CIVIL & STRUCTURAL CONSULTING ENGINEERS

Changing Rooms, Westhill Club

Structural Calculations

For

Westfield Parish Council

Date:
12/02/2025

Project Reference: M2-3103
Document Reference: SE-01_A1

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	Changing Rooms, Westhill Club		1
	Job Ref. M2-3103	Calc. by MC	Date 06/02/2025
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Document Issue History and Status

	Prepared By		Checked By		Approved By	
Revision	**Name**	**Date**	**Name**	**Date**	**Name**	**Date**
A1	**Matthieu Crosnier**	06.02.25	**Max Day**	12.02.25	**Matthieu Crosnier**	12.02.25

General Notes:

Calculations to be checked by Building Control Authority before work commences. Client to ensure all of contractors' works on site comply with and meet Approval of the relevant British Standards and the Local Authority including Building Control and Planning Departments. All temporary works to be the responsibility of the contractor and should be in accordance with BS 5975 to ensure temporary stability during the course of the works.

Dimensions: Note that all dimensions shown on the calculations are indicative and have been used for calculation purposes only. All dimensions should be checked prior to start of the works on site. It is the responsibility of the client to notify the Engineer of any discrepancies. The same applies to the alignment of walls and general layouts. All existing foundations and lintels to be exposed to verify suitability and to be checked for adequacy and/or replaced or surrounded in 150mm concrete cover if necessary. Prior to commencement a trial hole and /or soil report/investigation and an inspection of any trees in the areas may be required.

Introduction:

The following design calculations are for the new changing rooms.

Design Codes - Eurocodes:

BS EN 1990:	Eurocode 0:	"Basis of Structural Design"
BS EN 1991:	Eurocode 1:	"Actions on Structures"
BS EN 1992:	Eurocode 2:	"Design of Concrete Structures"
BS EN 1993:	Eurocode 3:	"Design of Steel Structures"
BS EN 1994:	Eurocode 4:	"Design of Composite Steel and Concrete Structures"
BS EN 1995:	Eurocode 5:	"Design of Timber Structures"
BS EN 1996:	Eurocode 6:	"Design of Masonry Structures"
BS EN 1997:	Eurocode 7:	"Geotechnical Design"
BS EN 1998:	Eurocode 8:	"Design of Structures for Earthquake Resistance"
BS EN 1999:	Eurocode 9:	"Design of Aluminium Structures"

Loadings

Roof Loading (Flat Timber Roof)

Dead Load

Asphalt & Waterproofing;	$Roof_{D1}$	=	**0.15** kN/m²
Firrings;	$Roof_{D2}$	=	**0.05** kN/m²
Insulation & Vapour Barrier;	$Roof_{D3}$	=	**0.05** kN/m²
Boarding;	$Roof_{D4}$	=	**0.12** kN/m²
Joists;	$Roof_{D5}$	=	**0.12** kN/m²
Services;	$Roof_{D6}$	=	**0.05** kN/m²
Plasterboard & Skim;	$Roof_{D7}$	=	**0.15** kN/m²
Total Dead Load (on plan);	$Roof_{DL} = sum(Roof_{D1},Roof_{D2},Roof_{D3},Roof_{D4},Roof_{D5},Roof_{D6},Roof_{D7})$	=	**0.69** kN/m²

Imposed Load

;Roof Imposed Load (on plan);	$Roof_{IL1}$	=	**0.75** kN/m²

Precast Floor Loading (Ground Floor)

Dead Load

Finishes;	$Floor_{1\_D1}$	=	**0.20** kN/m²
75mm Screed;	$Floor_{1\_D2}$	=	**1.80** kN/m²
Precast Units;	$Floor_{1\_D3}$	=	**2.50** kN/m²
Total Dead Load;	$Floor_{1\_DL} = sum(Floor_{1\_D1},Floor_{1\_D2},Floor_{1\_D3})$	=	**4.85** kN/m²

Imposed Load

Imposed Load;	$Floor_{1\_I1}$	=	**3.00** kN/m²
Partitions;	$Floor_{1\_I2}$	=	**1.00** kN/m²
Total Imposed Load;	$Floor_{1\_IL} = sum(Floor_{1\_I1},Floor_{1\_I2})$	=	**4.00** kN/m²

Cavity Wall Loading

Dead Load

Masonry (Outer Leaf);	CW_{D1}	=	**2.20** kN/m²
Insulation;	CW_{D2}	=	**0.05** kN/m²
Masonry (Inner Leaf);	CW_{D3}	=	**1.80** kN/m²
Plasterboard & Skim;	CW_{D4}	=	**0.15** kN/m²
Total Dead Load;	$CW_{DL} = sum(CW_{D1},CW_{D2},CW_{D3},CW_{D4})$	=	**4.20** kN/m²

Internal Blockwork Wall Loading

Dead Load

Masonry;	IW_{D1}	=	**1.80** kN/m²
Plasterboard & Skim (both sides);	IW_{D2}	=	**0.30** kN/m²
Total Dead Load;	$IW_{DL} = sum(IW_{D1},IW_{D2})$	=	**2.10** kN/m²

Stud Wall Loading

Dead Load

Stud;	SW_{D1}	=	**0.20** kN/m^2
Plasterboard & Skim (both sides);	SW_{D2}	=	**0.30** kN/m^2
Total Dead Load;	$SW_{DL} = sum(SW_{D1},SW_{D2})$	=	**0.50** kN/m^2

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TIMBER FLAT ROOF JOIST DESIGN (EN1995)

TIMBER JOIST ANALYSIS & DESIGN (EN1995-1-1:2004)

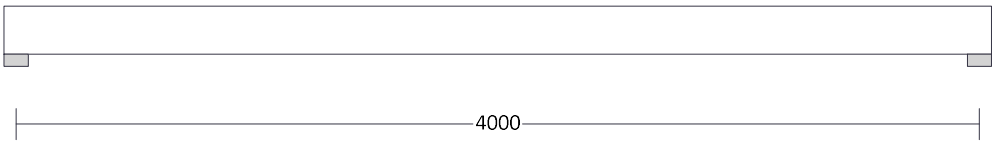
In accordance with EN1995-1-1:2004 + A2:2014 incorporating corrigendum June 2006 and the UK national annex

Tedds calculation version 1.0.07

Joist details

Description; 50 x 200 C24 timber joists

Joist spacing; s_{Joist} = **400** mm



Forces input on Joist

Vertical permanent load on joist; F_{G_Joist}= **0.69** kN/m^2

Vertical imposed load on joist; F_{Q_Joist}= **0.75** kN/m^2

Joist loading details

Distributed loads

Vertical permanent load on joist; $p_G = F_{G\_Joist} \times s_{Joist}$= **0.28** kN/m

Vertical imposed load on joist; $p_Q = F_{Q\_Joist} \times s_{Joist}$= **0.30** kN/m

Member results summary	Unit	Capacity	Maximum	Utilisation	Result
Bearing stress	N/mm^2	1.7	0.3	0.158	PASS
Bending stress	N/mm^2	16.2	5.2	0.321	PASS
Shear stress	N/mm^2	2.7	0.4	0.144	PASS
Beam stability check				0.321	PASS
Deflection	mm	16	10.4	0.648	PASS

ANALYSIS

Tedds calculation version 1.0.38

Loading

Self weight included (Permanent x 1)

Load combination factors

Load combination	Permanent	Imposed	Snow	Wind
1.35G + 1.50Q (Strength)	1.35	1.50	0.00	0.00
1.00G + 1.00Q (Service)	1.00	1.00	0.00	0.00

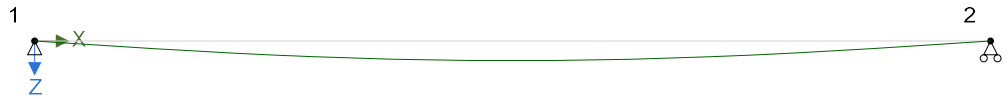
Member Loads

Member	Load case	Load Type	Orientation	Description
Member	Permanent	UDL	GlobalZ	0.28 kN/m at 0 m to 4 m
Member	Imposed	UDL	GlobalZ	0.3 kN/m at 0 m to 4 m

Results

Total deflection

1.35G + 1.50Q (Strength) - Total deflection



1.00G + 1.00Q (Service) - Total deflection

Node deflections

Load combination: 1.35G + 1.50Q (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.36208	
2	0	0	-0.36208	

Load combination: 1.00G + 1.00Q (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.25432	
2	0	0	-0.25432	

Total base reactions

Load case/combination	Force	
	FX (kN)	FZ (kN)
1.35G + 1.50Q (Strength)	0	3.5
1.00G + 1.00Q (Service)	0	2.4

Element end forces

Load combination: 1.35G + 1.50Q (Strength)

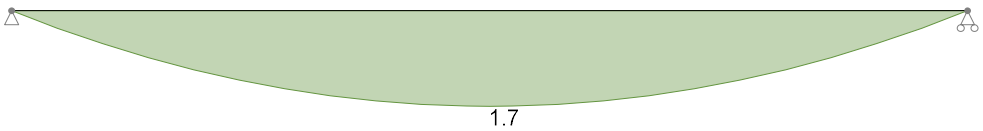
Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4	1	0	-1.7	0
		2	0	-1.7	0

Load combination: 1.00G + 1.00Q (Service)

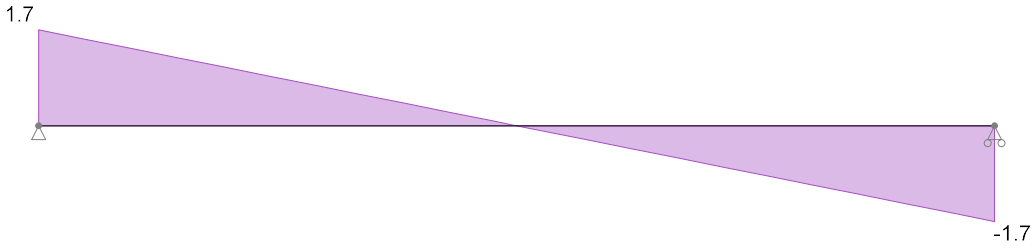
Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4	1	0	-1.2	0
		2	0	-1.2	0

Forces

Strength combinations - Moment envelope (kNm)



Strength combinations - Shear envelope (kN)



Member results

Envelope - Strength combinations

Member	Position (m)	Shear force (kN)		Moment (kNm)	
Member	0	1.7 (max abs)		0 (min)	
	2	0		1.7 (max)	
	4	-1.7		0 (min)	

;

Tedds calculation version 2.2.20

Member - Span 1

Partial factor for material properties and resistances

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

Member details

Load duration - cl.2.3.1.2; Medium-term

Service class - cl.2.3.1.3; 2

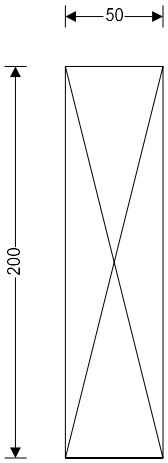
Timber section details

Number of timber sections in member; N = **1**

Breadth of sections; b = **50** mm

Depth of sections; h = **200** mm

Timber strength class - EN 338:2016 Table 1; **C24**



50x200 timber section
Cross-sectional area, A, 10000 mm^2
Section modulus, W_y, 333333.3 mm^3
Section modulus, W_z, 83333 mm^3
Second moment of area, I_y, 33333333 mm^4
Second moment of area, I_z, 2083333 mm^4
Radius of gyration, i_y, 57.7 mm
Radius of gyration, i_z, 14.4 mm
Timber strength class C24
Characteristic bending strength, $f_{m.k}$, 24 N/mm^2
Characteristic shear strength, $f_{v.k}$, 4 N/mm^2
Characteristic compression strength parallel to grain, $f_{c.0.k}$, 21 N/mm^2
Characteristic compression strength perpendicular to grain, $f_{c.90.k}$, 2.5 N/mm^2
Characteristic tension strength parallel to grain, $f_{t.0.k}$, 14.5 N/mm^2
Mean modulus of elasticity, $E_{0.mean}$, 11000 N/mm^2
Fifth percentile modulus of elasticity, $E_{0.05}$, 7400 N/mm^2
Shear modulus of elasticity, G_{mean}, 690 N/mm^2
Characteristic density, ρ_k, 350 kg/m^3
Mean density, ρ_{mean}, 420 kg/m^3

Span details

Bearing length; L_b = **100** mm

Consider Combination 1 - 1.35G + 1.50Q (Strength)

Modification factors

Duration of load and moisture content - Table 3.1; k_{mod} = **0.8**

Deformation factor - Table 3.2; k_{def} = **0.8**

Bending stress re-distribution factor - cl.6.1.6(2); k_m = **0.7**

Crack factor for shear resistance - cl.6.1.7(2); k_{cr} = **0.67**

System strength factor - cl.6.6; k_{sys} = **1.1**

Check design at start of span

Check compression perpendicular to the grain - cl.6.1.5

Design perpendicular compression - major axis; $F_{c,y,90,d}$ = **1.738** kN

Effective contact length; $L_{b,ef} = L_b + \min(L_b, 30\ mm)$ = **130** mm

Design perpendicular compressive stress - exp.6.4; $\sigma_{c,y,90,d} = F_{c,y,90,d} / (b \times L_{b,ef})$ = **0.267** N/mm^2

Design perpendicular compressive strength; $f_{c,y,90,d} = k_{mod} \times k_{sys} \times f_{c.90.k} / \gamma_M$ = **1.692** N/mm^2

$\sigma_{c,y,90,d} / (k_{c,90} \times f_{c,y,90,d})$ = **0.158**

PASS - Design perpendicular compression strength exceeds design perpendicular compression stress

Check shear force - Section 6.1.7

Design shear force; $F_{y,d}$ = **1.738** kN

Design shear stress - exp.6.60; $\tau_{y,d} = 1.5 \times F_{y,d} / (k_{cr} \times b \times h)$ = **0.389** N/mm^2

Design shear strength; $f_{v,y,d} = k_{mod} \times k_{sys} \times f_{v.k} / \gamma_M$ = **2.708** N/mm^2

$\tau_{y,d} / f_{v,y,d}$ = **0.144**

PASS - Design shear strength exceeds design shear stress

Check design 2000 mm along span

Check bending moment - Section 6.1.6

Design bending moment; $M_{y,d}$ = **1.738** kNm

Design bending stress; $\sigma_{m,y,d} = M_{y,d} / W_y =$ **5.214** N/mm^2

Design bending strength; $f_{m,y,d} = k_{mod} \times k_{sys} \times f_{m.k} / \gamma_M =$ **16.246** N/mm^2

$\sigma_{m,y,d} / f_{m,y,d} =$ **0.321**

PASS - Design bending strength exceeds design bending stress

Check beams subjected to either bending or combined bending and compression - cl.6.3.3

Lateral buckling factor - exp.6.34; $k_{crit} =$ **1.000**

Beam stability check - exp.6.33; $\sigma_{m,y,d} / (k_{crit} \times f_{m,y,d}) =$ **0.321**

PASS - Beam stability is acceptable

Consider Combination 2 - 1.00G + 1.00Q (Service)

Check design 2000 mm along span

Check y-y axis deflection - Section 7.2

Instantaneous deflection; $\delta_y =$ **5.8** mm

Quasi-permanent variable load factor; $\psi_2 =$ **0.3**

Final deflection with creep; $\delta_{y,Final} = \delta_y \times (1 + k_{def}) =$ **10.4** mm

Allowable deflection; $\delta_{y,Allowable} = L_{m1\_s1} / 250 =$ **16** mm

$\delta_{y,Final} / \delta_{y,Allowable} =$ **0.648**

PASS - Allowable deflection exceeds final deflection

Provide 50x200 C24 flat roof joists at 400c/c.