

Xianglin Gu  
Xianyu Jin  
Yong Zhou

# Basic Principles of Concrete Structures

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Xianglin Gu · Xianyu  
Yong Zhou

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# Basic Principles of Concrete Structures

*To engineers who, rather than blindly  
following the codes of practice, seek to apply  
the laws of nature.*

T.Y. Lin, 1955

# Preface

More than ten years ago, when the first version of the textbook *Basic Principles of Concrete Structures* was published in Chinese, I started considering writing a textbook with same contents in English. The primary motivation at the time for this idea was to help Chinese undergraduate students with a language environment so that they could keep learning English continuously, while those foreign undergraduate students in China could be able to study this specialty course more easily when they have a textbook in English. However, this idea turned out to be a tough work for me. As different countries have different codes in civil engineering, those existing textbooks in English from other countries cannot be used directly for students in China. It only made sense that I wrote a new textbook in English to not only introduce basic principles of concrete structures and existing Chinese codes, but also reflect the most recent research results and practical experiences in concrete structures in China. Now I am very happy to see that my dream has come true and the textbook is to be published pretty soon. I hope that this textbook can also serve as a window for those outside China who are interested in China and its developments in civil engineering.

As a basic specialty course for undergraduates majoring in civil engineering, *Basic Principles of Concrete Structures* is different from either the previously learnt mechanics courses or the designing courses to be learnt. Compared with mechanics courses, quite a number of basic theories of reinforced concrete structures cannot be derived solely by theoretical analysis. And compared with designing courses, this course emphasizes on introductions of basic theories rather than simply being a translation of designing specifications. That means the course of *Basic Principles of Concrete Structures* should focus on both theoretical derivations and engineering practices. Therefore, based on the latest version of designing codes both for buildings and bridges (GB 50010-2010 and JTG D62-2004), the textbook starts from steel and concrete materials, whose properties are very important to mechanical behavior of reinforced concrete structural members. Step by step, analyses of reinforced concrete members under basic loading types (tension, compression, bending, shearing, and torsion) and environmental actions are

introduced. One of the characteristics of the book that I was trying to distinguish it from other textbooks on concrete structures is that more emphasis has been laid on basic theories on concrete structures as well as on applications of the basic theories both in designing new structures and in analyzing existing structures. Examples and problems in each chapter are carefully designed to cover every key knowledge point and practical case.

Professor Xianyu Jin prepared the draft for Chaps. 1, 4, and 5. I prepared the draft for Chaps. 2, 3, and 6–9. Prof. Xiaozu Su prepared the draft for Chap. 10. Dr. Feng Lin prepared the draft for Chap. 11. Prof. Weiping Zhang prepared the draft for Chap. 12. Dr. Qianqian Yu and Ph.D. candidate, Mr. Chao Jiang, drew all of the figures. Dr. Xiaobin Song helped me with the first revision of the draft, while Dr. Yong Zhou helped with the second revision, based on which I finished modifying the final draft. Without help from my colleagues and students, it would be very difficult for me to finish this tough work. I would like to deliver my sincere thanks to all of them. I would also like to thank Mr. Yi Hu from Tongji University Press for his support on the publication of this book. Finally, I would like to thank Publication Foundation of Books at Tongji University for their financial support.

May 2015

Xianglin Gu

# Abstract

*Basic Principles of Concrete Structures* is one of the key courses for undergraduates majoring in civil engineering. The objective of this book is to help students to completely understand the basic mechanical properties and design methods of structural members made of concrete and reinforcement and to lay the foundation for future study of the design and construction of various types of reinforced concrete structures.

The book consists of 12 chapters, i.e., introduction, materials, bond and anchorage, axially loaded members, flexural members, eccentrically loaded members, shearing, torsion, punching and local bearing, prestressed concrete members, serviceability of members, and durability of reinforced concrete structures.

The book is suitable for teachers and college students majoring in civil engineering and can also be referred by civil engineers.

The textbook is jointly edited by Prof. Xianglin Gu, Prof. Xianyu Jin, and Dr. Yong Zhou.

As a basic specialty course for undergraduates majoring in civil engineering, *Basic Principles of Concrete Structures* is different from either the previously learnt mechanics courses or the design courses to be learnt. Compared with mechanics courses, the basic theories of reinforced concrete structures cannot be solely derived by theoretical analysis. And compared with design courses, this course emphasizes the introduction of basic theories rather than simply being a translation of design specifications. That means the course of *Basic principles of Concrete Structures* should focus on both theoretical derivation and engineering practice. Therefore, based on the latest version of *designing codes both for buildings and bridges* (GB 50010-2010 and JTG D62-2004), the book starts from the steel and concrete materials, whose properties are very important to the mechanical behavior of reinforced concrete members. Step by step, the design and analysis of reinforced concrete members under basic loading types (tension, compression, flexure,



shearing, and torsion) and environmental actions are introduced. The characteristic of the book that distinguishes it from other textbooks on reinforced concrete structures is that more emphasis has been laid on the basic theories of reinforced concrete structures and the application of the basic theories in design of new structures and analysis of existing structures. Examples and problems in each chapter are carefully designed to cover every important knowledge point.

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