C/22/52

Structural Calculations

For

Proposed Alterations

At

Chepping Wycombe Parish Council

May 2022

Contents

1.00 Design Data

Timbers to be strength class C24 unless noted otherwise.

Steelwork to be grade 43.

Brickwork to be 20N/mm3 in 1. 1. 6. mortar unless noted otherwise.

Blockwork to be 3.6N/mm3 in 1. 1. 6. mortar unless noted otherwise.

NOTES

1. All steelwork to be shot blasted and painted.

2. All steels supporting existing walls to be wedged up at 1.0Mc/c to predeflect new beam prior to pinning up with 1-3 dry-pack incorporating 'Combex 100' expanding agent.

3. All beam ends to be built in solid each end.

4. Existing walls and floor over to be properly pinned propped and supported during construction.

2.0 Loadings

ROOF (PITCHED

Dead Loads:			
Tiles	=	0.70	KN/m²
Battens, Felt & Insulation	=	0.10	KN/m²
Rafters	=	0.10	KN/m²
Ceiling	=	0.30	KN/m²
Dead Load Total	**=**	**1.20**	**KN/m**
Live Loads:			
Live Load on Roof (45° pitch)	=	0.50	KN/m²
Live Load on Ceiling	=	0.25	KN/m²
Live Load Total	**=**	**0.75**	**KN/m²**
TOTAL	**=**	**1.95**	**KN/m²**

FIRST FLOOR

Dead Loads:			
Boarding	=	0.15	KN/m²
Joists	=	0.15	KN/m²
Ceiling	=	0.20	KN/m²
Dead Load Total	**=**	**0.50**	**KN/m**
Live Loads:			
Live Load on Floor	=	1.50	KN/m²
Live Load Total	**=**	**1.50**	**KN/m²**
TOTAL	**=**	**2.00**	**KN/m²**

WALLS (ELEVATION AREA)

105mm Brick	=	2.50	KN/m²
100mm Block	=	1.50	KN/m²
100mm Stud	=	0.50	KN/m²

3.00 Structure over Ground Floor

3.01 - B1 - BEAM 1

Analysis for a simply-supported single-span beam to BS 5950 (with LTB)

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}
5100	**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"**	**"WALL"**
2	**"Dead"**	**"FLOOR"**
3	**"Imposed"**	**"FLOOR"**

Loading data (unfactored)

Ref.	Category	Type	Load kN/m	Position mm	Load kN/m	Position mm
1	**"Dead"**	UDL	**1.2**	**0**	-	**5100**
2	**"Dead"**	UDL	**1.7**	**0**	-	**5100**
3	**"Imposed"**	UDL	**8.7**	**0**	-	**5100**

Analysis results - entire span

R_a kN (fac)	R_b kN (fac)	F_{vy} kN (fac)	M_x		Deflection: δEI_x	
			kNm (fac)	Sense	kNm^3	Direction
46.0	**46.0**	**46.0**	**58.6**	**"Sagging"**	**102.54**	**"Down"**

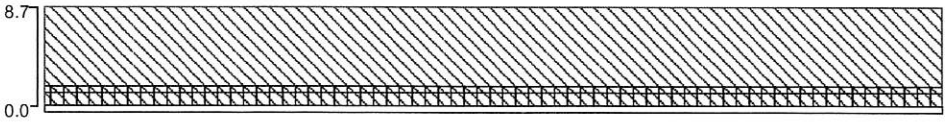
Unfactored support reactions

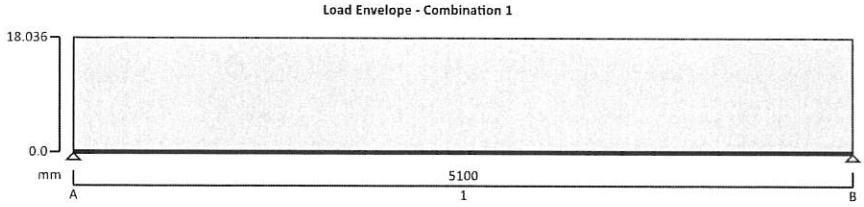
Support A; Dead load; **-7.5** kN; Live load; **-22.2** kN; Wind load; **0.0** kN;
Support B; Dead load; **-7.5** kN; Live load; **-22.2** kN; Wind load; **0.0** kN;

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**	**5100**	**5100**	**58.6**	**44.0**	**58.6**	**44.0**

Beam Loads





Member design checks for a simply-supported single-span beam to BS 5950 (with LTB)

Summary of results;

Material;	Grade = **"S275"**;	p_y = **275** N/mm^2;	
Section;	**"UC 203x203x46"**;	Classification;	**"Compact"**;

Check;	*Load*;	*Capacity*;	*Notes*;	*Result*;
Deflection;	δ_{y_max} = **10.9** mm;	δ_{lim} = **14.2** mm;	**Span / 360 or 14.2 mm**;	**Pass**
Shear;	F_{vy} = **46.0** kN;	P_{vy} = **241.4** kN;	**Low shear**;	**Pass**;
Moment;	M_x = **58.6** kNm;	M_{cx} = **136.8** kNm;	**Low shear**;	**Pass**
LTB;	M_{LT} = **58.6** kNm;	M_b / m_{LT} = **106.1** kNm;	L_{E_LT} = **5.1** m; m_{LT} = **0.93**;	**Pass**;

;

3.02 - B2 - BEAM 2

Analysis for a simply-supported single-span beam to BS 5950 (with LTB)

TEDDS calculation version 1.0.02

Span length & partial factors for loading

Span	Factors for moments & forces			Factors for deflection		
(mm)	γ_{fd}	γ_{fi}	γ_{fw}	γ_{dd}	γ_{di}	γ_{dw}
900	**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"**	**"WALL"**
2	**"Dead"**	**"B1"**
3	**"Imposed"**	**"B1"**

Loading data (unfactored)

Ref.	Category	Type	Load kN/m	Position mm	Load kN/m	Position mm
1	**"Dead"**	UDL	**14.4**	**0**	-	**900**
2	**"Dead"**	Point load	**8.0** kN	**800**	-	-
3	**"Imposed"**	Point load	**22.0** kN	**800**	-	-

Analysis results - entire span

R_a	R_b	F_{vy}	M_x		Deflection: δEI_x	
kN (fac)	kN (fac)	kN (fac)	kNm (fac)	Sense	kNm^3	Direction
14.2	**50.3**	**50.3**	**5.0**	**"Sagging"**	**0.27**	**"Down"**

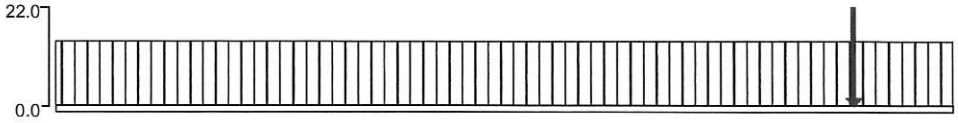
Unfactored support reactions

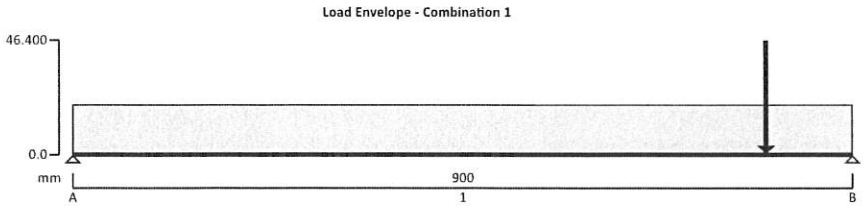
Support A;	Dead load; **-7.4** kN;	Live load; **-2.4** kN;	Wind load; **0.0** kN;
Support B;	Dead load; **-13.6** kN;	Live load; **-19.6** kN;	Wind load; **0.0** kN;

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**	**900**	**900**	**5.0**	**2.7**	**4.4**	**5.0**

Beam Loads





Member design checks for a simply-supported single-span beam to BS 5950 (with LTB)

Summary of results;

Material;	Grade = **"S275"**;	p_y = **275** N/mm^2;	
Section;	**"UB 203x102x23"**;	Classification;	**"Plastic"**;

Check;	*Load*;	*Capacity*;	*Notes*;	*Result*;
Deflection;	δ_{y_max} = **0.1** mm;	δ_{lim} = **2.5** mm;	**Span / 360 or 2.5 mm**;	**Pass**
Shear;	F_{vy} = **50.3** kN;	P_{vy} = **181.1** kN;	**Low shear**;	**Pass**;
Moment;	M_x = **5.0** kNm;	M_{cx} = **64.4** kNm;	**Low shear**;	**Pass**
LTB;	M_{LT} = **5.0** kNm;	M_b / m_{LT} = **74.5** kNm;	L_{E_LT} = **0.9** m; m_{LT} = **0.86**;	**Pass**;

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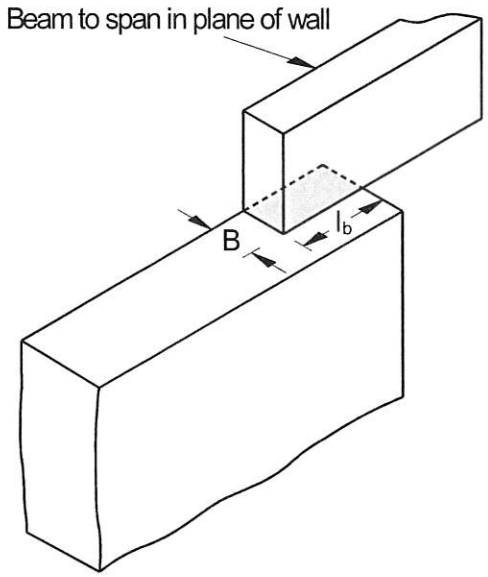
3.03 - P1 - PADSTONE 1

MASONRY BEARING DESIGN TO BS5628-1:2005

TEDDS calculation version 1.0.06

Masonry details

Masonry type;	**Aggregate concrete blocks (25% or less formed voids)**
Compressive strength of unit;	p_{unit} = **3.6** N/mm^2
Mortar designation;	**iii**
Least horizontal dimension of masonry units;	l_{unit} = **100** mm
Height of masonry units;	h_{unit} = **215** mm
Category of masonry units;	**Category II**
Category of construction control ;	**Normal**
Partial safety factor for material strength;	γ_m = **3.5**
Thickness of load bearing leaf;	t = **100** mm
Effective thickness of masonry wall;	t_{ef} = **150** mm
Height of masonry wall;	h = **2400** mm
Effective height of masonry wall;	h_{ef} = **1800** mm



Bearing details

Beam spanning in plane of wall

Width of bearing;	B = **100** mm
Length of bearing;	l_b = **600** mm

Compressive strength from Table 2 BS5628:Part 1 - aggregate concrete blocks (25% or less formed voids)

Mortar designation;	Mortar = **"iii"**
Block compressive strength;	p_{unit} = **3.6** N/mm^2
Characteristic compressive strength (Table 2c);	f_{kc} = **1.70** N/mm^2
Characteristic compressive strength (Table 2d);	f_{kd} = **3.50** N/mm^2
Height of solid block;	h_{unit} = **215.0** mm ;
Least horizontal dimension;	l_{unit} = **100.0** mm
Block ratio;	ratio = h_{unit} / l_{unit} = **2.2**

Ratio between 0.6 and 4.5 - OK

Characteristic compressive strength; f_k = **3.50** N/mm^2

Loading details

Characteristic concentrated dead load; G_k = **14** kN

Characteristic concentrated imposed load; Q_k = **20** kN

Design concentrated load; $F = (G_k \times 1.4) + (Q_k \times 1.6)$ = **51.6** kN

Characteristic distributed dead load; g_k = **0.0** kN/m

Characteristic distributed imposed load; q_k = **0.0** kN/m

Design distributed load; $f = (g_k \times 1.4) + (q_k \times 1.6)$ = **0.0** kN/m

Masonry bearing type

Bearing type; **Not applicable**

Bearing safety factor; γ_{bear} = **1.00**

Check design bearing without a spreader

Design bearing stress; $f_{ca} = F / (B \times l_b) + f / t$ = **0.860** N/mm^2

Allowable bearing stress; $f_{cp} = \gamma_{bear} \times f_k / \gamma_m$ = **1.000** N/mm^2

PASS - Allowable bearing stress exceeds design bearing stress

Check design bearing at 0.4 × h below the bearing level

Slenderness ratio; h_{ef} / t_{ef} = **12.00**

Eccentricity at top of wall; e_x = **0.0** mm

From BS5628:1 Table 7

Capacity reduction factor; β = **0.99**

Length of bearing distributed at 0.4 × h; l_d = **1560** mm

Maximum bearing stress; $f_{ca} = F / (l_d \times t) + f / t$ = **0.331** N/mm^2

Allowable bearing stress; $f_{cp} = \beta \times f_k / \gamma_m$ = **0.990** N/mm^2

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

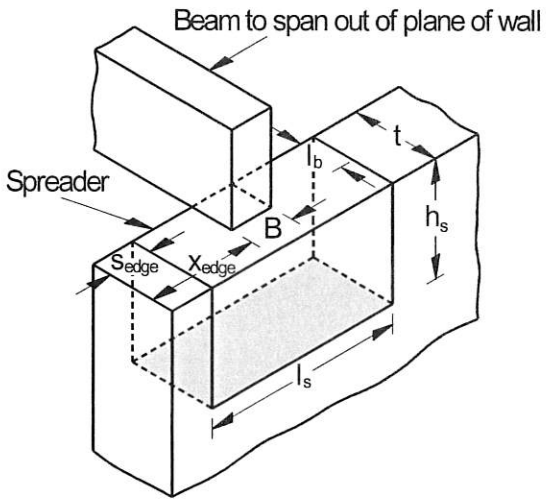
3.04 - P3 - PADSTONE 3

MASONRY BEARING DESIGN TO BS5628-1:2005

TEDDS calculation version 1.0.06

Masonry details

Masonry type;	**Aggregate concrete blocks (25% or less formed voids)**
Compressive strength of unit;	p_{unit} = **3.6** N/mm^2
Mortar designation;	**iii**
Least horizontal dimension of masonry units;	l_{unit} = **100** mm
Height of masonry units;	h_{unit} = **215** mm
Category of masonry units;	**Category II**
Category of construction control ;	**Normal**
Partial safety factor for material strength;	γ_m = **3.5**
Thickness of load bearing leaf;	t = **100** mm
Effective thickness of masonry wall;	t_{ef} = **100** mm
Height of masonry wall;	h = **2400** mm
Effective height of masonry wall;	h_{ef} = **1800** mm



Bearing details

Beam spanning out of plane of wall

Width of bearing;	B = **200** mm
Length of bearing;	l_b = **100** mm
Edge distance;	x_{edge} = **1000** mm

Compressive strength from Table 2 BS5628:Part 1 - aggregate concrete blocks (25% or less formed voids)

Mortar designation;	Mortar = **"iii"**
Block compressive strength;	p_{unit} = **3.6** N/mm^2
Characteristic compressive strength (Table 2c);	f_{kc} = **1.70** N/mm^2
Characteristic compressive strength (Table 2d);	f_{kd} = **3.50** N/mm^2
Height of solid block;	h_{unit} = **215.0** mm ;
Least horizontal dimension;	l_{unit} = **100.0** mm

Block ratio; ratio = h_{unit} / l_{unit} = **2.2**

Ratio between 0.6 and 4.5 - OK

Characteristic compressive strength; f_k = **3.50** N/mm^2

Loading details

Characteristic concentrated dead load; G_k = **8** kN

Characteristic concentrated imposed load; Q_k = **22** kN

Design concentrated load; F = (G_k × 1.4) + (Q_k × 1.6) = **46.4** kN

Characteristic distributed dead load; g_k = **0.0** kN/m

Characteristic distributed imposed load; q_k = **0.0** kN/m

Design distributed load; f = (g_k × 1.4) + (q_k × 1.6) = **0.0** kN/m

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} = F / (B × l_b) + f / t = **2.320** N/mm^2

Allowable bearing stress; f_{cp} = γ_{bear} × f_k / γ_m = **1.500** N/mm^2

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

Spreader details

Length of spreader; l_s = **400** mm

Depth of spreader; h_s = **215** mm

Edge distance; s_{edge} = max(0 mm, x_{edge} – (l_s - B) / 2) = **900** 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} = F / (l_s × t) + f / t = **1.160** N/mm^2

Allowable bearing stress; f_{cp} = γ_{bear} × f_k / γ_m = **1.500** N/mm^2

PASS - Allowable bearing stress exceeds design bearing stress

Check design bearing at 0.4 × h below the bearing level

Slenderness ratio; h_{ef} / t_{ef} = **18.00**

Eccentricity at top of wall; e_x = **0.0** mm

From BS5628:1 Table 7

Capacity reduction factor; β = **0.84**

Length of bearing distributed at 0.4 × h; l_d = **2120** mm

Maximum bearing stress; f_{ca} = F / (l_d × t) + f / t = **0.219** N/mm^2

Allowable bearing stress; f_{cp} = β × f_k / γ_m = **0.836** N/mm^2

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

3.05 - B3 - BEAM 3

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}
3050	**1.00**	**1.00**	**1.00**	**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"**	**"FLOOR"**
2	**"Imposed"**	**"FLOOR"**

Loading data (unfactored)

Ref.	Category	Type	Load kN/m	Position mm	Load kN/m	Position mm
1	**"Dead"**	UDL	**1.7**	**0**	-	**3050**
2	**"Imposed"**	UDL	**8.7**	**0**	-	**3050**

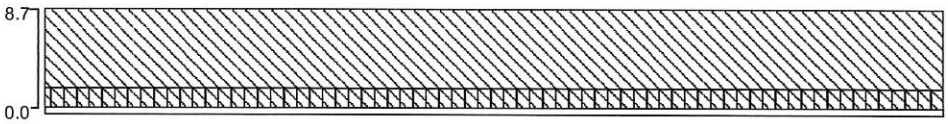
Analysis results - entire span

R_a kN (fac)	R_b kN (fac)	V kN (fac)	M kNm (fac)	M Sense	Deflection: δEI kNm^3	Deflection: δEI Direction
15.9	**15.9**	**15.9**	**12.1**	**"Sagging"**	**11.75**	**"Down"**
W_{tot} = **31.8** kN						

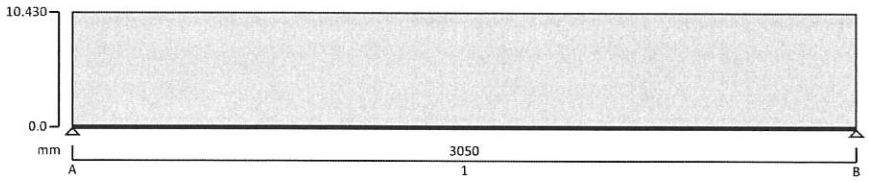
Unfactored support reactions

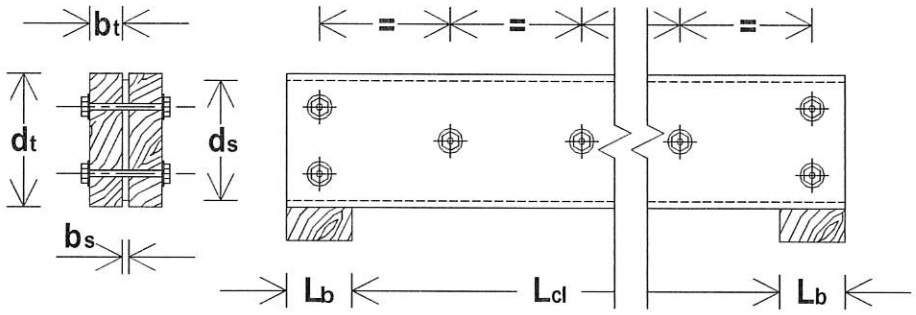
Support A;	Dead load; **-2.7** kN;	Live load; **-13.3** kN;	Wind load; **0.0** kN;
Support B;	Dead load; **-2.7** kN;	Live load; **-13.3** kN;	Wind load; **0.0** kN;

Beam Loads



Load Envelope - Combination 1





Typical flitch beam details

FLITCH BEAM CALCULATIONS TO BS5268-2:2002

Timber section properties

Breadth of timber; b_t = **50** mm; Depth of timber; d_t = **200** mm

Number of timbers; N_t = **2**; Strength class; **C24**

Steel section properties

Breadth of steel; b_s = **12** mm; Depth of steel; d_s = **200** mm

Number of plates; N_s = **1**; Bending stress; p_y = **275** N/mm^2

Check bending stress in timber

Permissible bending stress; σ_{m_adm} = **8.626** N/mm^2; Applied bending stress; σ_{m_a} = **5.550** N/mm^2

PASS - Timber stress not exceeded in bending

Check bending stress in steel

Permissible bending stress; p_y = **275** N/mm^2; Applied bending stress; $\sigma_{m\_a\_s}$ = **105** N/mm^2

PASS - Steel stress not exceeded in bending

Check shear stress in timber

Permissible shear stress; τ_{adm} = **0.781** N/mm^2; Applied shear stress; τ_a = **0.364** N/mm^2

PASS - Timber stress not exceeded in shear

Check beam deflection

Permissible deflection; δ_{adm} = **9.2** mm; Calculated deflection; δ_{actual} = **6.6** mm

PASS - Deflection is acceptable

Check bearing stress in timber

Permissible bearing stress; σ_{cp1} = **2.400** N/mm^2; Applied bearing stress; σ_{c_a} = **1.591** N/mm^2

PASS - Timber compressive stress not exceeded at bearing

Bolting requirements

Provide a minimum of 3 No.12 mm diameter bolts at each end of the beam

Provide 12 mm diameter bolts at a maximum of 500 mm centres along the length of the beam