

Preface

It has been nearly 40 years since I started the study of hydraulic engineering as an undergraduate student. I still can recall vividly the magnificent impression in the winter of 1980 by a chance of field practicing tour organized by the university, when I first visited one of the most important hydraulic projects in my country at that time—the Danjiangkou Project with a gravity dam at a height of 97 m. In the following three decades, I have continued my profession in the education and consultant related to hydraulic engineering, and witnessed a rapid progress of China in this field. I have been content with my works and contributed the sustainable career passion to the following mutually promote impetuses.

- In an attempt to enlighten and to encourage our students to have a good command of the courses and to be creatively engaged in their career related to hydraulic engineering, I should organize and present appropriate materials in a logical and imaginative way. The students in my classes and field practicing tours, as well as the practicing engineers in the design and construction institutions, also make contribution by asking penetrating questions and demanding constructive and exercisable answers.
- I am fortunate to have the chance to participate in consultant works for more than 30 giant hydraulic projects in China, which is attributable to the fast economy development in the past three decades. For example, accompanied by the continuous consulting service works for the Xiaowan Project with a 294.5m-high arch dam from 1996 until today, covering its abutment excavation and reinforcement, as well as the dam body placement and reservoir operation, I have been growing up, and growing old of course. By these engineering consulting activities, I am also lucky enough to have got acquainted with and made good friends with some field engineers and to have accumulated experiences concerning engineering design, construction, and management.
- These education and consulting experiences provide a vast engineering background for my academic research of hydraulic structures, covering their deformation, stress, stability, seepage control, and reinforcement. In these researches, the structural issues related to the numerical modeling (e.g., FEM,

BEM, CEM), the coupling of strain/seepage/thermal in jointed rock mass and concrete, the feedback analysis and performance forecasting, etc., are explored and exercised. These research experiences, in turn, promote the university education and help to undertake the engineering consultant.

Not very long ago, I perceived that I was losing career energy and passion due to personal reasons; then I was aware that it could be the right time for stepping into a life stage that Bertrand Russell described in his prose entitled “How to Grow Old” that “... gradually the river grows wider, the banks recede, the waters flow more quietly, and in the end, without any visible break, they become merged in the sea.” Therefore, I decided to complete this last academic book concerning hydraulic structures, as a full stop to conclude a phase of active engineering works, afterward the time may come for another new mission designed by God.

This book is designed to provide useful, pragmatic, basic, and up-to-date knowledge and a road map for the design, construction, and management of hydraulic structures. It is aimed primarily at students who are planning to become hydraulic engineers, but it should also appeal to practicing engineers and engineering geologists with several experiences, as well as at postgraduate students and researchers wishing for a comprehensive and straightforward introduction to the current theories and practices with regard to hydraulic structures. In addition, this book will also be a useful reference for relevant contractors and consultants.

The author hopes to provide a logical and imaginative framework for teaching, studying, and exercising the basic principles of the subject that is developed right from the start and is unfolded through elaboration on the topics related to the planning and investigation, the basic theories (e.g., hydrology, geology, environment, economy, material), the prevalent design tool kits (e.g., analysis of actions and their effects), and the design and construction as well as management of typical hydraulic structures (e.g., layout, configuration, safety calibration, modification, foundation treatment, miscellaneous, surveillance, instrumentation, emergency action plan, aging and mitigation). Continuing the spirit of our predecessors, this book is not only about the fundamentals of related engineering knowledge but also on the concept of sharing experience and knowledge of practice engineers, which is reflected in the following distinct features:

- The history and state of the art concerning hydraulic engineering and structures, equally emphasizing on both the world's and Chinese recent experiences, are elaborated comprehensively in this book (Chap. 1).
- In many cases, a hydraulic project will be of multi-purpose, and the study comprises a large number of matters; some or all of them will influence the selection of the project site and scale, while others will dominate the types, sizes, and locations of the structures. Hence, the entire project must be investigated as a whole before the design requirements for each single structure (e.g., dam) can be firmly established. This book covers and presents many basic and practical concepts as well as techniques for the design and study of multi-purpose hydraulic projects (Chaps. 2 and 3), inclusive of the planning and economic evaluation for the project; the ecology and environment protection

studies and engineering hydrology and geology studies, for the project sites; and the exploration and property studies on the construction materials (concrete, soil, rock).

- It is a basic requirement that the design of hydraulic structures should make allowance for the actions, and when analyzing a given set of actions, it is commonly necessary to employ many techniques. This book has tried to group the various routine calculation techniques for actions in a single chapter (Chap. 4) so that it would not be necessary to discuss the same technique more than once. However, several particular actions such as elastic resistance and uplift diagram will retain in the corresponding chapters.
- In the recent decades, there has been a magnificent progress in the analysis of structural performances under various anticipated actions, ranging from traditional calculation (e.g., gravity method and trial load method) to modern mathematical modeling (e.g., FEM), from traditional physical (e.g., brittle material) modeling to geomechanical and emulating material modeling, and from laboratory testing to systematic field instrumentation and monitoring. This book is particularly heartened by the illustration of these modern and prevalent tool kits for structural analysis, which should be helpful to those who already have some knowledge of the basic concepts (Chap. 5). In doing so, the attempt to balance and complement the theoretical aspects of the subject with practical applications is exercised.
- The book provides and reviews recent advances in important design methodologies related to the reliability theory, the CAD technique, and the optimal theory (Chap. 6). Students and engineers will find use in these new developments. My hope is that after working through the book and recommended references and bibliography, the reader will be ready and able to design hydraulic structures methodically, thoroughly, confidently, and efficiently.
- The book closely links the whole hydraulic project comprising various hydraulic structures in lieu of traditional structure design solely. Rock slopes are geology bodies located on the surface of the earth's crust, which are often parts of or at the vicinity of hydraulic structures. Their failure and deformation will give rise to an important impact on the safety and normal operation of hydraulic projects. Since more and more hydraulic projects built in western China are situated on the deep valleys in this mountainous area, the stability and stabilization study on them are introduced in this book (Chap. 14). Over these years, the role of the management and aging mitigation has expanded beyond the framework of civil concrete structures to meet various needs of hydraulic structures (e.g., concretes in dam body, tunneling, and spillway lining; rocks and soils of dam body and foundation). The challenges are wider covering issues of environmental protection and sustainable development. Recognizing this, I decide that it is timely for the book to be reviewed and updated by management (Chap. 18). This includes the latest standards and practices as well as technologies applicable and useful for handling of issues such as surveillance and monitoring, nondestructive testing, aging scenarios, and mitigation. My belief is that university students

and engineering practitioners should know and understand the basic principles and techniques described in this book.

- I am well aware that hydraulic structure design is mostly about the application of engineering concepts rather than the use of mathematical and mechanical techniques. Therefore, I am convinced that comprehensive design ability for hydraulic structures should be emphasized throughout the book (Chaps. 7–13, 15–17) rather than merely on computational formulas or routine processes. By providing knowledge and engineering examples concerning the assumptions and principles, parameters and criteria, evaluations and modifications, treatments and countermeasures, etc., the book is intended to present more philosophy in the “design” apart from general description of the hydraulic structures and related computations. I strongly expect that individual lecturers will bring in other engineering examples drawn from their own experiences. However, I do hope that they would discuss their engineering examples within the simple framework described in this book.

The courses at Wuhan University which form the basis of this book have been developed jointly with my colleagues over the decades. I am fortunate to have had assistance and encouragement from them and other friends, particularly Profs Tan Guang-ming (Wuhan University, China), Peter Egger (EPFL, Switzerland), and Isam Shahrour (Lille University 1, France) for their general help and suggestions. My special thanks go to my family and confidants for their warm company, loving concern, and steady support, all these were essential for the successful completion of the book. I am grateful to Wuhan University for allowing me the time to write this book. I also thank Mr. Wang HL and Mrs. Xu Q for their help with the production of some of the figures.

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