

Beam design 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 $\psi_s = 0.7$
 $G + \psi_l Q = 2.10$ kN/m long term deflection $\psi_l = 0.4$

Try double component 240x45 MSG8 machine stress graded timber

$d = 240$ $b = 45$

Check bending strength (NZS3603 3.2.4)

Design strength:

$\phi M_n = \phi k_1 k_4 k_5 k_8 f_b Z$ for sawn timber
 $\phi = 0.8$
 $k_1 = 0.6$ 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
 $Z = bd^2/6 = 864000$ mm³
 $\phi M_{n\text{ long}} = 6.62$ kNm for long term loading (permanent)
 $\phi M_{n\text{ med}} = 8.83$ kNm for medium term loading

Compare with design load

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

Check shear strength (NZS3603 3.2.3)

Design strength:

$\phi V_n = \phi k_1 k_4 k_5 f_s A_s$
 ϕ, k_1, k_4, k_5 factors from above
 $f_s = 3.8$ MPa for MSG8 radiata, from NZS3603 Amendment 4, Table 2.3
 $A_s = \frac{2}{3}bd = 14400$ mm²
 $\phi V_{n\text{ long}} = 29.9$ kN for long term loading (permanent)
 $\phi V_{n\text{ med}} = 39.9$ kN for medium term loading

Compare with design load

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

Check bearing strength (NZS3603 3.2.9)

assume bearing on 75mm wide top plate

Design strength:

$\phi N_{nbp} = \phi k_1 k_3 f_p A_p$

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
$\phi N_{nbp \text{ long}} =$	33.2	kN				
$\phi N_{nbp \text{ med}} =$	44.2	kN				
$N^*_{1.35G} =$	1.7	kN	<	$\phi N_{nbp \text{ long}} =$	33.2	OK
$N^*_{1.2G+1.5Q} =$	8.6	kN	<	$\phi N_{nbp \text{ med}} =$	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 Table 2.3
$\Delta_G =$	1.1	mm				instantaneous dead load deflection, using $E = 8.0$
$\Delta_Q =$	4.0	mm				instantaneous live load deflection, using $E = 8.0$
$k_2 =$	2.0					creep factor for solid timber
$\Delta_{G+\psi_s Q} =$	3.9	mm				
$\Delta_{k2(G+\psi_l Q)} =$	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:

	$E=(E+E_{lb})/2$	6.7	GPa			
so	$\Delta_{G+\psi_s Q} =$	4.6	mm	Span/400=	7.5	mm OK
	$\Delta_{k2(G+\psi_l Q)} =$	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, Structural Engineer.