

Construction of Large-Scale Ballasted Track Analytical Model by QDEM

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The dynamic characteristics of ballast layers in relation to repeated impact loads have not yet been sufficiently elucidated. To gain greater insight into the causes of ballasted track deterioration, it is critical to be able to evaluate the dynamic internal behavior of ballast with high precision. A new method for numerical simulations, namely quadruple discrete element method (QDEM), was developed to build a ballasted track model capable of reproducing various ballast states in detail. The QDEM takes into account the interaction defined by four particles consisting a tetrahedron vertex. Assuming a micro-continuum for each tetrahedron with viscoelasticity in continuum mechanics, the relationship between the motion of four particles and the stress developed in the tetrahedron can be formulated. In this research, the parallelized QDEM simulation is applied to the analysis of ballast track behavior influenced by impulse load associated with a running train on a rail, which made it possible to simulate track subsidence due to the elastic vibrations and the rolling / displacement of the ballasted track caused by passing trains. In future these analytical models can be used to gain deeper insight into mechanisms leading to ballasted track deterioration. It is also expected to be used to evaluate various corrective measures.