Table 3.10 Modification factor for tension reinforcement (BS 8110 Part 1 1985 Table 3.11)

Service stress	M/bd^2 0.50	0.75	1.00	1.50	2.00	3.00	4.00	5.00	6.00
100	2.00	2.00	2.00	1.86	1.63	1.36	1.19	1.08	1.01
150	2.00	2.00	1.98	1.69	1.49	1.25	1.11	1.01	0.94
156 ($f_y = 250$)	2.00	2.00	1.96	1.66	1.47	1.24	1.10	1.00	0.94
200	2.00	1.95	1.76	1.51	1.35	1.14	1.02	0.94	0.88
250	1.90	1.70	1.55	1.34	1.20	1.04	0.94	0.87	0.82
288 ($f_y = 460$)	1.68	1.50	1.38	1.21	1.09	0.95	0.87	0.82	0.78
300	1.60	1.44	1.33	1.16	1.06	0.93	0.85	0.80	0.76

Note 1: The values in the table derive from the equation

$$\text{Modification factor} = 0.55 + \frac{477 - f_s}{120(0.9 + M/bd^2)} \leqslant 2.0$$

where M is the design ultimate moment at the centre of the span or, for a cantilever, at the support.

Note 2: The design service stress in the tension reinforcement in a member may be estimated from the equation

$$f_s = \frac{5 f_y A_{s,req}}{8 A_{s,prov}} \times \frac{1}{\beta_b}$$

Note 3: For a continuous beam, if the percentage of redistribution is not known but the design ultimate moment at mid-span is obviously the same as or greater than the elastic ultimate moment, the stress f_s in this table may be taken as $5/8 f_y$.

The ratio β_b does not apply to the simply supported beams dealt with in this manual. Hence the expression for simply supported beams becomes

$$f_s = \frac{5}{8} f_y \frac{A_{s,req}}{A_{s,prov}}$$

Using the tables, the minimum effective depth d for a singly reinforced beam to satisfy deflection requirements may be written as follows:

$$\text{Minimum effective depth } d = \frac{\text{span}}{\text{Table 3.9 factor} \times \text{Table 3.10 factor}}$$

Before proceeding to examine the effect of shear on concrete beams, let us look at some examples on the bending and deflection requirements.

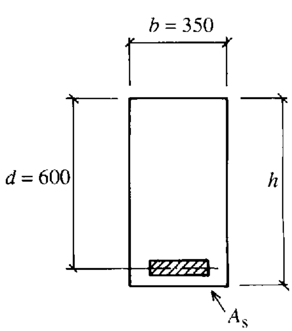

Figure 3.6 *Beam cross-section*

Example 3.4

The singly reinforced concrete beam shown in Figure 3.6 is required to resist an ultimate moment of 550 kN m. If the beam is composed of grade 30 concrete and high yield (HY) reinforcement, check the section size and determine the area of steel required.

In this example the breadth and effective depth dimensions which are given can be checked by using the BS 8110 simplified stress block formulae.

Grade 30 $f_{cu} = 30\,\text{N/mm}^2$

HY steel reinforcement $f_y = 460\,\text{N/mm}^2$

Ultimate bending moment $M_u = 550\,\text{kNm} = 550 \times 10^6\,\text{N mm}$

Using BS 8110 formulae:

$$K = \frac{M}{bd^2 f_{cu}} = \frac{550 \times 10^6}{350 \times 600^2 \times 30} = 0.146 < K' = 0.156$$

Therefore compression reinforcement is not necessary and the section size is adequate for a singly reinforced beam.

The area of tension reinforcement needed may now be determined. The lever arm is given by

$$z = d[0.5 + \surd(0.25 - K/0.9)] = d[0.5 + \surd(0.25 - 0.146/0.9)]$$
$$= 0.796d < 0.95d$$

This is satisfactory. Therefore

$$A_s \text{ required} = \frac{M}{0.87 f_y z} = \frac{550 \times 10^6}{0.87 \times 460 \times 0.796 \times 600} = 2878\,\text{mm}^2$$

This area can be compared with the reinforcement areas given in Table 3.8 to enable suitable bars to be selected:

Provide six 25 mm diameter HY bars in two layers ($A_s = 2948\,\text{mm}^2$).

The overall beam depth, as shown in Figure 3.7, can now be determined by reference to the dimensional requirements for beams and by assuming that the

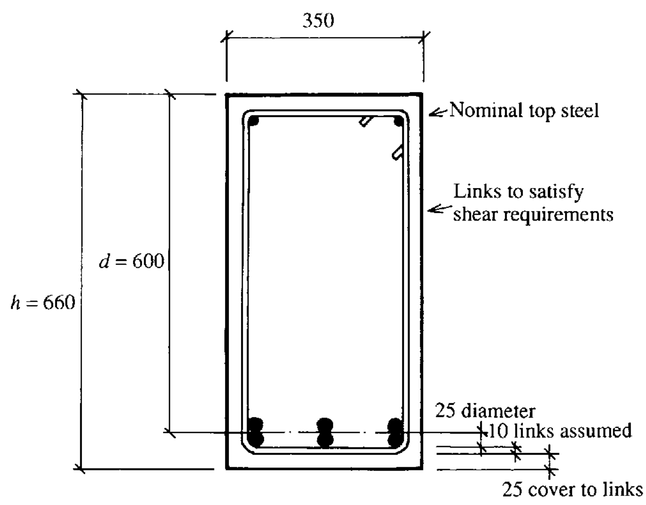

Figure 3.7 *Finalized beam cross-section*