_k = **11** kN

Design concentrated load; F = **47.6** kN

Masonry bearing type

Bearing type; **Not applicable** ; Bearing safety factor; γ_{bear} = **1.00**

Check design bearing without a spreader

Design bearing stress; f_{ca} = **2.346** N/mm^2; Allowable bearing stress; f_{cp} = **1.429** 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 outside middle third – triangular stress distribution

Design bearing stress; f_{ca} = **1.443** N/mm^2; Allowable bearing stress; f_{cp} = **2.857** 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} = **0.102** N/mm^2; Allowable bearing stress; f_{cp} = **1.414** N/mm^2

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

Consider bearing onto internal wall pier:

→ **no padstone required but provide 440mm long x 100mm wide (C8/10) concrete padstone, 215mm deep, at bearing**

MASONRY BEARING DESIGN TO BS5628-1:2005

TEDDS calculation version 1.0.07

Masonry details

Masonry type; **Clay or calcium silicate bricks**

Compressive strength; p_{unit} = **20.0** N/mm^2; Mortar designation; **iii**

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

Partial safety factor; γ_m = **3.5**; Characteristic strength; f_k = **5.0** N/mm^2

Leaf thickness; t = **215** mm; Effective wall thickness; t_{ef} = **215** mm

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

Bearing details

Beam spanning out of plane of wall

Width of bearing; B = **203** mm; Length of bearing; l_b = **100** mm

Edge distance; x_{edge} = **100** mm

Loading details

Concentrated dead load; G_k = **11** kN; Concentrated imposed load; Q_k = **10** kN

Design concentrated load; F = **30.8** 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} = **1.515** N/mm^2; Allowable bearing stress; f_{cp} = **2.143** 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} = **0.113** N/mm^2; Allowable bearing stress; f_{cp} = **0.731** N/mm^2

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

FLOOR JOISTS

Consider joists over lh-side of the seating area with a max. span = 2.85m as worst case; applied loading (as previous), dead = 0.75 kN/m^2 and imposed = 2.00 kN/m^2

Adopt C16 timber joists at 400mm max. centres.

→ **provide 47 x 175mm C16 joists at 400mm centres throughout with mid-span strutting**

TIMBER JOIST DESIGN (BS5268-2:2002)

Tedds calculation version 1.1.04

Joist details

Joist breadth; b = **47** mm; Joist depth; h = **175** mm

Joist spacing; s = **400** mm; Service class of timber; **1**

Timber strength class; **C16**

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Span details

Number of spans; N_{span} = **1**; Length of bearing; L_b = **50** mm

Clear length of span; L_{s1} = **2850** mm; ;

Section properties

Second moment of area; I = **20990885** mm^4; Section modulus; Z = **239896** mm^3

Loading details

Joist self weight; F_{swt} = **0.03** kN/m; Dead load; F_{d_udl} = **0.75** kN/m^2

Imposed UDL(Long term); F_{i_udl} = **2.00** kN/m^2

Imposed point load (Medium); F_{i_pt} = **1.40** kN

Consider long term loads

Design bending moment; M = **1.142** kNm; Design shear force; V = **1.603** kN

Design support reaction; R = **1.603** kN; Design deflection; δ = **5.535** mm

Check bending stress

Permissible bending stress; σ_{m_adm} = **6.186** N/mm^2; Applied bending stress; σ_{m_max} = **4.761** N/mm^2

PASS - Applied bending stress within permissible limits

Check shear stress

Permissible shear stress; τ_{adm} = **0.737** N/mm^2; Applied shear stress; τ_{max} = **0.292** N/mm^2

PASS - Applied shear stress within permissible limits

Check bearing stress

Permissible bearing stress; σ_{c_adm} = **1.870** N/mm^2; Applied bearing stress; σ_{c_max} = **0.682** N/mm^2

PASS - Applied bearing stress within permissible limits

Check deflection

Permissible deflection; δ_{adm} = **8.550** mm; Actual deflection; δ = **5.535** mm

PASS - Actual deflection within permissible limits

Consider medium term loads

Design bending moment; M = **1.327** kNm; Design shear force; V = **1.863** kN

Design support reaction; R = **1.863** kN; Design deflection; δ = **5.519** mm

Check bending stress

Permissible bending stress; σ_{m_adm} = **7.733** N/mm^2; Applied bending stress; σ_{m_max} = **5.534** 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} = **0.340** N/mm^2

PASS - Applied shear stress within permissible limits

Check bearing stress

Permissible bearing stress; σ_{c_adm} = **2.338** N/mm^2; Applied bearing stress; σ_{c_max} = **0.793** N/mm^2

PASS - Applied bearing stress within permissible limits

Check deflection

Permissible deflection; δ_{adm} = **8.550** mm; Actual deflection; δ = **5.519** mm

PASS - Actual deflection within permissible limits

FLOOR TRIMMERS

Consider landing trimmer (1); max. span = 1.80m (supports floor plus stairs), adopt C16 timber

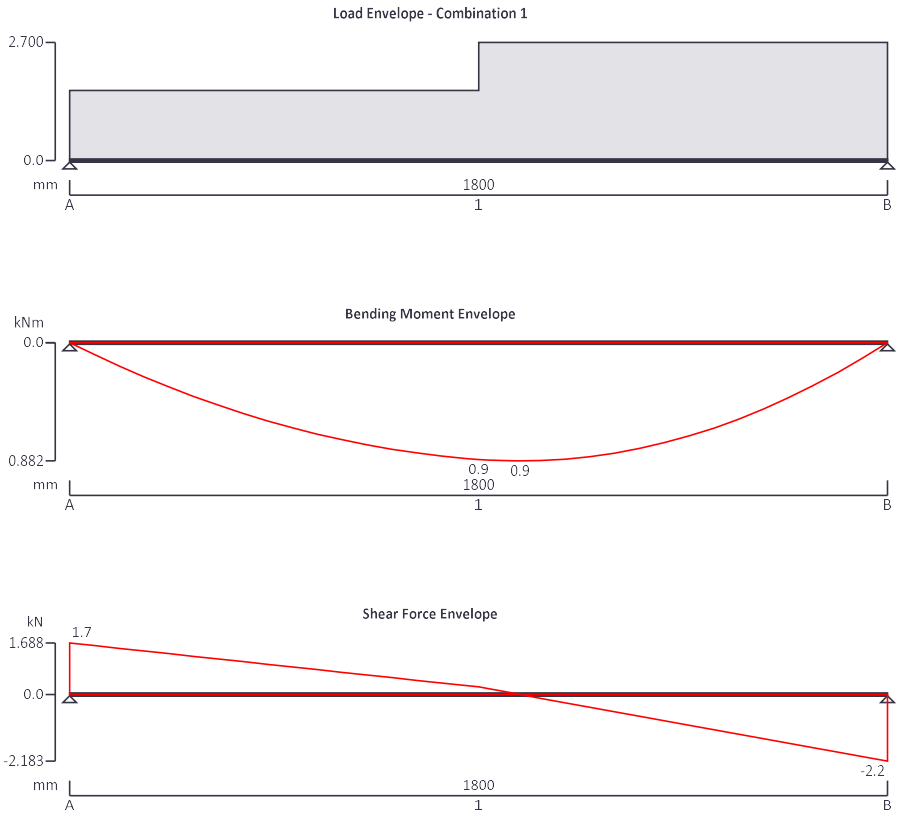
Loading:	floor (d)	=	0.75# x (0.98 / 2)	=	0.37	
	floor (i)	=	2.00# x (0.98 / 2)	=		0.98
	stairs (d)	=	say, as floor	=	0.37	
	stairs (i)	=	say, as floor	=		0.98
	balustrade (d)	=	say,	=	0.25	

Reactions	R_A	=	*1.69 kN*	*(d = 0.59kN & i = 1.10kN)*
	R_B	=	*2.18 kN*	*(d = 0.64kN & i = 1.54kN)*

→ **provide 1-No. 47 x 175mm C16 joist as trimmer to landing**

TIMBER BEAM ANALYSIS & DESIGN TO BS5268-2:2002

TEDDS calculation version 1.7.02



Applied loading

Beam loads

	Dead full UDL 0.000 kN/m
floor	Dead full UDL 0.370 kN/m
floor	Imposed full UDL 0.980 kN/m
stairs	Dead partial UDL 0.370 kN/m from 900 mm to 1800 mm
stairs	Imposed partial UDL 0.980 kN/m from 900 mm to 1800 mm
h'rail	Dead partial UDL 0.250 kN/m from 0 mm to 900 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

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Analysis results

Design moment; M = **0.882** kNm; Design shear; F = **2.183** kN

Total load on beam; W_{tot} = **3.870** kN

Reactions at support A; R_{A_max} = **1.688** kN; R_{A_min} = **1.688** kN

Unfactored dead load reaction at support A; R_{A_Dead} = **0.585** kN

Unfactored imposed load reaction at support A; $R_{A\_Imposed}$ = **1.103** kN

Reactions at support B; R_{B_max} = **2.183** kN; R_{B_min} = **2.183** kN

Unfactored dead load reaction at support B; R_{B_Dead} = **0.639** kN

Unfactored imposed load reaction at support B; $R_{B\_Imposed}$ = **1.544** kN

Timber section details

Breadth of section; b = **47** mm; Depth of section; h = **175** 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; **Long 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; **3.72**

PASS - Lateral support is adequate

Check bearing stress

Permissible bearing stress; σ_{c_adm} = **1.700** N/mm^2; Applied bearing stress; σ_{c_a} = **0.929** 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} = **5.624** N/mm^2; Applied bending stress; σ_{m_a} = **3.677** N/mm^2

PASS - Applied bending stress is less than permissible bending stress

Shear parallel to grain

Permissible shear stress; τ_{adm} = **0.670** N/mm^2; Applied shear stress; τ_a = **0.398** 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 = **2.771** mm

PASS - Total deflection is less than permissible deflection

Consider stair trimmer (2); max. span = 3.25m (supports nominal floor plus reaction from landing trimmer), adopt C16 timber

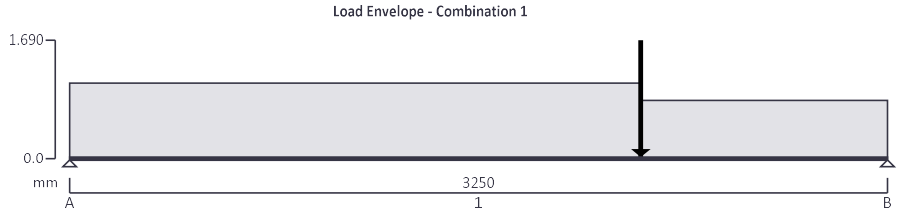
Loading:	floor (d)	=	0.75# x say, 0.30m	=	0.23	
	floor (i)	=	2.00# x say, 0.30m	=		0.60
	balustrade (d)	=	say,	=	0.25	
	reaction (d)	=	0.59 kN	*applied at 2.27m from R_A*		
	reaction (i)	=	1.10 kN	*applied at 2.27m from R_A*		

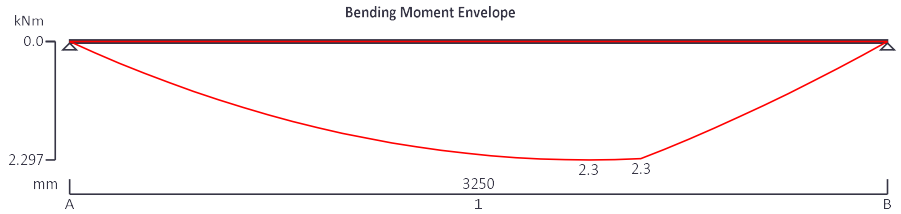
Reactions	R_A	=	*2.23 kN*	*(d = 0.92kN & i = 1.31kN)*
	R_B	=	*2.72 kN*	*(d = 0.98kN & i = 1.74kN)*

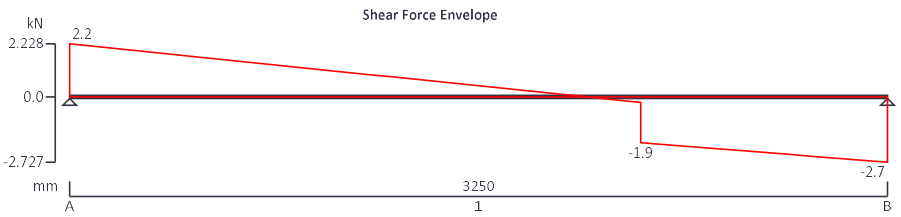
→ **provide 2-No. 47 x 175mm C16 joists as trimmer adjacent stairs**

TIMBER BEAM ANALYSIS & DESIGN TO BS5268-2:2002

TEDDS calculation version 1.7.02







Applied loading

Beam loads

floor	Dead full UDL 0.230 kN/m
floor	Imposed full UDL 0.600 kN/m
trimmer	Dead point load 0.590 kN at 2270 mm
trimmer	Imposed point load 1.100 kN at 2270 mm
h'rail	Dead partial UDL 0.250 kN/m from 0 mm to 2270 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 = **2.297** kNm;	Design shear;	F = **2.727** kN
Total load on beam;	W_{tot} = **4.955** kN		
Reactions at support A;	R_{A_max} = **2.228** kN;	R_{A_min} = **2.228** kN	
Unfactored dead load reaction at support A;	R_{A_Dead} = **0.921** kN		
Unfactored imposed load reaction at support A;	$R_{A\_Imposed}$ = **1.307** kN		
Reactions at support B;	R_{B_max} = **2.727** kN;	R_{B_min} = **2.727** kN	
Unfactored dead load reaction at support B;	R_{B_Dead} = **0.984** kN		
Unfactored imposed load reaction at support B;	$R_{B\_Imposed}$ = **1.743** kN		

Timber section details

Breadth of section;	b = **47** mm;	Depth of section;	h = **175** mm
Number of sections;	N = **2**;	Breadth of beam;	b_b = **94** mm
Timber strength class;	**C16**		

Member details

Service class of timber;	**1**;	Load duration;	**Long 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; **1.86**

PASS - Lateral support is adequate

Check bearing stress

Permissible bearing stress; σ_{c_adm} = **1.870** N/mm^2; Applied bearing stress; σ_{c_a} = **0.580** 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} = **6.186** N/mm^2; Applied bending stress; σ_{m_a} = **4.788** N/mm^2

PASS - Applied bending stress is less than permissible bending stress

Shear parallel to grain

Permissible shear stress; τ_{adm} = **0.737** N/mm^2; Applied shear stress; τ_a = **0.249** 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 = **9.267** mm

PASS - Total deflection is less than permissible deflection

Consider chimney trimmer (3); max. span = 2.00m (supports floor only), adopt C16 timber

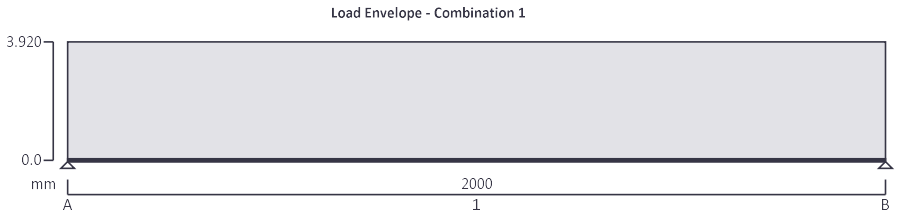
Loading:	floor (d)	=	0.75# x (2.85 / 2)	=	1.07	
	floor (i)	=	2.00# x (2.85 / 2)	=		2.85

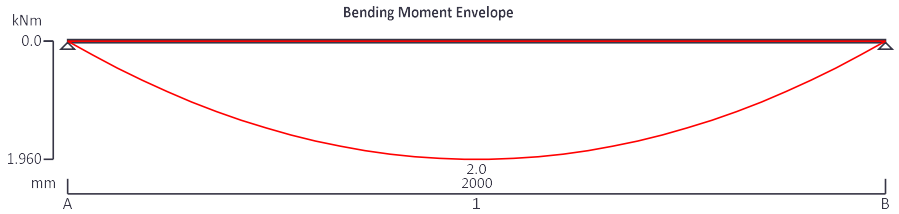
Reactions $R_A = R_B$ = *3.92 kN* *(d = 1.07kN & i = 2.85kN)*

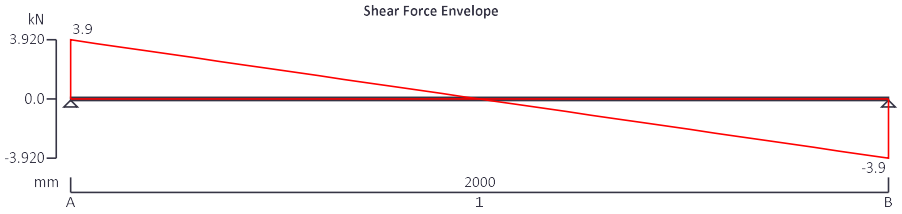
→ **provide 2-No. 47 x 175mm C16 joists as trimmer to chimney**

TIMBER BEAM ANALYSIS & DESIGN TO BS5268-2:2002

TEDDS calculation version 1.7.02







Applied loading

Beam loads

	Dead full UDL 0.000 kN/m
floor	Dead full UDL 1.070 kN/m
floor	Imposed full UDL 2.850 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 = **1.960** kNm;	Design shear;	F = **3.920** kN
Total load on beam;	W_{tot} = **7.840** kN		
Reactions at support A;	R_{A_max} = **3.920** kN;	R_{A_min} = **3.920** kN	
Unfactored dead load reaction at support A;	R_{A_Dead} = **1.070** kN		
Unfactored imposed load reaction at support A;	$R_{A\_Imposed}$ = **2.850** kN		
Reactions at support B;	R_{B_max} = **3.920** kN;	R_{B_min} = **3.920** kN	
Unfactored dead load reaction at support B;	R_{B_Dead} = **1.070** kN		
Unfactored imposed load reaction at support B;	$R_{B\_Imposed}$ = **2.850** kN		

Timber section details

Breadth of section;	b = **47** mm;	Depth of section;	h = **175** mm
Number of sections;	N = **2**;	Breadth of beam;	b_b = **94** mm
Timber strength class;	**C16**		

Member details

Service class of timber;	**1**;	Load duration;	**Long term**
Length of span;	L_{s1} = **2000** 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; **1.86**

PASS - Lateral support is adequate

Check bearing stress

Permissible bearing stress; σ_{c_adm} = **1.700** N/mm^2; Applied bearing stress; σ_{c_a} = **0.834** 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} = **5.624** N/mm^2; Applied bending stress; σ_{m_a} = **4.085** N/mm^2

PASS - Applied bending stress is less than permissible bending stress

Shear parallel to grain

Permissible shear stress; τ_{adm} = **0.670** N/mm^2; Applied shear stress; τ_a = **0.357** N/mm^2

PASS - Applied shear stress is less than permissible shear stress

Deflection

Permissible deflection; δ_{adm} = **6.000** mm; Total deflection; δ_a = **3.748** mm

PASS - Total deflection is less than permissible deflection

Consider floor trimmer (4); max. span = 3.25m (supports floor plus reaction from chimney trimmer), adopt C16 timber

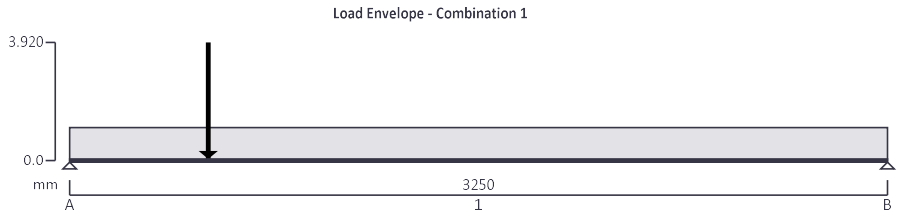
Loading:	floor (d)	=	0.75# x 0.40m	=	0.30
	floor (i)	=	2.00# x 0.40m	=	0.8
	reaction (d)	=	1.07 kN	*applied at* 0.55*m from* R_A	
	reaction (i)	=	2.85 kN	*applied at* 0.55*m from* R_A	

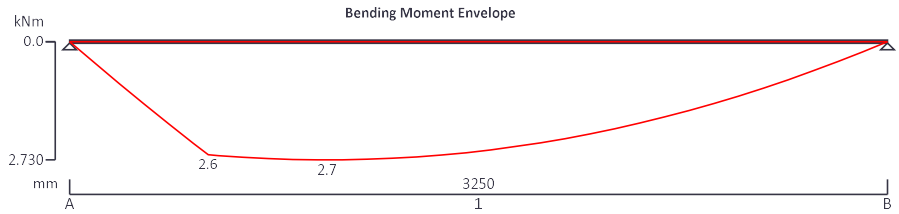
Reactions	R_A	=	*5.05 kN*	*(d = 1.38kN & i = 3.67kN)*
	R_B	=	*2.45 kN*	*(d = 0.67kN & i = 1.78kN)*

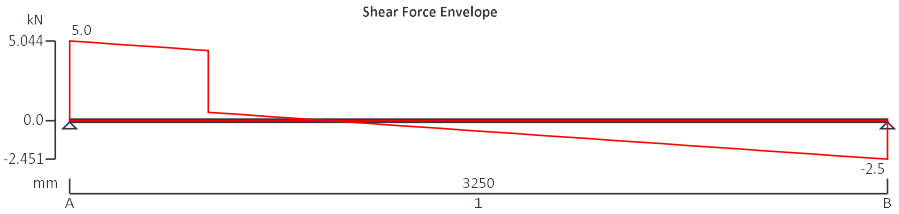
→ **provide 2-No. 47 x 175mm C24 joists as trimmer adjacent stairs**

TIMBER BEAM ANALYSIS & DESIGN TO BS5268-2:2002

TEDDS calculation version 1.7.02







Applied loading

Beam loads

floor	Dead full UDL 0.300 kN/m
floor	Imposed full UDL 0.800 kN/m
trimmer	Dead point load 1.070 kN at 550 mm
trimmer	Imposed point load 2.850 kN at 550 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 = **2.730** kNm; Design shear; F = **5.044** kN

Total load on beam; W_{tot} = **7.495** kN

Reactions at support A; R_{A_max} = **5.044** kN; R_{A_min} = **5.044** kN

Unfactored dead load reaction at support A; R_{A_Dead} = **1.376** kN

Unfactored imposed load reaction at support A; $R_{A\_Imposed}$ = **3.668** kN

Reactions at support B; R_{B_max} = **2.451** kN; R_{B_min} = **2.451** kN

Unfactored dead load reaction at support B; R_{B_Dead} = **0.669** kN

Unfactored imposed load reaction at support B; $R_{B\_Imposed}$ = **1.782** kN

Timber section details

Breadth of section; b = **47** mm; Depth of section; h = **175** mm

Number of sections; N = **2**; Breadth of beam; b_b = **94** mm

Timber strength class; **C24**

Member details

Service class of timber; **1**; Load duration; **Long 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; **1.86**

PASS - Lateral support is adequate

Check bearing stress

Permissible bearing stress; σ_{c_adm} = **2.090** N/mm^2; Applied bearing stress; σ_{c_a} = **1.073** 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} = **8.754** N/mm^2; Applied bending stress; σ_{m_a} = **5.691** N/mm^2

PASS - Applied bending stress is less than permissible bending stress

Shear parallel to grain

Permissible shear stress; τ_{adm} = **0.781** N/mm^2; Applied shear stress; τ_a = **0.460** 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 = **9.036** mm

PASS - Total deflection is less than permissible deflection

FLOOR JOISTS

Consider joists over staff kitchen (i.e. council meeting room) with a max. span = 4.10m; applied loading as previous, dead = 0.75 kN/m^2 and imposed = 2.00 kN/m^2

Adopt **C24** timber joists at 400mm max. centres.

→ **provide 47 x 175mm C24 joists at 400mm centres throughout with mid-span strutting**

TIMBER JOIST DESIGN (BS5268-2:2002)

Tedds calculation version 1.1.04

Joist details

Joist breadth;	b = **72** mm;	Joist depth;	h = **175** mm
Joist spacing;	s = **400** mm;	Service class of timber;	**1**
Timber strength class;	**C24**		

Span details

Number of spans;	N_{span} = **1**;	Length of bearing;	L_b = **50** mm
Clear length of span;	L_{s1} = **4100** mm;	;	

Section properties

Second moment of area;	I = **32156250** mm^4;	Section modulus;	Z = **367500** mm^3

Loading details

Joist self weight;	F_{swt} = **0.04** kN/m;	Dead load;	F_{d_udl} = **0.75** kN/m^2
Imposed UDL(Long term);	F_{i_udl} = **2.00** kN/m^2		
Imposed point load (Medium);	F_{i_pt} = **1.40** kN		

Consider long term loads

Design bending moment;	M = **2.402** kNm;	Design shear force;	V = **2.344** kN
Design support reaction;	R = **2.344** kN;	Design deflection;	δ = **12.451** mm

Check bending stress

Permissible bending stress; σ_{m_adm} = **8.754** N/mm^2; Applied bending stress; σ_{m_max} = **6.537** N/mm^2

PASS - Applied bending stress within permissible limits

Check shear stress

Permissible shear stress; τ_{adm} = **0.781** N/mm^2; Applied shear stress; τ_{max} = **0.279** N/mm^2

PASS - Applied shear stress within permissible limits

Check bearing stress

Permissible bearing stress; σ_{c_adm} = **2.090** N/mm^2; Applied bearing stress; σ_{c_max} = **0.651** N/mm^2

PASS - Applied bearing stress within permissible limits

Check deflection

Permissible deflection; δ_{adm} = **12.300** mm; Actual deflection; δ = **12.451** mm

FAIL - Actual deflection exceeds permissible deflection

NOTE: deemed acceptable as 1.2% over as, practically, it is unlikely that partions will be constructed within this room

Consider medium term loads

Design bending moment; M = **2.156** kNm; Design shear force; V = **2.104** kN

Design support reaction; R = **2.104** kN; Design deflection; δ = **9.729** mm

Check bending stress

Permissible bending stress; σ_{m_adm} = **10.942** N/mm^2; Applied bending stress; σ_{m_max} = **5.867** N/mm^2

PASS - Applied bending stress within permissible limits

Check shear stress

Permissible shear stress; τ_{adm} = **0.976** N/mm^2; Applied shear stress; τ_{max} = **0.250** N/mm^2

PASS - Applied shear stress within permissible limits

Check bearing stress

Permissible bearing stress; σ_{c_adm} = **2.613** N/mm^2; Applied bearing stress; σ_{c_max} = **0.584** N/mm^2

PASS - Applied bearing stress within permissible limits

Check deflection

Permissible deflection; δ_{adm} = **12.300** mm; Actual deflection; δ = **9.729** mm

PASS - Actual deflection within permissible limits