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REINFORCED CONCRETE DESIGN

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Preface

The purpose of this book is to provide a straightforward introduction to the principles and methods of design for concrete structures. It is directed primarily at students and young designers who require an understanding of the basic theory and a concise guide to design procedures. Although the detailed design methods are generally according to British standards, much of the theory and practice is of a fundamental nature and should, therefore, be useful to engineers in other countries. Limit state concepts, as recently introduced in the new codes of practice, are used and the calculations are in SI units throughout.

The subject matter has been arranged so that chapters 1 to 6 deal mostly with theory and analysis while the following chapters cover the design and detailing of various types of member and structure. In order to include topics that are usually in an undergraduate course, there is a chapter on earth- and water-retaining structures and also a final chapter on prestressed concrete.

Important equations that have been derived within the text are highlighted by an asterisk adjacent to the equation number.

A major problem with books on design practice is that the design standards and specifications are liable to be revised after the book is published. For this reason the reader should ensure that he is using the latest edition of the relevant standard. This is particularly true when the design may involve the use of any of the tables within the text that have been taken from CP 110.

Extracts from the British Standards are reproduced by permission of the British Standards Institution, 2 Park Street, London W1A 2BS, from whom complete copies can be obtained. The Cement and Concrete Association have kindly given permission to use tables 6.1 and 6.2 which are based on tables in the *Handbook on the Unified Code for Structural Concrete*.

Finally the authors wish to thank Mrs B. Cotgreave who prepared the diagrams and Mrs F. Zimmermann who typed most of the draft and final copies of the manuscript.

Notation

Notation is generally in accordance with CP 110, and the principal symbols are listed below. Other symbols are defined in the text where necessary. The symbols ϵ for strain and f for stress have been adopted throughout, with the general system of subscripts such that the first subscript refers to the material, c – concrete, s – steel, and the second subscript refers to the type of stress, c – compression, t – tension.

a	Deflection
b	Width of section
b_t	Breadth of section at level of tension reinforcement
b_w	Breadth of web or rib of a member
d	Effective depth of tension reinforcement
d'	Depth to compression reinforcement
E_c	Static secant modulus of elasticity of concrete
E_s	Modulus of elasticity of steel
e	Eccentricity
F	Ultimate load
f_{bs}	Bond stress
f_{cu}	Characteristic concrete cube strength
f_{pu}	Characteristic strength of prestressing tendons
f_s	Service stress or steel stress
f_y	Characteristic strength of reinforcement
f_{yv}	Characteristic strength of link reinforcement
G_k	Characteristic dead load
g_k	Characteristic dead load per unit area
h	Over-all depth of section in plane of bending
h_f	Thickness of flange
I	Second moment of area
k_1	Average compressive stress in the concrete for a rectangular – parabolic stress block
k_2	A factor that relates the depth to the centroid of the rectangular – parabolic stress block and the depth of the neutral axis
l_a	Lever-arm factor = z/d
l_e	Effective height of a column or wall
M	Bending moment
M_u	Ultimate resistance moment
N	Axial load at section considered
N_{bal}	Axial load on a column corresponding to the balanced condition
P	Final prestress force (chapter 12)

Q_k	Characteristic imposed load
q_k	Characteristic live load per unit area
$1/r_x$	Curvature of a beam at point x
s_v	Spacing of links along the member
T	Torsional moment
u	Perimeter
V	Shear force
ν	Shear stress
ν_c	Ultimate shear stress in concrete
W_k	Characteristic wind load
x	Neutral axis depth
z	Lever arm
α_e	Modular ratio
β_{red}	Ratio of the reduction in resistance moment
γ_f	Partial safety factor for load
γ_m	Partial safety factor for strength
ϵ_{sh}	Shrinkage strain
μ	Coefficient of friction
ξ_s	Depth of slab factor
Φ	Bar size
ϕ	Creep coefficient
Σu_s	Sum of the effective perimeters of the tension reinforcement