3 Concrete elements

3.1 Structural design of concrete

Guidance on the use of concrete in building and civil engineering structures, other than for bridges and liquid retaining structures, is given in BS 8110 'Structural use of concrete'. This is divided into the following three parts:

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.

The design of reinforced concrete dealt with in this manual is based on Part 1, which gives recommendations for concrete elements contained in routine construction. Design charts presented in Part 3 will also be examined for comparison with the results obtained from the guidance given in Part 1.

Whilst Part 1 covers the majority of structural applications encountered in everyday design, circumstances may arise that require further assessment, such as torsional or other less common analyses. Part 2, which is complementary to Part 1, gives recommendations for such special circumstances.

For information on all aspects of bridge design, reference should be made to BS 5400 'Steel, concrete and composite bridges'. Similarly for the design of liquid retaining structures other than dams, reference is made to BS 8007 'Design of concrete structures for retaining aqueous liquids'. These are beyond the scope of this manual.

3.2 Symbols

BS 8110 adopts a policy of listing symbols at the beginning of each subsection. In this context care needs to be exercised since certain symbols appear in more than one place with subtle differences in definition.

Those symbols that are relevant to this manual are listed below and for ease of reference some are repeated under more than one heading:

General

f_{cu} characteristic strength of concrete
f_y characteristic strength of reinforcement
G_k characteristic dead load
Q_k characteristic imposed load
W_k characteristic wind load
SLS serviceability limit state
ULS ultimate limit state

γ_f partial safety factor for load
γ_m partial safety factor for strength of materials

Section properties

A_c net cross-sectional area of concrete in a column
A_s area of tension reinforcement
A_{sc} area of main vertical reinforcement
b width of section
b_c breadth of compression face of a beam
b_v breadth of section used to calculate the shear stress
d effective depth of tension reinforcement
h overall depth of section
x depth to neutral axis
z lever arm

Bending

A_s area of tension reinforcement
b width of section
d effective depth of tension reinforcement
f_{cu} characteristic strength of concrete
f_y characteristic strength of reinforcement
K coefficient obtained from design formula for rectangular beams
K' 0.156 when redistribution of moments does not exceed 10 per cent
M design ultimate resistance moment; or
M_u design ultimate bending moment due to ultimate loads
x depth to neutral axis
z lever arm

Deflection

b width of section
d effective depth of tension reinforcement
f_y characteristic strength of reinforcement
M design ultimate bending moment at centre of the span or, for a cantilever, at the support

Shear

A_s area of tension reinforcement
A_{sb} cross-sectional area of bent-up bars
A_{sv} total cross-section of links at the neutral axis
b_v breadth of section used to calculate the shear stress
d effective depth of tension reinforcement
f_{cu} characteristic strength of concrete
f_{yv} characteristic strength of links (not to exceed 460 N/mm^2)
s_b spacing of bent-up bars
s_v spacing of links along the member
V design shear force due to ultimate loads