For a flexural member to be adequate in deflection the summation of the actual deflection due to bending δ_m and that due to shear δ_v must not be greater than the permissible value δ_p:

$$\delta_m + \delta_v \not> \delta_p$$

The actual bending deflection δ_m is calculated using the formula relevant to the applied loading:

For a UDL:

$$\delta_m = \frac{5}{384}\frac{WL^3}{EI}$$

For a central point load:

$$\delta_m = \frac{1}{48}\frac{WL^3}{EI}$$

The E value to be adopted is E_{min} for isolated members and E_{mean} for load sharing members.

The actual deflection δ_v produced by shear on rectangular (and square) cross-section members is calculated using the following expression:

$$\delta_v = \frac{SM}{AG}$$

where

M mid-span bending moment

S member shape factor, which is 1.2 for rectangular sections

A section area

G modulus of rigidity or shear modulus, taken as $E/16$

E appropriate E value: E_{min} for isolated members, E_{mean} for load sharing members

The expression can be rewritten to include the values for S and G as follows:

$$\delta_v = \frac{SM}{AG} = \frac{1.2M}{AE/16} = \frac{19.2M}{AE}$$

The total actual deflection δ_a resulting from bending and shear will therefore be the summation of the relevant formulae:

$$\delta_a = \delta_m + \delta_v$$

For a UDL:

$$\delta_a = \frac{5}{384}\frac{WL^3}{EI} + \frac{19.2M}{AE}$$

For a point load:

$$\delta_a = \frac{1}{48}\frac{WL^3}{EI} + \frac{19.2M}{AE}$$

2.12.3 Shear

The critical position for shear on a normally loaded flexural member is at the support where the maximum reaction occurs. The shear stress occurring at that position is calculated and compared with the permissible value.

For rectangular timber flexural members the maximum applied shear stress parallel to the grain, r_a, occurs at the NA and is calculated from the following expression:

$$r_a = \frac{3}{2}\frac{F_v}{A}$$

where F_v is the maximum vertical shear (usually maximum reaction) and A is the cross-sectional area (bh).

The applied shear stress must be less than the permissible shear stress parallel to the grain, r_{adm}. This is obtained by multiplying the grade shear stress parallel to the grain, r_g (Table 2.2), by the K_3 load duration and K_8 load sharing factors as appropriate. Thus

$$r_a \leqslant r_{adm}$$
$$r_a \leqslant r_g K_3 K_8$$

Notches occurring at the ends of flexural members affect their shear capacity. To allow for this, the permissible shear stress parallel to the grain is further reduced by a modification factor K_5. Thus

$$r_a = \frac{3}{2}\frac{F_v}{A} \leqslant r_{adm} K_5$$

The factor K_5 is obtained in one of two ways depending on whether the notch occurs in the top (Figure 2.1) or the bottom (Figure 2.2) of the member:

$$\text{Top edge notches: } K_5 = \begin{cases} \dfrac{h(h_e - a) + ah_e}{h_e^2} & \text{when} \quad a \leqslant h_e \\ 1.0 & \text{when} \quad a > h_e \end{cases}$$

$$\text{Bottom edge notches: } K_5 = \frac{h_e}{h}$$

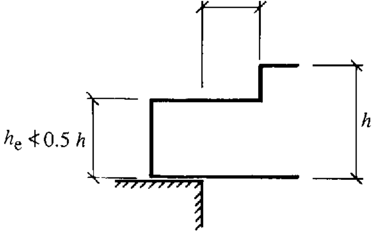

Figure 2.1 *Top edge notch*

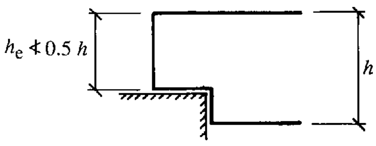

Figure 2.2 *Bottom edge notch*