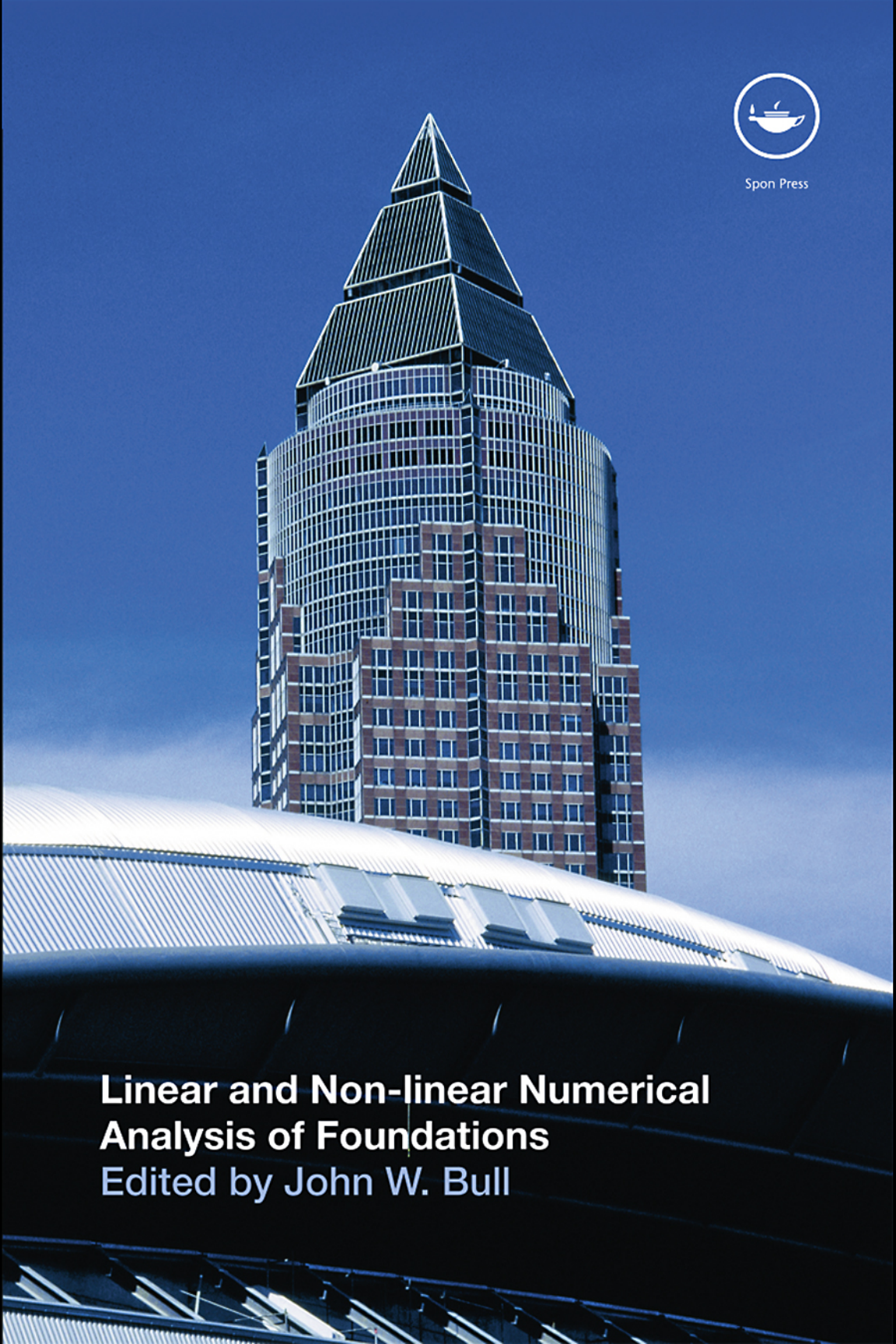
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Linear and Non-linear Numerical Analysis of Foundations
Edited by John W. Bull

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Preface

John W. Bull

The correct understanding, design and analysis of foundations that support structures are fundamental to the safety of those structures. Witness the leaning tower of Pisa, which, if built a short distance from its present location, would have remained upright and have been just another safe structure!

With the introduction of more complex design codes, such as the Eurocodes in Europe, it is becoming increasingly necessary to use linear and non-linear numerical analysis in the design of foundations to model accurately the structure's response to loading.

In order to allow designers, engineers, architects, researchers and clients to understand the advanced numerical techniques used in the analysis and design of foundations, and to guide them into safer, less expensive and longer-lasting structural foundations, a wide range of world experts with knowledge in the latest advances in the design and analysis of foundations has been brought together, and their expertise presented in a clear and logical way.

The chapters in this book provide a review of state-of-the-art techniques for modeling foundations, using linear and non-linear numerical analysis, as they affect a range of infrastructure, civil engineering and structural engineering foundations. The use of these chapters will allow designers, engineers, architects, researchers and clients to understand the advanced numerical techniques used in the analysis and design of foundations, and to guide them into safer, less expensive and longer-lasting structural foundations.

The following topics are covered in the book:

Using probabilistic methods to measure the risk of geotechnical site investigations illustrates that probabilistic methods can be employed successfully to measure the effectiveness of site investigations.

The contribution of numerical analysis to the response prediction of pile foundations considers the necessity of including design procedures that incorporate soil non-linearity and the effects from pile group structural non-linearities.

Uplift capacity of inclined plate ground anchors in soil gives a rigorous numerical study of the ultimate capacity of inclined strip anchors, taking into account the effect of embedment depth, material strength and overburden pressure.

Numerical modeling of geosynthetic reinforced soil walls uses an instrumented full-scale laboratory test wall to identify numerical modeling issues associated with achieving reasonable predictions of key performance features of geosynthetic reinforced soil walls.

Seismic analysis of pile foundations in liquefying soil outlines a dynamic effective-stress-based free-field ground response analysis method and a numerical procedure for the seismic analysis of pile foundations in liquefying soils.

The effect of negative skin friction on piles and pile groups investigates the effects of soil slip at the pile–soil interface on dragload development for single piles and pile groups.

Semi-analytical approach for analyzing ground vibrations caused by trains moving over elevated bridges with pile foundations presents an investigation into ground vibrations induced by trains traveling over a multi-span elevated bridge with pile foundations.

Efficient analysis of buildings with grouped piles for seismic stiffness and strength design shows that a detailed and efficient examination on pile-group effect is necessary in the practical seismic design of buildings from the viewpoint of stiffness and of strength.

Modeling of cyclic mobility and associated lateral ground deformations for earthquake engineering applications focuses on important aspects of soil cyclic mobility and its effects on lateral ground deformations, including liquefaction scenarios.

Bearing capacity of shallow foundations under static and seismic conditions analyses shallow footings in various ground conditions under both static and seismic loading.

Free vibrations of industrial chimneys or communications towers with flexibility of soil shows that soil flexibility under the foundation of a chimney considerably influences the chimney's natural modes and natural periods.

Assessment of settlements of high-rise structures by numerical analysis assesses settlement for both the serviceability limit state and the ultimate limit state of high-rise structures.

Analysis of coupled seepage and stress fields in the rock mass around the Xiaowan arch dam considers the coupled seepage and stress fields in the rock mass around the dam.

Development of bucket foundation technology for operational platforms used in offshore oilfields shows that bucket foundation technology is a reliable, low-cost, environment-friendly technology especially suitable for the construction of oil and gas development platforms in shallow-water areas with thick sea-floor sediment layers.

I am extremely grateful to all of the authors for their diligence in writing their chapter and for giving so generously of their time and knowledge to ensure the high quality of this book. I would like also to express my thanks to my publishers, Taylor & Francis, for their help and guidance in producing this book.

1 Using probabilistic methods to measure the risk of geotechnical site investigations

J. S. Goldsworthy and M. B. Jaksa

1 Introduction

The site investigation phase plays a vital role in foundation design where inadequate characterization of the subsurface conditions may lead to either an under-designed solution, resulting in failure, or an over-designed solution that is not cost-effective. Whether the design is for a building foundation or for a retaining wall for an unstable slope, an investigation of some form is required to predict the soil properties in order to estimate the soil response to applied loading. However, determining whether the scope and type of an investigation is suited to the site and the required design situation is not a straightforward task. Typically, the type and scope of an investigation is determined by a senior geotechnical engineer within the budget and time constraints placed on a project. However, it is rarely known, in other than subjective terms, whether the type and scope of the investigation is adequate or suitable. In order to account for this, as well as for the complex nature of soil behavior under load, geotechnical engineers use higher factors of safety than are otherwise used in other forms of engineering, such as structural engineering.

One of the reasons for the use of high factors of safety is the lack of knowledge regarding the effectiveness of the site investigation performed. Questions such as 'Were sufficient bore holes drilled and/or excavations dug to characterize the stratigraphy appropriately?' and 'Were enough samples taken and tests performed to gain an adequate representation of the ground response to load?' cannot be answered objectively and therefore result in additional redundancies being added to the design. If geotechnical engineers were able to gain a better understanding of the effectiveness of the investigation, the factors of safety used in the design could be selected more appropriately. As such, Jaksa et al. (2003) proposed a framework to measure the effectiveness of geotechnical site investigations using probabilistic methods and risk analysis. The framework was developed into a simulation model and used by Goldsworthy (2006), who presented results that illustrated the risks associated with geotechnical investigations.