STRUCTURAL CONTRIBUTION OF GEOGRID REINFORCEMENT IN FLEXIBLE PAVEMENTS: A REVIEW

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Abstract**—**Indian road network is the World's second largest road network after United States. Roads in India faces the problems of potholes, rutting, cracks and localized settlement especially during rainy season. These problems occur mainly due to the less bearing capacity of the subgrade. Geogrid is one of the reinforcing materials that has being used to increase the stability and improve the performance of the road. Geogrids are polymeric material comprising of tractable ribs with openings of adequate size to permit interlocking with the encompassing soil. The paper reviews the effect of geogrids to improve the performance of pavement that has being experimentally investigated. The different softwarehave being used to check the functioning of geogrids in flexible pavements. This paper seeks to provide the information that Pavement having geogrid reinforcement at the bottom of the bituminous concrete layer shows considerable improvement in pavement service life on varying load where fatigue life is governing criteria in prediction of service life.

Index Terms—Geogrid, California Bearing Ratio, Pavement Layer thickness, Finite element Analysis, Pavements;

I. INTRODUCTION

Geogrids is known as a reinforcement material that has been used to increase stability and improve performance of soft and weak subgrade in roadways. Geogrids are polymeric material comprising of tractable ribs with openings of adequate size to permit interlocking with the encompassing soil. This geogrid-soil interlock instrument permits the geogrid cross section to act as a reinforcement component, which upgrades the dirt shear quality. Thus, geogrids have been broadly utilized as a part of present day development innovation. A few application cases include: geogrid reinforced earth holding Dividers (GRS); expressway development and extension over delicate soils; geogrid-reinforced heap upheld roadway dikes; and geogrid reinforced inclines. Utilization of geogrids in adaptable asphalt development is generally well known and exhibits its profitable association with the total utilized. The geogrid lattice is laid inside the total base course and gives expanded modulus and sidelong restriction for the squashed stones meddling the openings of the geogrid. Geogrid is used in flexible pavements in two major application areas - base reinforcement and subgrade stabilization. In base reinforcement applications, the geogrid is placed within or at the bottom of unbound layers of a flexible pavement system and to improve the load-carrying capacity of the pavement under repeated traffic. In subgrade stabilization applications, the geogrid is used to build a construction platform over weak subgrades to carry equipment and facilitate the construction of the pavement system without excessive deformations of the subgrade. Geogrid is gaining acceptance as an effective way of improving on the properties of naturally occurring soils for road pavement construction (Prof V. B. Shrirame,2018)

II. LITERATURE SURVEY

S.K. AhirwarJ.N. Mandal (2017) conducted a research using Finite Element Analysis of Flexible Pavement with Geogrids with PLAXIS 2D software. The main objective of this research was to access the functioning of geogrids in flexible pavement through finite element analysis with PLAXIS 2D software. The finite element analysis results shows the reduction in vertical surface deformation when the geogrids were added between the pavement layers. The output results of PLAXIS software shows the beneficial effects of the axial stiffness of geogrids in the base course and interface strength of materials at different thickness of base course layer on vertical surface deformation. The study was concluded with four major conclusions. Firstly, vertical surface deformation in flexible pavement reinforced with geogrids are less as compared to unreinforced flexible pavements. Secondly, the reduction in vertical surface deformation shows approximate constant when thickness of base layer varies from 150mm to 200mm. Thirdly, the beneficial effect of geogrid in terms of axials stiffness observed at 800 kN/m. No further reduction in deformation has observed after increasing the axial stiffness of geogrids. And lastly, the minimum reduction in vertical surface deformation is achieved when coefficient of interface friction reach to 0.92.

Satish Pandey K. Ramachandra Rao Devesh Tiwari (2012) conducted a research on effect of geogrid reinforcement on critical responses of bituminous pavement by presenting a two- dimensional axisymmetric finite model that behavior of unreinforced and geogrid reinforced bituminous pavement subjected to static and dynamic loading conditions. They performed a parametric and constant study to find out the effect of geogrid location on structural performance of the flexible pavement system.They kept the geogrids at two different locations separately i.e. at the interface of bituminous layer and base course and between the sub grade and base course. Although geogrid was provided on entire width of the carriageway but during the research study they had provided up to 1.5 m horizontal extent from axis of symmetry to study the reinforcement effect on horizontal strain. They carried out series offinite element simulations to evaluate the benefits of integrating a high modulus geosynthetic into the pavement foundation and therefore concluded that when the geogrid reinforcement is placed at the bottom of the bituminous concrete layer, it lead to the highest reduction in horizontal tensile strain amounting to 14.96% to 22.35% under dynamic and static loading conditions respectively. Geosynthetic reinforcement thus show a good potential of decreasing fatigue strain in the pavement. There was no real difference in residual vertical surface deflectionfound between unreinforced and the geogrid reinforced pavement under dynamic load. The geogrid reinforcement potential decreased the vertical strain (amounting to 11.80%) was more pronounced under dynamic loading condition, when it was placed between base course and subgrade layer. Pavement having the geogrid reinforcement at the bottom of the bituminous concrete layer showed considerable improvement in the pavement service life on varying load where fatigue life is governing criteria in prediction ofthe service life.

Charles Anum Adams, Nana Yaw Amofa, Richter Opoku – Boahen (2014) conducted a research on effect of the geogrid reinforced subgrade on layer thickness design of low volume bituminous sealed road pavements. There were two main objectives of this research. Firstly, it was to determine the effect strength of Geogrid reinforcement material on the California Bearing Ratio (CBR)of a sample of relatively poor lateritic subgrade material under soaked and unsoaked conditionand secondly, it focused on establishingthe effectof the geogrid reinforced subgrade on the design thickness of low volume paved roads.They selected a natural lateritic subgrade soil and tested without reinforcement. Then they placed a layer of tri-axial geogrid above the third layer within the sample height, and investigated the effects of the geogrid above the third layer within the sample height, and investigated the effects of the geogrid reinforcement on CBR values. This was undertaken for two strengths of the geogrid in both soaked and unsoaked conditions.The California Bearing Ratios of the soil–geogrid subgrade was used todetermine the pavement layer thicknesses for a low volume paved road using the Transport Research Laboratory Road,Note 31 method of pavement design. They resulted in concluding that interfacing soil with a geogrid material increases the penetration resistance and hence the CBR strength in both soaked and unsoaked conditions.Thus the performance of a subgrade material in a pavement system was better with the incorporation of a geogrid.

Prof. V. B. Shrirame, Devendra K. Gomase, Gajanan U. Pawar, Vishal K. Sahare, Ashok D. Bopcha(2018) performed a study on use of geogrid in road construction.In their project to see the use of the geogrid in road construction they applied the following steps: Firstly, they selected the site for study. Then they collected the soil sample. The various laboratory tests were performed to find out the soil particle size distribution, Soil Atterberg Limits (liquid limit, plastic limit, shrinkage limit). Specific gravity was found out. Determination of water content was done, and California Bearing Ratio was performed. Traffic load count and pavement modeling was done. They prepared a proper estimate of the whole work. Lastly selection of the geogrid was done, and its placement was done and hence pavement was designed.
The results resulted that the Base course thickness reduction as a result of geogrid reinforcement for a subgrade soil tended to decrease with increasing traffic volume. Base course reduction benefits accruing from the use of geogrids was felt most in lower volume roads especially in areas where water was drained into the lower layers of pavements as was occurred with unsealed shoulders and under conditions of poor surface maintenance where the roadbase was pervious or in high rainfall areas.

E. M. IbrahimS. et al. conducted a research on effect ofthe geogrid reinforcement on the flexible pavement (2017). The effectiveness of the geogrids in the flexible pavement reinforcement was investigated throughout laboratory testing and finite-element analysis (FEA). The laboratory testing involved the routine material characterization, the resilient modulus testing, andthe five pavement prototype sections. These sections consisted of a 5 cm asphalt concrete layer, 15 cm granular base layer, and a 30 cm clay subgrade. The base layer was reinforced with a single layer of the uniaxial geogrid placed at four different positions within the base layer. The pavement sections were loaded with a static plate-loading equipment and the results were compared with the control section (CS), which had no reinforcement. This study resulted in showing that the geogrids can be used to reduce tensile stresses in flexible pavement systems. The optimum position of the geogrid reinforcement to reduce tensile strains was found to be directly underneath the Asphalt Concrete layer than within 33–50% of the granular base layer height as measured from the bottom of the base layer.

Adel A. Al-Azzawi (2012) prepared a paper which described the finite element analysis of the flexible pavement strengthened with geogrid. The axisymmetric finite element simulations through ANSYS software were carried out to evaluate the benefits of using geogrid inthe flexible pavements. This paper described the behavior of asphalt concrete (AC) pavement under axisymmetric conditions and subjected to static loading. The results of the flexible pavements improvement using geogrid were presented. The analytical results for four different most possibilities of geogrid reinforcement in the paved road layers had been evaluated. The best position was decided based upon the predicated tension and compressive stress reduction and, deformation reduce rate. Four types of reinforcing model and one type of unreinforced model of paved road was selected. The results showed a higher tension stress absorption when they placedgeogrid between the base course layer and subbase layer in the selected modelrecord the intensity of the light achieved from the blood volume at fingertip. The disadvantage of the proposed approach was that it was modest to specific smart phones, thus wasn't versatile.

PeketiMadhu Ganesh Yadav etal. (2018) presented a paper on the usage of geogrids in the flexible pavements designs.They mainly focused on trying to increase the bearing capacity of the pavement using geogrid and they also focused on reducing the thickness of the pavement as to reduce the cost of road construction. They also aimed at increasing the service life of road. They conducted Laboratory and stimulated field CBR test on different soil samples i.e. samples with and without the inclusion of geogrids andalso by varying the position of it in the mould. They computed the design traffic and then the grain size distribution and after performing all the tests concluded that the positive effect of the Geogrid reinforced subgrade course scan economically and ecologically be utilised to reduce aggregate thickness. And it can also increase the life of the pavement and can decrease the overall cost of the pavement construction with an increased lifetime.

III. CONCLUSION

Here, by reviewing different papers onthe effect of geogrids in reinforcement of flexible pavement we therefore observed that the positive effects of geogrid reinforced subgrade courses can efficiently and ecologically be utilized to reduce aggregate thickness.Geogrid can be used for the reinforcement in the pavements as it increases the strength of the pavement and is not costly.Pavement having the geogrid reinforcement at the bottom of the bituminous concrete layer shows considerable improvement in pavement service life on varying load where fatigue life is governing criteria in prediction of service life.The output results of PLAXIS software showed the beneficial effects of the axial stiffness of the geogrids in the base course and interface strength of materials at different thickness of the base course layer on the vertical surface deformation.

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