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Closure to "Deformation of Coal Fouled Ballast Stabilized with Geogrid under Cyclic Load" by Buddhima Indraratna, Ngoc Trung Ngo, and Cholachat Rujikiatkamjorn

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Abstract

The writers highly appreciate the keen feedback provided by the discussor and also for raising some other important aspects of the experimental program. While the writers are in general agreement with the discussor's comments, some points warrant further clarification.

Keywords

coal, fouled, ballast, stabilized, geogrid, under, cyclic, load, buddhima, indraratna, ngoc, trung, closure, ngo, deformation, cholachat, rujikiatkamjorn

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The writers highly appreciate the keen feedback provided by the discussor and also for raising some other important aspects of the experimental program. While the writers are in general agreement with the discussor's comments, some points warrant further clarification.

The main purpose of the paper was to investigate the effects of the geogrid and the influence of coal fines on the deformation and degradation of fresh and fouled ballast, by means of both laboratory study and discrete element modeling (DEM). The complex deformation and degradation mechanisms of coal-fouled ballast and the reinforcement effect of geogrid had not been documented earlier, and this reflects the uniqueness of the present work. The writers agree with the discussor that, because of the compaction of the ballast layers, the ballast-geogrid system would be forced to interact more with the subballast, and this could have resulted in the additional tensioning of the geogrid. Within the scope of this study, the strains developed across the geogrid caused by compaction could not be captured properly. However, the development of strains in the geogrids during cyclic loading has been studied elsewhere and presented by Ngo et al. (2014). During the process of sample preparation and compaction, the apparatus was rigidly clamped to prevent any deformation induced by compaction. After the test setup assembly, the clamps were removed, and lateral pressures typically provided by the crib and shoulder ballast in a real track were imposed, followed by the application of initial vertical pressure (e.g., 45 kPa). The readings of all settlement pegs and potentiometers before the cyclic load

application were recorded to serve as a reference for all lateral displacement and settlement readings. In this respect, the deformation of ballast resulting from the seating load and subsequent in-service loading were measured separately.

The writers are grateful for the discussor's comment that further modification of the apparatus could be undertaken for cyclic load testing resulting from the wheel loads, considering the deformations occurring from compaction. These studies would also be beneficial in geogrid reinforcement of earth walls. In fact, further large-scale experimentation taking into account the water content, different ballast characteristics (e.g., gradation, angularity, hardness, and toughness), varying amplitude and frequency of loading, and ongoing extensive field investigation are currently progressing at the Centre of Geomechanics and Railway Engineering, University of Wollongong, Wollongong, Australia (Indraratna et al. 2013).

The placement of the geogrid-geotextile (bonded) layer is now popular in Australian rail networks for providing the beneficial reinforcement and filtration functions. The nonwoven geotextile layer used in the current study was placed over the subballast and beneath the geogrid to act as a separator between the ballast and subballast layers and to prevent other layered materials (e.g., subgrade, subballast, and ballast aggregates) from intermixing. As the ballast layer is placed on top of the geogrid, the interlock between the geogrid and ballast is not at all affected by the geotextile that acts as a separator between the ballast and subballast layers. The writers agree with the discussor's comment that it is appropriate to use another nonwoven geotextile placed between the bottom of the subballast and subgrade to prevent the effect of pumping of the subgrade under train loading, where the presence of excess moisture could result in possible slurring of the soft subgrade (mud pumping), leading to track instability. Such a geogrid-geotextile composite arrangement is currently applied in large-scale field trials conducted in the town of Singleton and Bulli in the state of New South Wales. The use of both single and dual layer arrangements has been examined in these field trials, and results show that the most favorable depth is on the order of 400 mm from the bottom of sleeper, as suggested by Raymond (1982).

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