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Investigating the Shear Behaviour of Fouled Ballast Using Discrete Element Modelling

Authors : Ngoc Trung Ngo, Buddhima Indraratna, Cholachat Rujikiathmakjornr

Abstract : For several hundred years, the design of railway tracks has practically remained unchanged. Traditionally, rail tracks are placed on a ballast layer due to several reasons, including economy, rapid drainage, and high load bearing capacity. The primary function of ballast is to distributing dynamic track loads to sub-ballast and subgrade layers, while also providing lateral resistance and allowing for rapid drainage. Upon repeated trainloads, the ballast becomes fouled due to ballast degradation and the intrusion of fines which adversely affects the strength and deformation behaviour of ballast. This paper presents the use of three-dimensional discrete element method (DEM) in studying the shear behaviour of the fouled ballast subjected to direct shear loading. Irregularly shaped particles of ballast were modelled by grouping many spherical balls together in appropriate sizes to simulate representative ballast aggregates. Fouled ballast was modelled by injecting a specified number of miniature spherical particles into the void spaces. The DEM simulation highlights that the peak shear stress of the ballast assembly decreases and the dilation of fouled ballast increases with an increase level of fouling. Additionally, the distributions of contact force chain and particle displacement vectors were captured during shearing progress, explaining the formation of shear band and the evolutions of volumetric change of fouled ballast.

Keywords : railway ballast, coal fouling, discrete element modelling, discrete element method
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