If either of the effective height ratios did exceed 15 then the braced column would be considered to be a slender column. In such circumstances the slender braced column would have to be designed to resist additional bending moments induced by lateral deflection.

For the purpose of this manual only the design of short braced columns will be studied.

The effective heights l_{ex} and l_{ey} about the respective axes are influenced by the degree of fixity at each end of the column. Simplified recommendations are given in BS 8110 Part 1 for the assessment of effective column heights for common situations. For braced columns the effective height is obtained by multiplying the clear height between restraints l_o by an end condition factor β from BS 8110 Part 1 Table 3.21, reproduced here as Table 3.15:

$$\text{Effective heights } l_{ex} \text{ or } l_{ey} = \beta l_o$$

Table 3.15   Values of β for braced columns (BS 8110 Part 1 1985 Table 3.21)

End condition at top	End condition at bottom		
	1	2	3
1	0.75	0.80	0.90
2	0.80	0.85	0.95
3	0.90	0.95	1.00

The types of end condition that influence end fixity are defined in BS 8110 as follows:

Condition 1   The end of the column is connected monolithically to beams on either side which are at least as deep as the overall dimension of the column in the plane considered (Figure 3.33). Where the column is connected to a foundation structure, this should be of a form specifically designed to carry moment.
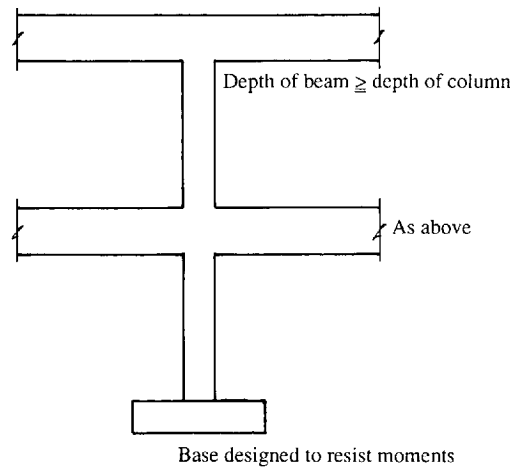

Depth of beam $\geq$ depth of column

As above

Base designed to resist moments

Figure 3.33   *End fixity condition 1*

Condition 2 The end of the column is connected monolithically to beams or slabs on either side which are shallower than the overall dimensions of the column in the plane considered (Figure 3.34).

Condition 3 The end of the column is connected to members which, while not specifically designed to provide restraint to rotation of the column will nevertheless provide some nominal restraint (Figure 3.35).
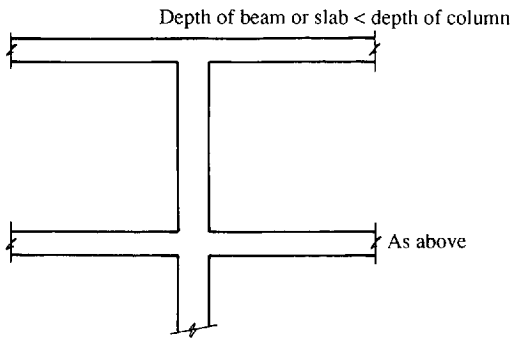

Depth of beam or slab < depth of column

As above

Figure 3.34 *End fixity condition 2*

Nominal restraint between beams and column, e.g., beams designed and detailed as simply supported
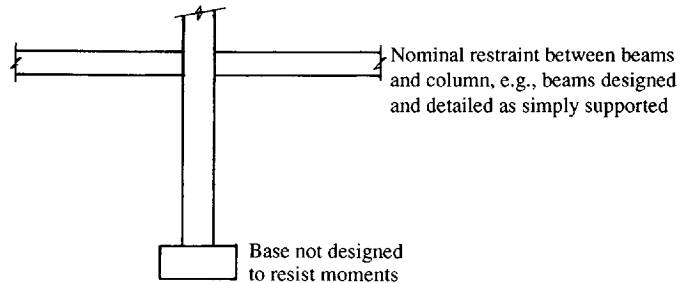
Base not designed to resist moments

Figure 3.35 *End fixity condition 3*

Where a more accurate assessment of the effective height is desired it may be calculated from the equations given in Section 2.5 of BS 8110 Part 2.

The basic mode of failure of a braced short column is by crushing of the constituent materials due to the compressive loads.

The various aspects of the design of braced short columns, including a number of dimensional considerations which can influence the design, will be considered under the following headings:

(a) Column cross-section
(b) Main reinforcement areas
(c) Minimum spacing of reinforcement
(d) Maximum spacing of reinforcement
(e) Lateral reinforcement
(f) Compressive ULS
(g) Shear ULS
(h) Cracking SLS
(i) Lateral deflection.

3.11.1 Column cross-section

The provisions of column design given in BS 8110 apply to vertical load bearing members whose greater cross-sectional dimension does not exceed four times its smaller dimension. This proviso is illustrated in Figure 3.36. It should be appreciated that square, circular or any other symmetrical shape will satisfy this requirement.
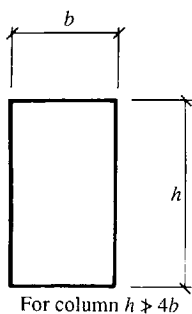

b

h

For column $h \not> 4b$

Figure 3.36 *Cross-sectional limitation for columns*