Where the cover to the outermost reinforcement exceeds 40mm special precautions against spalling may be required, e.g. partial replacement by plaster, lightweight aggregate or the use of fabric as supplementary reinforcement (see BS 8110, Part 2[1]).

4.4.2.2 Durability

The requirements for durability in any given environment are:

(a) an upper limit to the water/cement ratio
(b) a lower limit to the cement content
(c) a lower limit to the thickness of the cover to the reinforcement
(d) good compaction, and
(e) adequate curing.

Values for *(a)*, *(b)* and *(c)* which, in combination, will be adequate to ensure durability are given in Table 18 for various environments.

As *(a)* and *(b)* at present cannot be checked by methods that are practical for use during construction, Table 18 gives, in addition, the characteristic strengths that have to be specified in the UK to ensure that requirements *(a)* and *(b)* are satisfied.

Table 18 Durability requirements for beams

Conditions of exposure (For definitions see Appendix C)	Cover to *all* reinforcement mm	mm	mm
Mild	25	20	20
Moderate	—	35	30
Severe	—	—	40
Very severe	—	—	50
Maximum free water/cement ratio	0.65	0.60	0.55
Minimum cement content, kg/m^3	275	300	325
Characteristic concrete strength in the UK, N/mm^2	30	35	40

Notes to Table 18
1. The cover to *all* reinforcement should not be less than the nominal maximum size of the aggregate.
2. The cover in mm to the *main* reinforcement should not be less the the bar size.

The strengths quoted in Table 18 will often require cement contents that are higher than those given in Table. The potential problems of increased shrinkage arising from high cement and water contents should be considered in the design.

4.4.3 Bending moments and shear forces

The maximum values of the bending moments and shear forces at any section of a continuous beam may be obtained by either:

(a) consideration of the beam as part of a structural frame as described in subsection 4.3 or
(b) as a beam that is continuous over its supports and capable of free rotation about them.

For beams that support substantially uniformly distributed loads over three or more spans that do not differ in length by more than 15% of the longest span, and for which the characteristic imposed load does not exceed the characteristic dead load, the values of the ultimate bending moments and shear forces should be obtained from Table 19. No redistribution of moments should be made when using values obtained from this Table.

Table 19 Design ultimate bending moments and shear forces for beams

	At outer support	Near middle of end span	At first interior support	At middle of interior spans	At interior supports
Moment	0	$0.09Fl$	$-0.11Fl$	$0.07Fl$	$-0.08Fl$
Shear	$0.45F$	—	$0.6F$	—	$0.55F$

where l is the effective span and
$F = 1.4\,G_k + 1.6\,Q_k$

Where a cantilever of a length exceeding one-third of the adjacent span occurs, the condition of maximum load on the cantilever and minimum load on the adjoining span must be checked.

4.4.4 Span/effective depth ratios

The span/effective depth should not exceed the appropriate value in Table 20 multiplied by the modification factor in Table 21. Compliance with these ratios will normally ensure that the total deflection does not exceed span/250.

Table 20 Span/effective depth ratios for beams

	$b_w/b = 1$	$b_w/b \leq 0.3$
cantilever	7	5.6
simply supported	20	16.0
continuous	26	20.8

Table 21 Modification factors for M/bd^2 for beams

Steel stress N/mm^2	M/bd^2 0.50	0.75	1.00	1.50	2.00	3.00	5.00
(f_y = 250) 156	2.00	2.00	1.96	1.66	1.47	1.24	1.00
(f_y = 460) 288	1.68	1.50	1.38	1.21	1.09	0.95	0.82

Notes to Tables 20 and 21
1. For spans in excess of 10m, the above ratios should be multiplied by 10/(span in metres). For exceptionally long spans the span/depth ratio may be exceeded if calculations of deflections are carried out according to BS 8110, Part 2[1].
2. M in the tables is to be taken as the moment at midspan, or for a cantilever at the support.
3. b is the effective width of the compression flange of a flanged beam or the width of a rectangular beam.
4. b_w is the average web width of the beam.
5. For values of b_w/b between 1 and 0.3, interpolate linearly between the values in the Table.

If the section is found to be inadequate, the span/depth ratio can be further modified using Table 22 which determines the percentage of compression steel required to limit deflections. If this percentage is impractical, the section should be redesigned. Any compression reinforcement determined at this stage may have to be increased to provide adequate strength (see clause 4.4.5.1).

Table 22 Modification factors for compression reinforcement for beams.

Factor	1.00	1.05	1.08	1.10	1.14	1.20	1.25	1.33	1.40	1.45	1.50
$\frac{100A'_s}{bd}$	0.00	0.15	0.25	0.35	0.50	0.75	1.0	1.5	2.0	2.5	3.0