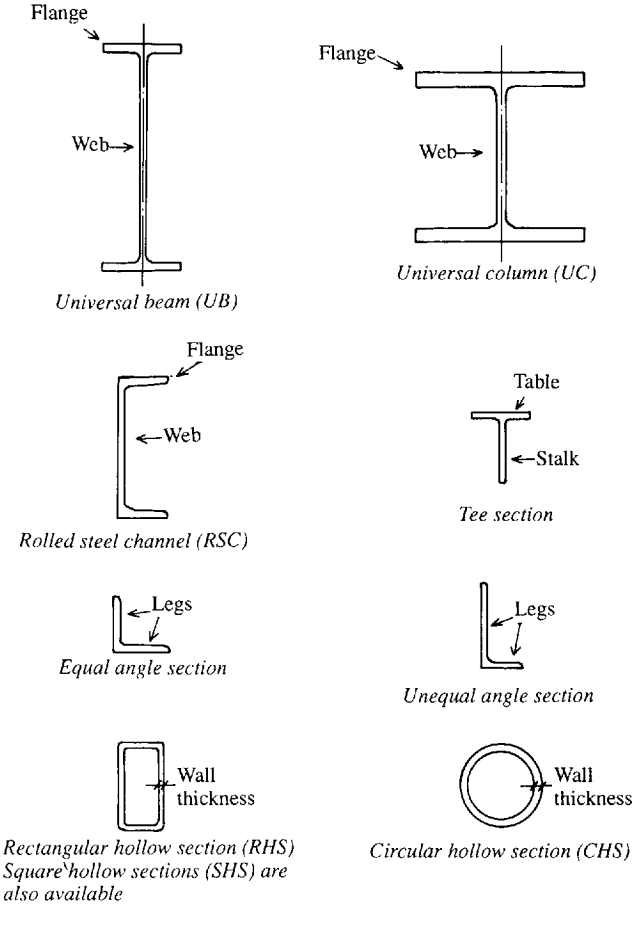


**Figure 1.21** *Rolled steel sections, typical shapes available*

Timber posts, because of the cross-sectional dimensions of available sizes, are normally also in the long column category.

Since long columns fail due to a combination of crushing and lateral buckling, the permissible stress is related to their slenderness. This depends upon the column height, its cross-sectional geometry and how it is held at the top and bottom.

The factor which governs the permissible stress of a long column is its slenderness ratio. This is the ratio of the effective length to the least radius of gyration of the member. The permissible compressive stress reduces as the slenderness ratio of the column increases. Thus

$$\text{Slenderness ratio} = \frac{\text{effective length}}{\text{least radius of gyration}}$$

$$SR = \frac{l}{r}$$

The radius of gyration is another geometric property, related to the second moment of area of the column section and its area:

$$\text{Radius of gyration} = \sqrt{\left(\frac{\text{second moment of area}}{\text{area}}\right)}$$

$$r = \sqrt{\left(\frac{I}{A}\right)}$$

The effective length of a column is controlled by the way it is held at each end or, as it is termed, its end fixity. By effective length we mean the height of column which is subject to lateral buckling.

If a column is located in position at each end but not held rigidly, it would buckle over a distance equivalent to its full height (see Figure 1.22). The ends in this instance are said to be held in position only or pinned. If the column were held rigidly at each end, however, the distance over which it would tend to buckle would reduce to something less than its full height (see Figure 1.23). In this instance the ends are said to be both held in position and restrained in direction or fixed.

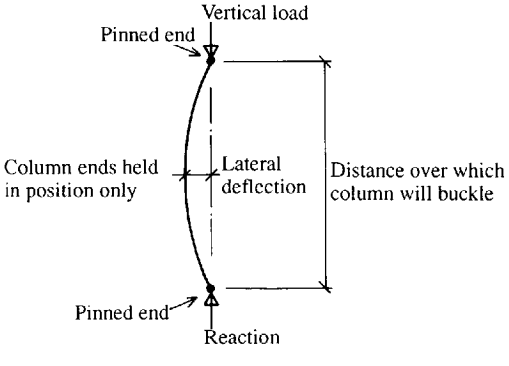


**Figure 1.22** *Column located in position only at each end*

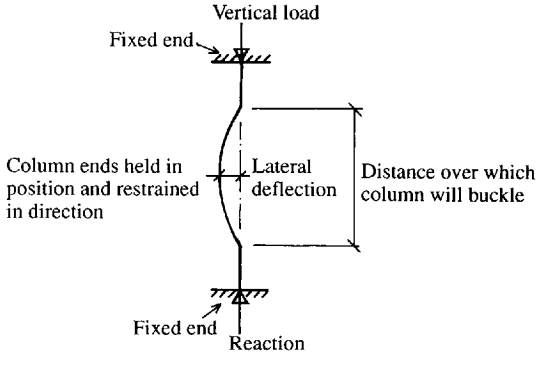


**Figure 1.23** *Column held rigidly at each end*

It can be seen therefore that different conditions of end fixity produce different effective lengths. In general there are four standard effective length conditions; these are illustrated in Figure 1.24. Guidance on the type of end connection needed to produce the different end restraint conditions in relation to the various materials is given in the relevant British Standards. It should be understood that, all other things being equal, the shorter the effective length the stronger the member.

There are subtle differences in the design approach for columns depending on the material. Therefore, to avoid confusion, examples on the design of columns will be dealt with in each of the respective material chapters of this manual.