

Book review

Advanced Rail Geotechnology: Ballasted Track

Buddhima Indraratna, Wadud Salim and Cholachat Rujikiatkamjorn. CRC Press, Boca Raton, FL, USA, 2011, ISBN 978-0-415-66957-3, £95-00, 432 pp.

Despite developments in specifications and materials, the essential components of ballasted railway track have remained substantially unchanged for nearly 200 years. This is especially so for the ballast itself, on which (together with the underlying sub-base) the whole system is founded. Traditionally, the design and maintenance of the ballast and sub-base have been based on observation and experience, with little place for the application of fundamental scientific principles or understanding. For the most part, this empirical approach has served its purpose at least adequately.

However, the increases in train speed and intensity of use that have accompanied the growth in popularity and importance of rail transport over the past two decades or so have raised serious questions concerning the performance of ballasted track as currently implemented. These focus on the need to reduce maintenance requirements (for reasons of both cost and track utilisation) and on the suitability of ballasted track for very high speeds (in excess of 400 km/h).

Fortunately, the past two decades have also seen the growth of several university-based research groups and centres around the world, focusing on obtaining a better understanding of railway track behaviour that can be translated into improved performance and reduced maintenance. These centres have often developed as a result of strategic government investments, and complement the work being carried out within the industry itself.

One of the leading centres for railway geotechnical engineering is that at the University of Wollongong, Australia, founded and led by Professor Buddhima Indraratna. This book is based largely on the fundamental work on the geotechnical aspects of ballasted railway track carried out by Professor Indraratna and his colleagues over the past 20 years. As such, it is something of a milestone in the subject.

The book starts with three chapters setting out the background, basic components and requirements of traditional ballasted railway track,

including the loads to which the track may be subjected, and how these are transferred as stresses into the ground. Chapter 3 sets out the factors governing ballast behaviour, which include aggregate mineralogy, particle size, shape, size distribution and strength. Particle degradation – a topic of considerable importance and recent research – is introduced in Section 3.4. Chapter 4 addresses state-of-the-art laboratory testing and degradation assessment of ballast, ranging from single grain crushing through to large-scale cyclic triaxial tests. Further chapters relate mainly to the ballast cover and its behaviour with and without geosynthetics and energy-absorbing mats (chapter 5); a new constitutive model (chapter 7); ballast drainage and fouling (chapter 8); discrete element modelling (DEM) at the particle or sub-particle scale (chapter 10); and ballast grading (chapter 15).

The sub-base and underlying earthworks have just as important an effect on track performance as the ballast, and are covered in chapters 8 and 9 (which address mainly drainage and the use of geosynthetics), and chapter 16 (bio-engineering for track stabilisation, through the controlled use of appropriate lineside vegetation). Other topics covered are existing deformation models for granular materials such as ballasts and soils (chapter 6), field instrumentation for performance verification (Chapter 10), finite-element modelling (chapter 12), non-destructive testing and track condition assessment (chapter 13), and track maintenance (chapter 14).

The book covers the background to the geomechanics of railway track in an appropriate level of detail, and provides quite comprehensive reviews of some advanced topics – notably elasto-plastic constitutive models, including multi-surface models, for soils and granular materials in chapter 6; and drainage and filtration in chapter 9. Its main focus, however, is the work of Professor Indraratna and his group, with the constitutive model for ballast (including the effects of breakage) described in chapter 7 being a particularly major contribution.

The book will be of significant interest and use to practising track engineers and researchers in railway geotechnology alike, and an investment that I can unreservedly recommend.

William Powrie