Rail Research UK

The universities' centre for railway systems research

Engineering Interfaces

Discrete Element Modelling of Railway Ballast

Institution:

The University of Nottingham

Researchers:

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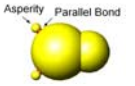
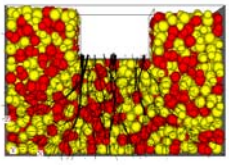
Background:

The interaction of ballast particles with one another is physically complex. Particle shape and strength play important roles in determining the stiffness of the tracked and the accumulation of the permanent settlement. Permanent deformation arises from particle breakage (and the associated rearrangement of particles) and most of the degradation of ballast particles under cyclic loading is due to abrasion rather than bulk fracture.

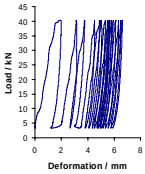
The aim of this project is to gain a better understanding of the behaviour of railway ballast at a micro mechanical level, especially degradation, using the discrete element method.



2-ball clump with two asperities



Box test simulation



Load against deformation for the box test on 2-ball clumps with two asperities

Progress:

Irregular shaped clumps are used in the box test simulations to investigate the effect of particle shape.

A simple 2-ball clump with two additional small balls (asperities) bonded to represent each single ballast particle is used in the box test simulations to investigate the behaviour under cyclic loading and the effect of particle breakage on the accumulated permanent deformation.

A series of both monotonic and cyclic triaxial test simulations using 10-ball clumps with eight asperities have also been carried out to investigate the effect of degradation.

Novel Aspects:

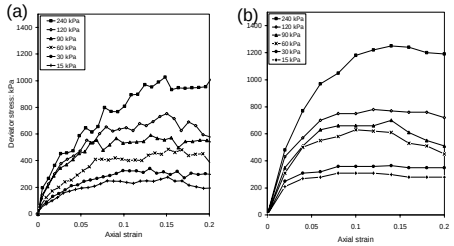
Modelling particle shape

Particle shape strongly influences the behaviour of the ballast assembly. Different shaped clumps are used to represent each single ballast particle in order to simulate the mechanical behaviour of ballast. A clump is a single entity of overlapping balls in PFC3D and internal overlapping contacts are ignored in calculations.

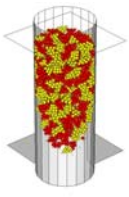
Modelling particle breakage

Instead of using the crushable agglomerate (formed by bonding spheres together), which makes the calculations time-consuming when modelling a large number of agglomerates, small balls are bonded at the surface of the rigid clumps in order to provide a mechanism for abrasion.

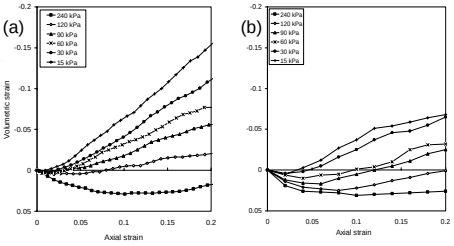
10-ball clump with eight asperities



Results of deviator stress against axial strain under a range of confining pressure (a) using breakable clumps; (b) experiment results (Indraratna *et al*., 1998).



Triaxial test simulation



Results of volumetric strain against axial strain under a range of confining pressure (a) using breakable clumps; (b) experiment results (Indraratna et al., 1998).

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