INFORMATION SHEET
BEAM DESIGN

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EXAMPLE 1 – SOLID TIMBER

Consider a simply supported floor beam spanning 3.0m with uniformly distributed loads
Beam supporting floor joists @ 450crs

Dead load	G =	0.84	kN/m
Live load	Q =	3.15	kN/m

Load combinations from AS1170.0

Strength limit state:

1.35G	1.1	kN/m
1.2G+1.5Q	5.7	kN/m

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

Try double component 240x45 MSG8 machine stress graded timber

d =	240	b =	45

Check bending strength (NZS3603 3.2.4)

Design strength:

ϕM_n =	$\phi k_1 k_4 k_5 k_8 f_b Z$	for sawn timber		
ϕ =	0.8			
k_1 =	0.6	for a permanent load or	0.8	for medium term load
k_4 =	1.14	parallel support factor, 2 components		
k_5 =	1.0			
L_{ay} =	450	mm distance between restraints		
S =	1.35 (L_{ay} / b ((d/b)^2 - 1)^0.5)^0.5 =		9.77	(or use Fig 3.1)
k_8 =	1.0	from Table 2.8		
f_b =	14.0	MPa	for MSG8, from NZS3603 Amendment 4, Table 2.3	
$Z = bd^2/6$ =	864000	mm^3		
$\phi M_{n\ long}$ =	6.62	kNm for long term loading (permanent)		
$\phi M_{n\ med}$ =	8.83	kNm for medium term loading		

Compare with design load

$M^*_{1.35G}$ =	1.3	kNm	<	$\phi M_{n\ long}$ =	6.62	OK
$M^*_{1.2G+1.5Q}$ =	6.4	kNm	<	$\phi M_{n\ med}$ =	8.83	OK

Check shear strength (NZS3603 3.2.3)

Design strength:

ϕV_n =	$\phi k_1 k_4 k_5 f_s A_s$		
$\phi k_1, k_4, k_5$	factors from above		
f_s =	3.8	MPa	for MSG8 radiata, from NZS3603 Amendment 4, Table 2.3
$A_s = {}^2/_3 bd$ =	14400	mm^2	
$\phi V_{n\ long}$ =	29.9	kN	for long term loading (permanent)
$\phi V_{n\ med}$ =	39.9	kN	for medium term loading

Compare with design load

$V^*_{1.35G}$ =	1.7	kN	<	$\phi V_{n\ long}$ =	29.9	OK
$V^*_{1.2G+1.5Q}$ =	8.6	kN	<	$\phi V_{n\ med}$ =	39.9	OK

Check bearing strength (NZS3603 3.2.9)

assume bearing on 75mm wide top plate

Design strength:

ϕN_{nbp} =	$\phi k_1 k_3 f_p A_p$		
k_1	from above		
k_3 =	1.15		
f_p =	8.9	MPa	for MSG8, from NZS3603 Amendment 4, Table 2.3
A_p =	6750	mm^2	bearing area
$\phi N_{nbp\ long}$ =	33.2	kN	
$\phi N_{nbp\ med}$ =	44.2	kN	

$N^*_{1.35G}$ =	1.7	kN	<	$\phi N_{nbp\ long}$ =	33.2	OK
$N^*_{1.2G+1.5Q}$ =	8.6	kN	<	$\phi N_{nbp\ med}$ =	44.2	OK

Check serviceability design limit state

E =	8.0	GPa	for MSG8, from NZS3603 Amendment 4, Table 2.3
E_{lb} =	5.4	GPa	lower bound modulus of elasticity, NZS3603 A4 Table2.3
Δ_G =	1.1	mm	instanteous dead load deflection, using E = 8.0
Δ_Q =	4.0	mm	instanteous live load deflection, using E = 8.0
k_2 =	2.0		creep factor for solid timber
$\Delta_{G+\psi sQ}$ =	3.9	mm	
$\Delta_{k2(G+\psi lQ)}$ =	5.3	mm	

these is the most likely deflections, however it is possible that these timber members may have a lower stiffness than the average, from NZS3603 A4 2.4.2.3 b) for 2 components, use:

	E=(E+Elb)/2	6.7	GPa				
so	$\Delta_{G+\psi sQ}$ =	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 2 – GLUED LAMINATED TIMBER

Design a Glulam floor beam, simply supported, spanning 6.0m with uniformly distributed loads
Beam supporting floor joists @ 450crs

Dead load	G =	1	kN/m
Live load	Q =	2.9	kN/m

Load combinations from AS1170.0

Strength limit state:

1.35G	1.4	kN/m
1.2G+1.5Q	5.6	kN/m

Serviceability limit state:

$G+\psi_s Q$ =	3.03	kN/m	short term deflection	where	ψ_s= 0.7
$G+\psi_l Q$ =	2.16	kN/m	long term deflection		ψ_l = 0.4

Using GL grades from AS/NZS 1328.2
Try 360x90 GL10 Glulam beam, using 45mm laminations

d =	360	b =	90

Check bending strength (NZS3603 3.2.4)
Design strength:

ϕM_n =	$\phi k_1 k_4 k_5 k_6 k_8 k_{24} f_b Z$	for Glulam		
ϕ =	0.8			
k_1 =	0.6	for a permanent load or	0.8	for medium term load
k_4 =	1.0	taken as 1.0 for GL grades		
k_5 =	1.0	taken as 1.0 for GL grades		
L_{ay} =	450	mm distance between restraints		
S =	1.35 (L_{ay} / b ((d/b)^2 - 1)^0.5)^0.5 =		5.94	(or use Fig 3.1)
k_8 =	1.0	from NZS3603 Table 2.8		
f_b =	22.0	MPa	for GL10 from AS/NZS 1328.2 Table 1.2	
$Z = bd^2/6$ =	1944000	mm^3		
$\phi M_{n\ long}$ =	20.5	kNm for long term loading (permanent)		
$\phi M_{n\ med}$ =	27.4	kNm for medium term loading		

Compare with design load

$M^*_{1.35G}$ =	6.1	kNm	<	$\phi M_{n\ long}$ =	20.5	OK
$M^*_{1.2G+1.5Q}$ =	25.0	kNm	<	$\phi M_{n\ med}$ =	27.4	OK

Check shear strength (NZS3603 3.2.3)

Design strength:

ϕV_n =	$\phi k_1 k_4 k_5 f_s A_s$		
$\phi k_1 k_4 k_5$	factors from above		
f_s =	3.7	MPa	for GL10 from AS/NZS 1328.2 Table 1.2
$A_s = \phi bd$ =	43200	mm^2	
$\phi V_{n\ long}$ =	76.7	kN	for long term loading (permanent)
$\phi V_{n\ med}$ =	102.3	kN	for medium term loading

Compare with design load

$V^*_{1.35G}$ =	4.1	kN	<	$\phi V_{n\ long}$ =	76.7		OK
$V^*_{1.2G+1.5Q}$ =	16.7	kN	<	$\phi V_{n\ med}$ =	102.3		OK

Check bearing strength (NZS3603 3.2.9)

assume bearing on 100mm wide top plate

Design strength:

ϕN_{nbp} =	$\phi k_1 k_3 f_p A_p$						
k_1	from above						
k_3 =	1.06						
f_p =	8.9	MPa	using MSG8 value, from NZS3603 Amendment 4, Table 2.3				
A_p =	13500	mm^2	bearing area				
$\phi N_{nbp\ long}$ =	61.1	kN					
$\phi N_{nbp\ med}$ =	81.5	kN					
$N^*_{1.35G}$ =	4.1	kN	<	$\phi N_{nbp\ long}$ =	61.1		OK
$N^*_{1.2G+1.5Q}$ =	16.7	kN	<	$\phi N_{nbp\ med}$ =	81.5		OK

Check serviceability design limit state

E =	10.0	GPa	for GL10 from AS/NZS 1328.2 Table 1.2			
The lower bound modulus of elasticity, NZS3603 A4 doesn't need to be considered for Glulam						
Δ_G =	4.8	mm	instanteous dead load deflection			
Δ_Q =	14.0	mm	instanteous live load deflection			
k_2 =	1.5		creep factor for Glulam NZS3603 8.7.4			
$\Delta_{G+\psi sQ}$ =	14.6	mm	Span/400=	15	mm	OK
$\Delta_{k2(G+\psi lQ)}$ =	15.6	mm	Span/250=	24	mm	OK

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

need to make a judgement call on the expected actual long term live load, the standard says 40% of live load (ψl = 0.4), but probably 25% of the live load would be more accurate for a domestic situation (ψl = 0.25)

using ψl =	0.25	
$\Delta_{k2(G+\psi lQ)}$ =	12.5	mm
Camber =	12.0	mm

use 360 x 90 GL10 Glulam, camber 12mm