Large-Scale Testing Facilities to Study Stress-Strain, Degradation and Drainage Behaviour of Railway Ballast

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The demand for quicker and safer transport and solutions for congestion in main highways during peak hours has made the railways the most favourable means of public transportation in many countries. Besides, the demand for increased axle loads of heavy-haul trains for industrial needs is inevitable to provide a cost-effective and efficient transportation system. However, when subjected to heavy axle and faster wheel loading, ballast aggregates rapidly degrade, compromising the particle shear resistance and associated substructure's load-bearing capacity. The conventional geotechnical testing facilities such as direct shear, triaxial and permeability apparatus are the most versatile laboratory methods for obtaining the strength, deformation and drainage properties of fine-grained materials to small size granular rock specimens. The sizes of ballast particles used in rail tracks ranges from 20 mm to about 65 mm. Therefore, the load-bearing capacity of ballast and its deformation, degradation and drainage characteristics can only be studied using large-scale testing equipment, because the conventional geotechnical equipment cannot accommodate relatively large size aggregates. Nevertheless, the difference between the actual particle sizes used in rail tracks and the significantly reduced particle sizes used in aforesaid conventional laboratory equipment contribute to imprecise deformation, degradation and drainage behaviour and failure modes. This is because of the inevitable size-dependent dilation and different mechanisms of particle crushing that occur in real-sized particles. To overcome these size-dependent problems, large-scale direct shear, triaxial, and permeability test facilities for testing ballast have been designed and built in-house at the Department of Civil Engineering of the University of Peradeniya. These test apparatus provide more realistic information on stress, strain, degradation and drainage characteristics of ballast particles used in actual rail tracks. This study elucidates the results of this major testing program conducted at the Department of Civil Engineering where static, dynamic and drainage testing of ballast are being conducted. The Sri Lankan railway ballast materials tested by this large-scale testing shows that the friction angle of the fresh ballast is 69° and the permeability is 0.43 m/s which are generally within the accepted limits for railway ballast materials.

Keywords: Ballast, Deformation, Degradation, Direct shear, Triaxial, Permeability

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