

Consulting Civil & Structural Engineers Tel: 01473 858 960 www.stroud-associates.co.uk admin@stroud-associates.co.uk	STROUD ASSOCIATES		Job Ref: S4219	
	CALCULATION SHEET		Sheet No: 01	
	Project: EXTENSION TO TRINITY MEMORIAL HALL TRUSS DESIGN.		Date: Aug 2024	Made By: WB
		Checked By:	Date Revised:	

Roof Loads (35° Pitch) DL U

SLATE TILES	-	0.35	
FELT	-	0.02	
BATTENS	-	0.03	
RAPTEYS	-	0.12	
PLASTER BOARD	-	0.12	
INSULATION	-	0.05	

Slope Total = 0.69 kN/m²

ON PLAN TOTAL = 0.69 / cos(35) = 0.84 kN/m

(60 - 35) x 0.6 / 30 = 0.5

0.50 kN/m²

SOLAR PANELS = 0.25 kN/m²

Σ = 1.09 kN/m² + 0.50 kN/m²

Purlins (SPAN = 1.6m) DL U

PURLINS AT 1.7m CENTRES.

∴ UDL ON SLOPE = 0.69 x 1.7 = 1.17 kN/m

∴ 0.6 x 1.7 = 1.02 kN/m

0.25 x 1.7 = 0.43 kN/m

PROPOSED 75 x 225 C24 TIMBER WORK

REACTION FOR EACH PURLIN = 1.36 kN 0.82 kN

THEFORE POINT LOAD AT EACH PURLIN NODE

ON TRUSS FRAME = 2.72 kN 1.64 kN

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Beam: PURLIN

Span: 1.6 m.

	Load name	Loading w1	Start x1	Loading w2	End x2	R1comp	R2comp	Defl.
O G	o.w.	0.1	0		L	0.08	0.08	0.01
U G	ROOF	1.17	0		L	0.94	0.94	0.10
U QH	ROOF	1.02	0		L	0.82	0.82	0.09
U G	SOLAR PANEL	0.43	0		L	0.34	0.34	0.04
Total load (unfactored):						4.35 kN	2.18	0.23
Dead/Permanent (unfactored):						2.72 kN	1.36	0.15
Live/Variable (unfactored):						1.63 kN	0.82	0.09
Factored (6.10):						6.12 kN	3.06	

Load types: O:Beam o.w.; U:UDL; Load positions: m. from R1

Load durations: G: Dead; Qx: Imposed; QH: Roof

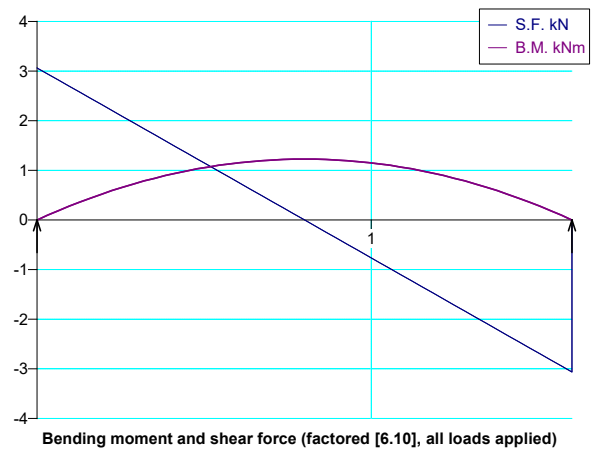
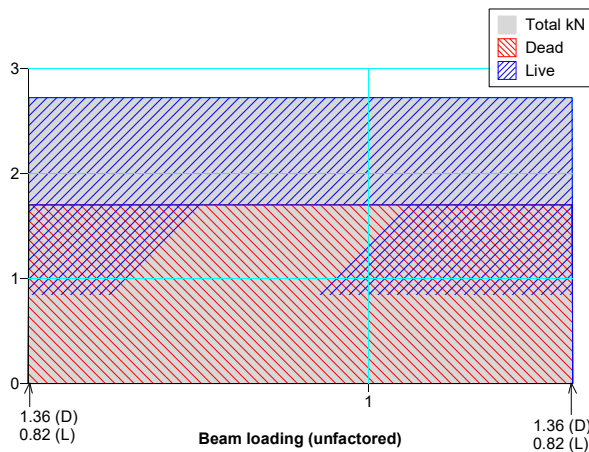
Maximum B.M. = 1.22 kNm (6.10) at 0.80 m. from R1

Maximum S.F. = 3.06 kN (6.10) at R1

Mid-span deflections: Dead: $0.15 \times 10^8 / EI$ (E in N/mm^2 , I in cm^4)

Live: $0.09 \times 10^8 / EI$

Total: $0.23 \times 10^8 / EI$



Timber beam calculation to BS EN1995-1-1 using C24 timber

Use **75 x 225 C24** 7.1 kg/m approx

$W_{el,y} = 632.8 \text{ cm}^3$ $I_y = 7,119 \text{ cm}^4$

Timber grade: C24

Grade bending strength, $f_{m,k} = 24.0 \text{ N/mm}^2$ [BS EN 338: 2009 Table 1]

Grade shear strength, $f_{v,k} = 4.0 \text{ N/mm}^2$ [BS EN 338: 2009 Table 1]

$E_{0.05} = 7,400 \text{ N/mm}^2$; $E_{0,mean} = 11,000 \text{ N/mm}^2$ [BS EN 338: 2009 Table 1]

Material partial factor, $\gamma_M = 1.3$ [EC5 UK Table NA.3]

Loading modification factor, $k_{mod} = 0.6$ (Service class 1; Live load duration: Permanent) [EC5 Tables 2.2/3.1]

Load sharing factor, $k_{sys} = 1.0$

Deflection modification factor, $k_{def} = 0.60$ (Service class 1, solid timber/glulam/LVL) [EC5 Table 3.2]

Bending

Height factor, $k_h = 1.0$ [EC5 3.2(3)]

Design bending strength, $f_{m,y,d} = f_{m,k} \cdot k_{mod} \cdot k_h \cdot k_{sys} / \gamma_M = 24.0 \times 0.60 \times 1.00 \times 1.0 / 1.30 = 11.08 \text{ N/mm}^2$

Design bending stress, $\sigma_{m,y,d} = 1.22 \times 1000 / 633 = 1.93 \text{ N/mm}^2$ OK

Bending resistance = $11.08 \times 633 / 1000 = 7.01 \text{ kNm}$

Shear

Effective width for shear, $b_{ef} = k_{cr} \cdot b = 0.67 \times 75 = 50.3 \text{ mm}$. [A1:2008 (6.13a)]

Design shear strength, $f_{v,d} = f_{v,k} \cdot k_{mod} \cdot k_{sys} / \gamma_M = 4.00 \times 0.60 \times 1.0 / 1.30 = 1.85 \text{ N/mm}^2$

Design shear stress, $\sigma_{v,y,d} = 3.06 \times 1000 \times (3/2) / (50.3 \times 225) = 0.41 \text{ N/mm}^2$ OK

Shear resistance = $1.85 \times 50.3 \times 225 \times (2/3) / 1000 = 13.92 \text{ kN}$

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Deflection

Final deflection limit = $L/250 = 6.40$ mm

Final deflection, $u_{fin} = \sum u_{inst}(1 + \psi_2 \cdot k_{def})$ [EC2 Eq.2.29/2.30]

Instantaneous mid-span shear deflection, $u_{inst,v} = 1.2M_{int}/(G_{mean}A)$ where ($G = E/16$)

$$u_{inst,v} = 1.2 \times 0.87 \times 10^6 / ((11,000/16) \times 75 \times 225) = 0.09 \text{ mm}$$

Final shear deflection is assumed to increase in proportion to total bending deflection

Mid-span deflections:	$\times 10^8/EI$	Inst. mm	k_{def}	ψ_2	Final mm	
G:	0.15	0.19	0.60	1.00	0.30	
QH:	0.09	0.11	0.60	0.00	0.11	
Shear deflection:		0.09			0.12	
Total mm.		<u>0.39</u>			<u>0.53</u>	OK

TRADA Nail, Screw, Bolt & Dowel Connection Designer Version 2.02

Company name
Address

Date **26/09/2024**
Engineer
Project
Reference
Design code **BS 5268-2: 2002**

Design data

General:	Service class	2	Load duration	Short-term	No. of members	2
Bolt:	Diameter	16.00 mm	Length (min.)	139 mm	Tensile strength	400 N/mm²
Member A:	Material	Steel	Thickness	15.00 mm		
Member B:	Material	GL28h	Thickness	100.00 mm		
Minimum spacing for loading parallel to the grain				7d	Connection made dry	Yes

Results

Permissible lateral load for 1 bolt in the side grain: **9988 N**

To obtain the permissible load for the connection, multiply by the no. of fasteners and by modification factor K57 ($= 1.0 - 0.03(n-1)$ for $n \leq 10$, or 0.7 for $n > 10$), where n = no. of fasteners in load line).

Minimum spacings and distances in glulam Member B

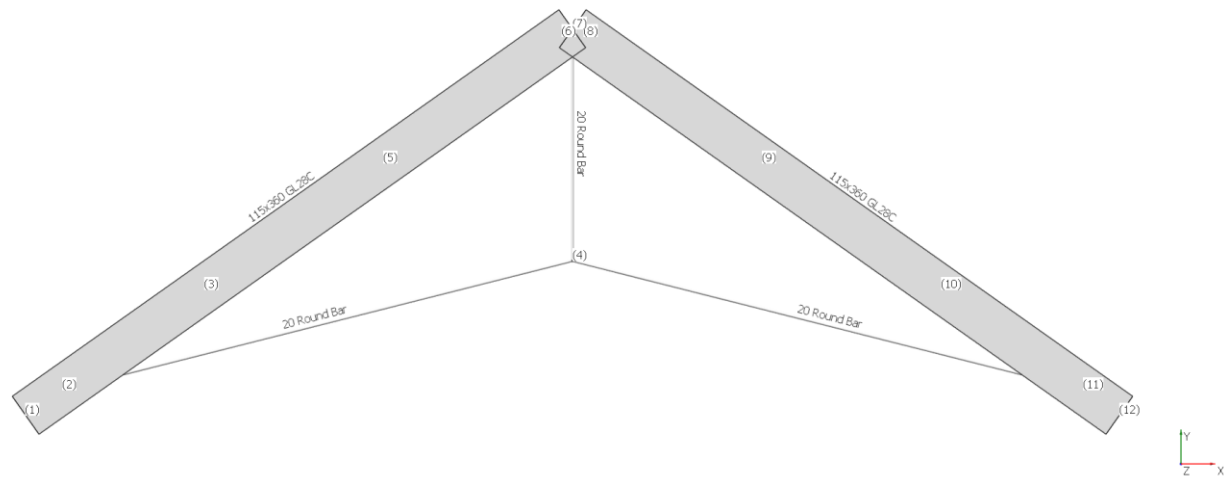
Spacing between bolts measured parallel to the grain	103 mm
Spacing between bolts measured perpendicular to the grain	64 mm
Loaded end distance measured parallel to the grain	112 mm
Unloaded end distance measured parallel to the grain	64 mm
Loaded edge distance measured perpendicular to the grain	64 mm
Unloaded edge distance measured perpendicular to the grain	24 mm
Angle of load to the grain	35.0°

The strength of the steel plate(s) should be checked.

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MasterFrame : Graphics



Frame Geometry - Full Frame - Front View

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MASTERFRAME DATA FILE

LOADING CASES AND LOAD COMBINATION

Load Group Labels

Load Group UT	Unity Load Factor (All Cases)
Load Group D0	Dead Load
Load Group D1	Dead Load
Load Group L1	Live Load

Load Case 001 : Dead+Live 1.35D0+1.35D1+1.50L1 (Ultimate)

Load Combination	+ 1.00 UT + 1.35 D0 + 1.35 D1 + 1.50 L1
Load Duration	Long Term

Load Case 002 : Dead+Live 1.00D0+1.00D1+1.00L1 (Serviceability)

Load Combination	+ 1.00 UT + 1.00 D0 + 1.00 D1 + 1.00 L1
Load Duration	Long Term

Load Case 003 : Live Only 1.00L1 (Serviceability)

Load Combination	+ 1.00 UT + 1.00 L1
Load Duration	Long Term

Load Case 004 : Dead Only 1.00D0+1.00D1 (Serviceability)

Load Combination	+ 1.00 UT + 1.00 D0 + 1.00 D1
Load Duration	Long Term

THE NODAL CO-ORDINATES

Node	X (m)	Y (m)	Z (m)	Node	X (m)	Y (m)	Z (m)
1	0.000	0.000	0.000	2	0.283	0.200	0.000

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						Sheet : Trimley Memorial Hall / 4-
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						Checked :
						Approved :

3	1.389	0.980	0.000	4	4.250	1.200	0.000
5	2.778	1.961	0.000	6	4.167	2.941	0.000
7	4.250	3.000	0.000	8	4.334	2.941	0.000
9	5.722	1.961	0.000	10	7.111	0.980	0.000
11	8.217	0.200	0.000	12	8.500	0.000	0.000

MEMBER PROPERTIES

Members 1-2, 4 & 6-12			
M	115x360 GL28C E 12.50E6 G .650E6 TG GL28c1010000		
A 414.0E-4	Iy 44712E-8	Iz 4563E-8	It 18251E-8
Members 3, 5 & 13			
M	20 Round Bar [S 275]		
A 3.142E-4	Iy 0.785E-8	Iz 0.785E-8	It 1.57E-8
E 210.0E6	G 80.77E6		

MEMBER LOADING

Member Self Weight Density Load Included in Load Group D1, defined by Modulus of Elasticity	
E kN/mm²	Density kN/m³
>= 200.00	77.01
>= 20.00	24.00
>= 2.00	10.00

Members 1-2, 4 & 6-12 - MasterFrame Pro Loads	
D1 D	010.000 (kN/m³)
Members 3, 5 & 13	
UT Tension-Only (No Compression)	
Members 3, 5 & 13 - MasterFrame Pro Loads	
D1 D	077.010 (kN/m³)

MEMBER END RELEASES

Symbols	End 1 torsion-minor-major	End 2 torsion-minor-major	O Released	@ Fixed
3 @OO @@@	5 @@@ @OO	7 @@@ @OO	8 @OO @@@	

NODAL LOADING AND SUPPORT CONDITIONS

NODES 3, 5-6 & 8-10					
D1 Ls	+0000.000	-0002.720	+0000.000	+0000.000	+0000.000
NODES 3, 5-6 & 8-10					
L1 Ls	+0000.000	-0001.640	+0000.000	+0000.000	+0000.000
NODE 12					
UT Rs	0	1	0	0	0 (Vertical Restraint)
NODE 1					
UT Rs	1	1	1	0	0 (Pinned)
NODES 4 & 7					
UT Rs	0	0	0	0	1

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Nodal Deflections (001 : Dead+Live 1.35D0+1.35D1+1.50L1 (Ultimate))									
Node	Nodal Def.Nodal Def. (mm and degrees)				Node	Nodal Def. (mm and degrees)			
	δY →	θX ↑	θZ ↗	θXZ		δY →	θX ↑	θZ ↗	θXZ
1	0.00	0.00	-0.35	0.00	2	1.22	-1.74	-0.34	2.12
3	5.00	-7.30	-0.21	8.85	4	4.92	-8.06	0.00	9.45
5	6.59	-9.77	0.01	11.78	6	5.06	-7.80	0.13	9.30
7	4.92	-7.61	0.00	9.07	8	4.79	-7.80	-0.13	9.15
9	3.26	-9.77	-0.01	10.30	10	4.85	-7.30	0.21	8.76
11	8.63	-1.74	0.34	8.81	12	9.85	0.00	0.35	9.85

Stroud Associates

Suite F, Harkstead Hall Barnes
Harkstead, Ipswich, Suffolk, IP9 1DB
Tel: (01473) 858 960 Email :admin@stroud-associates.co.uk

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Nodal Deflections (002 : Dead+Live 1.00D0+1.00D1+1.00L1 (Serviceability))									
Node	Nodal Def.Nodal Def. (mm and degrees)				Node	Nodal Def. (mm and degrees)			
	δY →	θX ↑	θZ ↗	θXZ		δY →	θX ↑	θZ ↗	θXZ
1	0.00	0.00	-0.25	0.00	2	0.87	-1.24	-0.25	1.52
3	3.58	-5.22	-0.15	6.33	4	3.52	-5.76	0.00	6.75
5	4.71	-6.98	0.01	8.42	6	3.62	-5.57	0.09	6.64
7	3.52	-5.44	0.00	6.48	8	3.42	-5.57	-0.09	6.54
9	2.33	-6.98	-0.01	7.36	10	3.46	-5.22	0.15	6.26
11	6.17	-1.24	0.25	6.29	12	7.04	0.00	0.25	7.04

Nodal Deflections (003 : Live Only 1.00L1 (Serviceability))									
Node	Nodal Def.Nodal Def. (mm and degrees)				Node	Nodal Def. (mm and degrees)			
	δY →	θX ↑	θZ ↗	θXZ		δY →	θX ↑	θZ ↗	θXZ
1	0.00	0.00	-0.08	0.00	2	0.28	-0.40	-0.08	0.49
3	1.16	-1.69	-0.05	2.05	4	1.16	-1.90	0.00	2.22
5	1.53	-2.28	0.00	2.75	6	1.19	-1.84	0.03	2.19
7	1.16	-1.79	0.00	2.14	8	1.13	-1.84	-0.03	2.15
9	0.78	-2.28	0.00	2.41	10	1.16	-1.69	0.05	2.05
11	2.04	-0.40	0.08	2.08	12	2.32	0.00	0.08	2.32

Nodal Deflections (004 : Dead Only 1.00D0+1.00D1 (Serviceability))									
Node	Nodal Def.Nodal Def. (mm and degrees)				Node	Nodal Def. (mm and degrees)			
	δY →	θX ↑	θZ ↗	θXZ		δY →	θX ↑	θZ ↗	θXZ
1	0.00	0.00	-0.17	0.00	2	0.59	-0.84	-0.17	1.02
3	2.42	-3.52	-0.10	4.27	4	2.36	-3.86	0.00	4.52
5	3.18	-4.71	0.01	5.68	6	2.43	-3.74	0.06	4.45
7	2.36	-3.65	0.00	4.34	8	2.29	-3.74	-0.06	4.38
9	1.54	-4.71	-0.01	4.95	10	2.30	-3.52	0.10	4.21
11	4.13	-0.84	0.17	4.22	12	4.72	0.00	0.17	4.72

Nodal Deflections (Maximum Values)									
Node	Nodal Def.Nodal Def. (mm and degrees)				Node	Nodal Def. (mm and degrees)			
	δY →	θX ↑	θZ ↗	θXZ		δY →	θX ↑	θZ ↗	θXZ
1	0.00	0.00	-0.35	0.00	2	1.22	-1.74	-0.34	2.12
3	5.00	-7.30	-0.21	8.85	4	4.92	-8.06	0.00	9.45
5	6.59	-9.77	0.01	11.78	6	5.06	-7.80	0.13	9.30
7	4.92	-7.61	0.00	9.07	8	4.79	-7.80	-0.13	9.15
9	3.26	-9.77	-0.01	10.30	10	4.85	-7.30	0.21	8.76
11	8.63	-1.74	0.34	8.81	12	9.85	0.00	0.35	9.85

Nodal Deflections (Minimum Values)									
Node	Nodal Def.Nodal Def. (mm and degrees)				Node	Nodal Def. (mm and degrees)			
	δY →	θX ↑	θZ ↗	θXZ		δY →	θX ↑	θZ ↗	θXZ
1	0.00	0.00	-0.08	0.00	2	0.28	-0.40	-0.08	0.49
3	1.16	-1.69	-0.05	2.05	4	1.16	-1.90	0.00	2.22
5	1.53	-2.28	0.00	2.75	6	1.19	-1.84	0.03	2.19
7	1.16	-1.79	0.00	2.14	8	1.13	-1.84	-0.03	2.15
9	0.78	-2.28	0.00	2.41	10	1.16	-1.69	0.05	2.05
11	2.04	-0.40	0.08	2.08	12	2.32	0.00	0.08	2.32

Member Forces Ultimate (001 : Dead+Live 1.35D0+1.35D1+1.50L1 (Ultimate))						
Member No.	Node End1 End2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kNm)	Maximum Moment (kNm @m)	Maximum Deflection (mm@m)
1	1	12.380C	17.537	0.000	12.995	6.689
	2	12.269C	17.378	6.054	@ 1.700	@ 2.533
2	2	43.080C	5.439	6.054	12.995	6.689
	3	42.644C	4.821	12.995	@ 1.700	@ 2.533
3	2	33.044T	0.065	0.000	0.066	70.008
	4	33.077T	-0.065	0.000	@ 1.964	@ 2.045
4	3	39.107C	-0.186	12.995	12.995	6.689
	5	38.560C	-0.962	12.020	@ 1.700	@ 2.533

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Member Forces Ultimate (001 : Dead+Live 1.35D0+1.35D1+1.50L1 (Ultimate))						
Member No.	Node End1 End2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kNm)	Maximum Moment (kNm @m)	Maximum Deflection (mm@m)
5	4	33.077T	0.065	0.000	0.066	70.008
	11	33.044T	-0.065	0.000	@ 1.964	@ 2.045
6	5	35.023C	-5.975	12.020	12.995	6.689
	6	34.475C	-6.751	1.203	@ 1.700	@ 2.533
7	6	30.943C	-11.750	1.203	12.995	6.689
	7	30.910C	-11.796	0.000	@ 1.700	@ 2.533
8	7	30.910C	11.796	0.000	12.995	6.688
	8	30.943C	11.750	1.203	@ 3.502	@ 2.669
9	8	34.475C	6.751	1.203	12.995	6.688
	9	35.023C	5.975	12.020	@ 3.502	@ 2.669
10	9	38.560C	0.962	12.020	12.995	6.688
	10	39.107C	0.186	12.995	@ 3.502	@ 2.669
11	10	42.644C	-4.821	12.995	12.995	6.688
	11	43.080C	-5.439	6.054	@ 3.502	@ 2.669
12	11	12.269C	-17.378	6.054	12.995	6.688
	12	12.380C	-17.537	0.000	@ 3.502	@ 2.669
13	4	16.297T	0.000	0.000	0.000	0.000
	7	16.356T	0.000	0.000	@ 0.000	@ 0.000
Member Forces Ultimate (Maximum Values)						
Member No.	Node End1 End2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kNm)	Maximum Moment (kNm @m)	Maximum Deflection (mm@m)
1	1	12.380C	17.537	0.000	12.995	6.689
	2	12.269C	17.378	6.054	@ 1.700	@ 2.533
2	2	43.080C	5.439	6.054	12.995	6.689
	3	42.644C	4.821	12.995	@ 1.700	@ 2.533
3	2	33.044T	0.065	0.000	0.066	70.008
	4	33.077T	-0.065	0.000	@ 1.964	@ 2.045
4	3	39.107C	-0.186	12.995	12.995	6.689
	5	38.560C	-0.962	12.020	@ 1.700	@ 2.533
5	4	33.077T	0.065	0.000	0.066	70.008
	11	33.044T	-0.065	0.000	@ 1.964	@ 2.045
6	5	35.023C	-5.975	12.020	12.995	6.689
	6	34.475C	-6.751	1.203	@ 1.700	@ 2.533
7	6	30.943C	-11.750	1.203	12.995	6.689
	7	30.910C	-11.796	0.000	@ 1.700	@ 2.533
8	7	30.910C	11.796	0.000	12.995	6.688
	8	30.943C	11.750	1.203	@ 3.502	@ 2.669
9	8	34.475C	6.751	1.203	12.995	6.688
	9	35.023C	5.975	12.020	@ 3.502	@ 2.669
10	9	38.560C	0.962	12.020	12.995	6.688

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Member Forces Ultimate (Maximum Values)							
Member No.	Node End1 End2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kNm)	Maximum Moment (kNm @m)	Maximum Deflection (mm@m)	
	10	39.107C	0.186	12.995	@ 3.502	@ 2.669	
11	10	42.644C	-4.821	12.995	12.995	6.688	
	11	43.080C	-5.439	6.054	@ 3.502	@ 2.669	
12	11	12.269C	-17.378	6.054	12.995	6.688	
	12	12.380C	-17.537	0.000	@ 3.502	@ 2.669	
13	4	16.297T	0.000	0.000	0.000	0.000	
	7	16.356T	0.000	0.000	@ 0.000	@ 0.000	
Member Forces Ultimate (Minimum Values)							
Member No.	Node End1 End2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kNm)	Maximum Moment (kNm @m)	Maximum Deflection (mm@m)	
1	1	12.380C	17.537	0.000	12.995	6.689	
	2	12.269C	17.378	6.054	@ 1.700	@ 2.533	
2	2	43.080C	5.439	6.054	12.995	6.689	
	3	42.644C	4.821	12.995	@ 1.700	@ 2.533	
3	2	33.044T	0.065	0.000	0.066	70.008	
	4	33.077T	-0.065	0.000	@ 1.964	@ 2.045	
4	3	39.107C	-0.186	12.995	12.995	6.689	
	5	38.560C	-0.962	12.020	@ 1.700	@ 2.533	
5	4	33.077T	0.065	0.000	0.066	70.008	
	11	33.044T	-0.065	0.000	@ 1.964	@ 2.045	
6	5	35.023C	-5.975	12.020	12.995	6.689	
	6	34.475C	-6.751	1.203	@ 1.700	@ 2.533	
7	6	30.943C	-11.750	1.203	12.995	6.689	
	7	30.910C	-11.796	0.000	@ 1.700	@ 2.533	
8	7	30.910C	11.796	0.000	12.995	6.688	
	8	30.943C	11.750	1.203	@ 3.502	@ 2.669	
9	8	34.475C	6.751	1.203	12.995	6.688	
	9	35.023C	5.975	12.020	@ 3.502	@ 2.669	
10	9	38.560C	0.962	12.020	12.995	6.688	
	10	39.107C	0.186	12.995	@ 3.502	@ 2.669	
11	10	42.644C	-4.821	12.995	12.995	6.688	
	11	43.080C	-5.439	6.054	@ 3.502	@ 2.669	
12	11	12.269C	-17.378	6.054	12.995	6.688	
	12	12.380C	-17.537	0.000	@ 3.502	@ 2.669	
13	4	16.297T	0.000	0.000	0.000	0.000	
	7	16.356T	0.000	0.000	@ 0.000	@ 0.000	
Support Reactions Serviceability (002 : Dead+Live 1.00D0+1.00D1+1.00L1 (Serviceability))							
Load Case	Support Reactions (kN and kNm)			Load Case	Support Reactions (kN and kNm)		
	Rx → (kN)	Ry ↑ (kN)	Mz ↗ (kNm)		Rx → (kN)	Ry ↑ (kN)	Mz ↗ (kNm)
1	0.000	15.354	0.000	4	0.000	0.000	0.000
7	0.000	0.000	0.000	12	0.000	15.354	0.000

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Support Reactions Serviceability (Minimum Values)							
Load Case	Support Reactions (kN and kNm)			Load Case	Support Reactions (kN and kNm)		
	R _x → (kN)	R _y ↑ (kN)	M _z ↗ (kNm)		R _x → (kN)	R _y ↑ (kN)	M _z ↗ (kNm)
1	0.000	4.920	0.000	4	0.000	0.000	0.000
7	0.000	0.000	0.000	12	0.000	4.920	0.000
Total	0.000	9.840	0.000				

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Stroud Associates

Suite F, Harkstead Hall Barnes
Harkstead, Ipswich, Suffolk, IP9 1DB
Tel: (01473) 858 960 Email :admin@stroud-associates.co.uk

Fax: 08707 061135 www.stroud-associates.co.uk

Job ref : Truss Model
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Approved :

MASTERKEY : TIMBER DESIGN**AXIAL LOAD WITH MOMENT DESIGN TO BS EN 1995-1-1:2004 + A1:2008****Member TBL1Id 1 @ Level 1****Summary Design Data**

Eurocode National Annex	Using UK values
Strength class code	BS EN 338:2009
Design Cases Covered	1.35 D0 + 1.35 D1 + 1.5 L1
Deflection Cases Covered	1.0 D0 + 1.0 D1 + 1.0 L1, 1.0 D0 + 1.0 D1
	Glued Laminated Grade - BS EN 14080
Section Size	b = 115, h = 360, 360x115 in Strength Class GL28c
Section Properties (c,cm ³ ,cm)	Area 414, W _{el,y} 2484, W _{el,z} 793.5, i _y 10.39, i _z 3.32
Specification	2 : Covered and generally heat, Long term loading
Integrated Design Critical Case	: Dead+Live 1.35D0+1.35D1+1.50L1 (Ultimate)
Member Details	N _{Ed} = 43.08 kN, L = 5.202 m, L _y = 5.202 m, L _z = 5.202 m, L _{cr,y} = 1.0 L _y , L _{cr,z} = 1.0 L _z Bearing length 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class GL28c)

$f_{m,y,d} = K_{mod} \cdot K_{hy} \cdot K_{sys} \cdot f_{m,k} / \gamma_m$	$0.70 \times 1.05 \times 1.00 \times 28.00 / 1.25$	16.50 N/mm ²	
$f_{m,z,d} = K_{mod} \cdot K_{hz} \cdot K_{sys} \cdot f_{m,k} / \gamma_m$	$0.70 \times 1.10 \times 1.00 \times 28.00 / 1.25$	17.25 N/mm ²	
$f_{c,0,d} = K_{mod} \cdot K_{sys} \cdot f_{c,0,k} / \gamma_m$	$0.70 \times 1.00 \times 24.00 / 1.25$	13.44 N/mm ²	
$f_{c,90,d} = K_{mod} \cdot K_{c,90} \cdot K_{sys} \cdot f_{c,90,k} / \gamma_m$	$0.70 \times 1.75 \times 1.00 \times 2.50 / 1.25$	2.45 N/mm ²	
$f_{v,d} = K_{mod} \cdot K_{sys} \cdot f_{v,k} / \gamma_m$	$0.70 \times 1.00 \times 3.50 / 1.25$	1.96 N/mm ²	
E _{mean}	Instantaneous Deflection	12500 N/mm ²	Deflection

Compression Resistance

$\lambda_y = L_{ey} / i_y$	$520 / 10.392 \leq 180$	50.1	OK
$\lambda_{rel,y} = \lambda_y / \sqrt{\alpha} \sqrt{f_{c,0,k} / E_{0.05}}$	$50.1 / \sqrt{p} \sqrt{24 / 10400}$	0.765	
$k_{c,y} = \text{fn}(\beta_c, \lambda_{rel,y}, k_y)$	0.1, 0.765, 0.816	0.909	
$f_{c,y,0,d} = k_{c,y} \cdot f_{c,0,d}$	0.909×13.44	12.22 N/mm ²	
$\lambda_z = L_{ez} / i_z$	$520 / 3.320 \leq 180$	156.7	OK
$\lambda_{rel,z} = \lambda_z / \sqrt{\alpha} \sqrt{f_{c,0,k} / E_{0.05}}$	$156.7 / \sqrt{p} \sqrt{24 / 10400}$	2.396	
$k_{c,z} = \text{fn}(\beta_c, \lambda_{rel,z}, k_z)$	0.1, 2.396, 3.475	0.167	
$f_{c,z,0,d} = k_{c,z} \cdot f_{c,0,d}$	0.167×13.44	2.24 N/mm ²	
$\sigma_{c,a} = N_{Ed} / \text{Area}$	$43.08 / 414 \leq 2.24$	1.04 N/mm ²	OK

Axial Load with Moments Check

Critical Design Location	X = 1.700		
$\sigma_{m,y,d} = M_y / W_{el,y}$	$12.995 / 2484 \leq 16.50$	5.23 N/mm ²	OK
$U_{c,y} = \sigma_{c,0,d} / (k_{c,y} \cdot f_{c,0,d})$	$1.041 / (0.909 \times 13.440)$	0.085	OK
$U_{c,z} = \sigma_{c,0,d} / (k_{c,z} \cdot f_{c,0,d})$	$1.041 / (0.167 \times 13.440)$	0.464	OK
$U_{m,y} = \sigma_{m,y,d} / f_{m,y,d}$	$5.230 / 16.502$	0.317	OK
$U_{c,z} + U_{m,y}$	$0.464 + 0.317$	0.781	OK
$L_{eff} = L_{LTB}$	5.202x1.000	5.202	
$\sigma_{m,crit} = \sqrt{p} \sqrt{(E_{05} \cdot I_z \cdot G_{05} \cdot J) / (L_{eff} \cdot W_y)}$	$\sqrt{p} \sqrt{(10.40 \times 4562.63 \times 0.54 \times 14580.77) / (5.202 \times 2484.00)}$	47.028	
$\lambda_{r,elm} = \sqrt{(f_{mk} / \sigma_{m,crit})}$	$\sqrt{(28.00 / 47.03)}$	0.772	
k_{crit}	$1.56 - 0.75 \lambda_{r,elm}$	0.981	
$U_{c,z} + (\sigma_{m,y,d} / (k_{crit} \cdot f_{m,y,d}))^2$	$0.464 + (5.230 / (0.981 \times 16.502))^2$	0.568	OK

Shear and Bearing Check

Critical Design Location	X = 0.000		
$T_a = 1.5 V_{y,Ed} / \text{Area} / k_{cr}$	$1.5 \times 17.537 / 414 / 0.67 \leq 1.96$	0.95 N/mm ²	OK
$\sigma_{c,ax} = V_{y,Ed} / (b \cdot l_y)$	$17.537 / (115 \times 75) \leq 2.45$	2.03 N/mm ²	OK

Deflection Check (Shear Deflection Not Included)

Critical Load Case 002 : Dead+Live 1.00D0+1.00D1+1.00L1 (Serviceability)			
$\delta = \delta_m$	In-span $4.78 \leq L / 250$	4.78 mm	OK

Stroud Associates

Suite F, Harkstead Hall Barnes
Harkstead, Ipswich, Suffolk, IP9 1DB
Tel: (01473) 858 960 Email :admin@stroud-associates.co.uk

Fax: 08707 061135 www.stroud-associates.co.uk

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Made By : TS/wb
Date : 26/09/2024/ 2024.09.25
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Approved :

MASTERKEY : TIMBER DESIGN**AXIAL LOAD WITH MOMENT DESIGN TO BS EN 1995-1-1:2004 + A1:2008****Member TBL1Id 7 @ Level 1****Summary Design Data**

Eurocode National Annex	Using UK values
Strength class code	BS EN 338:2009
Design Cases Covered	1.35 D0 + 1.35 D1 + 1.5 L1
Deflection Cases Covered	1.0 D0 + 1.0 D1 + 1.0 L1, 1.0 D0 + 1.0 D1
	Glued Laminated Grade - BS EN 14080
Section Size	b = 115, h = 360, 360x115 in Strength Class GL28c
Section Properties (c,cm ³ ,cm)	Area 414, W _{el,y} 2484, W _{el,z} 793.5, i _y 10.39, i _z 3.32
Specification	2 : Covered and generally heat, Long term loading
Integrated Design Critical Case	: Dead+Live 1.35D0+1.35D1+1.50L1 (Ultimate)
Member Details	N _{Ed} = 43.08 kN, L = 5.202 m, L _y = 5.202 m, L _z = 5.202 m, L _{cr,y} = 1.0 L _y , L _{cr,z} = 1.0 L _z Bearing length 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class GL28c)

f _{m,y,d} = K _{mod} .K _{hy} .K _{sys} .f _{m,k} /γ _m	0.70 x 1.05 x 1.00 x 28.00/1.25	16.50 N/mm ²	
f _{m,z,d} = K _{mod} .K _{hz} .K _{sys} .f _{m,k} /γ _m	0.70 x 1.10 x 1.00 x 28.00/1.25	17.25 N/mm ²	
f _{c,0,d} = K _{mod} .K _{sys} .f _{c,0,k} /γ _m	0.70 x 1.00 x 24.00/1.25	13.44 N/mm ²	
f _{c,90,d} = K _{mod} .K _{c,90} .K _{sys} .f _{c,90,k} /γ _m	0.70 x 1.75 x 1.00 x 2.50/1.25	2.45 N/mm ²	
f _{v,d} = K _{mod} .K _{sys} .f _{v,k} /γ _m	0.70 x 1.00 x 3.50/1.25	1.96 N/mm ²	
E _{mean}	Instantaneous Deflection	12500 N/mm ²	Deflection

Compression Resistance

λ _y = L _{ey} /i _y	520/10.392 ≤ 180	50.1	OK
λ _{rel,y} = λ _y /~p √ (f _{c,0,k} /E _{0,05})	50.1/~p √ 24/10400	0.765	
k _{c,y} = fn(β _c , λ _{rel,y} , k _y)	0.1, 0.765, 0.816	0.909	
f _{c,y,0,d} = k _{c,y} . f _{c,0,d}	0.909 x 13.44	12.22 N/mm ²	
λ _z = L _{ez} /i _z	520/3.320 ≤ 180	156.7	OK
λ _{rel,z} = λ _z /~p √ (f _{c,0,k} /E _{0,05})	156.7/~p √ 24/10400	2.396	
k _{c,z} = fn(β _c , λ _{rel,z} , k _z)	0.1, 2.396, 3.475	0.167	
f _{c,z,0,d} = k _{c,z} . f _{c,0,d}	0.167 x 13.44	2.24 N/mm ²	
σ _{c,a} = N _{Ed} /Area	43.08 / 414 ≤ 2.24	1.04 N/mm ²	OK

Axial Load with Moments Check

Critical Design Location	X = 3.502		
σ _{m,y,d} = M _y /W _{el,y}	12.999 / 2484 ≤ 16.50	5.23 N/mm ²	OK
U _{c,y} = σ _{c,0,d} /(k _{c,y} •f _{c,0,d})	1.041/(0.909x13.440)	0.085	OK
U _{c,z} = σ _{c,0,d} /(k _{c,z} •f _{c,0,d})	1.041/(0.167x13.440)	0.464	OK
U _{m,y} = σ _{m,y,d} /f _{m,y,d}	5.230/16.502	0.317	OK
U _{c,z} +U _{m,y}	0.464+0.317	0.781	OK
L _{eff} =L.K _{LTB}	5.202x1.000	5.202	
σ _{mcrit} =~p√(E ₀₅ .I _z .G ₀₅ .J)/(L _{eff} .W _y)	~p√(10.40x4562.63x0.54x14580.77)/(5.202x2484.00)	47.028	
λ _{r,elm} =√(f _{m,k} /σ _{mcrit})	√(28.00/47.03)	0.772	
k _{Crit}	1.56-0.75λ _{r,elm}	0.981	
U _{c,z} +(σ _{m,y,d} /(k _{Crit} •f _{m,y,d})) ²	0.464+(5.230/(0.981x16.502)) ²	0.568	OK

Shear and Bearing Check

Critical Design Location	X = 5.072		
T _a = 1.5 V _{y,Ed} / Area / k _{cr}	1.5 x 17.477 / 414 / 0.67 ≤ 1.96	0.95 N/mm ²	OK
σ _{c,⊥,ax} = V _{y,Ed} / (b.l _y)	17.477 / (115 x 75) ≤ 2.45	2.03 N/mm ²	OK

Deflection Check (Shear Deflection Not Included)

Critical Load Case 002 : Dead+Live 1.00D0+1.00D1+1.00L1 (Serviceability)			
δ = δ _m	In-span 4.78 ≤ L/250	4.78 mm	OK

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Member Loading and Member Forces

Loading Combination : 1 UT + 1.35 D0 + 1.35 D1 + 1.5 L1

D1 D 077.010 (kN/m³)
UT Tension-Only (No Compression)

Member Forces in Load Case 1						
Member No.	Node End 1 End 2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kNm)	Maximum Moment (kNm)	Maximum Deflection (mm @ m)
3	2	33.044T	0.065	0.000	0.066	0.000
	4	33.077T	-0.065	0.000	@ 1.964	@ 0.000

Classification and Effective Area (EN 1993: 2006)

Section (2.466 kg/m)

20 mm Round Bar 2.466 [S 275]

(Axial: Non-Slender)

Class 1

Auto Design Load Cases

1

Local Capacity Check

$$N_{pl.Rd} = A_g \cdot f_y / \gamma_{M0}$$

3.14x265/1 (No bearing / block tearing design)

83.252 kN

OK

$$N_{Ed}/N_{pl,Rd}$$
$$-33.077 / 83.252 =$$

0.397

OK

Member Loading and Member Forces

Loading Combination : 1 UT + 1.35 D0 + 1.35 D1 + 1.5 L1

D1 D 077.010 (kN/m³)
UT Tension-Only (No Compression)

Member Forces in Load Case 1						
Member No.	Node End 1 End 2	Axial Force (kN)	Shear Force (kN)	Bending Moment (kNm)	Maximum Moment (kNm)	Maximum Deflection (mm @ m)
5	4	33.077T	0.065	0.000	0.066	0.000
	11	33.044T	-0.065	0.000	@ 1.964	@ 0.000

Classification and Effective Area (EN 1993: 2006)

Section (2.466 kg/m)

20 mm Round Bar 2.466 [S 275]

(Axial: Non-Slender)

Class 1

Suite F, Harkstead Hall Barnes
Harkstead, Ipswich, Suffolk, IP9 1DB
Tel: (01473) 858 960 Email :admin@stroud-associates.co.uk

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OK

UT Tension-Only (No Compression)

OK