Non Smooth Contact Dynamic approach for railway engineering: investigation of ballast behaviour under stabilisation process.

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ABSTRACT

The numerical developments of three-dimensional discrete element approach taking into account the polyhedral shapes of ballast grains [1] with the Non-Smooth Contact Dynamic approach (NSCD) allow evaluating the performance of industrial processes. Railway ballast has been studied using DEM [2] and NSCD approach in different cases in order to characterize geotechnical testing [3], understanding the behaviour of thin granular layers or analyse tamping process.

The NSCD method is based on implicit time integration of the dynamic equations and a non-smooth formulation of steric exclusion and friction between particles. This method requires no elastic repulsive potential and no smoothing of the Coulomb friction law for the determination of forces. For this reason, the simulations can be performed with large time steps compared to molecular dynamics simulations.

In this paper we propose an investigation of the process of ballast stabilisation where the sleeper is loaded laterally along its main axis with a cyclic load and vertically with a constant load. The impact on the compaction of various parameters like the longitudinal stabilisation speed along the track are analysed with a view of optimising the process.

The authors used LMGC90, a multi-purpose software based on NSCD capable of modelling a collection of deformable or non-deformable particles of various shapes by different algorithms to simulate stabilisation of a three-sleeper track section with a total of 99000 particles. The ballast particles are modelled as polyhedrons of irregular shapes based on real ballast particles scans and the sleepers as polyhedrons based on regular geometry of real sleepers.

This study highlights the efficiency of LMGC90 and associated NSCD approach in analysing the mechanical behaviour of ballasted tracks in different types of loading avoiding at the same time costly experimental in-situ testing campaigns.

REFERENCES

[1] Modeling ballast behavior under dynamic loading. Part 1: A 2D polygonal discrete element method approach, Comput. Methods Appl. Mech. Engrg. 195 (2006) 2841–2859

[2] A method to model realistic particle shape and inertia in DEM. J.-F. Ferellec, G.R. McDowell. Granular Matter 12 (2010) 459-467

[3] Penetration test in coarse granular material using Contact Dynamics Method. Computers and Geotechnics (Impact Factor: 1.65). 01/2014; 55:248–253. DOI: 10.1016/j.compgeo.2013.09.006