The actual deflection is given by

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

The second moment of area I for a rectangular section is given by

$$I = \frac{bd^3}{12} = \frac{100 \times 200^3}{12} = 66.66 \times 10^6 \text{ mm}^4$$

Therefore

$$\delta_a = \frac{5}{384} \times \frac{4 \times 10^3 \times 5000^3}{6600 \times 66.66 \times 10^6} = 14.8 \text{ mm}$$

The permissible deflection is given by

$$\delta_p = 0.003 \times \text{span} = 0.003 \times 5000 = 15 \text{ mm}$$

The actual deflection of 14.8 mm is less than the permissible 15 mm and therefore the beam would be adequate in deflection.

1.6 Compression members

Compression members are those elements within a structure which have to resist compressive stresses induced by the loads they support. The most obvious examples to be found in a building are the main vertical support members to the roof and floors. These are commonly referred to as either columns, posts or stanchions depending on the material from which they are formed. Reinforced concrete compression members are usually called columns, timber compression members posts, and steel compression members stanchions.

The vertical loads they support can be concentric or eccentric. If the load is concentric its line of application coincides with the neutral axis (NA) of the member (see Figure 1.18). Such compression members are said to be axially loaded and the stress induced is a direct compressive stress. In practice the vertical load is often applied eccentrically so that its line of action is eccentric to the NA of the member (see Figure 1.19). This induces compressive bending stresses in the member in addition to direct compressive stresses.

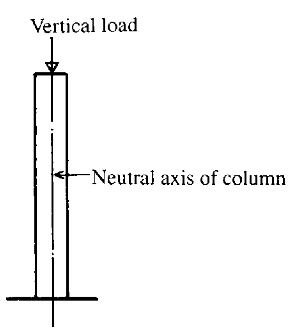

Figure 1.18 *Concentric load*

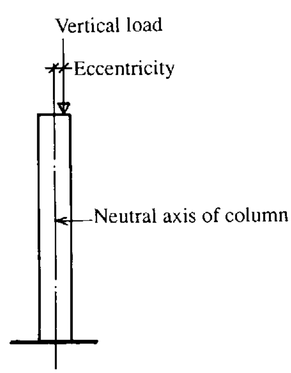

Figure 1.19 *Eccentric load*

In relation to their mode of failure, compression members can be described as either 'short' or 'long'. A short compression member would fail due to the material crushing, whereas a long member may fail by buckling laterally before crushing failure of the material is reached (see Figure 1.20).

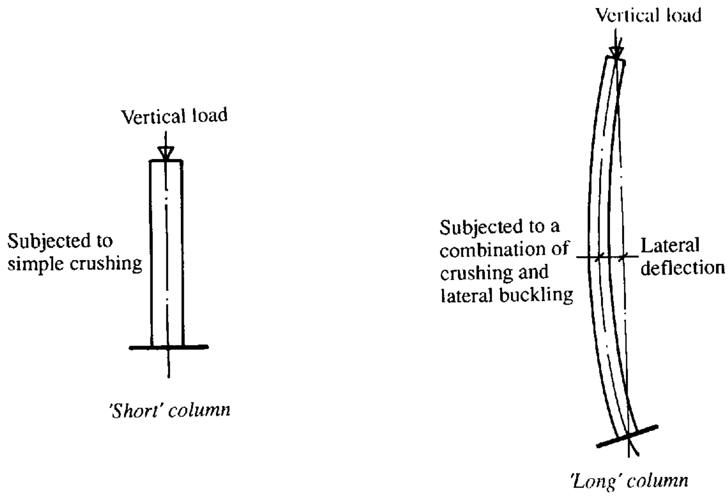

Figure 1.20 *Short and long columns*

A reinforced concrete column is considered to be a short column when its effective height does not exceed fifteen times its least width. Thus a column of 300 mm by 200 mm cross-section is in the short category when its effective height does not exceed 3 m. A large majority of reinforced concrete columns are in this category.

The design of axially loaded short columns is simply based on the expression

$$\text{Stress} = \frac{\text{load}}{\text{area}}$$

where the stress is the permissible compressive stress of the column material, the load is the applied vertical load, and the area is the cross-sectional area of the column.

Steel sections are produced by rolling the steel whilst hot into various standard cross-sectional profiles. Some of the typical shapes available are shown in Figure 1.21. Information on the dimensions and geometric properties of standard steel sections may be obtained from British Standards or publications produced by the Steel Construction Institute.

For a steel column to be considered as a short column, its effective height must generally not exceed six times its least width. Hence, the effective height of a 203 mm × 203 mm universal column (UC) section would not have to exceed 1218 mm for it to be a short column. This serves to illustrate that in practical terms steel columns are usually in the long column category.