Industrial Engineering Journal
ISSN: 0970-2555
Volume: 52, Issue 4, April 2023

REINFORCEMENT OF SOIL USING GEOGRIDS INHIGHWAY CONSTRUCTION

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Abstract:

Since it has a long history of use in geotechnical engineering, reinforced soil is used for a variety of geotechnical structures, including foundations, embankments, slopes, walls, pavements, railway track beds, and other geotechnical structures. The available reinforcing elements show a variety of properties because they are made from a variety of basic materials and using a variety of very different manufacturing processes. A method for improving the stability and bearing capability of soils is soil reinforcement. Therefore, in this study, we use the CBR test to evaluate the stability and strength of expansive soil that contains reinforcement materials like Geo synthetics (Geo grids). The idea behind reinforced soil is that adding a substance creates a tensile restraint force that lowers the amount of lateral tension needed.

In order to improve the bearing capability of soil, particularly on the approaches to elevated roadways, we primarily concentrate on the use of reinforced soil in highway construction.

Keywords:

Expansive soil, Geogrids, Standard proctor test, Hydrometer analysis, Reinforcement, CBR test.

I. Introduction:

One of the major challenges engineers face in building highways in India's plains and coastal areas is the presence of soft/loose soil at ground level. It costs more money to build roadways over this loose soil because thicker granular materials are needed. Alternately, attempts to make a construction more affordable by reducing the thickness of the pavement layer would lead to early pavement deterioration, which would make the road impassable shortly after construction. This issue may worsen if there is insufficient or no draining. There are some states in India that are in high-rainfall regions with poor drainage and feeble subgrade conditions. This is one of the main reasons for the poor state of the roads in those nations. Due to the poor state of some Indian state roads, the use of geogrid is permitted during road building to improve the performance of the roads. The geo synthetic material made of plastics is called Geo grid for thisreason.

An important class of geo synthetics with an open mesh grid construction is called Geo grid. It can be applied to embankments, earth-retaining structures, reservoirs, waterways, dams, and shoreline protection projects as well as for soil reinforcement, separation, drainage, and filtration. Three popular kinds of geo grids are uniaxial, biaxial, and triaxial. Recently, geo grids have been widely used to reinforce weak soil conditions along paved and unpaved roadways.

II. Literature Review

Due to the poor state of some Indian roads, the use of geo grid is permitted during road building to improve the performance of the roads. The geosynthetic material made of plastics is called Geo grid for this reason.

(Leng, Ju & Gaber, 2002) Fourteen laboratory scale test were carry out in a1.5 *1.5 *1.35 m (59 * 59 * 53 in) box at North Carolina State University to probe the parcels of biaxial geo grid corroborated summations constructed over a poor condition subgrade soil. Cyclic loading were performed through indirect shape plate with periphery of 305 mm (12 in) with outside applied pressure of 500 kPa (72 Psi). Rutting depth and perpendicular stress at the bottom of the base subcaste were recorded. The experimental results revealed that geogrid addition in test sections dropped the rutting depth and bettered the stress distribution at the interface between subgrade and base. Large-scale Field Investigation.

In 2010, **Cox, McCartney, Wood & Curry**, conducted a exploration pro-gram to study the goods of geogrid underpinning on rutting depth of flexible pavements. A vibroseis (shaker) was used to apply cyclic lading on the face of geosynthetic corroborated pavement sections. A line of LVDTs were installed on the face of test sections to record elastic distortions and endless rutting depths. Grounded on experimental results of this study, lower rutting depths were observed for thicker base course subcaste pavements. Not any remarkable advancements were detected in pavement performance by geogrid underpinning, conceivably due to lack of enough strain in pavement section rally the underpinning subcaste.

Naeini and Moayed (2009) Studied the effect of reinforcement and variation in plasticity index (PI) on CBR values. The soil sample used was collected from Khatoon Abad, Iran and was classified as clay of low plasticity (CL). It was found that the CBR values for both unsoaked and soaked specimens decreased with increase in plasticity index.

Zornberg and Gupta (2009) Studied the effect of geo grid reinforcement in mitigation of longitudinal cracks induced in pavements constructed over highly plastic expansive clay sub grades. He took three field evaluations on pavements constructed in TEXAS.

III.Materials and Methodology:

Materials:

1.Expansive soil 2.Micro silica fume **EXPANSIVE SOIL:**

In this project, we used expansive soil for conducting the experiments. The soil is found at NAC building located in Pulivendula, Y.S.R. Kadapa district.

GEO GRIDS

As shown in the below figure we used the geo grids are the bi axial geo grids of aperture size of 4.0 cm *4.0 cm on both directions. As woven and non woven geo grids were placed in the California Bearing Ratio test moulds at different heights.

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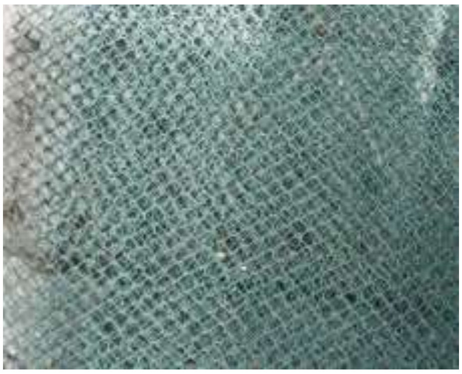

F i g . 1 NONWOVEN GEOGRID

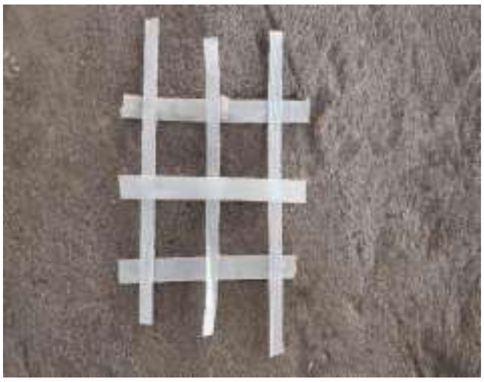

Fig. 2 WOVEN GEOGRID

Methodology:

With soil samples, with and without Geo grid and by altering the position of it in the mould, laboratory CBR tests are performed.

- To design grade, the site needs to be cleared, raked, and dug while removing any top- soil, soft soils, and other unsuitable materials. Lightweight proof rolling activities should be taken into consideration when the site has moderate site characteristics i.e., CBR more than 1 aid in locating inappropriate materials.
- To encourage good drainage, isolated pockets where more excavation is needed should be backfilled. To drain secluded locations, geo textile wrapped trench drains offer an alternative.
- Care should be taken not to significantly disturb the sub grade when performing stripping operations. For low strength, impregnated, non-cohesive, and low-cohesive soils, this may support the usage of featherlight slumberers. Avoid shovelling face accessories into areas of exceptionally soft ground, such as peat bogs, in order to take use of any root mat strength that may be there. In this situation, the ground face should be used to remove any foliage. To protect the geo grid, cover holes or roots that protrude above the ground face with sawdust or sand. Rewind: The geo grid or the sub grade medicine must match the geo grid'ssurvival packages.
- The geo grid should be rolled in accordance with the placement of the new roadway aggregate once the sub grade along a specific section of the road alignment has been constructed. If the geo grid is made to design, field operations can be accelerated. so that it

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can be unrolled in one continuous sheet. Widths are manufactured in the factory. When utilized with geo textiles, geo grids should be laid directly on top of them. You shouldn't pull the geo synthetic across the sub grade. Placement and rollout should be done as smoothly as feasible. The geo grid should be stretched and staked as necessary to remove creases and folds.

- Geo textile or geo grid parallel rolls should be overlapping, stitched, or linked as necessary.
- The geo grid for curves should be sliced and overlapped in turn's direction.
- The geo synthetic should reach all the way to the edge of the previous system when the geo grid crosses a pavement region. Consider anchoring the geo grid at the thruway border for roads that are being widened or cut where geo textiles or geo grids have been deployed. The new geo synthetic should be mechanically attached to the existing geo synthetic, and the edge of the highway should be shovelled over to the existing geo synthetic (i.e., mechanically connected with plastic ties to the geo grid).
- On the total that was placed initially, the base total should be end- ended. To prevent sub grade failure, pile heights should be kept to a minimum for genuinely soft sub grades. The first lift of the total should be distributed and graded to 12 in (300 mm), or to the design consistence if lower than 12 in (300 mm), prior to contraction. The maximum placement lift consistence for identical soils shouldn't exceed the first lift of the total. Business should never be permitted on a soft throughway with a total overhang of less than 8 in. (200 mm) (or 6 in. (150 mm) for CBR 3). If the sub grade is strong enough, the outfit can operate on the throughway without complete geo composite installation beneath acceptable bases.
- Featherlight construction vehicles will likely be required for access on the initial lift for particularly soft soils. Rutting in the original lift should be limited to 3 in. due to size and weight restrictions for construction trucks (75 mm). It will be essential to reduce the size and/or weight of the construction vehicle or to reduce the lift consistency if the pattern depths are greater than 3 in (75 mm). For instance, it could be necessary to provide the filler in half-filled rather than fully loaded exchanges or to minimise the size of the slum carrierneeded to blade out the filler.

- To achieve a minimal compacted density, the first lift of foundation aggregate should be tracked using a dozer, then compacted with a smooth-drum vibratory roller. Compaction for permeable foundation construction must adhere to specification requirements. Design density shouldn't be expected for the initial lift in very soft soils, therefore the amount of compaction needed in this situation should be decreased. One suggestion is to allow 5% less compaction than the initial lift's required minimum specification density.
- The road alignment should be paralleled during construction. For the initial lift of base aggregate, turning should not be permitted. To make building easier, turnouts may be built along the edge of the road.
- If the geo grid is to provide any reinforcing on very soft sub grades, pre tensioning of the geo synthetic material should be taken into consideration. Pre tensioning requires the use of a strongly laden, rubber-tired vehicle, like a loaded dump truck. The wheel load need to be equal to the highest level anticipated for the site. At each part of the site, the vehicle shall pass the first lift at least four times. Alternately, the roadway could be used for a while after the design aggregate has been laid before being paved in order to prestress the geo grid aggregate.

S.NO	TESTS CONDUCTED	TESTS VALUES
1.	Liquid limit (Cone Penetrometer)	51%
2.	Plastic limit	26.1%
3.	Plasticity Index	24.9%
4.	Specific gravity of soil (Density bottle)	2.5
5.	Standard proctor compaction test	OMC = 20.0% MDD =1.65 g/cc
6.	California Bearing Ratio Test (CBR test) Non-Woven geo grid(height 3H/4=13.87 cm from bottom) Woven geo grid (height 3H/4 =13.87 cm from bottom)	At 2.5mm=3.77%At 5.0mm=2.7% At 2.5mm=3.85%At 5.0mm=2.75%
7.	Unconfined Compressive strength	q_u = 8.54 Kpa C = 4.27 Kpa

Table-1 Results of the methodology.

1. Liquid Limit (IS 2720 (Part 5)-1985)
2. Plastic limit test (IS 2720(Part 5)-1985)
3. Specific gravity (IS 2720(Part 3)-1980)
4. Standard Proctor test (IS 2720(part-5)-1985)
5. Unconfined compression strength test (IS 2720(Part 10)-1991)
6. California bearing ratio test (IS 2720(Part 16)-1987)

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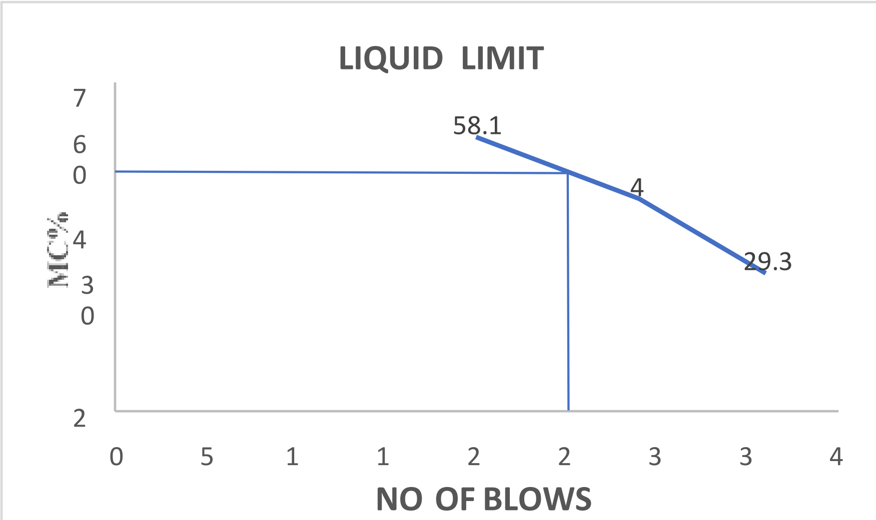
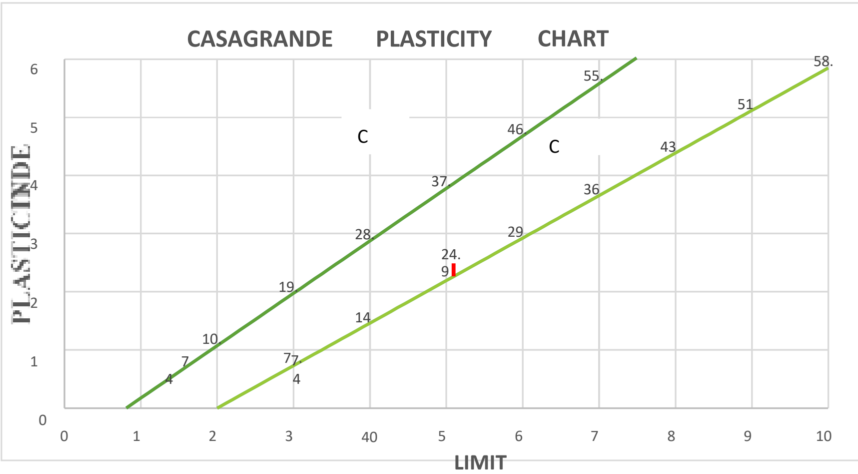
IV. Results and Discussions

1. LIQUID LIMIT



Graph-1 Liquid Limit. **2. PLASTICITY CHART**



Graph-2 Plasticity Chart.

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3. STANDARD PROCTOR TEST

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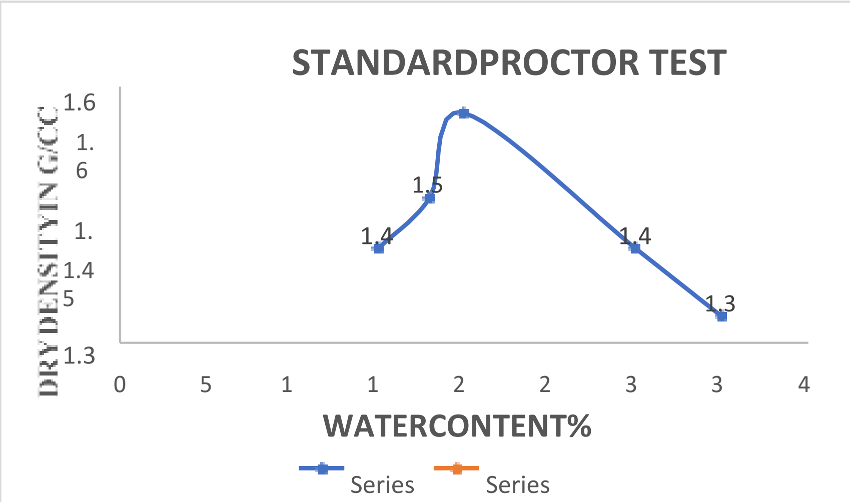
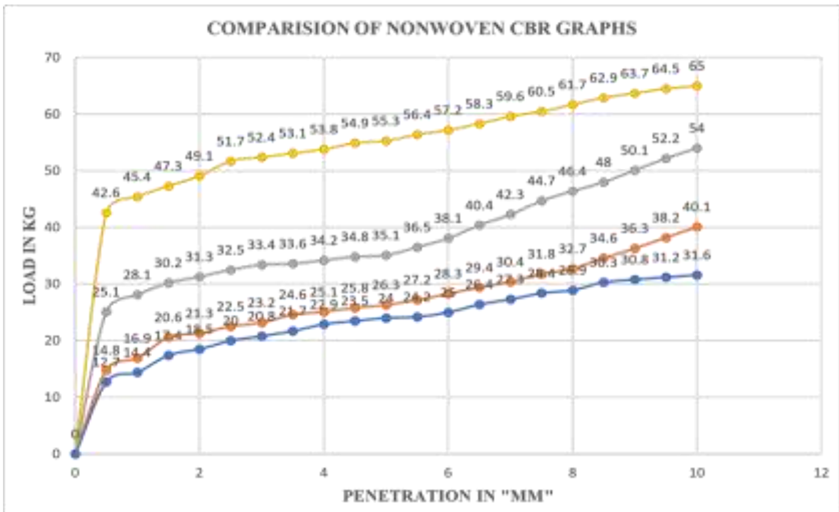


Graph-3 Standard Proctar Test.

4. CALIFORNIA BEARING RATIO TEST

I. CBR CONTRAST WITH NONWOVEN GEOGRID APPLICATION



Graph-4 Comparision graph at various heights with pure soil.

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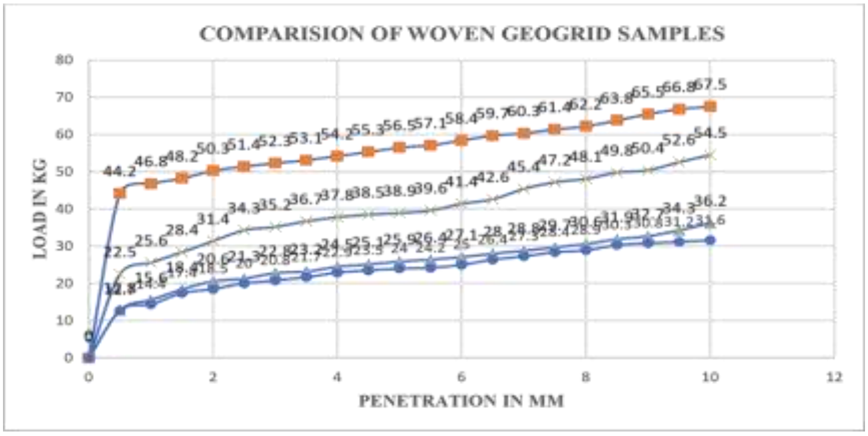
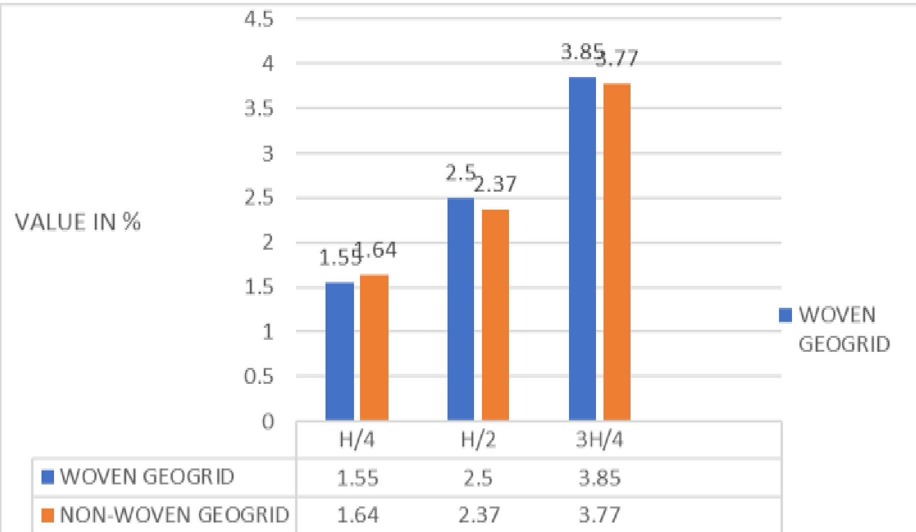
II. CBR CONTRAST WITH WOVEN GEOGRID APPLICATION



Graph-5 Comparision graph at various heights with pure soil.

III GRAPH COMPARISON OF WOVEN AND NON-WOVEN GEO-GRID CBRVALUE IN %:

At penetration 2.50 mm:



Graph-6 Comparison of Woven and non-Woven geogrids.

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At penetration 5.0 mm:

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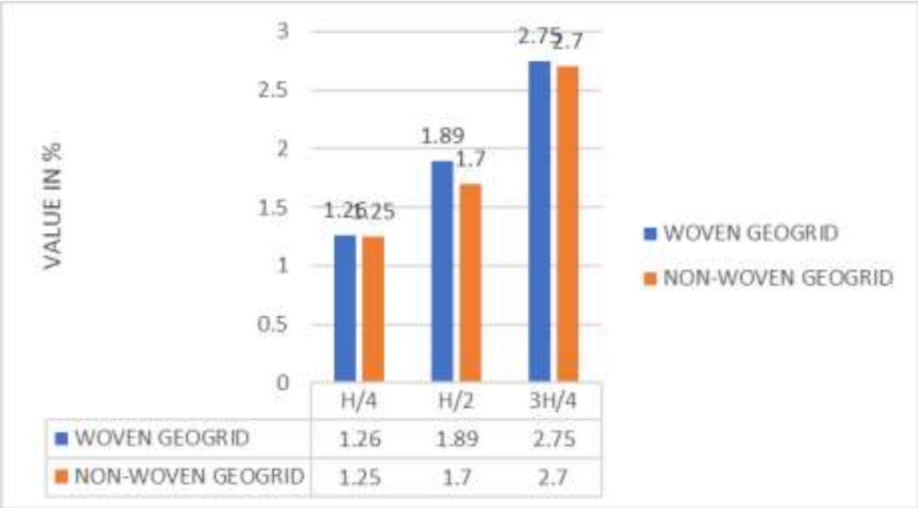
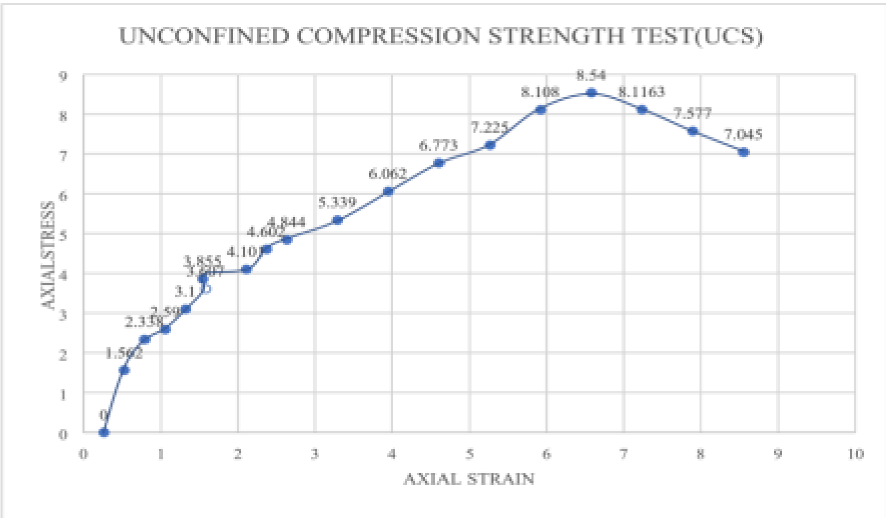


Graph-6 Comparison of Woven and non-Woven geogrids.

5. UNCONFINED COMPRESSION TEST:



Graph-7 Unconfined Compression Test.

V. CONCLUSIONS:

Reducing aggregate thickness can be accomplished cheaply and environmentally by utilising the advantages of geo grid reinforced sub grade courses. And with a longer lifespan, it can also lengthen the pavement's lifespan and reduce the entire cost of pavement development. The study looked into the use of geo grids as a kind of road construction reinforcement when applied to sub grade material. The addition of the geo grid significantly boosts the resilience of weak soils, as evidenced by the increased CBR values. According to the study, placing the geo grid at different depths greatly improves the sub grade's strength. 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.

For its index properties, ranging natural black cotton soil is examined. To determine the CBR's strength specifications, a test is run. WOVEN and NONWOVEN geo grids were the two types of geo grids used. The Geo grid is added in fractions of one-fourth, middle, and three-fourths to the earth sample. By combining the woven geo grids and the non-woven geo grids, it is discovered that the strength is increased from 1.46% to 3.85% and from 1.46% to 3.77%, respectively. The 3/4th position is where the extreme CBR number is attained. Woven Geo grid shows greater strength improvement than Non-woven Geo grid. Geo grids are used to reinforce weak soils, increasing their power. Due to its durability and lack of biodegradability, it also extends the pavement's useful life. Therefore, the use of Geo grids should be supported as an efficient and current method of enhancing road building on unacceptable subgrade materials.

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