

**Elastic Quadruple Discrete Element Method (QDEM)  
for Evaluating Dynamic Response and Wear Propagation Phenomena of Ballasted Track**

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The Quadruple Discrete Element Method (QDEM) is an elastic and/or viscoelastic large-scale analysis code for multi-body structures including continuum and/or discontinuity. In addition, QDEM can quantitatively evaluate elastic and/or viscoelastic deformation behavior, fracture propagation behavior, and natural vibration characteristics. To quantitatively evaluate the wear propagation phenomena of the ballast grains, a new wear progress model, which slightly reduces the sharp angularity shapes of the ballast grains when the contact load value between the ballasts exceeds a predetermined threshold, is implemented in the QDEM. The QDEM can reproduce not only the rotation and movement phenomena of the ballast assembly but also the wear propagation behavior at the ballast contact points caused by the repeated dynamic loads of trains. This paper describes that the reproducibility of the natural vibration modes of the ballasted track structure by using the actually measured loads, the analysis of the track settlement behavior using the wear propagation model.