International Journal of Advance Research in Science and Engineering
Volume No.07, Issue No.10, October 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

LABORATORY STUDY ON IMPROVEMENT OF RAILWAY BALLAST USING GEO-CELLS

Vinay Kumar Pandey[1],Sachin Bansal[2],
Mohammad Anas Beg[3], Mequat Raza[4]

[1,2,3,4]*(Civil Engineering, NIET, Greater Noida, Uttar Pradesh, India)*

ABSTRACT

The Classical railway track basically consists of a flat frame work made up of rails and sleepers, which are supported on ballasted track formation. Ballast particles break down and deteriorate progressively under heavy cyclic rail loading. Moreover, excessive consolidation settlement and progressive shear failure may occur in soft track formation under repetitive stresses. In order to rectify these problems, frequent maintenance operations are generally required in ballasted track. In order to minimize the deterioration of track substructure and also to reduce maintenance cost, the use of various types of geosynthetics including recycling of waste ballast has been studied in the laboratory. the prospective use of three types of geosynthetics (i.e.geogrids,geotextiles and geocomposites) in enhancing the performance of fresh and recycled ballast have been examined. The aspect of deformation and degradation of ballast under cyclic loading has been studied using large-scale prismoidal triaxial rig. The research findings reveal that recycled ballast stabilized with geosynthetic reinforcement has a good potential for resilient track construction and for reducing the cost of track maintenance. The experimental findings may be beneficial to the railway engineers and encourage them to upgrade current tracks based on these innovative techniques.

I.INTRODUCTION

Railway continues to provide mass transportation, public and freight, and thereby form one of the major worldwide transportation networks. Ballasted tracks are still the most common railroad structure, owing to the relatively low cost of construction. Super structure consists of the rails, fastening system and the sleepers. The substructure consists of the ballast, sub-ballast and the subgrade soils. With ever increasing traffic and axel load, tracks are undergoing deterioration thereby seriously hampering safety and efficiency, for instance enforcing speed restrictions and more regular track maintenance and upgrading. Hundreds of millions of dollars are spent each year for the construction and maintenance of rail tracks in large countries like India, China, USA, Canada and Australia. According to statistics from the Chinese railways about the 75%of the daily maintenance work on track substructures is due to the ballast and its deformation.

Among several problems, the track is subjected to; spread out of ballast is a major concern, particularly in case of high speed tracks. Constant vibration from repeated wheel loads, coupled with lateral and longitudinal forces exerted on the track from train movements, causes ballast spread out leading to differential settlement which eventually alters the geometry of tracks. Studies have shown that geosynthetics such as geotextiles and geogrids can be an effective means of ballast sub grade stabilization. It has been reported that the geosynthetics induce additional confinement onto the ballast and thereby the vertical and lateral deformation of the track substructure. Geocells are recently developed technique in the area of soil reinforcement. It is the three dimensional, polymeric, honeycomb like structure of cells interconnected at joints. The geocell reinforcement owing to its three-dimensional configuration arrests the lateral spreading of the in-fill soil and creates a relatively stiffened mat that redistributes the surcharge pressure over wide area.

It is also found that , the geocell system is a superior form of reinforcement over the planer geogrid. Therefore it is expected that the geocells if provided at the ballast-capping interface, would provide a better interlocking leading to increase resistance against ballast deformation. This aspect has been studied, in this paper, through a series of large size box shear tests. The most critical condition in the performance of the ballast is the initial loading, just after construction/maintenance, when the ballast is loose that it has least resistance against sliding. The findings from the present study shall be of use in such situations i.e. track design corresponding to the initial stage of the cyclic loading. Besides, the present tests with monotonic shear loading would help developing an insight into the basic mechanism of ballast-geocell interaction.

II.TEST DETAILS

We will use the ballast granite for the present investigation from the designated railway quarry. The ballast particle will be irregular in shape and their physical properties will be evolve using the standard test procedure as per IRSGE. Their impact crushing value and Los Angles abrasion value will be evolve, which should be well below the upper limit of 20 % (crushing) and 30% (abrasion), as recommended by Indian Railway Services Authority (IRSGE) . The particle size distribution of ballast specimen as per the fig.1, which is similar to gradation for rail ballasts as recommended by IRSGE1. The ballast particles will be in the size range of 20-60 mm. the average size , coefficient of uniformity and the coefficient of curvature of the ballast will be found which should be uniformly graded.

The soil for the capping layer should be well graded sand, as recommended by IRSGE, the particle size distribution should like fig.2, their coefficient of uniformity and coefficient of curvature will be evolved. The geocells will be fabricated in the chevron pattern. Using a biaxial geogrid made of oriented polymer will have aperture opening size of 35×35 mm, will have at least ultimate tensile strength of 20kN/m, secant modulousof 160kN/m at 5 %strain (ASTM Standard D6637). Plan view of geocell system is shown in fig.3. The joints of geocells, in the present study will be formed using 6mm wide and 3mm thick plastic strips made of low density polypropylene. The joints will be made by pulling the strands of transverse georgid.

The test beds will be prepared in large size direct shear box having inside dimensions of 300 mm length, 300 mm width and 220 mm depth. The lower half will be filled with capping soil compacted to a density of 17.5 kN/. The upper half will filled with ballast compacted to a density og 15 kN/. The ballast mass will be tested for its frictional characteristics, both top and bottom half of the shear box will filled with ballast alone. In the other tests, the capping soil will be filled in the lower half of the box and the ballast in the upper half of the box. Tests wherein influence of geocell reinforcement was studied, the geocell-soil mattress will be in the lower half and the ballast will be filled in the upper half. The soil in the geocell mattress wills same as that of the capping layer. Shearing will be applied at a rate of 1.25mm/min. through a motorized arrangement. The load and the deformation will be recorded through proving ring and dial gauges respectively. The test setup will be modified such that maximum horizontal shear displacement can be up to 100 mm.

Three different series of tests will be carried out, by varying different parameters and the details will be captured in tabulated form. Under the tests series A, tests will carried out with ballast alone. Tests with ballast overlying capping soil will be performed in the test series B. the influence of geocell reinforcement on the performance of ballast-capping soil interface will be studied through test series C. I n this series five different geocell pocket sizes () will be used. The pocket size is the equivalent circular diameter of the geocell pocket opening, shown through the hatched area.

III.RESULTS AND DISCUSSION

Twenty one specimens will be tested to evaluate the shearing response of the ballast-soil interface and its improvement through geocell reinforcement. The resistance against lateral spread of ballast is evaluated by comparing the shear stress-shear displacement responses, typical shear stressdisplacement responses of the ballast at different normal pressures, applied onto it during shearing. The shear displacement that depicts the lateral spread of the ballast is normalized with respect to initial length of the specimen expressed in percentage,. This attributed to the breaking of interlocking, a dominant mechanism in the performance of highly angularly ballast particles. The increased stiffness (i.e. slope of the stress-strain response), with increase in normal pressure, indicates that the ballast can perform better under higher surcharge pressure. However, with the capping soil below the shear resistance is much less compared to that of the ballast alone.

This will indicate that the geocell reinforcement at base, the ballast is able to mobilize its peak capacity against shearing. With increase in normal pressure near about 50 %, the performance will improved substantially.

IV.CONCLUSIONS

In this paper a study on the performance improvement of railway ballast against lateral spreading using geocells has been studied through a series of shear test. The results will obtained that the geocell reinforcement can significantly improve the frictional characteristics of the ballast capping interface and therefore can arrest the lateral spreading of ballast mass substantially. The performance improvement will be found to be maximum when the pocket size of geocells is about twice that of the average size of ballasts. With reduced lateral spreading of ballast, overstressing of the sub grade of the soil etc. too would come down giving rise to increased maintenance period and hence reduced track maintenance cost. However, the findings of this study needs to be verified through large scale tests.

REFERENCES

1. ASTM Standard D6637 (2001) Standard test method for determiningtensile properties of geogrids by single or multi-rib tensilemethod. ASTM International, West Conshohocken, vol 04.13
2. Dash SK, Krishnaswamy NR, Rajagopal K (2001) Bearingcapacity of strip footings supported on geocell-reinforced sand.J GeotextGeomembr 19:235–256
3. Dash SK, Sireesh S, Sitharam TG (2003) Behaviour of geocellreinforced sand beds under circular footing. J Ground Improv7:111–115
4. Dash SK, Rajagopal K, Krishnaswamy NR (2004) Performanceof different geosynthetic reinforcement materials in sand foundations.J GeosynthInt 11:35–42
5. GM/TT0088 (1993) Rail Safety and Standards Board. Permissibletrack forces for railway vehicles. Group Standard GM/TT0088, Issue 1, Revision A. Rail Safety and Standards Board,

IJARSE
ISSN: 2319-8354

London. http://www.rgsonline.co.uk. Accessed 17 May 2010

6. Indraratna B, Ionescu D, Christie D, Chowdhury R (1997)Compression and degradation of railway ballast under onedimensionalloading. Aust Geomech J 32(4):48–61
7. Indraratna B, Khabbaz H, Salim W, Christie D (2003) Geotechnicalcharacteristics of railway ballast and the role of geosyntheticsin minimising ballast degradation and track deformation. In: Proceedings of RAILTECH 2003: railway technology in thenew millennium, Kuala Lumpur, pp 1–22
8. Indraratna B, Khabbaz H, Salim W, Christie D (2006) Geotechnicalproperties of ballast and the role of geosynthetics in railtrack stabilisation. J Ground Improv 10(3):91–101