SW of joists at 600 centres $= \frac{540}{100} \times 0.225 \times 0.05 \times \frac{1000}{600} = 0.1\,\text{kN/m}^2$

SW assumed $= 0.1\,\text{kN/m}^2$

Conclusion

Use 50 mm × 225 mm SC3 whitewood sawn joists.

Example 2.2

Design the timber floor for a dwelling if it comprises tongued and grooved (T&G) boards carried by 3.6 m span joists at 600 mm centres. The load imposed by the dead weight of the boards is $0.1\,\text{kN/m}^2$, by the joists $0.12\,\text{kN/m}^2$ and by a plaster ceiling on the underside $0.18\,\text{kN/m}^2$. The floor is subjected to a domestic imposed load of $1.5\,\text{kN/m}^2$.

Use home grown Douglas fir M50/SS timber.

Loading

Dead load: boards	0.10	
joists	0.12	
ceiling	0.18	
	0.4	kN/m^2

Imposed load: $1.5\,\text{kN/m}^2$

Combined load: dead	0.4	
imposed	1.5	
	1.9	kN/m^2

Guidance on the specification of T&G softwood flooring is given in BS 1297. The thickness of T&G floor boards for domestic situations may be obtained directly from the Building Regulations. The board thickness recommended for joists spaced at 600 mm is 19 mm.

UDL per joist $= 1.9 \times 3.6 \times 0.6 = 4.1\,\text{kN} = 4.1 \times 10^3\,\text{N}$

Bending

$$M = \frac{WL}{8} = \frac{4.1 \times 3.6}{8} = 1.85\,\text{kN m} = 1.85 \times 10^6\,\text{N mm}$$

$\sigma_{\text{m,g,par}}$ for M50/SS $= 5.3\,\text{N/mm}^2$

K_3 (long term) $= 1.0$; $K_8 = 1.1$; K_7 is unknown

Approximate Z_{xx} required

$$= \frac{M}{\delta_{\text{m,g,par}} K_3 K_8} = \frac{1.85 \times 10^6}{5.3 \times 1.0 \times 1.1} = 317\,324\,\text{mm}^3 = 317 \times 10^3\,\text{mm}^3$$

By reference to Table 2.8, the maximum depth to breadth ratio needed to ensure lateral stability is 5.

From Table 2.4, a 50 mm × 200 mm joist has $Z_{xx} = 333 \times 10^3\,\text{mm}^3$. Check with $K_7 = 1.046$:

$$\text{Final } Z_{xx} \text{ required} = \frac{317 \times 10^3}{1.046} = 303 \times 10^3\,\text{mm}^3$$

Deflection

Permissible $\delta_p = 0.003 \times \text{span} = 0.003 \times 3600 = 10.8\,\text{mm}$

$$\text{Actual } \delta_a = \delta_m + \delta_v = \frac{5}{384}\frac{WL^3}{EI} \times \frac{19.2M}{AE}$$

$$= \frac{5}{384} \times \frac{4.1 \times 10^3 \times 3600^3}{8800 \times 33.3 \times 10^6} + \frac{19.2 \times 1.85 \times 10^6}{10 \times 10^3 \times 8800}$$

$$= 8.5 + 0.4 = 8.9\,\text{mm} < 10.8\,\text{mm}$$

Thus the 50 mm × 200 mm joist is adequate in deflection.

Shear unnotched

$$\text{Maximum shear } F_v = \frac{UDL}{2} = \frac{4.1}{2} = 2.05\,\text{kN} = 2.05 \times 10^3\,\text{N}$$

$r_g = 0.67\,\text{N/mm}^2$

$r_{adm} = r_g K_3 K_8 = 0.67 \times 1 \times 1.1 = 0.737\,\text{N/mm}^2$

$$r_a = \frac{3}{2}\frac{F_v}{A} = \frac{3}{2} \times \frac{2.05 \times 10^3}{10 \times 10^3} = 0.308\,\text{N/mm}^2 < 0.737\,\text{N/mm}^2$$

Thus the 50 mm × 200 mm joist is adequate in shear unnotched.

Bearing

$F = 2.05 \times 10^3\,\text{N}$

Assume that the joists are supported on 100 mm blockwork; hence the bearing length will be 100 mm.

$$\sigma_{c,a,perp} = \frac{F}{\text{bearing area}} = \frac{2.05 \times 10^3}{100 \times 50} = 0.41\,\text{N/mm}^2$$

$\sigma_{c,g,perp} = 2.2\,\text{N/mm}^2$, wane prohibited

$\sigma_{c,adm,perp} = \sigma_{c,g,perp} K_3 K_8 = 2.2 \times 1 \times 1.1 = 2.42\,\text{N/mm}^2 > 0.41\,\text{N/mm}^2$

The section is adequate in bearing.

Conclusion

Use 50 mm × 200 mm M50/SS home grown Douglas fir joists.

Example 2.3

Timber roof purlins spanning 2.65 m support a total UDL, inclusive of their own weight, of 9 kN. Using GS grade redwood, what size of member is required?

Loading

Total UDL = 9 kN

Bending

$$M = \frac{WL}{8} = \frac{9 \times 2.65}{8} = 2.98\,\text{kN m} = 2.98 \times 10^6\,\text{N mm}$$