Now A_{sc} is 1 per cent of A_g or $0.01A_g$. Therefore

$$1500 \times 10^3 = 0.35 \times 35(A_g - 0.01A_g) + 0.67 \times 0.01A_g \times 460$$

$$1500 \times 10^3 = 12.25A_g - 0.1225A_g + 3.082A_g = 15.21A_g$$

$$A_g = \frac{1500 \times 10^3}{15.21} = 98\,619.33\,\text{mm}^2$$

Since the column is square, the length of side is $\sqrt{98\,619.33} = 314.04$ mm.

Provide a 315 mm × 315 mm square grade 35 concrete column.

The actual A_g is $315 \times 315 = 99\,225\,\text{mm}^2$. Therefore

$$\text{Area of main bars} = 1 \text{ per cent of } A_g = \frac{99\,225}{100} = 992.25\,\text{mm}^2$$

Provide four 20 mm diameter HY bars ($A_{sc} = 1256\,\text{mm}^2$).

Example 3.15

A short braced column supporting a vertical load and subjected to biaxial bending is shown in Figure 3.49. If the column is formed from grade 40 concrete, determine the size of HY main reinforcement required.

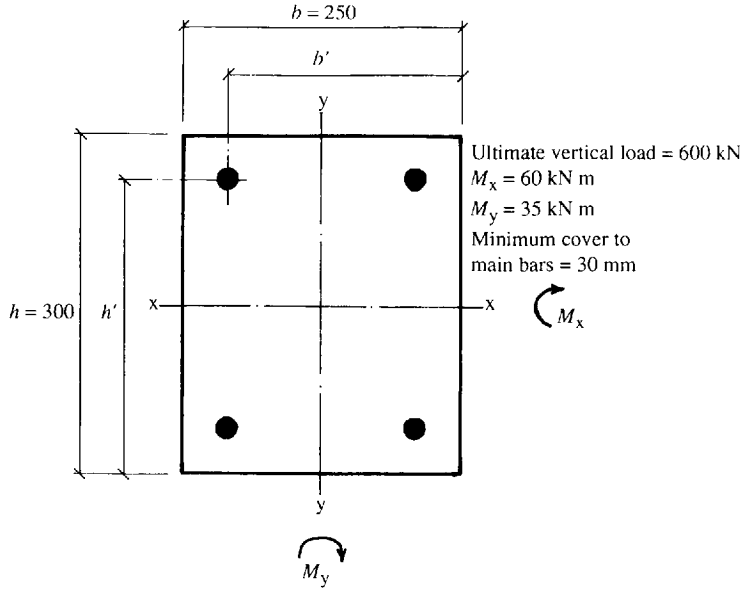

Figure 3.49 *Column subject to biaxial bending*

Since this column is subjected to bending it will be designed using the relevant BS 8110 Part 3 chart. To do so, it is first necessary to convert the biaxial bending into uniaxial bending by increasing one of the moments in accordance with the simplified procedure given in BS 8110 Part 1 as follows.

Assume 20 mm diameter bars will be adopted. Then $h' = 300 - 40 = 260$ and $b' = 250 - 40 = 210$. Thus

$$\frac{M_x}{h'} = \frac{60}{260} = 0.231 \quad \text{and} \quad \frac{M_y}{b'} = \frac{35}{210} = 0.17$$

Hence $M_x/h' > M_y/b'$. Therefore BS 8110 equation 40 will apply, where β is obtained from Table 3.16 using

$$\frac{N}{bhf_{cu}} = \frac{600 \times 10^3}{250 \times 300 \times 40} = 0.2$$

Hence from Table 3.16, $\beta = 0.77$. Therefore the increased moment about the x–x axis is given by

$$M'_x = 60 + 0.77 \times \frac{260}{210} \times 35 = 60 + 33.37 = 93.37\,\text{kN m}$$

In order to determine which of the BS 8110 Part 3 charts to use we need to know the d/h ratio together with the f_{cu} and f_y values. f_{cu} is 40, f_y is 460 and $d/h = 260/300 = 0.87 \simeq 0.85$. Therefore we use BS 8110 Chart 38, reproduced earlier as Figure 3.47. To use the chart the following ratios must be calculated:

$$\frac{N}{bh} = \frac{600 \times 10^3}{250 \times 300} = 8 \quad \text{and} \quad \frac{M}{bh^2} = \frac{93.37 \times 10^6}{250 \times 300^2} = 4.15$$

From the chart, $100A_{sc}/bh = 1.6$. Therefore

$$A_{sc} = \frac{1.6bh}{100} = \frac{1.6 \times 250 \times 300}{100} = 1200\,\text{mm}^2$$

Provide four 20 mm diameter HY bars ($A_{sc} = 1256\,\text{mm}^2$).

3.12 References

BS 5328 1990 Concrete, Parts 1, 2, 3 and 4.

BS 8110 1985 Structural use of concrete.
Part 1 Code of practice for design and construction.
Part 2 Code of practice for special circumstances.
Part 3 Design charts for singly reinforced beams, doubly reinforced beams and rectangular columns.

Manual for the Design of Reinforced Concrete Building Structures. Institution of Structural Engineers, October 1985.

Standard Method of Detailing Structural Concrete. Institution of Structural Engineers, August 1989.

For further information contact:

British Cement Asssociation (BCA), Wexham Springs, Slough, SL3 6PL.