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Book review

Ballast Railroad Design: SMART-UOW Approach

Buddhima Indraratna and Trung Ngo, CRC Press, Boca Raton, FL, USA, 2018, ISBN 978-1-1385-8703-8, £69·99 (Hardback), 160pp.

The book reviewer first saw a draft of this book during his time as the Industry Chair of the Australian Cooperative Research Centre for Rail Innovation (Australian Rail CRC) project on railway ballast design in 2013, which is a national research project pioneered to mitigate the deterioration of ballast and track foundations, funded by the Australian Rail CRC. Over the past 5 years, this book has significantly evolved from the draft and has comprehensively accumulated not only theoretical background but also practical case studies and field experience for the decision making of rail and geotechnical engineers. It should also be acknowledged that the book was established with significant Australian rail industry input across the country (e.g. RailCorp NSW, Australian Rail Track Corporation, Queensland Rail and Aurizon) together with the continuous research of the authors, Distinguished Professor Indraratna and Dr Ngo. It presents state-of-the-art knowledge and technologies for the comprehensive design of ballasted railway tracks based on a rational approach. The rational approach takes into account extensive laboratory testing, computational modelling and, importantly, field measurements conducted over the past two decades by the authors in Australia. This book portrays a variety of novelties in the advanced design of railway track geotechnics and provides an imperative design aid for rail practitioners, postgraduate students and researchers in railway engineering.

Typical ballasted railway track (Figure 1) has been adopted in the modern era of the rail industry for over a century. Ballasted track systems consist of a superstructure and a substructure. The superstructure includes rails, rail pads, fastening systems, sleepers or cross-ties and ballast. The rails are generally supported by cross-ties that are embedded in the ballast over the substructure (including subballast, formation and foundation). The railway sleepers, bearers and transoms are safety-critical structural elements in ballasted railway track systems. Their main functions are not only to withstand static and dynamic loads imposed by the wheels and to transfer them to the ballast and underlying formation, but also to secure the rail gauge to allow trains to travel safely. Railway ballast is one of the main components in ballasted railway track systems. It is installed under the railway sleepers to absorb dynamic wheel/rail interaction forces, preventing the underlying railway track subgrade from experiencing excessive stresses, enabling the interlocking of skeleton track onto the ground and providing lateral track stability. Railway ballast is mostly derived from crushed-rock-based local materials from various sources, such as crushed igneous rocks (granite, rhyolite, decite, basalt, quartzite or latite), crushed metamorphic rocks, crushed sedimentary rocks, crushed gravel (from river, lake) and sometimes waste products (e.g. crushed slag, chitter). In modern railway tracks, ballast is required to fulfil the task of maintaining the track in good alignment, both horizontally and vertically.

It should be highlighted that current and contemporary design methods for railway ballast and track foundation rely simply on static track deformation, without consideration of

- ballast breakage, voids and contamination
- cyclic loading and accumulative deformation
- confining pressure
- multi-layers of subgrade and formation
- the drainage capacity of the ballast
- fouling
- train speeds
- the potential use of geosynthetics in track foundations.

Figure 1. Typical ballast railway track in Australia

Conventional track foundation design idealises the foundation as an elastic media (e.g. Winkler model, 2·5 dimensional model, track stiffness model, Green function and so on) under static wheel loads. Although this approach is popular due to its convenience and reduced computation time, it cannot determine the accumulative deterioration of track foundation and ballast breakage.

Therefore, the new comprehensive approach developed at the University of Wollongong, Australia, and carefully discussed in this book is noble and highly appreciated by railway geotechnics communities. The book describes a new design approach that fills in gaps of knowledge in railway ballast and track foundations. The special commendation is the capability of the SMART-UOW design approach, which is the world's first to enable track foundation designers to predict ballast breakage and to consider the crucial effects of confining pressure, loading frequency, ballast fouling, track drainage, train speeds and the applications of potential geosynthetics in railway tracks. In addition, engineers can adopt the new approach to predict vertical track settlement, to incorporate any new constitutive model of ballast and to design subballast (capping layer) using geosynthetics. These advancements cannot be found in any other contemporary design method for ballasted railway track foundation. This book is thus highly recommended for railway engineers, undergraduate and postgraduate students, as well as researchers in railway communities.

New software based on the SMART-UOW design approach for track foundations has been developed and verified with field measurements taken in Australia. A variety of case studies of comparative evaluations between design and field data are available in the book (based on passenger rail, heavy-haul rail and mixed-traffic rail networks). To the book reviewer's knowledge, the software has been adopted by the Australian rail industry. If anyone is interested, the licence can be sought out by contacting the authors or through the commercial arm of Australian Rail CRC (i.e. Rail Innovation Pty Ltd).

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