ABSTRACT

Keywords: Railway track bed; Clay subgrade; Subballast; Geogrid reinforcement, Plate load test; Numerical modelling

The construction of railways over soft soils poses serious challenges which require design solutions that are sustainable andeconomic, enhancing safety and serviceability. To safeguard against the traffic-load induced failure in the subgrade, recent design solution favours provision of a cushion of stiffer granular layer over the subgrade, typically referred to as subballast. Owing to a relatively cumbersome and a costly proposition in procuring the subballast material, reinforcing the subballast with geogrid is a potential solution. The interlocking and tension membrane effect of geogrid induces confinement onto the soil mass leading to increased performance improvement.

Literatures report the beneficial effect of geogrid reinforcement in improving the bearing capacity of foundation bed but the studies are mostly on homogenous soil bed. In contrast, the ballasted track beds are generally multilayered systems, often constructed over clay soil. As such, a systematic study on the stiffness behaviour of such multilayered systems consisting of weak clay subgrade, subbase, and their improvement through geogrid reinforcement has not yet been well understood in the light of some key parameters.

In this present investigation, a detailed parametric study has been carried out through model Plate Load tests and laboratory scale California Bearing Ratio tests in order to develop an understanding of the load-settlement behavior of railway track bed foundations and to investigate the role of geogrid reinforcement in improving their performance. The influence of various parameters such as thickness ofgranular layer, position of geogrid reinforcement, effect of subgrade strength and number of reinforcement layers on the overall performance of the multilayered foundation bed has been studied extensively. Tests were also carried out

with a geotextile layer at the subballast-subgrade interface for comparison purpose. The test results are analysed to find out the optimum parameters giving maximum performance improvement. Further, a numerical model has been developed through which more detailed analysis of the system has been carried out.

The results of the model tests showed that the overall performance depends on the quality of underlying subgrade material as a relatively strong subgrade renders improved performance compared to a weak subgrade. Irrespective of the subgrade quality, the provision of subballast layer increases the load bearing capacity and it is directly dependent on the thickness of the layer with a thicker section outperforming a thinner section. In case of reinforced section, the improvement is a function of the depth of placement of the geogrid reinforcement and the number of reinforcement layers. Although the performance, both in terms of stiffness and bearing capacity, tends to increase as the geogrid was placed at a more shallow depth, a critical position of reinforcement was determined based on the test data. The effect of multilayer reinforcement showed much higher improvement but an additional layer at a very shallow depth reduces the performance owing to insufficient interlocking. It was also observed that a layer of geotextile at the subballast-subgrade interface tends to perform better than that with a layer of geogrid. However, provision of an additional layer of geogrid over the geotextile does not lead to further improvement in the performance.

Regression analysis of the test data helped in developing models that can predict various response parameters of the model tests from small scale observations to a desirable level of accuracy. Numerical analysis with the help of Finite Element based tool ABAQUS, showed satisfactory match of the observations and also helped in exploring the influence of additional parameters and its effect in improving the performance of geogrid reinforced railway track bed.