Liquefaction is one of the major causes of damage to soils and foundations during earthquakes and is one of the most important aspects in seismic research and the design of foundations. Recent seismic liquefaction-related damage to soils and foundations demonstrates the need for comprehensive hazard analysis of seismic soil liquefaction, in order to reduce related damages and to protect lives. The aim of this book is to examine the disaster mechanisms and deformation evolution of seismic liquefaction and provide references for risk assessment.

This book summarizes and generalizes the authors’ research into seismic liquefaction, including mechanisms, deformation characteristics, and comprehensive evaluations. First, macroscopic liquefaction phenomena observed since the beginning of this century are reviewed, and then the liquefaction potential evaluations based on in situ testing are discussed. Then, the studies of the dynamic mechanisms of liquefaction via laboratory and model tests are presented. In addition, numerical simulations for deformation analysis of liquefiable soils are described. Finally, a comprehensive evaluation of liquefaction damage during earthquakes is proposed.

This book has seven chapters. Chapter 1, the introduction, gives a preliminary presentation of seismic hazards in the world, and liquefaction hazards are detailed using typical earthquake damage examples. After introducing these natural hazards, current major components of liquefaction hazard analysis are reviewed.

In Chap. 2, major earthquakes and related liquefaction damage since the beginning of this century worldwide are reviewed in detail. Conventional liquefaction phenomena and macroscopic characteristics (e.g., sand boiling or sand blows, ground cracking or fissures, and lateral spread) are summarized by analyzing observations from various earthquakes. In addition, several new phenomena related to earthquakes in the twenty-first century are introduced.

Chapter 3 presents liquefaction potential evaluations based on in situ testing, including the standard penetration, cone penetration, dynamic cone penetration or Becker penetration, and wave velocity tests.

The next three chapters focus on dynamic behavior and deformation characteristic analyses of seismic liquefaction by laboratory experiment (Chap. 4), centrifugal shaking table testing (Chap. 5), and numerical simulation (Chap. 6). In the
above, accelerations, excess porewater pressures, and deformations are captured. These are all useful for the prevention and control of geo-disasters.

Chapter 7 presents a comprehensive evaluation of liquefaction damage during earthquakes in light of performance-based seismic design criteria and reliability analyses.

The mechanisms and deformation characteristics of liquefaction described in this book can provide a reference for safe construction and seismic assessment. This will benefit graduate students, engineers, and researchers in the field of geological, geotechnical, and civil engineering.

Our work in liquefaction analysis has been profoundly influenced by the contributions of Prof. Atsushi Yashima and Prof. Kazuhide Sawada (Gifu University, Japan), Prof. Feng Zhang (Nagoya Institute of Technology, Japan), and many others working in this field. We express our deep gratitude to these illustrious scholars.

A number of former students in our research group at Tongji University are gratefully acknowledged for compiling the manuscripts, especially Mr. Liang Hao, Mr. Zhijing Zhuang, Dr. Ximiao Jiang, Mr. Chen Jin, Mr. Guanghui Li, Dr. Hu Zheng, Dr. Wuwei Mao, and Dr. Weijie Zhang, who contributed to the comprehensive research work. Writing and editing were supported by Ph.D. students Mr. Liuyuan Zhao, Ms. Lin Wang, Mr. Chongqiang Zhu, Ms. Yangjuan Bao, and Mr. Min Xiong, and master’s students Mr. Wenbin Deng, Mr. Zhuoqiang Wen, and Mr. Junjia Liu, and other group members.

We express our deep appreciation for financial support from the National Natural Science Foundation of China (Grant Nos. 41625011, 41372355, 40841014 and 40802070), National Basic Research Program of China (973 Program) through Grant No. 2012CB719803, National Key Technologies R&D Program of China (Grant No. 2012BAJ11B04), and the Program of Shanghai Academic/Technology Research Leader (Grant No.17XD1403700).

Finally, the authors would also like to thank the relevant publishers, including Springer, Elsevier, American Society of Civil Engineers (ASCE), John Wiley and Sons, and NRC Research Press, for their kind permission to reuse the content in this book. The permissions include our previously published articles and other scholars’ works in this field, which would support the completeness of this book and better understanding for readers.

Because of our limited knowledge as well as time, there are some inevitable omissions and errors in this book. Therefore, we welcome all constructive criticism and corrections toward continually improving the hazard analysis of seismic soil liquefaction.

Shanghai, China

Prof. Yu Huang

January 2017
Hazard Analysis of Seismic Soil Liquefaction
Huang, Y.; Yu, M.
2017, XX, 165 p. 112 illus., 87 illus. in color., Hardcover