Elastic multi-body dynamic simulation for the ballast grains by QDEM-FEM coupled analysis

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ABSTRACT

A quadruple discrete element method (QDEM) was developed for elastic and/or viscoelastic multi-body dynamics for the ballast grains of railway. The motion of the sleeper and the gravels motion modelled using the assemblage of QDEM tetrahedron meshes on the general-purpose computing on graphics processing units (GPGPU) was coupled with the rail motion modelled using elastoplastic rolling contact dynamic analysis by a large-scaled finite element method (FEM) on high performance parallel computing (HPC). The traffic impact response of ballast grains and sleepers was analysed. The three-dimensional spatial distribution of ballast particle movement and subsidence were clearly revealed. Moreover, the ballast layer absorbed the low frequency vibration of the sleeper more effectively than its high frequency vibration. This study suggests that the proposed QDEM-FEM can provide greater insight into the impact response of ballasted railway tracks.

Keywords: discrete element method; viscoelastic deformation; finite element method; railway dynamics; ballasted track deterioration; impact response, vibration analysis

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