Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 4, Month 2021: 148-155

Use Of Geo- Grids In Flexible Pavement Design

Tavanam Maheswara Reddy[1], Akula. Priyanka[2]

[1]M-Tech Scholar, [2]Asst Professor
[1,2] Department of Civil Engineering
QIS COLLEGE OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS)
Approved by AICTE | Permanent Affiliation: JNTU-Kakinada | UGC-Recognized
Accredited by NBA | Accredited by NAAC | ISO 9001:2015 Certified
Vengamukkapalem (V), Ongole, Prakasam dist., Andhra Pradesh-523272

Abstract
As on 31st March 2021, estimates the total road length in India 6,603,293km (4,103,096 mi) making the Indian road network, the second largest road network in the world after the united states. But the roads are not giving the desired result due to poor CBR value. Roads in India have mostly the problems like the formation of potholes, ruts, cracks and localized depression and settlement, especially during rainy season. These are mainly due to the insufficient bearing capacity of the sub grade in water saturated condition. The sub grade soil mostly yields low CBR value 2-5%. In the CBR method of pavement design (IRC:37-2012) the total thickness of pavement increases exponentially with a decrease in the CBR value of sub grade soil which in turn increases the cost of construction. So, it has been tried to use the geo grid material for increasing the bearing capacity of the sub grade. Laboratory and simulated field CBR tests are conducted on soil samples with and without the inclusion of geo grid layer and also by varying the position of it in the mould. Use of geo grid increases the CBR value of the sub grade and thereby reduces the pavement thickness considerably up to 40%. This study will have a positive impact on cost as it will reduce the Project as well as maintenance cost of the road. Our project will discuss in detail the process and its successful applications.
KEYWORDS: Geo grids, Reinforcement, CBR Value, Flexible Pavement, Sub grade, Highway, Design, Expansive Soil.

1. Introduction

Geo grids used within a pavement system perform two of the primary functions of Geo synthetics: separation and reinforcements. Due to the large aperture size associated with most commercial geo grid products, geo grids are typically not used for achieving separation of dissimilar material. The ability of a geo grid to separate two materials is a function of the gradations of the two materials and is generally outside the specifications for typical pavement materials. However, geo grids can theoretically provide some measure of separation, albeit limited. For this reason, separation is a secondary function of geo grids used in pavements. The primary function of geo grids used pavements in reinforcement, in which the geo grid mechanically improves the engineering properties of the pavement system. The reinforcement mechanisms associated with geo grids.

Geo synthetics

Geo synthetics have been defined by the American Society for Testing and Materials (ASTM) Committee D35 on geo synthetics as planar products manufactured from polymeric materials used with soil, rock, earth, or other geotechnical engineering related material as an integral part of a man-made project, structure or system. Geo synthetics is the term used to describe a range of polymeric products used for Civil Engineering construction works.

Types of Geo synthetics

Application of geo synthetics

Four of the most common general uses of geo synthetics for local agencies are:

1. Separation
2. Filtration
3. Drainage
4. Reinforcement

Geo grids and its types

A Geo-Grid is a polymeric structure, unidirectional or bidirectional, in the form of a manufactured sheet, consisting of a regular network of integrally connected elements which may be linked by extrusion, bonding, and whose openings are larger than the constituents and are used in geotechnical, environmental, hydraulic and transportation engineering applications. Geogrids are unitized woven yarns or bonded straps. Geogrids consist of heavy strands of plastic materials arranged as longitudinal and transverse elements to outline a uniformly distributed and relatively large and grid-like array of apertures in the resulting sheet. These apertures allow direct contact between soil particles on either side of the sheet. (Bergado and Abuel-Naga, 2005)

According to Wikipedia, Geogrids represent a rapidly growing segment within geosynthetics. Rather than being a woven, nonwoven or knitted textile fabric, geogrids are polymers formed into a very open, grid-like configuration, i.e., they have large apertures between individual ribs in the machine and cross-machine directions. Geogrids are (a) either stretched in one or two directions for improved physical properties, (b) made on weaving or knitting machinery by standard textile manufacturing methods, or (c) by bonding rods or straps together. There are many specific application areas, however, they function almost exclusively as reinforcement materials. Modern geogrids were invented by Dr. Brian Mercer (Blackburn, UK) in the late 1970s. Dr. Mercer devised and patented the stretched sheet method of production which results in a stiff polymer grid and avoids the bonding of separate elements required in a woven or knitted grid. Subsequent development by Dr. Mercer led to the uniaxial (single direction stretch) geogrid with rectangular apertures and the biaxial (two-way stretch) geogrid with virtually square apertures.

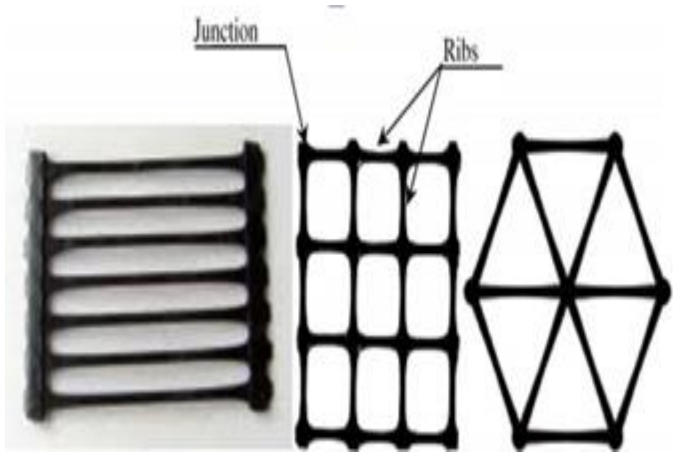
Types of Geogrids

Based on the manufacturing process involved in geogrids it can be of

1. Extruded Geogrid
2. Woven Geogrid
3. Bonded Geogrid

Based on which direction the stretching is done during manufacture, geogrids are classified as

1. Uniaxial geo grids
2. Biaxial Geo grids
3. Tri axial geo grids



Uniaxial, Biaxial and Tri axial geo grids

Materials Used for the study

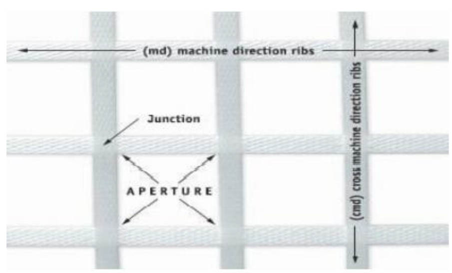
Expensive soil

Expansive soil is a kind of special Cohesive soil. the kind of soil can significantly become to soften after it absorbs water, and it also can become to contract after it losses water. It is a kind of Strong hydrophilic mineral geological body that was formed in the process of long-term natural geological historical role.

Expansive soil is high plastic clay that contains montmorillonite and illite as the main mineral composition. The clay content of the expansive soil is high, the free expansion rate is commonly more than 40%, and the liquid limit is higher than 40%. The expansive soil has not only the commonness of clay soil but also has its own particularity. The expansive soil has a specialty that it can be repeated deformation of wet bilge and drying shrinkage. The engineering properties of expansive soil have multiple fractures, over consolidation, swelling, collapse, weathering properties, the intensity attenuation, etc. Swell-shrink of expansive soil caused the destruction of buildings because of having repeatability and long-term potential hazards for many times, often can cause disasters to human beings.

Geo grids

The Geogrid can be installed in any weather conditions. Geogrid thus helps in proper land utilization. Geogrid promotes soil stabilization. A higher strength soil mass is obtained. Higher load bearing capacity. It is a good remedy to retain soil from erosion. Geogrids are flexible in nature. They are known for their versatility. Geogrids have high durability reducing maintenance cost. They are highly resistant to environmental influences.



Geo grids

Results and analysis

Traffic data analysis

Computation of Design Traffic:

$$N=\frac{365*[(1+r)^{n}-1]}{r}*A*D*F$$

Where,

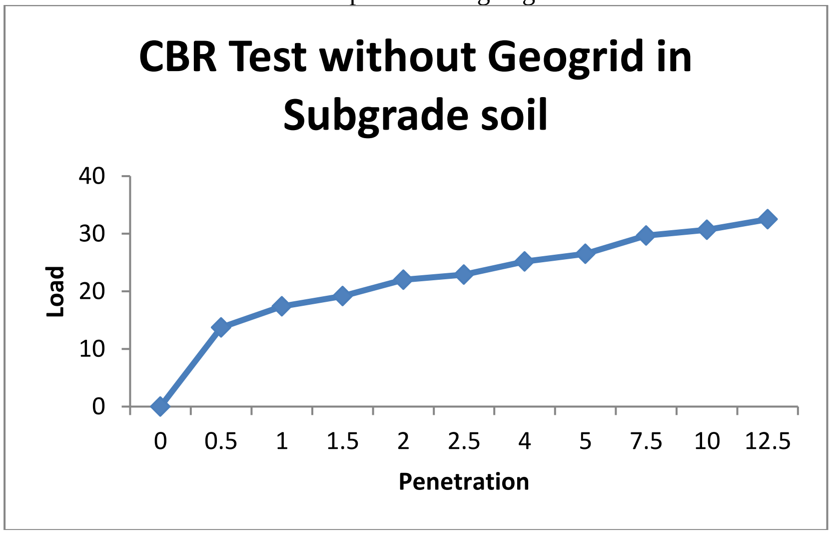
N = Cumulative number of standard axles to be catered for in the design in terms of msa.

A=Initial traffic in the year of completion of construction in terms of the number of Commercial Vehicles Per Day (CVPD).

D = Lane distribution factor = 0.5
F = Vehicle Damage Factor (VDF) = 3.5
n = Design life in years = 15
r = Annual growth rate of commercial vehicles in decimal = 7.5%
The traffic in the year of completion is estimated using the following formula
$A= P (1 + r)^x$.
Where, P= Number of commercial vehicles as per last count = 2646
x = Number of years between the last count and the year of completion of construction. (say 1 Year).
By substituting above Values, N Value is Computed as 47.45 msa

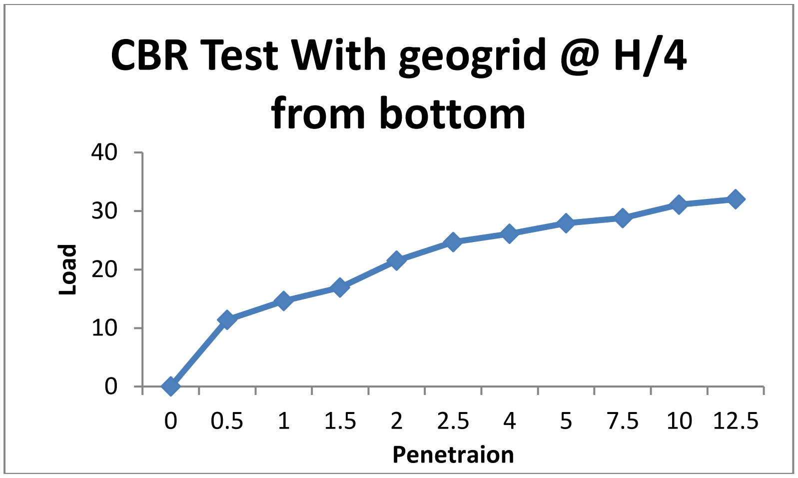
CBR Test Results
Without geo grid

Soil sample without geo grids



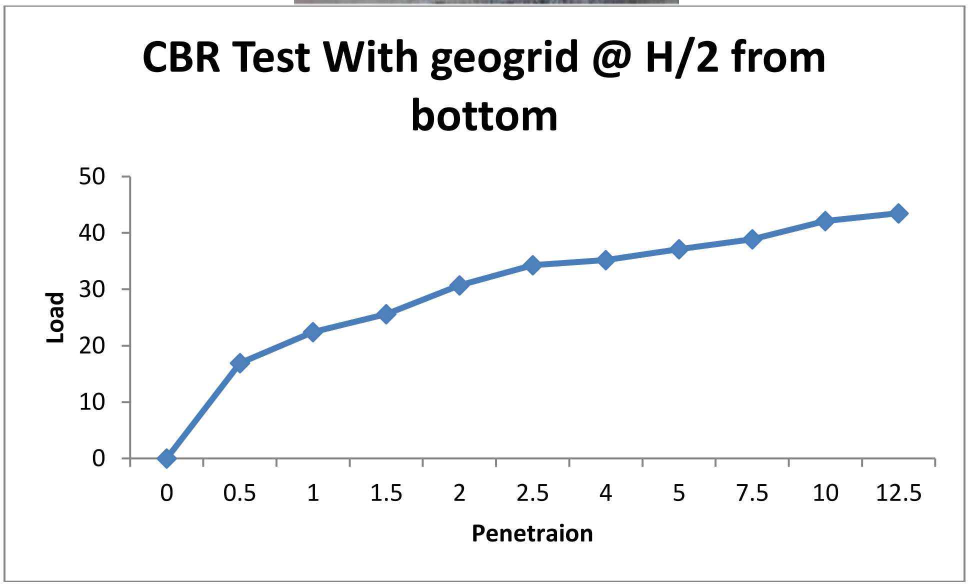
CBR @ 2.5 mm Penetration :1.67
CBR @ 5.0 mm Penetration:1.36
With geo grid at h/4 from the bottom

With geo grid at h/4 from the bottom



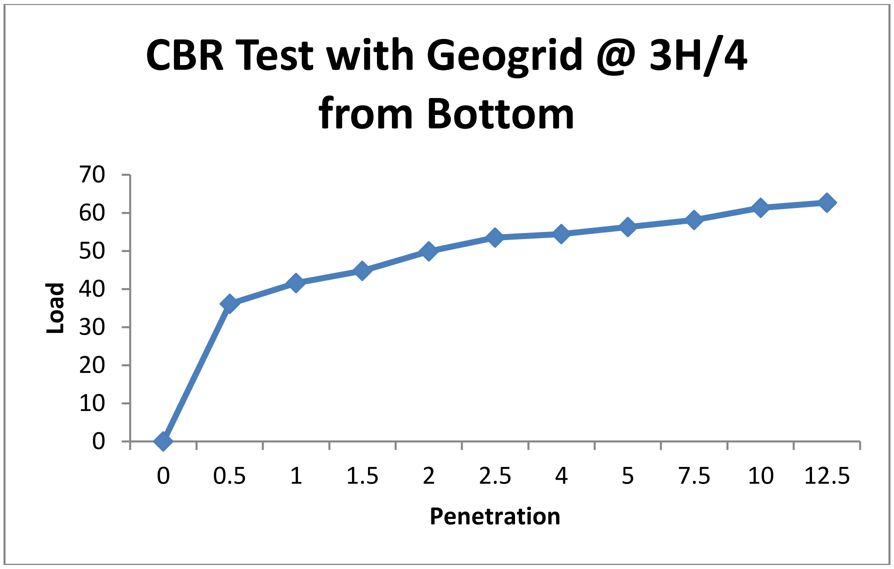
CBR @ 2.5 mm Penetration :1.80,
CBR @ 5.0 mm Pemetration:1.29

With geo grid at h/2 distance from the bottom

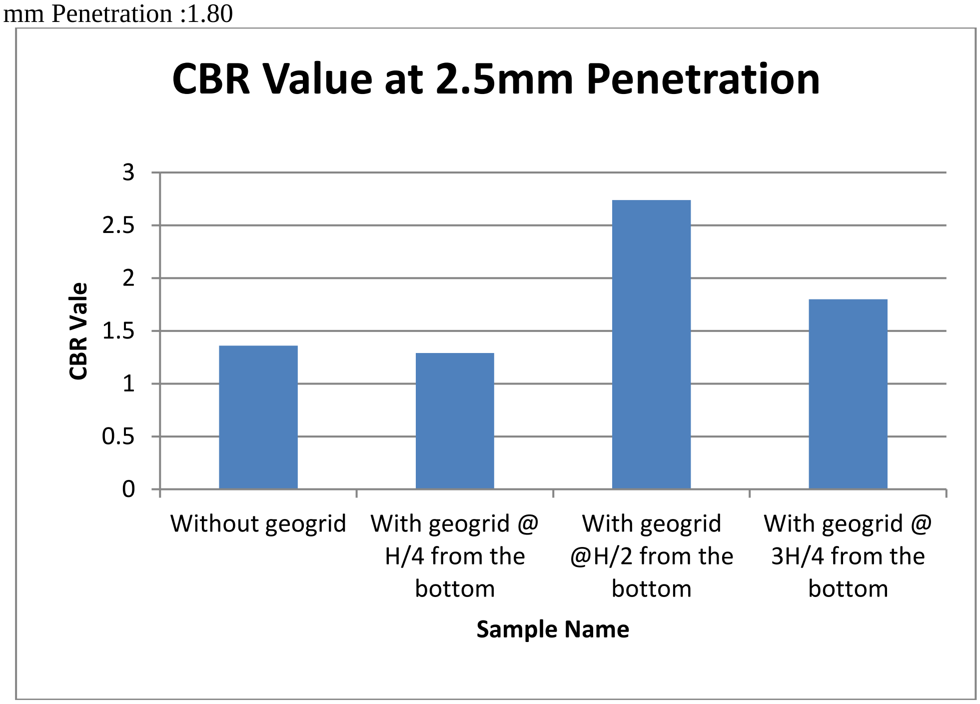


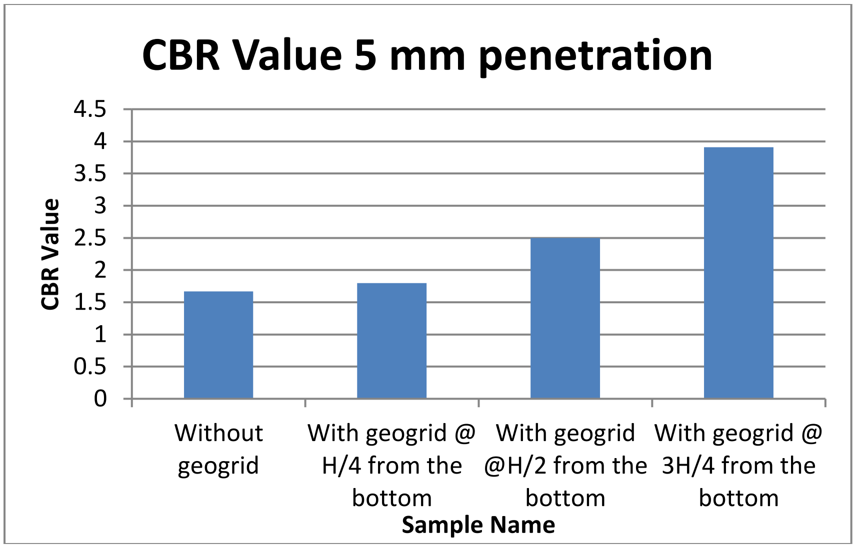
CBR @ 2.5 mm Penetration :2.50,
CBR @ 5.0 mm Penetration : 2.74

With geogrid at 3h/4 distance from the bottom



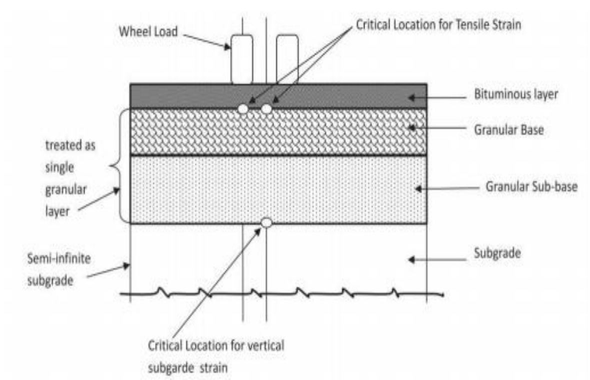
CBR @ 2.5 mm Penetration :3.91,
CBR @ 5.0 mm Penetration :1.80





DESIGN OF PAVEMENT as per (IRC: 37-2012)

Bituminous Surfacing with Granular Base and Granular Sub-base



Bituminous Surfacing with GB and GSB

IRC: 37-2012

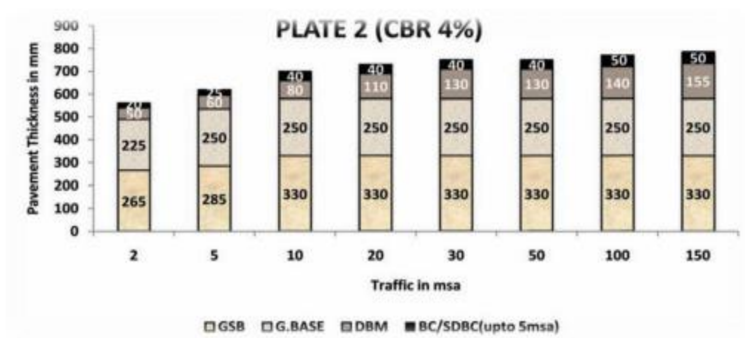


Plate-2 (IRC:37-2012) Pavement Design Catalogues

WITHOUT GEOGRID: CBR: 1.67 %, N: 47.45 msa ≈ 50 msa

i.e., not fit for laying a road directly on the Subgrade soil; which needs Stabilization to it.

WITH GEOGRID AT 3H/4 FROM BOTTOM: CBR: 3.91 %, N: 47.45 msa ≈ 50 msa i.e., the thickness of GSB: 300 mm, G. Base:250, DBM: 115 mm, BC/SDBC:40mm

Where; GSB: Granular Sub-base, G. Base: Granular Base, DBM: Dense Bituminous Macadam, BC: Bituminous Concrete, SDBC: Semi-Dense Bituminous Concrete.

The thickness of pavement required in mm

Thickness	Without Grid	With grid @H/4 from bottom

GSB	NA	300
G.BASE	NA	250
G.BASE	NA	115
G.BASE	NA	40
G.BASE	NA	705

Conclusions

The positive effects of geo grid reinforced sub grade courses can economically and ecologically be utilized to reduce aggregate thickness. And it can also increase the life of the pavement and can also decrease the overall cost of the pavement construction with an increased lifetime.

The study investigated the application of geo grids to sub grade material as a form of reinforcement to road construction. The inclusion of the geo-grid considerably increases the strength of poor soils, which is reflected in the higher CBR values. The study shows that the strength of the sub grade is significantly altered positively by the positioning of the geo-grid at varying depth. It was observed that the highest sub grade strength is achieved when it is placed at 3H/4 for a single layer although has a satisfactory result at H/2 and H/4 respectively. On reinforcing the soil, there is a considerable increase in performance of the sub grade in the un soaked condition. The use of geo grids as reinforcement to poor soils improves its strength. It is non-bio degradable and therefore durable; it also increases the ultimate service life of the pavement. The use of Geo grids should, therefore, be encouraged as an effective and modern form of improving road construction on poor sub-grade materials. Further research should be analyzed in ascertaining the effect of geo grids on sub grade soils under the un soaked condition.

REFERENCES

[1]. IRC:37-2012 Guidelines for DESIGN OF FLEXIBLE PAVEMENTS
[2]. Soil Mechanics and Foundation Engineering By DR.K.R. ARORA
[3]. Rankilor, P. R., Membranes in Ground Engineering, John Wiley and Sons, New York, 1981.
[4]. I.S: 2720 (Part – XVI), 1979: Indian Standard Methods of test for Soils, Laboratory Determination of CBR.
[5]. Mehndiratta H.C (1993) Chandra Satish, Sirsh Virendra “Correlations amongst strength parameters of soil reinforced with geotextile” HRB No 49, Indian Roads Congress, 13-24.
[6]. R. M. Koerner, “Designing with Geosynthetics: Volume 1,” 2005. [Online]. Available: Amazon.com [Accessed 2 June 2014].
[7]. A. C. Lopes, “Definition of Geosynthetics: Geosynthetics in engineering,” 2008. [Online]. Available: http://www.woodhead.com/geosynthetics/[Accessd 2 March 2014].
[8]. D. T. Bergado, and H. M. Abuel-Naga, “Tsunami devastations and reconstruction with Geosynthetics,” 2005. [Online]. Available: http://www.freelibrary.com [Accessed 2 March 2014].
[9]. A. Olawale, “Use of geosynthetics in road construction,” Department of Civil Engineering, Federal University of Technology, 2011. [Online]. Available: http://www.google. com/google books.
[10]. Motanelli, F., Zhao, A., and Rimoldi, P., 1997, Geosynthetics-reinforced pavement system: testing and design., Proceedings of Geosynthetics, 97, 549-604.
[11]. Kumar, P. S., and Rajkumar, R., 2012, Effect of geotextile on CBR strength of unpaved road with soft subgrade.,Electronic Journal of Geotechnical Engineering(EJGE), 17, 1355 – 1363.
[12]. Ministry of Roads and Highway, “Technical specification for roads and bridges,” Republic of Ghana, 2006