Response of Pavement Foundation Incorporating Geocell and EPS Geofoam: A Review

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***Abstract*—The pavement foundation consists of base, sub base and subgrade layer. The combination of all this plays important roles in the long-term performance of the pavement. Due to the traffic loading, permanent deformation in any of the pavement layers or subgrade is usually caused by consolidation or lateral movement of the materials. Subgrade rutting occurs when the subgrade exhibits wheel path depressions due to loading and the pavement settles into the subgrade. Use of the geosynthetic is one of the most desirable techniques under static and dynamic loads to strengthen the soil. In this study, a series of Plate Load Tests were performed on geosynthetics such as geocell and EPS geofoams reinforced at varying depthin reducing the rut depth, surface settlement and pavement cracks**

Keywords— Pavement, Geocell, EPS Geofoam, Plate Load Test

I. INTRODUCTION

The pavements are basically classified into flexible (asphalt) pavements and rigid(concrete) pavements. Majority of the pavements across the globe are flexible type. The pavement foundation consists of base, sub base and subgrade layer. The combination of all this plays important roles in the long-term performance of the pavement. Due to the traffic loading,permanent deformation in any of thepavement layers or subgrade usually caused by consolidation or lateral movement of thematerials. Flexible pavements predominantly fail due to two reasons: the bottom-up fatigue cracking and the rutting. Unlike fatigue cracking, rutting is a very common mode of failure seen in the low- volume roads. The low-volume roads usually consist of a thin layer of bituminous or asphalt surfacing or unpaved in nature. Rutting can be described as a depression or an excessive settlement of the surface layer due to the traffic wheel loads or settlements of the pavement layers below. The excessive rutting can be due to the poor quality of the pavement materials used and this can be avoided by using superior quality road materials or by stabilizing the poor-quality materials. Subgrade rutting occurs when the subgrade exhibits wheel path depressions due to loading and the pavement settles into the subgrade.

Geosynthetics have proven to be effective in improving the performance of pavement structures, and therefore they are widely used in pavement construction and rehabilitation. Over the past few decades, many researchers have investigated the effectiveness of the different geosynthetic products placing at different locations within pavement layers. Geosynthetic is one of the most desirable techniques used under static and dynamic loads to strengthen the soil. The rutting behaviour ofthe pavements can also be improved by inserting a geosynthetic material into the interface of subgrade and base or sub-base layers. Many researchers have found that the usage of geosynthetics as a reinforcement in the pavement layers has improved the performance of pavements against the rutting. Soil reinforcement with geosynthetics has gained popularity in the past few decades due to its superior performance, ease in installation, cost-effectiveness and speed of construction compared to other ground improvement methods. Among all the geosynthetic products, the geocells are the latest innovation in the geosynthetic family which offers three-dimensional confinement to thesoil and improves the bearing capacity of soft subgrade soils.

II. LITERATURE REVIEW

A series of cyclic plate load tests and a number of numerical simulations were performed by S.M.A. Ghotbi Siabil, et al. (2019) to study the suitability of geocell reinforcement in reducing rut depth, surface settlements and pavement cracks during service life of the pavement supported on EPS geofoam blocks. Geocells can reduce settlement of the pavement surface by up to41% compared to an unreinforced case, with even greater reduction as the load cycles increase. The improvement factors obtained in this study allow a designer to choose appropriate values for a geocell reinforced pavement foundation on EPS geofoam.[3]

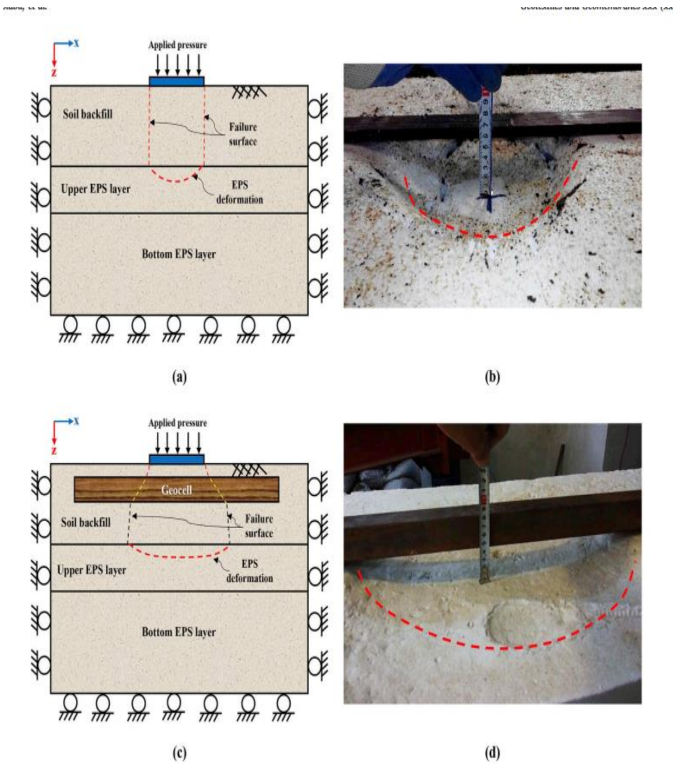

Fig. 1 (a) Schematic view of the possible failure mechanism for unreinforced pavement foundation, (b) typical punching failure of EPS geofoam, (c) Schematic view of the possible failure mechanism of geocell reinforced pavement foundations (d) typical wider deformation basin of EPS geofoam under geocell reinforced pavement foundation.

A series of large-scale laboratory plate load tests were performed by Ramesh Gedela, et al. (2021) on the geocell-reinforced base layer overlying soft subgrade. The numerical analyses were performed by FLAC-3D. The provision of 3D cellular reinforcement (geocells) in the base layer has substantially increased the bearing capacity of the pavement section. From the parametric study, it is observed that the potential benefits of geocell reinforcement increases with reduction in weld spacing and height of geocell while the influence decreases with increasing loading area for constant height of geocell layer. [2]

The cyclic plate load tests were conductedby Amarnath M Hegde, et al. (2020) on thesand subgrade reinforced with planar and3D geosynthetic reinforcements. Resultsrevealed that the performance of the subgrade soil improved significantly in thepresence of reinforcements.

Numericalsimulations were performed using PLAXIS2D to understand pressure and settlement distribution patterns in the reinforced subgrade. However, 3-dimensional geocell reinforcement proved to be more effective than other geosynthetic layer.[1]

A series of large-scale repeated model load tests were performed by Vinay Kumar V, et al (2016) on geocell reinforced and unreinforced base layers overlying weaksand subgrades. A considerable amount of improvement observed for different number of cycles and plate settlements on quantification of traffic benefit ratios (TBR), cumulative plastic deformations (CPD) and rut depth reduction (RDR) for geocell reinforced base courses. However, geocell reinforced granular base course have shown a better improvement comparatively. Geocell reinforcement can be used effectively to improve the performance of the unsurfaced rural pavements by reducing the rutting.[4]

III. CONCLUSION

The following conclusions are obtained from the literature study:

- High improvements in bearing pressure are noticed for geocell-reinforced systems. The improvements are attributed to soil-confinement through geocell pockets and resistance along geocell-soil interface.
- The number of geocell pockets under the loading plate play a vital role in terms of improvement.
- The geocells with lower weld distance perform much better compared to thosewith large weld distance. The response of geocells with weld spacing of 330 mm has 57% higher bearing capacity compared to 445 mm weld spacing.
- Use of geocell over EPS geofoam is best when the stress likely to be experienced by the EPS geofoam wouldbe excessive.
- The degree of effectiveness of usinggeocell on the soil above EPS geofoamis dependent on the soil thickness. Withdecreasing soil thickness, effectivenessof geocell reinforcement increases.
- 3-dimensional geocell proved to be more effective than other geosynthetic layer

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