The procedure for the design of flanged beams is as follows:

(a) Check the position of the neutral axis by determining

$$K = \frac{M}{f_{cu}bd^2}$$

using flange width b and selecting values of n and z from Table 24. Calculate $x = nd$.

(b) If $0.9x \leqslant h_f$ the neutral axis lies within the flange and A_s is determined as for a rectangular beam, i.e.

$$A_s = \frac{M}{0.87 f_y z}$$

(c) If $0.9x > h_f$ then the neutral axis lies outside the flange. Calculate the ultimate resistance moment of the flange M_{uf} from

$$M_{uf} = 0.45 f_{cu} (b - b_w) h_f (d - 0.5 h_f)$$

(d) Calculate $K_f = \dfrac{M - M_{uf}}{f_{cu} b_w d^2}$

where b_w is the breadth of the web.

If $K_f \leqslant K'$, obtained from Table 23, then select value of a_1 from Table 24 and calculate A_s from

$$A_s = \frac{M_{uf}}{0.87 f_y (d - 0.5 h_f)} + \frac{M - M_{uf}}{0.87 f_y z}$$

If $K_f > K'$, redesign the section or consult BS 8110[1] for design of compression steel.

4.4.5.2 Minimum and maximum amounts of reinforcement

The areas of reinforcement derived from the previous calculations may have to be modified or supplemented in accordance with the requirements below in order to prevent brittle failure and/or excessive cracking.

Tension reinforcement

The minimum areas of tension reinforcement are given in Table 25.

Table 25 Minimum areas of tension reinforcement for beams

	f_y=250N/mm^2	f_y=460N/mm^2
Rectangular beams with overall dimensions b and h	0.0024 bh	0.002 bh
Flanged beams (web in tension)		
$b_w/b<0.4$	0.0035 b_wh	0.002 b_wh
$b_w/b\geqslant0.4$	0.0024 b_wh	0.002 b_wh
Flanged beams (flange in tension over a continuous support)		
T-beam	0.0048 b_wh	0.0026 b_wh
L-beams	0.0036 b_wh	0.0020 b_wh
Transverse reinforcement in flanges of flanged beams (may be slab reinforcement)	0.0015 h_f per metre width	0.0015 h_f per metre width

Compression reinforcement
The minimum areas of compression reinforcement should be:

rectangular beam	$0.002\,bh$
flanged beam web in compression	$0.002\,b_w h$

Maximum area of reinforcement
Neither the area of tension reinforcement, nor the area of compression reinforcement should exceed $0.04\ b_w h$.

Main bars in beams should normally be not less than size 16.

Minimum area of bars in the side face of beams (to control cracking)
Where the overall depth of the beam exceeds 500mm, longitudinal bars should be provided at a spacing not exceeding 250mm. The size of the bars should not be less than

$0.75\ \sqrt{b_w}$ for high yield bars (f_y=460N/mm^2)

$1.00\ \sqrt{b_w}$ for mild steel bars (f_y=250N/mm^2)

where b_w is the width of the web for flanged beams and the beam width for rectangular beams. b_w need not be assumed to be greater than 500 mm.

Maximum spacing of tension bars
The clear space between main bars should not exceed the values in Table 26.

Table 26 Clear distance between bars in mm according to percentage redistribution

f_y N/mm^2	Redistribution to or from section considered						
	−30%	−20%	−10%	0%	+10%	+20%	+30%
250	210	240	270	300	300	300	300
460	115	130	145	160	180	195	210

Minimum spacing
The horizontal distance between bars should not be less than the bar size or the maximum size of the aggregate plus 5mm.

Where there are two or more rows the gaps between corresponding bars in each row should be vertically in line, and the vertical distance between bars should not be less than

two-thirds the maximum size of the aggregate or
when the bar size is greater than the maximum aggregate size plus 5mm, a spacing less than the bar size should be avoided.

4.4.5.3 Shear

The shear stress v at any point should be calculated from:

$$v = \frac{1000V}{b_w d}\ \text{N/mm}^2$$

where V is the ultimate shear force in kN
b_w is the width of the beam web in mm and
d is the effective depth in mm.

In no case should v exceed $0.8\ \sqrt{f_{cu}}$ or 5N/mm^2 even if shear reinforcement is provided.

The shear stress, v_c, which the concrete on its own can be allowed to resist, is given in Table 27 for various percentages of bending reinforcement and various effective depths for 30N/mm^2 concrete.