The maximum design shear stress occurring is

$$v = \frac{V}{b_v d} = \frac{38.75 \times 10^3}{1000 \times 224} = 0.173 \text{ N/mm}^2$$

Now

$$\frac{100 A_s}{b_v d} = 0.288 \text{ per cent}$$

Thus the design concrete shear stress (from Table 3.12) v_c is 0.48 N/mm^2 for grade 25 concrete. Therefore for grade 40 concrete,

$$v_c = 0.48(f_{cu}/25)^{1/3} = 0.48(40/25)^{1/3} = 0.56 \text{ N/mm}^2$$

Hence since $v = 0.173$ N/mm^2 is less than $v_c = 0.56$ N/mm^2, no shear reinforcement is required.

Deflection

Check the deflection SLS by reference to the recommended span to depth ratios given in Table 3.9 of this manual. The basic span to effective depth ratio is 20. But this must be modified by the factor for the amount of tension reinforcement in the slab, obtained from Table 3.10, when

$$\frac{M}{bd^2} = \frac{48.44 \times 10^6}{1000 \times 224^2} = 0.97$$

From the expression given in the second footnote to Table 3.10,

$$f_s = \frac{5}{8} f_y \frac{A_{s,req}}{A_{s,prov}} = \frac{5}{8} \times 460 \times \frac{569}{646} = 253.23 \text{ N/mm}^2$$

Therefore the modification factor for tension reinforcement is 1.56. The allowable span to effective depth ratio is $20 \times 1.56 = 31.2$, and the actual span to effective depth ratio is $5000/224 = 22.32 < 31.2$. Hence the slab is adequate in deflection.

3.11 Columns

Reinforced concrete columns are classified in BS 8110 as either unbraced or braced. The difference relates to the manner by which lateral stability is provided to the structure as a whole. A concrete framed building may be designed to resist lateral loading, such as that resulting from wind action, in two distinct ways:

(a) The beam and column members may be designed to act together as a rigid frame in transmitting the lateral forces down to the foundations (Figure 3.30). In such an instance the columns are said to be unbraced and must be designed to carry both the vertical (compressive) and lateral (bending) loads.

(b) Alternatively the lateral loading may be transferred via the roof and floors to a system of bracing or shear walls, designed to transmit the resulting forces down to the foundations (Figure 3.31). The columns are then said to be braced and consequently carry only vertical loads.

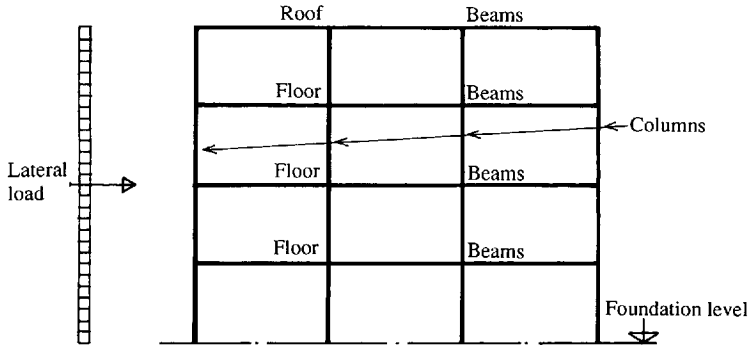

Figure 3.30 *Unbraced frame; lateral load must be resisted and transmitted down to the foundations by interaction between the beam and column frame members*

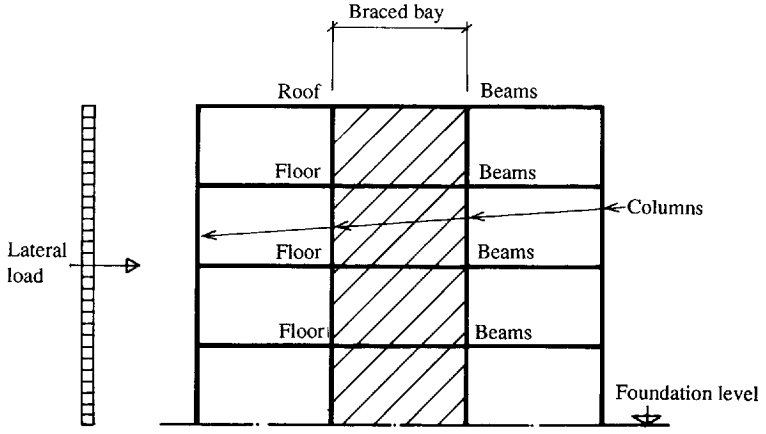

Figure 3.31 *Braced frame; lateral load transmitted down to foundations through a system of bracing or shear walls*

Columns are further classified in BS 8110 as either short or slender. A braced column may be considered to be short when neither of its effective height ratios exceeds 15; that is, for a short braced column

$$\frac{l_{ex}}{h} < 15 \quad \text{and} \quad \frac{l_{ey}}{b} < 15$$

where

l_{ex} effective height in respect of column major axis
l_{ey} effective height in respect of column minor axis
h depth in respect of major axis
b width in respect of minor axis

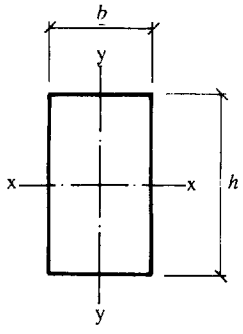

Figure 3.32 *Cross-section through a rectangular column*

The lateral dimensions h and b relative to the axes of a rectangular column are shown in Figure 3.32.