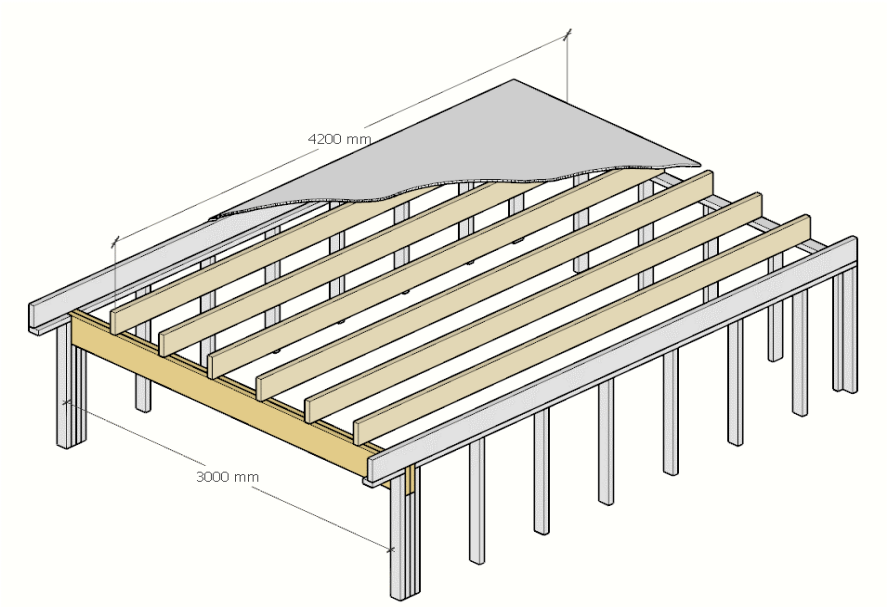
Beam design example 1 - Solid timber Design to NZS-AS 1720.1 2022



Consider a simply supported house floor beam spanning 3.0m 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	3	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:

SG8 is the most commonly available grade in radiata solid timber in NZ
Properties from Table ZZ2.1

Try double component 240x45 SG8 machine stress graded timber

d =	240	b =	45

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}	2	number of members in combinded parallel

n_{mem}	1	number of separate members in system	
g_{31}	1.14	Section 2.4.5.3	
g_{32}	1.14		
k_9	1.14		
L_{ay}	450	mm distance between restraints (joist spacing)	
ρ_b	0.76	Table ZZ3.1	
S_1	9.1	3.2.3.2a	
$\rho_b.S_1$	6.9		
k_{12}	1.0	3.2.4	
f_b	14.0	MPa	for SG8, from table ZZ2.1
$Z = bd^2/6$	864000	mm^3	section modulus
$M_{d\ long}$	6.29	kNm for long term action (permanent)	
$M_{d\ med}$	8.83	kNm for medium term action	
$M_{d\ short}$	10.37	kNm for short term action	

Compare with design load

$M^*_{1.35G}$ =	1.3	kNm	<	$M_{d\ long}$ =	6.29	OK
$M^*_{1.2G+1.5Qu}$ =	6.4	kNm	<	$M_{d\ med}$ =	8.83	OK
$M^*_{1.2G+1.5Qc}$ =	3.2	kNm	<	$M_{d\ short}$ =	10.37	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	3.8	MPa	for SG8, from table ZZ2.1
A_s = ⅔bd	14400	mm^2	
$V_{d\ long}$	25.0	kN	for long term loading (permanent)
$V_{d\ med}$	35.0	kN	for medium term loading

Compare with design load

$V^*_{1.35G}$ =	1.7	kN	<	$V_{d\ long}$ =	25.0	OK
$V^*_{1.2G+1.5Q}$ =	8.6	kN	<	$V_{d\ med}$ =	35.0	OK

Check bearing strength (AS/NZS1720 3.2.6)

assume bearing on 75mm 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
f'_p	6.9	MPa	Table ZZ2.1
A_p	6750	mm^2	bearing area
$N_{d,p\ long}$	21.2	kN	
$N_{d,p\ med}$	29.8	kN	

$N^*_{p\ 1.35G}$	1.7	kN	<	$N_{d,p\ long}$	21.2	OK
$N^*_{p\ 1.2G+1.5Q}$	8.6	kN	<	$N_{d,p\ med}$	29.8	OK

Check serviceability design limit state

E'	8.0	GPa	for SG8, from table ZZ2.1
E_{lb}	5.4	GPa	SG8 lower bound modulus of elasticity, table ZZ2.1
$E=(E'+E_{lb})/2$	6.7	GPa	allows for lower than average stiffness of the members
I	103680000	mm^4	moment of inertia
Δ_G	1.3	mm	instanteous dead load deflection
Δ_{Qu}	4.8	mm	instanteous live load deflection
Δ_{Qc}	1.5	mm	instanteous live load deflection due to point load
j_2 =	2.0		creep factor for solid dry timber table 2.4

$\Delta_{G+\psi sQ}$ =	4.6	mm	Span/400=	7.5	mm	OK
$\Delta_{k2(G+\psi lQ)}$ =	6.4	mm	Span/250=	12	mm	OK

refer to AS/NZS 1170.0 Table C1 for suggested serviceability limits

Example prepared by David Reid to NZS3603:1993 for NZ Timber Design Society website

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