Book review

Ground Improvement by Deep Vibratory Methods (Second Edition)

Klaus Kirsch and Fabian Kirsch, CRC Press, Boca Raton, FL, USA, 2016, ISBN 978-1-4822-5756-4, £99.00, 234 pp.

The deep vibratory methods of vibro compaction and vibro stone columns are recognised by the authors of *Ground Improvement by Deep Vibratory Methods* as the two dynamic methods of soil (ground) improvement most commonly used worldwide. This is reflected in having a publication dedicated solely to these ground improvement methods, the second edition of which is reviewed here.

Whilst the second edition of this book encompasses much of the content of the first edition (published in 2010), it is evident that the seven chapters have been updated to reflect recent developments and improvements in the equipment, execution and design approaches associated with deep vibratory (ground improvement) methods. Some additional case history information has been added and a new section on the use of depth vibrators in the construction of vibro concrete columns is also included. This is reflected in an overall increase in page numbers from 198 in the first edition to 234 in the second.

Chapter 1 provides a useful brief introduction to deep soil improvement by vibratory methods in the context of ground improvement techniques generally, with chapter 2 providing a history of vibratory deep compaction including the development of deep vibratory methods in Germany and their subsequent development outside Germany, together with an overview of developments in vibro execution methods and design. Some of the figure caption annotations in chapter 2 would have benefited from full translation into English from German. Chapters 3 and 4 are comprehensive, covering respectively vibro compaction of granular soils and improvement of fine-grained and cohesive soils by vibro (replacement) stone columns. Both chapters provide coverage of equipment details and characteristics, application and limitations, design principles (including seismic risk mitigation when applying these ground improvement techniques), quality control and testing, and case history information has been expanded. As in the first edition, chapter 4 also benefits from a useful section on the computational analysis of stone column behaviour.

Chapter 5, covering method variations and related processes, includes a new section on vibro concrete columns – a variation on the vibro stone column technique using similar equipment and employed in applications considered marginal for conventional vibro stone columns. The method/technique and equipment characteristics are discussed,

together with behaviour and design, applications and limitations, quality control and testing. Only one case history is provided, however, and the chapter would have benefitted from additional case history information demonstrating the range of application of the vibro concrete column technique.

Chapter 6, covering environmental considerations, includes sections on noise and vibration associated with vibratory ground improvement techniques. Useful reference data is provided, together with a risk assessment method for potential building damage due to vibratory deep compaction. Carbon dioxide emissions are also covered, including the environmental (sustainability) advantages of the deep vibratory ground improvement method compared with deep foundation methods with reference made to a carbon calculator tool that has been recently developed.

The final chapter briefly discusses the contractual implications of deep vibratory ground improvement techniques with commentary on the importance of site geotechnical characterisation, specifications, quality control and testing. A useful reference list is also provided at the end of the book.

Overall, the book broadly achieves its aim of providing a comprehensive insight into deep vibratory ground improvement methods, including an appreciation of their technological, economical and sustainability advantages. The authors understandably focus on both their own research experiences and also the experiences of their colleagues and companies they have been associated with. However, a greater reference to some of the more significant recent research and case history information within the wider deep vibratory ground improvement community would have been beneficial, albeit that one of the vibro (replacement) stone column case histories does attempt to address this.

As alluded to earlier, this publication is dedicated solely to deep vibratory ground improvement methods and its content is therefore more comprehensive and with a greater level of detail than one might typically find in some other geotechnical publications, which provide more generalised collective coverage of ground improvement techniques, some of which can be out-dated. The authors are therefore to be congratulated for their contribution. This practical guide will be of value to practising ground engineering professionals involved with deep vibratory (ground improvement) methods either as specifiers or practitioners, also to academics, civil and geotechnical engineering consultants and post-graduate students requiring a more detailed knowledge of the subject matter.

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