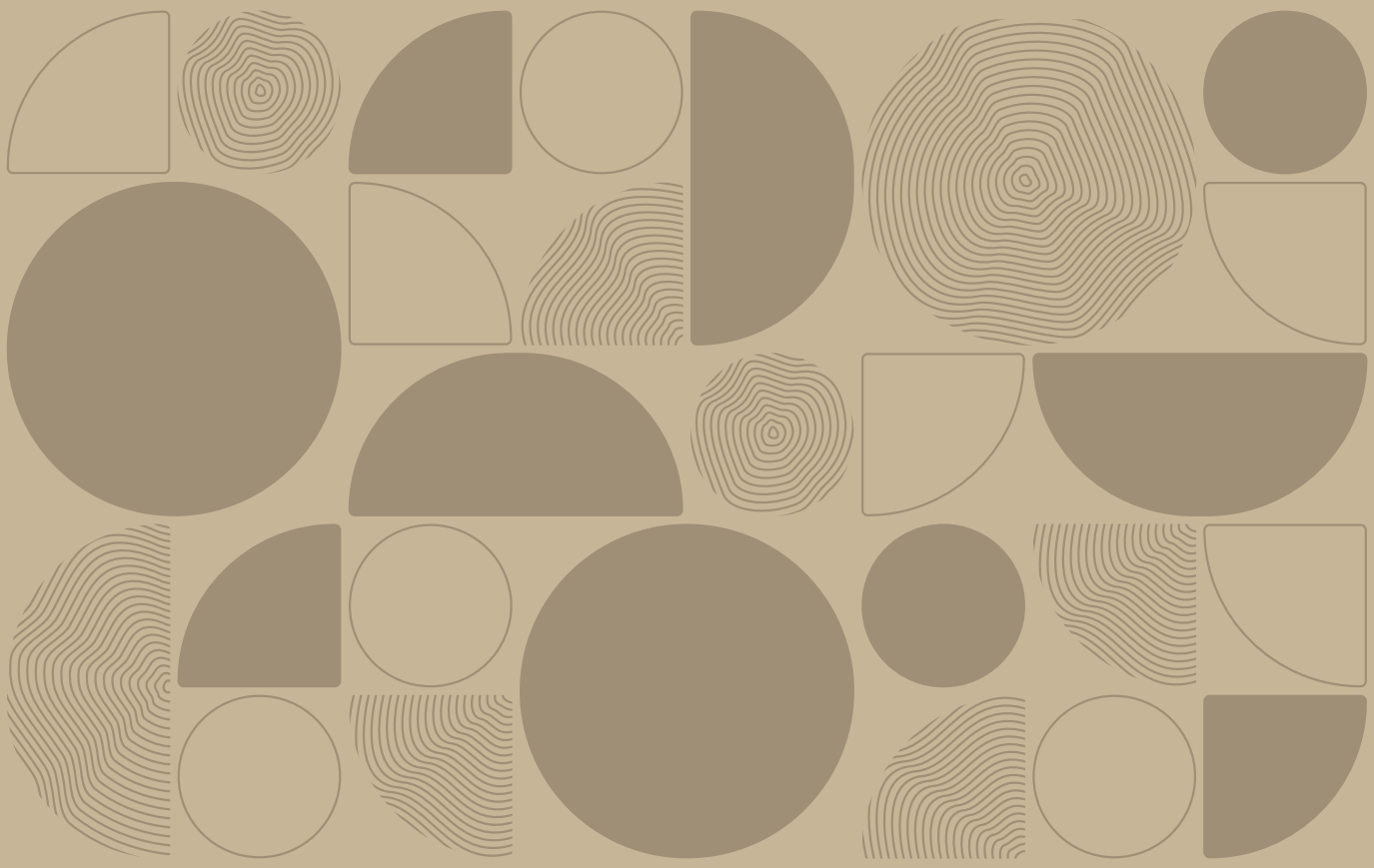
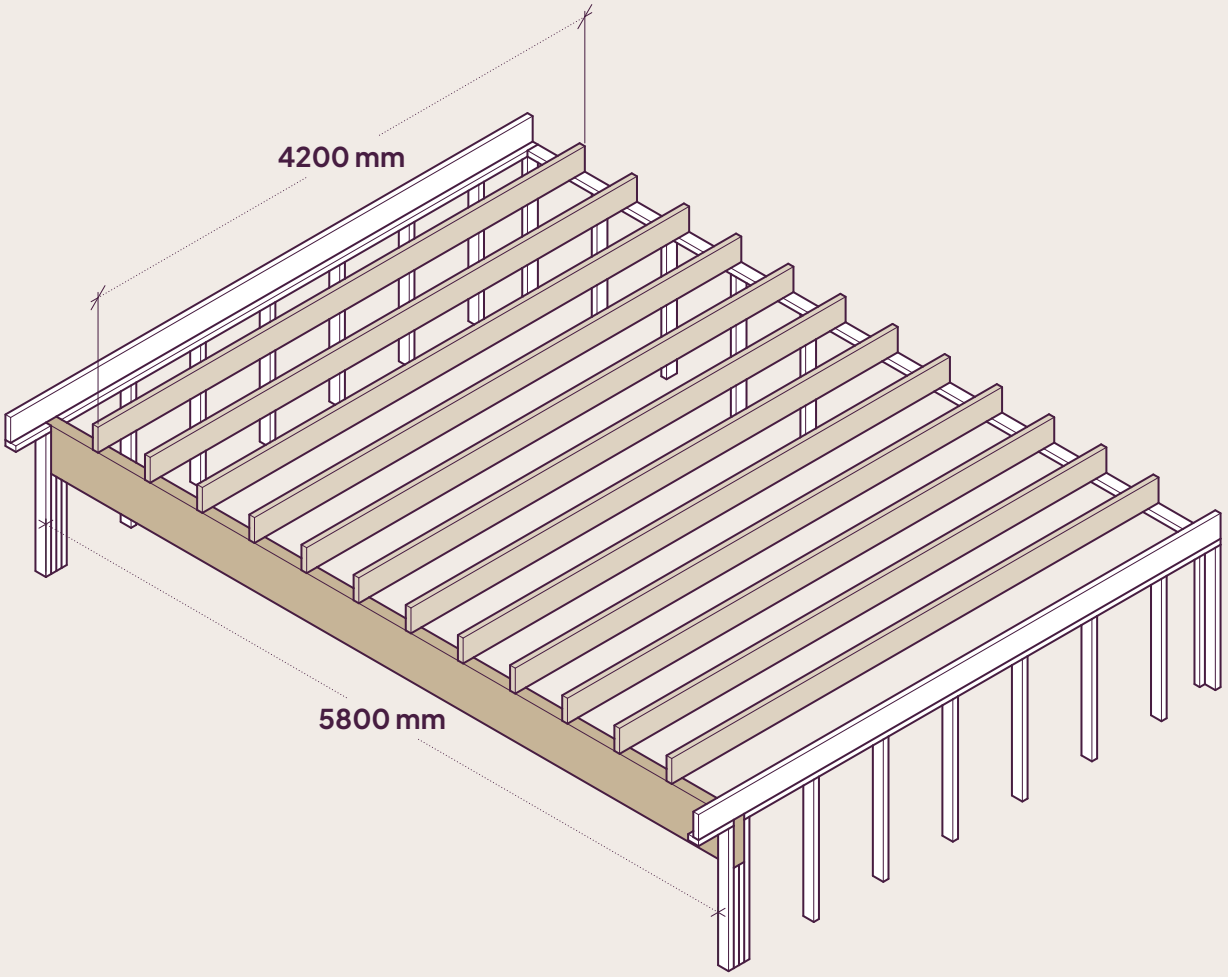
Timber Unlimited

Beam Design Example 2 – Glue Laminated Timber

DESIGNS TO NZS AS 1720.1:2022



Glue laminated timber



Design a Glulam floor beam, simply supported, spanning 5.8m with uniformly distributed loads.

Beam supporting floor joists @ 450crs spanning 4.2m, say dead load including self weight is 0.4kPa.

From AS/NZS1170, live load 1.5kPa UDL or 1.8kN point load.

	L	5.8	m		
	trib width s	2.1	m		
Dead load	G =	0.84	kN/m		
Live load	Q =	3.15	kN/m	or	1.8 kN

Load combinations from AS1170.0

Strength limit state

1.35G	1.1	kN/m		
1.2G+1.5Q	5.7	kN/m		
1.2G+1.5Qc	1.0	kN/m	plus	2.7 kN

Serviceability limit state

$G+\Psi_s Q$ =	3.05	kN/m	short term deflection	where Ψ_s =	0.7
$G+\Psi_l Q$ =	2.10	kN/m	long term deflection	Ψ_l =	0.4

Timber properties

GL8 and GL10 are the common glulam grades available in New Zealand

Properties from Table ZZ7.1

Try 360x90 GL10 Glulam beam, using 45mm laminations

d =	360
b =	90

Check bending strength (AS/NZS 1720 Section 2.1)

Design capacity

M_d	$\Phi\ K_1\ K_4\ K_6\ K_9\ K_{12}\ f'_b\ Z$		
Φ	0.8		from section ZZ2.3
K_1	0.57		for a permanent action - tables 2.3 and G1
	0.8		for medium term action - floor live load UDL - tables 2.3 and G1
	0.94		for short term action - floor live load concentrated - tables 2.3 and G1
K_4	1.00		moisture condition "seasoned" timber
K_6	1.00		temperature factor
n_{com}	1		number of members in combined parallel
n_{mem}	1		number of separate members in system
g_{31}	1.00		Section 2.4.5.3
g_{32}	1.00		
K_9	1.00		Section 7.4.3
L_{ay}	450		mm distance between restraints (joist spacing)
ρ_b	0.85		Table 7.2(A) for r = 0.25
S_1	5.6		3.2.3.2a
$\rho_b.S_1$	4.8		
K_{12}	1.0		3.2.4
f'_b	22.0	MPa	for GL10, from table ZZ7.1
$Z = bd^2/6$	1944000	mm^3	section modulus
$M_{d\,long}$	19.50	kNm	for long term action (permanent)
$M_{d\,med}$	27.37	kNm	for medium term action
$M_{d\,short}$	32.16	kNm	for short term action

Compare with design load

$M^*_{1.35G}$ =	4.8 kNm	<	$M_{d\,long}$	=	19.50	OK
$M^*_{1.2G+1.5Qu}$ =	24.1 kNm	<	$M_{d\,med}$	=	27.37	OK
$M^*_{1.2G+1.5Qc}$ =	8.2 kNm	<	$M_{d\,short}$	=	32.16	OK

Check shear strength (AS/NZS1720 3.2.5)

Design strength

V_d	$\Phi\ K_1\ K_4\ K_6\ f'_s\ A_s$		
Φ, K_1, K_4, K_6	factors from above		
f'_s	3.7	MPa	for GL10, from table ZZ7.1
$A_s = ⅔bd$	21600	mm^2	
$V_{d\,long}$	36.4	kN	for long term loading (permanent)
$V_{d\,med}$	51.1	kN	for medium term loading

Compare with design load

$V^*_{1.35G}$ =	3.3	kN	< $V_{d\,long}$	=	36.4	OK
$V^*_{1.2G+1.5Q}$ =	16.6	kN	< $V_{d\,med}$	=	51.1	OK

Check bearing strength (AS/NZS1720 3.2.6)

Assume bearing on 90mm wide top plate

Design strength

$N_{d,p}$	$\Phi\ K_1\ K_4\ K_6\ K_7\ f'_p\ A_p$				
$K_1\ K_4\ K_6$	from above				
K_7	1.00	length and position of bearing 2.4.4			
f'_p	6.9	MPa	using SG8/10 value as this is the material used for GL		
A_p	8100	mm^2	bearing area		
$N_{d,p\,long}$	25.5	kN			
$N_{d,p\,med}$	35.8	kN			
$N^*_{p\,1.35G}$	3.3	kN	< $N_{d,p\,long}$	25.5	OK
$N^*_{p\,1.2G+1.5Q}$	16.6	kN	< $N_{d,p\,med}$	35.8	OK

Check serviceability design limit state

E'	10.0	GPa	for GL10, from table ZZ7.1			
No need to apply the lower bound modulus of elasticity as glulam has lower variation in stiffness						
I	3.5×10^8	mm^4	moment of inertia			
Δ_G	3.5	mm	instantaneous dead load deflection			
Δ_{Qu}	13.3	mm	instantaneous live load deflection			
Δ_{Qc}	2.1	mm	instantaneous live load deflection due to point load			
j_2 =	1.5		creep factor for glulam in bending from ZZ7.4.2			
$\Delta_{G+\Psi sQ}$ =	12.8	mm	Span/400 =	14.5	mm	OK
$\Delta_{k2(G+\Psi lQ)}$ =	13.3	mm	Span/250 =	23.2	mm	OK

Refer to AS/NZS 1170.0 Table C1 for suggested serviceability limits, but apply engineering judgment.

Original examples produced by David Reid on behalf of TDS based on NZS 3603 and have been updated to reflect the new standard.

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