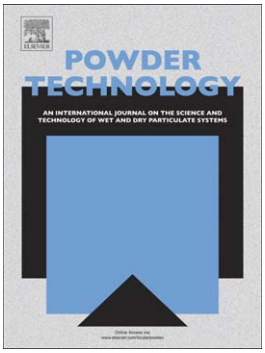

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Jan Eliáš

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Simulation of railway ballast using crushable polyhedral particles

Jan Eliáš[a,*]

[a] *Institute of Structural Mechanics, Faculty of Civil Engineering, Brno University of Technology, Czech Republic*

Abstract

The need to understand and predict the long and short term behavior of railway ballast calls for extensive experimental programs as well as the development of reliable numerical models. From the modeling point of view, the granular nature of ballast in connection with the high onset speed of dynamic loading makes it ideal for the application of the Discrete Element Method (DEM).

The paper describes the employment of the DEM to simulate ballast behavior in large-scale oedometric testing. Ballast grains are represented by convex polyhedral particles whose shapes are randomly generated via Voronoi tessellation. The effect of the aspect ratio of particles is investigated. A novel algorithm to compute repulsive contact force based on the intersecting volume of polyhedrons is presented. Crushing of grains is included via splitting the particles into smaller polyhedrons when a certain stress-based criterion is fulfilled. Results obtained from the model are compared with published experimental investigations.

Keywords: railway ballast, DEM, polyhedral shape, oedometric test, crushing, intersecting volume

1. Introduction

The power of modern computers is being utilized to help engineers in designing and understanding their technological solutions more frequently than ever. The need to deal with various types of problems has led to the development of many different methods, among which the Discrete Element Method (DEM) is especially suitable when granular media under highly dynamic loading is studied. The DEM treats every grain as an ideally rigid body which interacts with other particles through forces at their common contacts. In most cases, the simplest spherical elemental shapes are used. However, it has been reported that particle shape has a strong

*Corresponding author
Email address: elias.j@fce.vutbr.cz (Jan Eliáš)