(b) Calculate slenderness ratio λ from either of

$$\lambda = \frac{\text{effective length}}{\text{radius of gyration}} = \frac{L_e}{i} < 180$$

$$\lambda = \frac{\text{effective length}}{\text{least lateral dimension}} = \frac{L_e}{b} < 52$$

(c) Calculate the ratio of modulus of elasticity to compression stress $E_{min}/\sigma_{c,g,par}K_3$.

(d) Obtain K_{12} from Table 2.9 using λ and $E_{min}/\sigma_{c,g,par}K_3$ values.

(e) Calculate permissible compression stress:

$$\sigma_{c,adm,par} = \text{grade compression stress} \times K \text{ factors}$$
$$= \sigma_{c,g,par}K_3K_{12}K_8$$

(where K_8 is used if applicable).

(f) Calculate applied stress and compare with permissible stress:

$$\sigma_{c,a,par} = \frac{\text{applied load}}{\text{area of section}} < \sigma_{c,adm,par}$$

Alternatively the permissible load can be calculated and compared with the applied load:

$$\text{Permissible load} = \sigma_{c,adm,par} \times \text{area} > \text{applied load}$$

If the post is eccentrically loaded, the following additional steps should be taken:

(g) Calculate eccentricity moment $M_e = \text{load} \times e$.

(h) Obtain grade bending stress $\sigma_{m,g,par}$ from table.

(i) Calculate permissible bending stress:

$$\sigma_{m,adm,par} = \sigma_{m,g,par}K_3K_7$$

(j) Calculate applied bending stress and compare with permissible stress:

$$\sigma_{m,a,par} = \frac{M_e}{Z} < \sigma_{m,adm,par}$$

(k) Finally, check that the interaction quantity is less than unity:

$$\frac{\sigma_{m,a,par}}{\sigma_{m,adm,par}\{1 - [1.5\sigma_{c,a,par}K_{12}(L_e/i)^2/\pi^2E_{min}]\}} + \frac{\sigma_{c,a,par}}{\sigma_{c,adm,par}} \leqslant 1$$

Note that throughout this procedure the wet exposure modification factors should be applied where necessary if the member is to be used externally.

Let us now look at some examples on the design of timber posts.

Example 2.5

What is the safe long term axial load that a 75 mm × 150 mm sawn GS grade hem–fir post can support if it is restrained at both ends in position and one end in direction, and its actual height is 2.1 m?

By reference to Table 2.10 the effective length L_e will be 0.85 times the actual length L. The effective length is used to calculate the slenderness ratio which, together with the ratio of modulus of elasticity to compression stress, is used to obtain the K_{12} factor from Table 2.9.

The slenderness ratio λ may be calculated from either of the following two expressions:

$$\lambda = \frac{\text{effective length}}{\text{radius of gyration}} = \frac{L_e}{i} = \frac{0.85 \times 2100}{21.7} = 82.25 < 180$$

$$\lambda = \frac{\text{effective length}}{\text{least lateral dimension}} = \frac{L_e}{b} = \frac{0.85 \times 2100}{75} = 23.8 < 52$$

Both values are therefore satisfactory. It should be noted that the radius of gyration value used in the first expression is the least radius of gyration about the y–y axis, obtained from Table 2.4.

The ratio of modulus of elasticity to compression stress is calculated from the following expression:

$$\frac{E_{\text{min}}}{\sigma_{\text{c,g,par}} K_3} = \frac{5800}{6.8 \times 1} = 852.94$$

The K_{12} factor is now obtained by interpolation from Table 2.9 as 0.495. This is used to adjust the grade compression stress and hence take account of the slenderness:

Grade compression stress $\sigma_{\text{c,g,par}} = 6.8\ \text{N/mm}^2$

Permissible stress $\sigma_{\text{c,adm,par}} = \sigma_{\text{c,g,par}} K_3 K_{12} = 6.8 \times 1 \times 0.495 = 3.37\ \text{N/mm}^2$

Permissible load = permissible stress × area of post

$= 3.37 \times 11.3 \times 10^3 = 38 \times 10^3\ \text{N} = 38\ \text{kN}$

Example 2.6

Design a timber post to support a medium term total axial load of 12.5 kN restrained in position but not in direction at both ends. The post is 2.75 m in height and GS grade redwood or whitewood is to be used.

The actual length $L = 2.75\ \text{m} = 2750\ \text{mm}$; the effective length $L_e = 1.0L$. Try 63 mm × 150 mm sawn section. The grade compression stress $\sigma_{\text{c,g,par}} = 6.8\ \text{N/mm}^2$.