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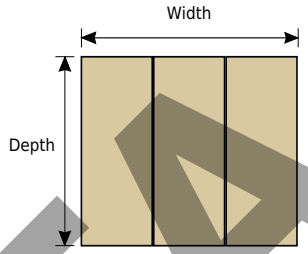
Timber Beam Design (BS5268-2:2002)

NOTE: THESE CALCULATIONS WERE GENERATED WITH BETA SOFTWARE FOR SOFTWARE TESTING PURPOSES ONLY. DO NOT USE THESE CALCULATIONS FOR A REAL PROJECT.

* You can add your own text, diagrams and photos here *

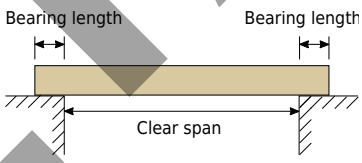
Beam details

Beam	**141 x 225mm (3 x 47x225mm)** **C24 Grade Timber**
Timber strength class	**C24**
Service class of timber	**2**
Width	b = **141** mm
Depth	h = **225** mm



Span details

Beam clear span	L_{cl} = **3.5** m
Bearing length	L_b = **100** mm
Beam effective span	$L_{eff} = L_{cl} + (2 \&times (L_b / 2))$ = **3.6** m



Diagrams not to scale

Loading details

Load 1: UDL - Sloping roof, 30° to 45°

Dead load	$F_{d,1}$ = **1.41** kN/m² × **2** m = **2.82** kN/m
Imposed load	$F_{i,1}$ = **0.75** kN/m² × **2** m = **1.5** kN/m

Reactions (unfactored)

	Dead	Imposed	Total
Left reaction	**5.08** kN	**2.70** kN	**7.78** kN
Right reaction	**5.08** kN	**2.70** kN	**7.78** kN

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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**
From BS5268-2 Table 18, bearing is < 75mm from joist end.	
Bearing modification factor	K_4 = **1.00**
Depth factor (BS5268-2 clause 2.10.6)	$K_7 = (300 / h)^{0.11}$ = **1.032**
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 = **1.21**

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	$E = E_{min} \times K_{2,mod} \times K_9$ = **8,712** N/mm²

Section properties

Area of section	Area = b × h = **31,725** mm²
Inertia of timber about xx axis	$I_{xx} = b \times h^3 / 12$ = **133,839,844** mm^4
Z to top edge of timber	$Z = b \times h^2 / 6$ = **1,189,688** mm^3

Section design parameters

Design bending moment	M_b = **6,998,400** Nmm
Design shear force	F_{ve} = **7,776** N

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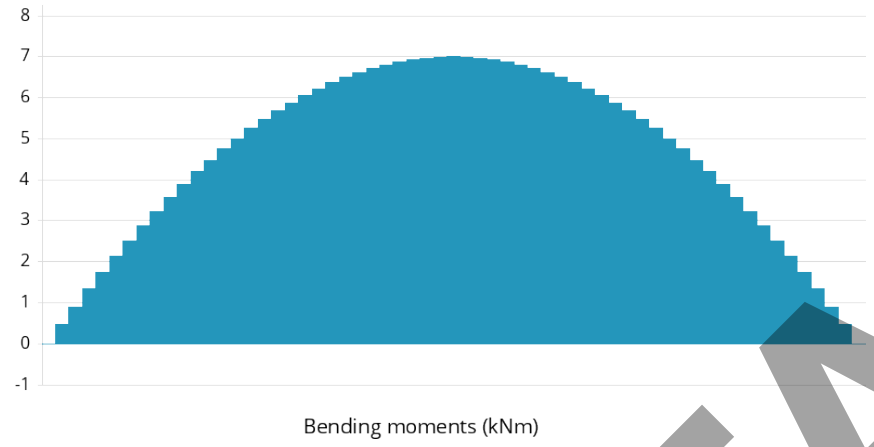
Check bending stress



Timber grade bending stress parallel to grain (BS5268-2 Table 8)	$\sigma_{t,m,g,\∥}$ = **7.5** N/mm²
Permissible timber bending stress (factored)	$\sigma_{t,m,adm} = \sigma_{t,m,g,\∥} \times K_{2,ben} \times K_3 \times K_7 \times K_8$ = **10.644** N/mm²
Maximum bending moment	M = **6.998** kNm
Applied bending stress in timber	$\sigma_{t,m,max}$ = M / Z = **5.883** N/mm²

Pass **$\sigma_{t,m,max}$ <= $\sigma_{t,m,adm}$ (5.883 N/mm² <= 10.644 N/mm²) applied bending stress in timber within permissible**

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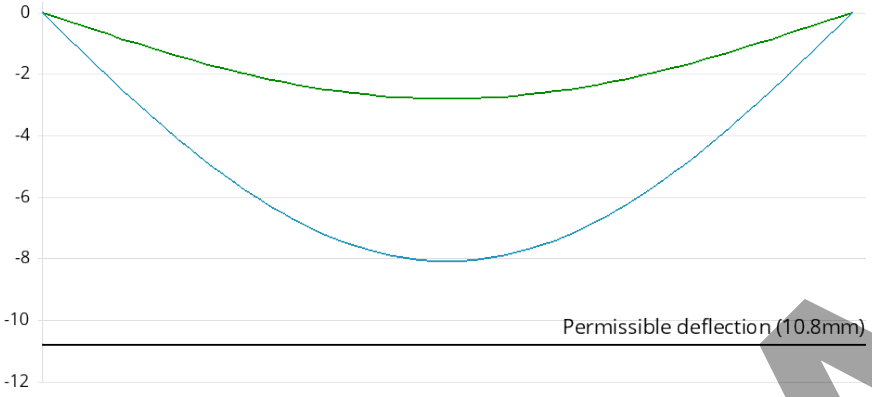
Check deflection (including shear deflection as required by clause 2.10.7)



Live load deflection (green) and total load deflection (blue) in mm

Deflection based on E = 8712 N/mm²	
Dead load deflection without shear	δ_d = **5.289** mm
Imposed load deflection without shear	δ_l = **2.813** mm
Total dead & imposed load deflection	δ_t = **8.103** mm
Modulus of rigidity	G = E / 16 = **544.5** N/mm²
Shape factor for rectangular section	K_F = **1.2**
Shear area for beam	A_y = EA / K_F = **26,438** mm²
Total dead & imposed load	WT = **15.552** 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) = **0.486** mm
Shear deflection	δ_{shear} = δ_{su} × M / (WT × L_{eff} / 8) = **0.486** mm
Permissible deflection	δ_{adm} = 0.003 × L_{eff} × 10^3 = **10.8** mm
Total deflection inclusive of shear	δ_{max} = δ_d + δ_l + δ_{shear} = **8.59** mm

Pass **δ_{max} <= δ_{adm} (8.59 mm <= 10.8 mm), therefore OK for deflection**

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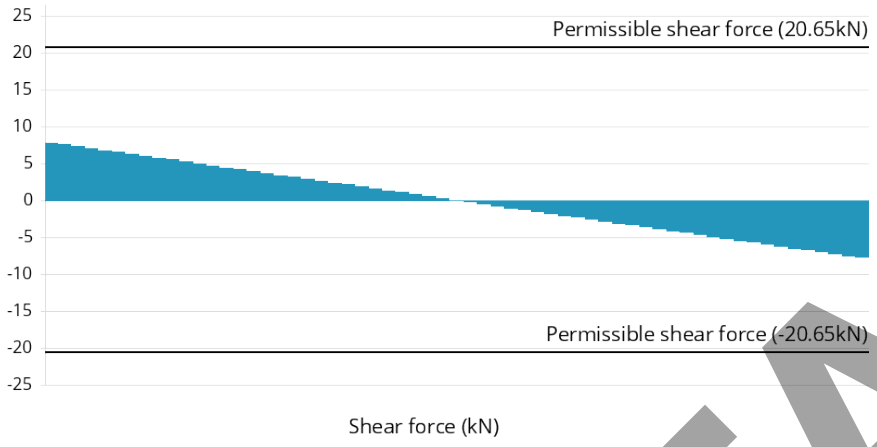
Check shear stress



No notches to occur at the critical shear position.

Timber grade shear stress parallel to grain (BS5268-2 Table 8)	$\tau_{t,g,\∥}$ = **0.71** N/mm²
Permissible shear parallel to grain (factored)	$\tau_{t,adm} = \tau_{t,g,\∥} \times K_{2,shr} \times K_3 \times K_8$ = **0.976** N/mm²
Permissible shear force on timber	$F_{t,adm} = 2 \times \tau_{t,adm} \times b \times h / 3$ = **20,648** N
Design shear force	F_{ve} = **7,776** N

Pass **F_{ve} <= $F_{t,adm}$ (7776 N <= 20647.688 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)	$\sigma_{t,c,g,\perp}$ = **1.9** N/mm²
Permissible compressive stress perpendicular to grain (factored)	$\sigma_{t,c,adm} = \sigma_{t,c,g,\perp} \times K_{2,per} \times K_3 \times K_4 \times K_8$ = **2.613** N/mm²
Timber bearing stress on support	$\sigma_{t,c,max} = F_{ve} / (L_b \times b)$ = **0.551** N/mm²

Pass **$\sigma_{t,c,max}$ <= $\sigma_{t,c,adm}$ (0.551 N/mm² <= 2.613 N/mm²) bearing stress is less than permissible timber stress, therefore OK**

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Design summary

	Permissible	Applied/Actual	Utilisation	Result
Shear force (kN)	**20.65**	**7.78**	**37.7 %**	**OK**
Bending stress (N/mm²)	**10.64**	**5.88**	**55.3 %**	**OK**
Bearing stress (N/mm²)	**2.61**	**0.55**	**21.1 %**	**OK**
Deflection (mm)	**10.8**	**8.59**	**79.5 %**	**OK**

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.

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