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Evaluation of Experimental and Numerical Simulation of Triaxial Geogrid Reinforcement on the Strength of Road Structures

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Abstract

The purpose of this research consists in analyzing the contribution to the bearing capacity of the road structures as brought by triaxial rib geogrids. The objective of the present study lies in diminishing the effects of void production under road structures and respectively in finding new ways of improving their bearing capacity with the help of geosynthetic materials reinforcing the structures. The experimental study involved performing a series of laboratory tests on the unreinforced and geogrid reinforced models. The test results demonstrate that the geogrid reinforced structure undergoes three times smaller deformations relatively into unreinforced structure The experimental results were also compared to the data obtained by using finite elements methods.

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Keywords: road structure; triaxial geogrid; bearing capacity; failure mode; MEF.

1. Introduction

Geosynthetic materials have been used over the last few decades to stabilize subgrade soils in many engineering applications, leading to improved performance, such as bearing capacity and longevity, of paved and unpaved roads [1,2]. Geosynthetics are defined as planar products manufactured from polymeric materials [3, 4] of high stability and density, which can be processed so as to reach tensile strength and strain requirements. The improved performance of the pavement due to geosynthetic reinforcement has been attributed to three mechanisms: lateral restraint or confinement, increased bearing capacity, and tensioned membrane effect. However, the most important

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of the three features is the lateral restraint considered to have a maximum contribution in improving the performance of geosynthetic-reinforced pavements.

Geogrid provide the confinement of the filling material/aggregates through shear resistance and friction between the geogrid and surrounding material. When an aggregate layer is subjected to traffic loading, the aggregate tends to move laterally unless it is restrained by the subgrade or by geosynthetic reinforcement. The interaction between the base aggregate and the geosynthetic allows the transfer of the shearing load from the base layer to a tensile load in the geosynthetic. The tensile stiffness of the geosynthetic limits the lateral strains in the base layer. Furthermore, a geosynthetic layer confines the base course layer thereby increasing its mean stress and leading to an increase in shear strength. Both frictional and interlocking characteristics at the interface between the soil and the geosynthetic contribute to this mechanism. For a geogrid, this implies that the geogrid apertures and base soil particles must be properly sized. A geotextile with good frictional capabilities can also provide tensile resistance to lateral aggregate movement [5].

The effectiveness of the geogrid reinforcement is highly dependent on physical and mechanical properties, i.e. index properties of the geogrid and on the properties of the interface between the geogrid and the surrounding materials [6]. There are many specific types of geosynthetic materials available: geotextiles (woven and non-woven), geogrids, geocells or geowebs, geomembranes, geosynthetic clay liners (GCLs), geonets, geocomposites, geofoam and geopipes.

Geogrids consist of heavy strands of plastic materials arranged so as longitudinal and traverse elements have a uniformly distributed array of apertures in the resulting sheet. The apertures, which are greater than 6 mm, allow the geogrids to interlock with the backfill soil, rock, earth and other surrounding materials, thereby providing confinement to the subgrade. Their application areas are not only in highways, but also in airport runway, gravel construction roads and construction of earth retaining walls [1].

Geosynthetic materials have been successfully used for reinforcing roads subgrade. Choudhary et. Al [7] investigated the CBR value of soils reinforced with multiple layers of geogrids and jute geotextile and showed the increase in CBR value with the increase of number of reinforcing layers. The jute geotextile offers a better reinforcing efficiency as compared to the geogrid and can be used for low cost road projects in rural areas [8]. Singh et al. [9] indicated that placing the geogrid reinforcement at 0.2H from the top give considerable improvement in CBR value and stress strain behaviour of subgrade soil [10]. Sireesh et. Al [11] evaluated the potential benefits of providing geocell reinforced sand mattress over clay bed with a continuous circular void. The test results clearly showed that geocell mattress can substantially increase the bearing capacity and reduce settlement of the clay subgrade with void.

The objective of the present study lies in diminishing the effects of void production under road structures and respectively in finding new ways of improving their bearing capacity with the help of geosynthetic materials reinforcing the structures. The occurrence of such voids can affect the embankment of the whole road system, leading to significant local settlements.

Nomenclature

CBR	California Bearing Ratio
E	modulus of elasticity
γ	specific weight
c_d	drained cohesion
c_u	undrained cohesion
ϕ_d	drained internal friction angle
ϕ_u	undrained internal friction angle
E_{ech}	the equivalent modulus of deformation