Project	Project ref
Ground Floor Wall Opening - 102 South Lane, Ash, GU126NJ	2023-7459b
Calcs for	Date
Mr Lee McGoldrick	6 Jul 2023

Timber Beam Design (BS 5268-2:2002)

Beam details

Beam	**100 x 175 mm (2 x 50x175 mm) C24 Grade Timber**
Timber strength class	**C24**
Service class of timber	**2**
Width	b = **100** mm
Depth	h = **175** mm

Width

Depth
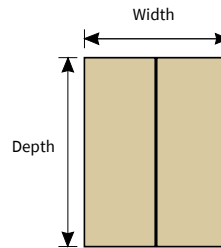
Span details

Beam clear span	L_{cl} = **2.635** m
Bearing length	L_b = **200** mm
Beam effective span	$L_{eff} = L_{cl} + (2 \times (L_b / 2))$ = **2.835** m

Bearing length   *Bearing length*

Clear span

Diagrams not to scale

Loading details

Load 1: UDL - Flat roof, with no permanent access

Dead load	$F_{d,1}$ = **1.25** kN/m² × **1.5** m = **1.875** kN/m
Imposed load	$F_{i,1}$ = **0.75** kN/m² × **1.5** m = **1.125** kN/m

Reactions (unfactored)

	Dead	Imposed	Total
Left reaction	**2.76** kN	**1.59** kN	**4.35** kN
Right reaction	**2.76** kN	**1.59** kN	**4.35** kN

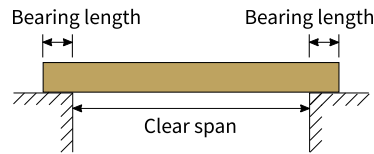| PlanningApplications.com	Project	Project ref
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Modification factors

Timber service class modification factor K2 as table 16

Bending parallel to grain	$K_{2,ben}$ = **1.00**
Compression perpendicular to grain	$K_{2,per}$ = **1.00**
Shear parallel to grain	$K_{2,shr}$ = **1.00**
Mean & min modulus of elasticity	$K_{2,mod}$ = **1.00**
Load duration factor	K_3 = **1.25**
Bearing modification factor	K_4 = **1.00**
Depth factor (BS5268-2 clause 2.10.6)	$K_7 = (300 / h)^{0.11}$ = **1.06**
Load sharing modification factor (BS5268-2 clause 2.10.11)	K_8 = **1.10**
Modulus of elasticity modification factor (BS5268-2 clause 2.9)	K_9 = **1.14**

Modulus of elasticity

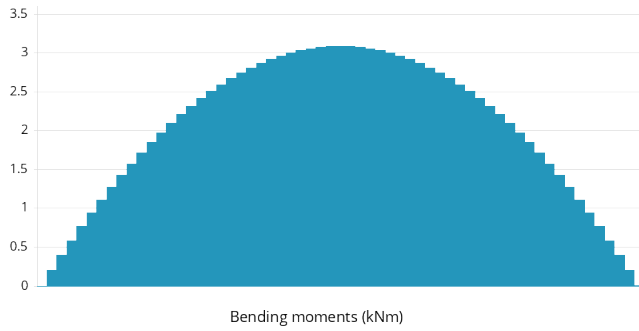|	
Timber minimum modulus of elasticity	E_{min} = **7,200** N/mm²
The minimum modulus of elasticity modified by the factor K9 should be used for deflections	$E = E_{min} \times K_{2,mod} \times K_9$ = **8,210** N/mm²

Section properties

Area of section	Area = $b \times h$ = **17,500** mm²
Inertia of timber about xx axis	$I_{xx} = b \times h^3 / 12$ = **44,700,000** mm⁴
Z to top edge of timber	$Z = b \times h^2 / 6$ = **510,000** mm³
Average density for C24 grade timber (BS 5268-2:2002 Table 8)	ρ_{mean} = **420** kg/m³
Self weight (g = 9.81 m/s²)	$F_{self} = b \times h \times L_{eff} \times \rho_{mean} \times g$ = **204** N

Section design parameters

Design bending moment	M_b = **3,090,000** Nmm
Design shear force	F_{ve} = **4,350** N

Check bending stress

Bending moments (kNm)

Timber grade bending stress parallel to grain (BS5268-2 Table 8)

$\sigma_{t,m,g,par} = $ **7.5** N/mm²

Permissible timber bending stress (factored)

$\sigma_{t,m,adm} = \sigma_{t,m,g,par} \times K_{2,ben} \times K_3 \times K_7 \times K_8 = $ **10.9** N/mm²

Maximum bending moment

$M = $ **3.09** kNm

Applied bending stress in timber

$\sigma_{t,m,max} = M / Z = $ **6.05** N/mm²

Pass $\sigma_{t,m,max} <= \sigma_{t,m,adm}$ (6.047 N/mm² <= 10.942 N/mm²) applied bending stress in timber within permissible

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Check deflection (including shear deflection as required by clause 2.10.7)
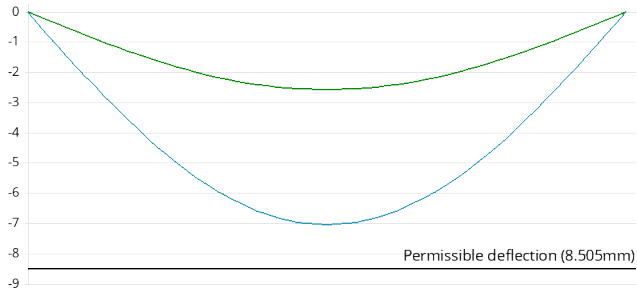
Live load deflection (green) and total load deflection (blue) in mm

Deflection based on E = 8208 N/mm²

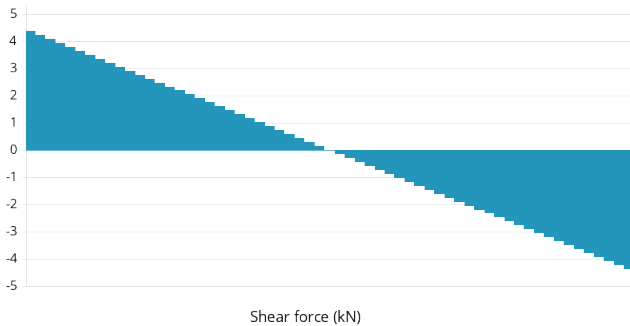|	
Dead load deflection without shear	δ_d = **4.47** mm
Imposed load deflection without shear	δ_l = **2.58** mm
Total dead & imposed load deflection	δ_t = **7.05** mm
Modulus of rigidity	G = E / 16 = **513** N/mm²
Shape factor for rectangular section	K_F = **1.2**
Shear area for beam	A_y = EA / K_F = **14,600** mm²
Total dead & imposed load	WT = **8.71** kN
If total dead & imposed load applied as a UDL, additional deflection due to shear	δ_{su} = WT × L_{eff} × 10^6 / (8 × A_y × G) = **0.413** mm
Shear deflection	δ_{shear} = δ_{su} × M / (WT × L_{eff} / 8) = **0.413** mm
Permissible deflection	δ_{adm} = 0.003 × L_{eff} × 10^3 = **8.51** mm
Total deflection inclusive of shear	δ_{max} = δ_d + δ_i + δ_{shear} = **7.46** mm

Pass δ_{max} <= δ_{adm} (7.46 mm <= 8.51 mm), therefore OK for deflection

Check shear stress

Shear force (kN)

No notches to occur at the critical shear position.

Timber grade shear stress parallel to grain (BS5268-2 Table 8) $\tau_{t,g,par} = \textbf{0.71}$ N/mm²

Permissible shear parallel to grain (factored) $\tau_{t,adm} = \tau_{t,g,par} \times K_{2,shr} \times K_3 \times K_8 = \textbf{0.976}$ N/mm²

Permissible shear force on timber $F_{t,adm} = 2 \times \tau_{t,adm} \times b \times h / 3 = \textbf{11,400}$ N

Design shear force $F_{ve} = \textbf{4,350}$ N

> **Pass** $F_{ve} <= F_{t,adm}$ (4355 N <= 11390 N) **shear capacity of timber is greater than applied shear force, therefore OK**

Check bearing stress

Timber grade compressive stress perpendicular to grain (BS5268-2 Table 8) $\sigma_{t,c,g,\boxtimes} = \textbf{1.9}$ N/mm²

Permissible compressive stress perpendicular to grain (factored) $\sigma_{t,c,adm} = \sigma_{t,c,g,\boxtimes} \times K_{2,per} \times K_3 \times K_4 \times K_8 = \textbf{2.61}$ N/mm²

Timber bearing stress on support $\sigma_{t,c,max} = F_{ve} / (L_b \times b) = \textbf{0.218}$ N/mm²

> **Pass** $\sigma_{t,c,max} <= \sigma_{t,c,adm}$ (0.218 N/mm² <= 2.613 N/mm²) **bearing stress is less than permissible timber stress, therefore OK**

Design summary

	Permissible	Applied/Actual	Utilisation	Result
Shear force (kN)	11.4	4.35	38.2 %	OK
Bending stress (N/mm²)	10.9	6.05	55.3 %	OK
Bearing stress (N/mm²)	2.61	0.22	8.3 %	OK
Deflection (mm)	8.51	7.46	87.7 %	OK

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Notes

Joists to be bolted together with M12 bolts at 600mm spacings.

This design is in accordance with BS 5268-2:2002 Structural use of timber - Part 2: Code of practice for permissible stress design, materials and workmanship.

The depth to width ratio of the timber does not exceed 5 and as per the requirements of BS 5268-2 Table 19 there is no risk of buckling under design load provided; The ends are held in position and compression edge held in line, as by direct connection of sheathing, deck or joists.

Timber to be covered, this calculation is not to be used for timber which is fully exposed to the elements.

Wane as allowed in BS 4978:2007 + A2:2017 is permitted.