An Experimental Investigation on usage of Geogrids in Flexible pavement Design

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ABTRACT

There are two main application areas for geogrid reinforcement in permanent paved roads.They are subgrade stabilization and base reinforcement. The kind of subgrade, subbase, and base course materials have a significant impact on the pavement's strength and lifespan.However, the majority of flexible pavements in India are built primarily over troublesome and poor subgrade. Base reinforcement increases the pavement's ability to support loads during repeated traffic by placing geogrids at the bottom of unbound layers of a flexible pavement system. The geogrid serves a critical function in subgrade stabilization applications by providing a construction platform over weak subgrades. This enables the transport of equipment and facilitates the construction of the pavement system while minimizing excessive deformations in the subgrade.Increased pavement thickness is required when the subgrades exhibit a relatively low California Bearing Ratio (CBR).

Soil samples with and without the geogrid layer are subjected to laboratory and simulated field CBR testing, as well as variations in the soil sample's location within the mold. The use of geogrid lowers the pavement thickness by up to 40% by raising the subgrade's CBR value.

Key word - Geogrids, Reinforcement, CBR Value, Flexible Pavement, Subgrade, Highway, Design, Expansive Soil

I. INTRODUCTION

The existence of soft or loose soil at ground level is one of the main issues engineers encounter when building highways in India's plains and coastal regions. Roads built on top of this loose dirt require thicker granular materials, which raises the building costs. Aernatively, attempts to produce an economical construction by lowering the thickness of the pavement layer would cause early pavement degradation, rendering the road unusable shortly after construction. If there is inadequate drainage or none at all, this problem might get worse. Some Indian states that are located in high-rainfall regions have weak subgrade conditions and inadequate drainage. In such states, this is one of the main reasons for the terrible status of the roads.

Given the poor status of some Indian states' roads, using geogrids in road building is expected to enhance road performance. For this, a geosynthetic made of polymers called Geogrid is chosen.

When included into a pavement system, geogrids serve two of the main purposes of geosynthetics: reinforcement and separation. Geogrids are generally not utilized to separate different materials because of the high aperture size associated with the majority of commercial geogrid products. A geogrid's capacity to separate two materials depends on their gradations and is typically not within the parameters for common paving materials. Geogrids, however, have the potential to offer a limited amount of isolation. As a result, separation is a secondary purpose of pavement geogrids. When geogrids are employed in reinforcement, their main purpose is to mechanically enhance the pavement system's engineering qualities. the geogrid-related reinforcing processes.

II. LITERATURE REVIEW

Tang et al. looked at how distinct short polypropylene fiber (PP-fiber) affected the mechanical properties and strength of both uncemented and cemented clayey soil. The cement concentration was 5% and 8% by weight of soil, while the PP fiber content was 0.05%, 0.15%, and 0.25% by weight of soil. When fiber was added, the failure strain rose from 0.5% to 1.25%. After adding 0.05% fiber, the UCS values for cemented soil specimens with 5% and 8% cement content rose noticeably from 0.40 to 1.02 MPa and from 0.63 to 1.28 MPa, respectively.

In order to determine how much geo-synthetic reinforcement contributes to the stiffness and strength of asphalt pavements, Ling and Liu (2001) conducted a number of static and dynamic tests on model sections. After the sub-grade was covered with the geo-grid reinforcement layer, the last layer of asphalt concrete was applied. Comparing reinforced pavement to un-reinforced pavement, the study found that the former had less settling over the loading area.

A.K. Among the sub-grade, Choudhary et al. (2011) positioned many layers of reinforcement, namely geo-grid and jute geo-textile. He discovered that once the soil is reinforced with a single layer, the enlargement quantitative relation decreases and continues to decrease as the number of reinforcing layers increases. This decrease is crucial only in the case of jute geotextile and marginal in the case of geogrid, indicating that the insertion of reinforcement regulates soil swelling. As the number of reinforcing layers increases, so will the soil's quantitative relation value in the United States. Although geo-grid is more effective at strengthening than jute geo-textile, it is nevertheless profitably used in low-value road projects.

III. OBJECTIVE

Develop efficient design methodologies to minimize pavement thickness, thereby reducing material usage and overall construction costs.

Design pavement thickness based on California Bearing Ratio (CBR) and million standard axles (MSA) traffic projections in accordance with **IRC:37-2012** guidelines.

IV. RESULT

CALIFORNIA BEARING RATIO TEST

The California Bearing Ratio (CBR) Test is a penetration test widely used in geotechnical engineering to evaluate the strength of subgrade soil, sub-base, and base layers of pavements. The test measures the bearing capacity of the soil by comparing its resistance to penetration with that of a standard crushed stone

Purpose

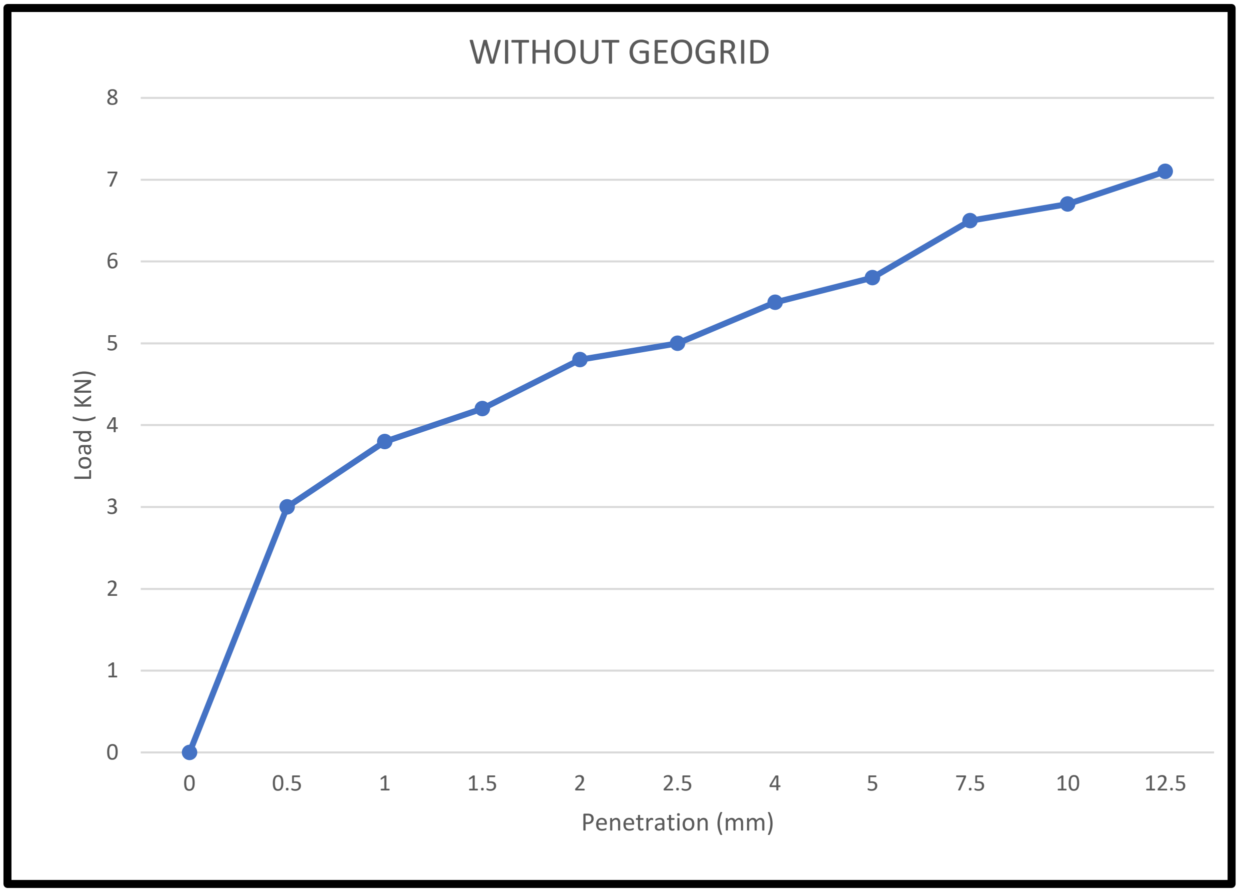
- To assess the load-bearing capacity of soil used in road and pavement construction.
- To determine the thickness of pavement layers required for traffic loads.

- The CBR value is the ratio of the measured load to the standard load at a specific penetration (usually 2.5 mm or 5 mm), expressed as a percentage.

CBR= Measured Load/

Table 1 CBR VALUE WITHOUT GEOGRID

SL No:	Penetration in mm (C1)	Proving Ring Readings (C2) KN	Proving Ring Readings in division (C3=C2*5)	Load in Kg C4=C4*0.915
1	0	0	0	0
2	0.5	3	15	13.6
3	1	3.8	19	17.3
4	1.5	4.2	21	19.1
5	2	4.8	24	21.1
6	2.5	5	25	21.8
7	4	5.5	27.5	23.2
8	5	5.8	29	25.2
9	7.5	6.5	32.5	28.7
10	10	6.7	33.5	30.2
11	12.5	7.1	35.5	31.5



Fiure 1 CBR Test without Geogrid in Subgrade soil

CBR @ 2.5 mm Penetration :1.67 , CBR @ 5.0 mm Penetration:1.36

II. WITH GEOGRID AT H/4 FROM THE BOTTOM

Table 2 CBR Test Data with geogrid @ H/4 from bottom

SL No:	Penetration in mm (C1)	Proving Ring Readings (C2) KN	Proving Ring Readings in division (C3=C2*5)	Load in Kg C4=C4*0.915
		WITH GEOGRID AT H/4 FROM THE BOTTOM		
1	0	0	0	0

2	0.5	2.5	12.5	11.2
3	1	3.2	16	14.4
4	1.5	3.7	18.5	16.8
5	2	4.7	23.5	21.4
6	2.5	5.4	27	**24.4**
7	4	5.7	28.5	26.12
8	5	6.1	30.5	**27.8**
9	7.5	6.3	31.5	28.7
10	10	6.8	34	31
11	12.5	7	35	31.32

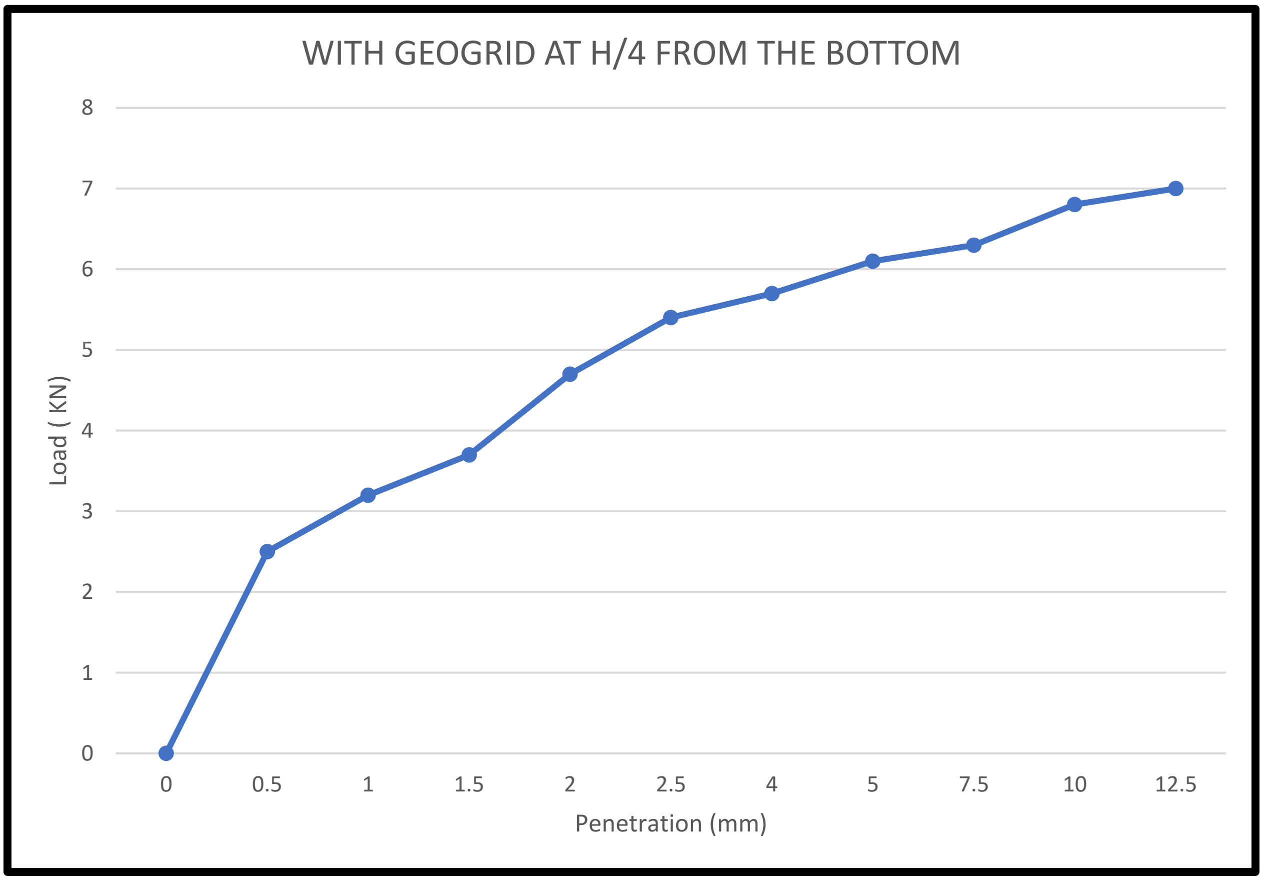


Figure 2 CBR Test Data with geogrid @ H/4 from bottom

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

WITH GEOGRID AT H/2 DISTANCE FROM THE BOTTOM

Table 3 CBR Test Data with geogrid @ H/2 from bottom

SL No:	Penetration in mm (C1)	Proving Ring Readings (C2) KN	Proving Ring Readings in division (C3=C2*5)	Load in Kg C4=C4*0.915
		WITH GEOGRID AT H/2 DISTANCE FROM THE BOTTOM		
1	0	0	0	0
2	0.5	3.7	18.5	16.9
3	1	4.9	24.5	22.4
4	1.5	5.6	28	25.6
5	2	6.7	33.5	30.7
6	2.5	7.5	37.5	**34.2**
7	4	7.7	38.5	35.1
8	5	8.1	40.5	**37.1**
9	7.5	8.5	42.5	38.8
10	10	9.2	46	42
11	12.5	9.5	47.5	43.4

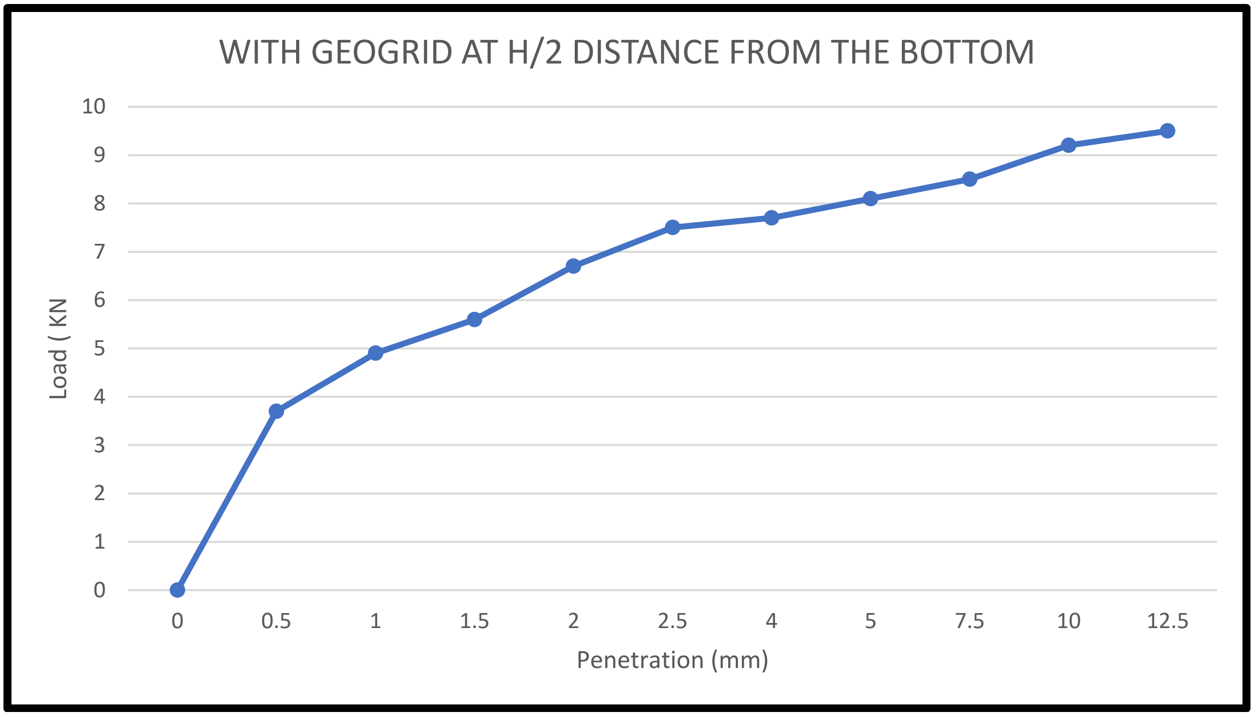


Figure 4 with geogrid at h/2 distance from the bottom

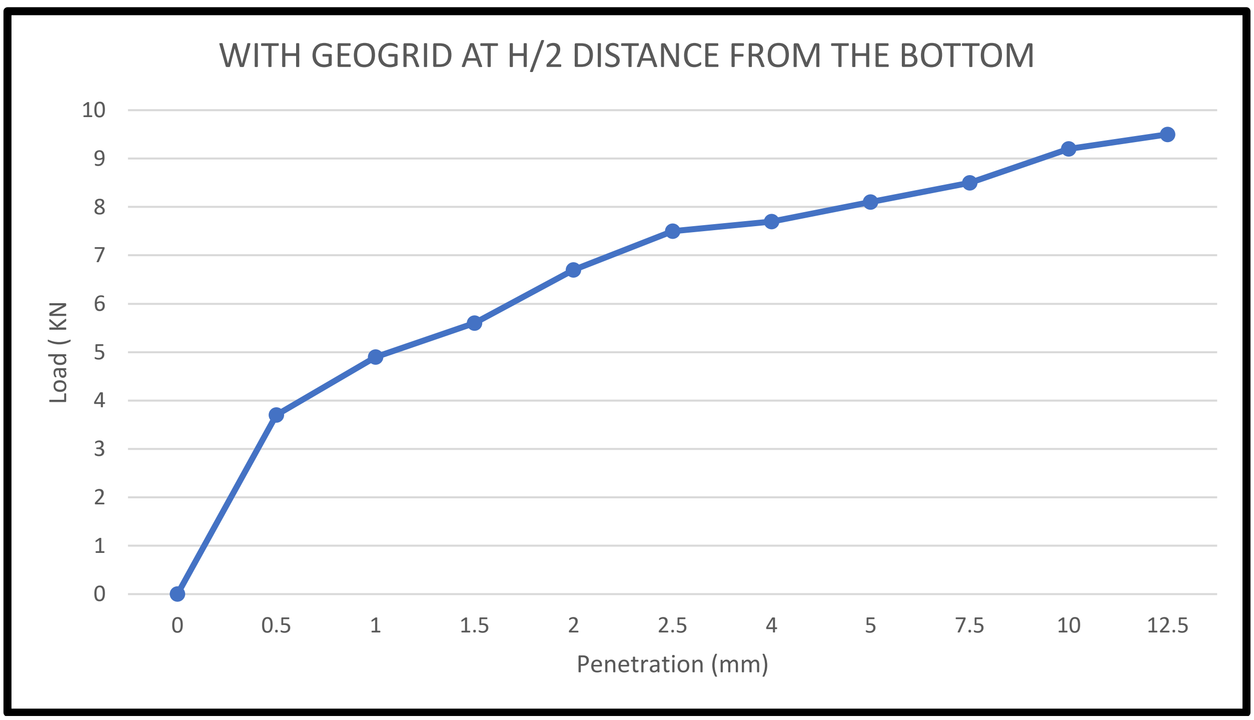


Figure 5 with geogrid at h/2 distance from the bottom

CBR @ 2.5 mm Penetration :2.50, CBR @ 5.0 mm Penetration : 2.

IV. WITH GEOGRID AT 3H/4 DISTANCE FROM THE BOTTOM

Table 4 Geogrid at 3h/4 distance from the bottom

SL No:	Penetration in mm (C1)	Proving Ring Readings (C2) KN	Proving Ring Readings in division (C3=C2*5)	Load in Kg C4=C4*0.915
		WITH GEOGRID AT 3H/4 DISTANCE FROM THE BOTTOM		
1	0	0	0	0
2	0.5	7.9	39.5	36.2
3	1	9.1	45.5	41.5
4	1.5	9.8	49	44.7
5	2	10.9	54.5	49.8
6	2.5	11.7	58.5	53.4
7	4	11.9	59.5	54.3
8	5	12.3	61.5	56.1
9	7.5	12.7	63.5	57.1
10	10	13.4	67	60.3

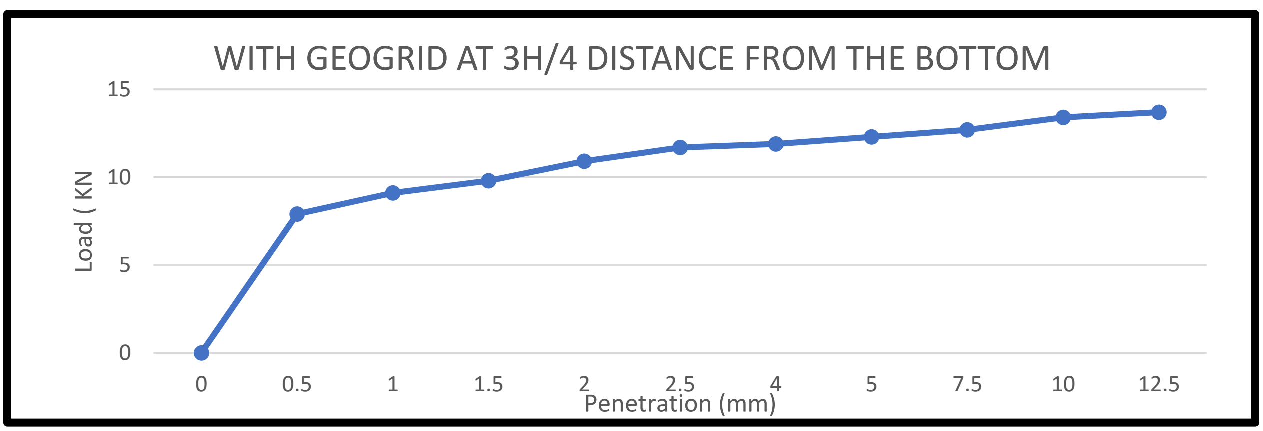


Figure 6 With geogrid at 3h/4 distance from the bottom

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

Description	**CBR Value**
Without geogrid	**1.67**
With geogrid @ H/4 from the bottom	**1.80**
With geogrid @H/2 from the bottom	**2.50**
With geogrid @ 3H/4 from the bottom	**3.9**

IV. CONCLUSION

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1.Economic and Ecological Benefits:

- Reduction in aggregate thickness, leading to material and cost savings.
- Decrease in overall pavement construction costs while extending the service life of the pavement.

1 **Strength Enhancement**:

- Geogrids improve the California Bearing Ratio (CBR) of poor soils, enhancing subgrade strength.
- Optimal strength is achieved when the geogrid is placed at 3H/4 depth, though satisfactory results are also observed at H/2 and H/4 depths.

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