Book review

Tang C, Phoon KK. (2021) Model uncertainties in foundation design. CRC Press, Taylor and Francis Group, 1st edition. 568 pages, ISBN: 978-0-429-02499-3, £112.00.

Digital technology and big data have transformed many sectors in industries and services. There are a lot of catch-ups to do for foundation engineering to enjoy the full benefits brought by digital transformation, such as increased productivity and reduced costs. One primary hurdle for this industry transformation is the lack of access to large data sets in geotechnical engineering. This issue is addressed in this book by collecting one of the largest and most diverse datasets of foundation load tests. This database covers many foundation types including shallow foundations, spudcans, driven piles, drilled shafts, rock sockets and helical piles as well as a wide range of ground conditions such as soft to stiff clay, loose to dense sand, layered soil profile and soft rocks. The database could be used to characterize the model uncertainty (i.e., biases and randomness) of various design methods for shallow, deep foundations, and other geotechnical structures. The characterized uncertainties could then be readily incorporated in geotechnical design, such as for calibration of the load and resistance factors used in the design. This book has provided excellent examples on how to treat the data as the "digital twin" of the physical asset and how to use the database to improve the design and decision-making in geotechnical engineering.

The book contains three parts. Part 1 (chapters 1-3) provides the background of the research and reviews the development of geotechnical uncertainty analyses and foundation engineering. Part 2 (chapters 4-7) is the main body of the book. It critically characterizes the model uncertainty of various design methods for shallow and deep foundations. Part 3 (chapter 8) presents the model uncertainties of other geotechnical structures including mechanically stabilized earth walls, soil nail walls, pipes and anchors, slopes and braced excavations. These three parts are reviewed briefly as follows with the intention to help the readers who have not had the opportunity to browse a copy of this book.

Chapter 1 covers the background of the research and the history of risk assessment in geotechnical engineering. The role, characteristics and value of geotechnical data in digital transformation are discussed. In particular, it is argued that geotechnical data can be rich if generic databases are considered together with the site-specific data, new sensing and monitoring technology. These "big data" make data-driven decision-making and digital transformation become achievable in geotechnical engineering. Chapter 2 introduces the various sources of uncertainty in geotechnical engineering and statistical tools and methods to deal with data. Aleatory uncertainty and epistemic uncertainty are distinguished and elaborated in this chapter. Chapter 3 covers the basic information for foundation engineering, including types of foundation, design principles, design processes and selection of foundations. Followed are detailed descriptions of permissible foundation movement, commonly used test methods to determine the bearing pressure and methods to interpret the test data. Chapters 2 and 3 provide the prior knowledge the readers need to know for model uncertainty characterization of foundation design.

Chapters 4 to 7 cover the model uncertainty characterizations for four different types of foundations, namely shallow foundations, offshore spudcans, driven piles and drilled shafts, and helical piles. The four chapters use a consistent and well-organized structure. Each chapter begins with the basic introduction of the involved foundation structure, followed by the failure modes and associated designed methods. Then, the collected databases are elaborated and the model uncertainties of the design methods are characterized using the compiled data. Finally, the model uncertainty results are used to calibrate the resistance factors in the load and resistance factor design.

Chapter 8 summarizes the foundation load test database presented in chapters 4-7 and covers the model uncertainty for other geotechnical structures, including mechanically stabilized earth walls, soil nail walls, pipes and anchors, slopes and braced excavations. The magnitudes of the model uncertainty for different design methods of various geotechnical structures are compared and summarized in Section 8.3. For readers who do not have time to read the whole book, Section 8.3 is not to be missed as it is the core of the book in our opinion. The book finishes with discussions of the challenges in model uncertainty assessments and with concluding remarks made in Section 8.4.

In summary, we recommend highly this book to geotechnical practitioners, code developers, researchers and research students in foundation engineering. The content contributes to code revisions of geotechnical structures, such as the load and resistance factor design in the American Association of State Highway and Transportation Officials (AASHTO) Bridge Design Specifications and provides practitioners straightforward information regarding the magnitude of bias and randomness in common design methods of foundation structures. In this regard, the book facilitates more rational decision-making of practitioners. Undergraduates and postgraduates of geotechnical engineering may also benefit greatly from the extensive review of the foundation structures and model uncertainty characterization methods.

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