

Preface

The fourteenth edition of *Design of Concrete Structures* has the same dual objectives as the previous work: first to establish a firm understanding of the behavior of structural concrete, then to develop proficiency in the methods used in current design practice. To produce this SI Edition, the text has been updated in accordance with the provisions of the metric version of the 2008 American Concrete Institute (ACI) Building Code (ACI 318M-08).

It is generally recognized that mere training in special design skills and codified procedures is inadequate for successful professional practice. As new research becomes available and new design methods are continually introduced, these procedures are subject to frequent changes. To understand and keep abreast of these rapid developments and to engage safely in innovative design, the engineer needs a thorough grounding in the basic performance of concrete and steel as structural materials, and in the behavior of reinforced concrete members and structures. On the other hand, the main business of the structural engineer is to design structures safely, economically, and efficiently. Consequently, with this basic understanding as a firm foundation, familiarity with current design procedures is essential. This edition, like the preceding ones, addresses both needs.

The text not only presents the basic mechanics of structural concrete and methods for the design of individual members for bending, shear, torsion, and axial forces, but also provides much detail pertaining to applications in the various types of structural systems, including an extensive presentation of slabs, footings, foundations, and retaining walls. The important topic of joint design is included. The chapter on flexural design has been expanded to improve the presentation of both the basic material and the example problems, coverage of seismic design is updated, and an introduction to prestressed concrete is included, as in previous editions.

There have been a number of significant changes in the 2008 ACI Building Code, which governs design practice in most of the United States and serves as a model code in many other countries as well. Among these are a reorganization of the provisions for both slender column and earthquake design, the former with some simplification compared to earlier Codes and the latter with some important additions; and the addition of headed studs for use as shear reinforcement in two-way slabs and headed deformed bars as another option for use in anchoring reinforcement.

In addition to changes in the ACI Code, the text includes the modified compression field theory method of shear design as updated in the 2008 Interim Revisions to the American Association of State Highway and Transportation Officials (AASHTO) *LRFD Bridge Design Specifications*.

A feature of the text is the comprehensive presentation of all aspects of slab design. A chapter covering one-way and two-way edge-supported and column-supported slabs, including the new Code material on headed studs, is followed by chapters on slab

analysis and design based on the theory of plasticity covering, respectively, the yield line method for analysis and the strip method for design of slabs, both particularly useful for innovative structures.

A special strength of the text is the analysis chapter, which includes load combinations for use in design, a description of envelope curves for moment and shear, guidelines for proportioning members under both gravity and lateral loads, and procedures for developing preliminary designs of reinforced concrete structures.

Most present-day design is carried out using computer programs, either general-purpose, commercially available software or individual programs written for special needs. Step-by-step procedures are given throughout the book to guide the student and engineer through the increasingly complex methodology of current design, with the emphasis on understanding the design process. Once mastered, these procedures are easily converted into flowcharts to aid in programming. References are given, where appropriate, to the more widely used commercial programs.

The text will be found suitable for either a one or two-semester course in the design of concrete structures. If the curriculum permits only a single course (probably taught in the fourth undergraduate year), the following will provide a good basis: the introduction and treatment of materials found in Chapters 1 and 2, respectively; the material on flexure, shear, and anchorage in Chapters 3, 4, and 5; Chapter 6 on serviceability; Chapter 8 on short columns; and the introduction to one and two-way slabs found in the first four sections of Chapter 13. Time may or may not permit classroom coverage of frame analysis or building systems, Chapters 12 and 18, but these could well be assigned as independent reading, concurrent with the earlier work of the course. In the authors' experience, such complementary outside reading tends to enhance student motivation.

The text is more than adequate for a second course, most likely taught in the first year of graduate study. The authors have found that this is an excellent opportunity to provide students with a more general understanding of reinforced concrete structural design, often beginning with Chapters 12 and 18 and followed by the increasingly important topics of torsion, Chapter 7; slender columns, Chapter 9; the strut-and-tie method, Chapter 10; and the design and detailing of joints, Chapter 11. It should also offer an opportunity for a much expanded study of slabs, including the remaining sections of Chapter 13, plus the methods for slab analysis and design based on plasticity theory found in Chapters 14 and 15, yield line analysis and the strip method of design. Other topics appropriate to a second course include foundations and retaining walls, Chapters 16 and 17, and the introduction to seismic design in Chapter 20. Prestressed concrete is sufficiently important to justify a separate course. If time constraints do not permit this, Chapter 19 provides an introduction and can be used as the text for a one-credit-hour course.

At the end of each chapter, the user will find extensive reference lists, which provide an entry into the literature for those wishing to increase their knowledge through independent study.

The authors are especially pleased to provide our readers with a true SI Edition. While the text has always been available worldwide, the presentation has in the past been limited to inch-pound units, which are customary in the United States. Well aware of the lack of applicability of inch-pound units throughout the rest of the world, it has been a goal of the authors to develop a version of the text in SI units based on the metric version of the ACI Code, ACI 318M. With this volume, that goal has been achieved.

A brief historical note may be of interest. This book is the fourteenth edition of a textbook originated in 1923 by Leonard C. Urquhart and Charles E. O'Rourke, both

professors of structural engineering at Cornell University at that time. Over its remarkable 86-year history, new editions have kept pace with research, improved materials, and new methods of analysis and design. The second, third, and fourth editions firmly established the work as a leading text for elementary courses in the subject area. Professor George Winter, also of Cornell, collaborated with Urquhart in preparing the fifth and sixth editions. Winter and the present senior author were responsible for the seventh, eighth, and ninth editions, which substantially expanded both the scope and the depth of the presentation. The tenth, eleventh, and twelfth editions were prepared by Professor Nilson subsequent to Professor Winter's passing in 1982, the latter with Professor David Darwin of the University of Kansas serving as a contributor.

Professors Nilson and Darwin were joined by Professor Charles Dolan of the University of Wyoming beginning with the thirteenth edition. All three have been deeply involved in research and teaching in the fields of reinforced and prestressed concrete, as well as professional Code-writing committees, and have spent significant time in professional practice, invaluable in developing the perspective and structural judgement that sets this book apart.

Special thanks are due to reviewers and former students for their many helpful comments and suggestions for this and previous editions. In particular, the authors would like to thank the following reviewers: Paul Barr, Utah State University; Robert N. Emerson, Oklahoma State University; A. Fafitis, Arizona State University; R. Craig Henderson, Tennessee Technological University; Max Porter, Iowa State University; Pizhong Qiao, The University of Akron; Aziz Saber, Louisiana Tech University; and Eric Steinberg, Ohio University. Thanks are also due to the McGraw-Hill project team, notably Debra Hash, Sponsoring Editor; Lorraine Buczek, Developmental Editor; and Melissa Leick, Project Manager.

We gladly acknowledge our indebtedness to the original authors. Although it is safe to say that neither Urquhart nor O'Rourke would recognize very much of the detail, the approach to the subject and the educational philosophy that did so much to account for the success of the early editions would be familiar. We acknowledge with particular gratitude the influence of Professor George Winter in developing a point of view that has shaped the work in the chapters that follow.

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