STABILIZATION OF SOILS USING GEOSYNTHETICS

S.Sugandini[1], Dr.M.Madhuri[2]

1P.G. student, Civil Engineering Department, Malla Reddy Institute of Technology, Telangana, India
2Professor, Civil Engineering Department, Malla Reddy Institute of Technology, Telangana, India

ABSTRACT

. *A Large variety of reinforcing materials emerged and have been developed for construction purposes, including: metal strips ,bar mats, Geotextile sheets, Geo Grids etc. Reinforced soil technologies has been extensively used during the past few decades in the construction of (railway formation, highway embarkments, earth dams and retaining walls). As a reinforcing material the Geo synthetics are widely used in engineering practice to strengthen the foundation, slope, road, pavement, crushed-stone column etc. Pavement is a hard crust constructed over the natural soil for the purpose of providing and even surface for the vehicles. In pavement construction soil stabilization is also deals with the construction practice(Highways, dams, bridges, railway structures)it shows the various mean by which the stabilization responds of different soils can be identified.*

This paper presents soil geostnthetic intraction properties for different types of soils, four types of soils were used with geocomposit reinforced materials for conducting CBR test to finding the density of soil samples and mechanical strength of sub grade soil.These geo synthetic products have helped desigeners and contractors to solve several types of engineering problems where the use of conventional construction materials would be restricted or considerably more expensive.

Keywords: *Geotextiles,geogrids,soils,CBR test.*

1.INTRODUCTION

Transportation by road or highways is that the solely mode that may offer most service to at least one and every one. Transportation contributes to the economic, industrial, social, and cultural development of any country. it's very important for the economic development of any region since each trade goods created whether or not it's food, clothing, industrial product or medication wants transport in the least stages from production to distribution. within the production stage, transportation is needed for carrying raw materials like seeds, manure, coal, steel, etc. within the distribution stage, transportation is needed from the production centers i.e. farms and factories to the marketing centers and later to the retailers and the consumers for distribution.The inadequate transportation facilities retard the method of socio-economic development of the country.

Construction of pavements and this project deals with the development of one such major property in the subgrade soil. When the soil on project web site cannot support the masses, ground improvement techniques are implied to increase the the strength, scale back softness, and enhance performance underneath applied loadings. the sector of ground improvement techniques has been recognized as a crucial and speedily increasing one. AN earth slope is unsupported, inclined surface of a soil mass. Earth slopes area unit shaped for railway formation, main road embankments, earth dams, canal banks, levees and at several different locations. On slopes that area unit being scoured away, swiftness down of surface water is required. To accomplish this installation of devices meant to bog down the water is required.

1.1 Objective and scope of the study

The main objective of the present work is to study the effect of the soil strength after the application of geosynthetics. In the present study the strength variations in different soil was observed. In the present thesis the analysis of soil has been carried out by application of geosynthetics in soils by using sieve analysis and CBR test.

The future scope appears to be more promising with stronger and more durable geosynthetics emerging into the market along with fibrous system to be mixed with soil for giving more hope as well as challenge to the geotechnical engineer in the years to come.

1.2 Applications of reinforcements for soil stabilization

The overall behavior of the strengthened mass depends on the reinforcement material properties, the soil characteristics, and therefore the nature of the interaction between the soil and therefore the reinforcement. The interaction mechanism is stricken by factors such as: state of stress inside the strengthened mass; nature of loading; direction of reinforcement; boundary conditions; and material and interface properties. within the case of monotonic loading, 3 mechanisms of interaction are identified: passive anchorage; increased confinement; and tensile membrane action.

1.3 Types of reinforcement

Reinforced Soil Structures square measure classified loosely, into three classes:

- Mechanically-Stabilized Earth (MSE) Walls
- Reinforced Slopes and Embankments
- Reinforced Foundations

Soil Reinforcement is also created with variety of materials:

- Woven Geotextiles
- Polymer Geogrids of synthetic resin (usually uniaxial) & plastic (usually biaxial)
- Polyester and covering material Geogrids (often unwoven or sewn at junctions) and frequently coated with a chemical compound like synthetic resin or PVC or with hydrocarbon.
- Steel Strips
- Welded wire mesh

2.GEOSYNTHETICS

Geosynthetics with high tensile strength used in combination with soil of high compressive strength have been found to be effective in the design of many civil engineering applications. The application of Geosynthetics in the field of geotechnical, transportation, hydraulics, and geo-environmental engineering has been explained by many researchers.

The materials employed in the manufacture of geosynthetics square measure primarily artificial materials, generally, derived from crude oil oils, though rubber, fiberglass. Geosynthetics could be a generic name representing a broad vary of plane merchandise factory-made from compound materials. the foremost common ones square measure geotextiles, geogrids, geonets, geomembranes and geocomposites, that square measure employed in contact with soil, rock Associate in Nursingd/or the other material as an integral a part of a artificial project, structure or system. The term 'geosynthetics' has 2 parts:

'GEO' touching on Associate in Nursing finish use related to rising the performance of applied science works involving earth/ground/soil.
'SYNTHETICS' touching on the very fact that the materials square measure virtually solely from artificial merchandise

2.1 Types

The various types of geosynthetics that are available in the market are named below:

- Geotextiles (GT)

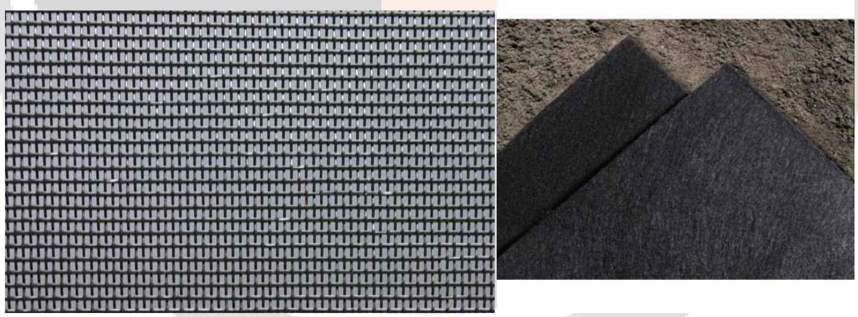
- Geogrids (GG)
- Geonets (GN)
- Geomembranes (GM)
- Geosynthetic clay liners (GCL)
- Geopipe (GP)
- Geofoam (GF)
- Geocomposite

2.1.1 Geotextiles (GT)

Geotextiles type one among the 2 largest teams of geosynthetics. Their rise in growth throughout the past 35years has been nothing wanting extraordinary. they're so textiles within the ancient sense, however they comprises artificial fibers instead of natural ones like cotton, wool, or silk. Thus, biodegradation and resultant short life isn't a drag. These artificial fibers ar created into versatile, porous materials by normal weaving machinery or ar matted along during a random non-woven manner. Some also are unwoven. There ar at-least a hundred specific application areas for geotextiles that are developed, however, the material invariably performs a minimum of one among four distinct functions: separation, reinforcement, filtration and/or drain.
Geotextiles are classified based on manufacturing process into the following:

- Woven GT
- A geotextile made by interwoven, sometimes at right angles, 2 or a lot of sets of yarns or
- Other parts employing a typical weaving method with a weaving loom.
- Non-woven GT
- A geotextile made from directionally or willy-nilly oriented fibres into a loose internet by bonding with partial melting, needle punching or chemical binding agents.
- Knitted GT A geotextile made by inter-looping one or a lot of yarns beside a textile machine rather than a weaving loom
- Stitched GT
- A geotextile within which fibres or yarns or each ar interlocked by handicraft or stitching.

Fig-1:Geotextiles



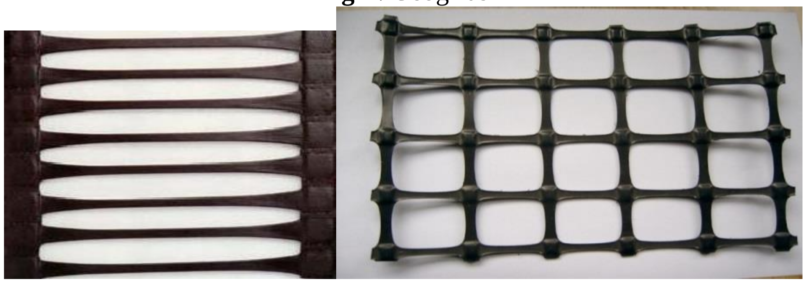
Wovengeotextiles Non Woven geotextile

2.1.2 Geogrids (GG)

Geogrids represent a quickly growing section among geosynthetics. instead of being a plain-woven, non-woven or unwoven textile material, geogrids ar polymers shaped into a awfully open, grid like configuration i.e. they need massive apertures between individual ribs within the crosswise and longitudinal directions. Geogrids are:

- Either stretched in one or 2 directions for improved physical properties
- Made on weaving or knitting machinery by commonplace textile producing ways
  Bonding rods or straps along

Fig-2: Geogrids

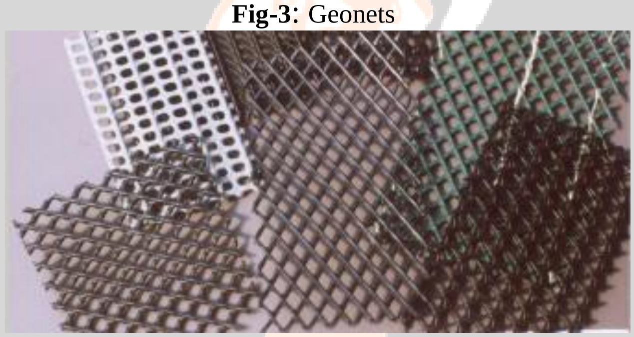


Axial geogrid Biaxial geo grid

2.1.3 Geonets (GN)

Geonets, also called geospacers, constitute another specialised phase inside the geosynthetics space. they're fashioned by a nonstop extrusion of parallel sets of chemical compound ribs at acute angles to 1 another. once the ribs area unit opened, comparatively giant aperture area unit fashioned into a web like configuration. 2 sorts area unit most typical, either biplanar or triplanar. Their style perform is totally inside the geographical region wherever they're wont to convey liquids of all sorts.

Fig-3: Geonets



2.1.4 Geosynthetic clay liners (GCL)

Geosynthetics clay liners are. rolls of manufactory made-up skinny layers of clay clay sandwiched between 2 geotextiles or guaranteed to a geomembrane. Structural integrity of ensuant composite is obtained by needle punching, sewing or physical bonding

Fig-4: Geosynthetic clay liners

2.1.5 Geopipes (GP)

A plastic pipe placed beneath the ground surface and subsequently backfilled.

Fig-5: Geopipes

2.1.6 Geofoams (GF)

Geofoam could be a product created by a compound enlargement method leading to a foam consisting of the many closed, however gas stuffed cells. The skeletal nature of the cell walls is that the unexpanded compound material.

Fig-6: Geofoams

2.1.7 Geocomposite (GC)

Geocomposite consists of a mixture of geotextiles, geogrids, geonets, and/or geomembranes during a works fictitious unit. Also, anyone of those four materials is combined with another artificial material i.e. unshapely plastic sheets or steel cables or perhaps with soil.

Fig-7: Geocomposite

2.2 Properties

Geosynthetics are usually supposed to have the following three basic kinds of properties:

1) Strength properties
2) Resistance properties
3) Permeability properties

2.2.1Strength properties

It must be tough to with stand the stresses during the installation process. Properties concerned are:

- Tensile strength
- Burst strength
- Grab strength
- Tear strength
- Resistance to ultraviolet light degradation for two weeks exposure with negligible strength loss

2.2.2 Resistance properties

It must be strong enough to withstand static and dynamic loads, high pore pressure and severe abrasive action to which it is subjected during its life span. The properties concerned are:

- Puncture resistance
- Abrasion resistance
- Elongation resistance

2.2.3 Permeability properties

It must be resistant to excessive clogging and blinding, allowing water to pass freely across and within the plane of the geotextile. At the same time, it must be capable of filtering out and retaining fines in the subgrade. The properties concerned are:

- Cross plane permeability
- In plane permeability
- Apparent opening size

3.Experimental programme

3.1 Soils used in the project

Some major kinds of soils that are encountered are:

(i) Black cotton soil – marshy regions, dried up river or lake beds, etc.
(ii) Marine clay – river delta, high rainfall zones, d/s of erosion prone areas.
(iii) Granular soil– Desert regions, coastal areas, etc.
(iv) Red laterite soil – Plateaus, boulder regions.

Black cotton soils are expansive in nature and tend to shrink in dry seasons while in wet seasons they expand highly depending on the mineral present in it. It has weak strength
Properties like the load bearing capacity. This is an adverse property for the construction of pavement and so the soil needs to be assessed for the various engineering properties including the depth of the layer to compensate the amount of expansion and shrinkage.
Marine clay also belongs to the family of pure clays but has fine sand embedded into it. This might have happened due to the exposure of clayey soils to desert winds and eroded soils. These sand grains have acted as coarse aggregate as in concrete and strengthened the soil to some extent but are still not good enough for engineering applications. Expansion behavior is reduced as compared to that of clays.
Red laterite soils possess good strength properties but when exposed to high moisture, these also behave like clay and may cause the failure of pavements and so need the assessment for strength behavior. From literature survey we found that expansive nature is not as extreme as in clays.

3.2 Collection and storing of samples

Red laterite soil:
Red soil is collected from the laboratory premises where a work for gardening was undergoing. The soil was broken down to make it free from lumps and all the non-required waste was carefully picked out and cleaned.
Marine clay:
This soil was collected from Maisammaguda
Black cotton soil:

Black cotton soil was also collected from the Narsapur Medak.
Granular soil**:**
Granular soil was also collected from the Bahadhurpally.

3.3 Application of geosynthetics.

The procedure for testing remains a similar for each the cases except the addition of geosynthetic layers into the soil whereas compacting at totally different heights of the soil within the mould. The geotextile and therefore the geogrid were take circular items that will match specifically into the mould while not. Layers were placed higher than of the primary and therefore the third layer whereas compacting the soil which might grow to be top of second layer and fourth layer when inverting the mould for cosmic microwave background testing and CBR test was conducted.

Fig-8: Geosynthetics application

4.Experimental Results

4.1 Red laterite (CBR test)

Table: 1 CBR test (Red laterite)

Penetration (mm)	CBR (plain soil)	CBR GG(40*40)	CBR (GT)
2.5	10.571	22.02	13.2145
5	9.9843	21.143	12.920
7.5	9.6368	20.88	12.390
10	9.488	20.115	12.144
12.5	9.387	19.78	12.07

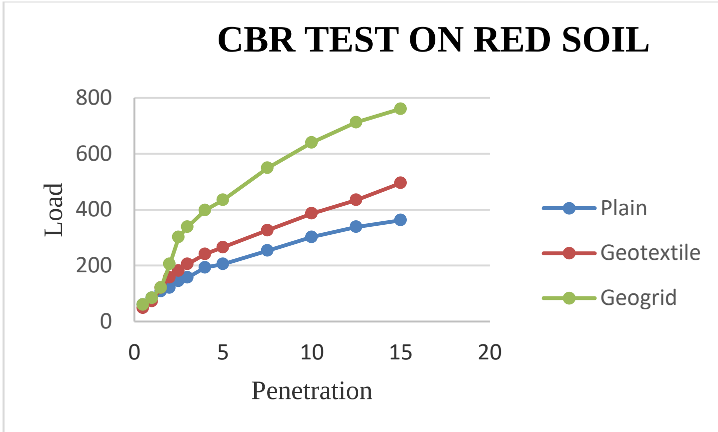


Chart-1: CBR test (Red laterite)

4.2 Marine clay (CBR test)

Table-2: CBR test (Marine clay)

Penetration (mm)	CBR (plain soil)	CBR GG(40*40)	CBR(GT)
2.5	6.166	7.9288	8.809
5	5.872	15.17	7.6350
7.5	5.50	12.89	7.34
10	5.3135	11.38	7.211
12.5	5.020	10.60	7.040

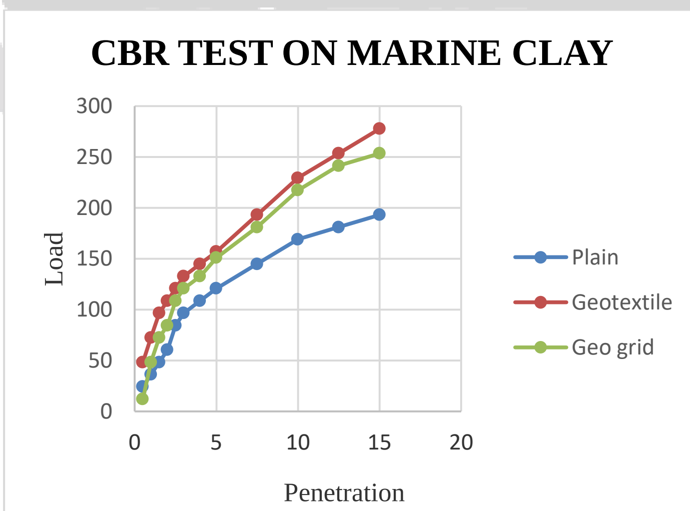


Chart-2: CBR Test (Marine clay)

4.3 Black cotton soil (CBR test)

Table-3: CBR test (BCS)

Penetration (mm)	CBR(plain soil)	CBR GG(40*40)	CBR(GT)
2.5	6.166	15.856	8.80
5	5.8729	12.92	8.22
7.5	5.5068	11.93	803
10	5.3135	11.754	7.211
12.5	5.0286	11.398	7.040

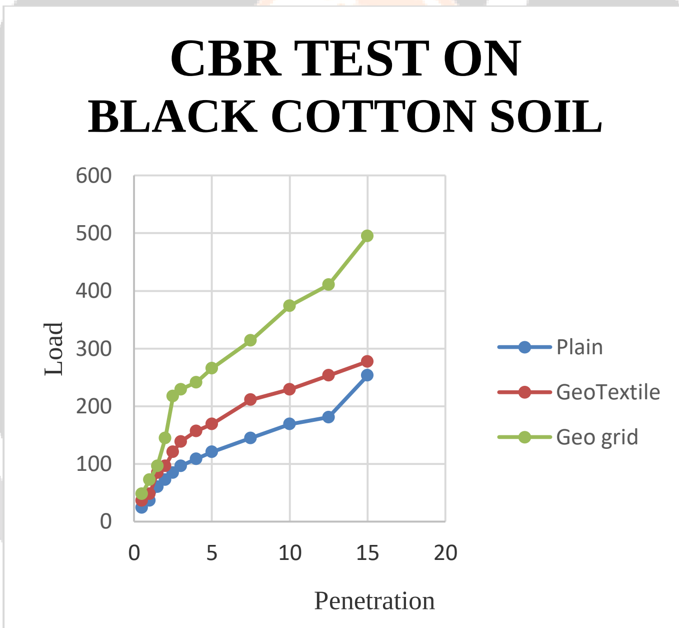


Chart-3: CBR Test (BCS)

4.4 Granular soil (CBR test)

Table-4: CBR test (Granular soil)

Penetration (mm)	CBR (plain soil)	CBR GG(40*40)	CBR (GT)
2.5	32.59	18.500	20.26
5	54.03	32.88	33.476
7.5	55.06	46.80	44.514
10	59.20	60.3465	53.89
12.5	63.02	73.75	59.675

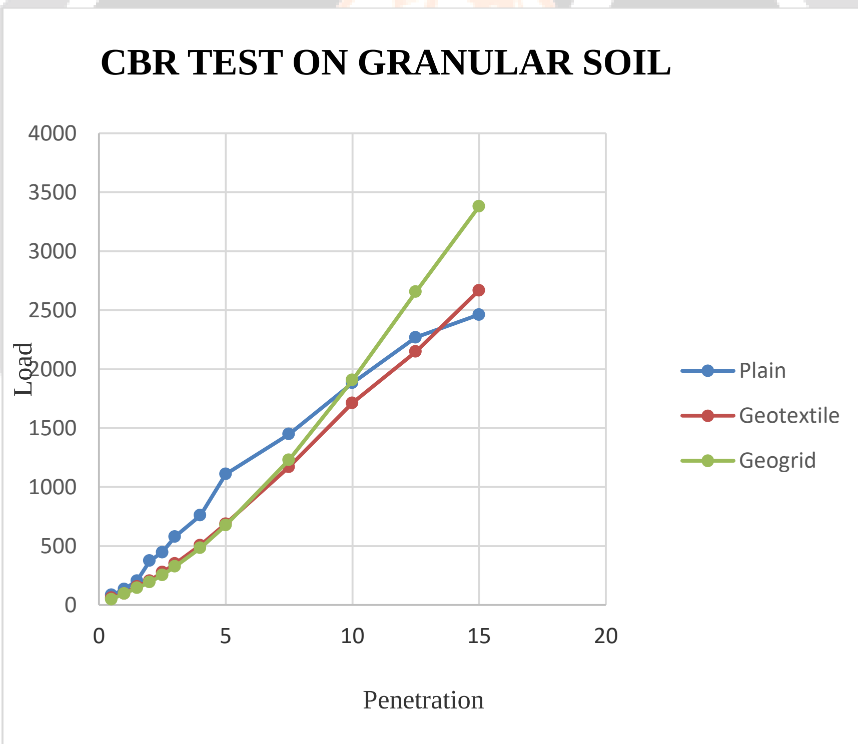
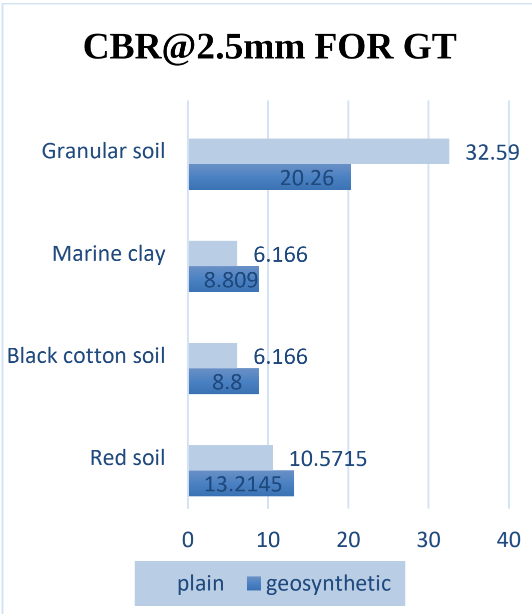
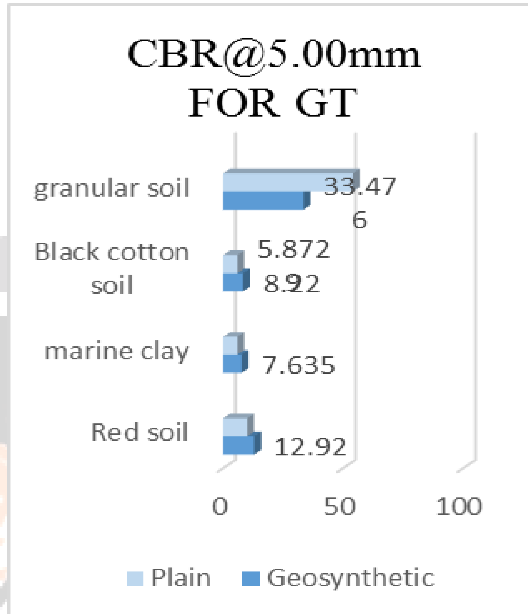
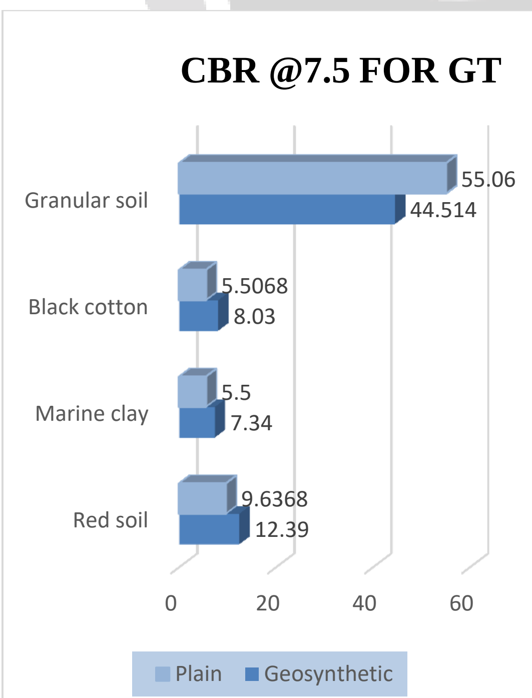


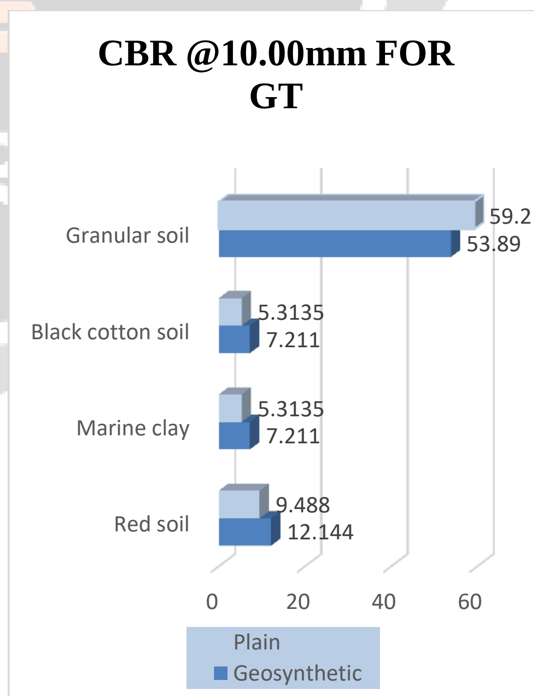
Chart-4: CBR test (Granular soil)

4.5 Data analysis
4.5.1 Geotextile









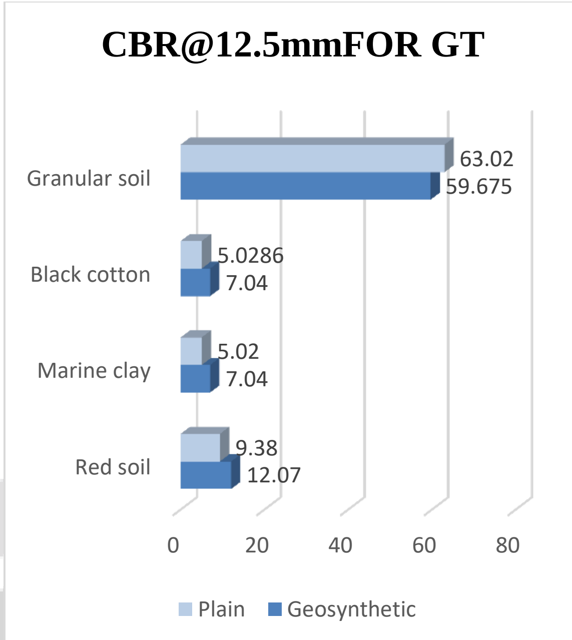
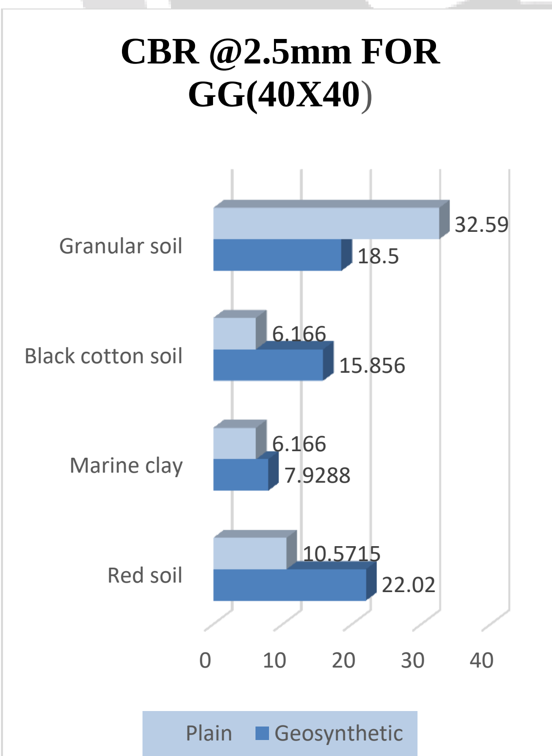
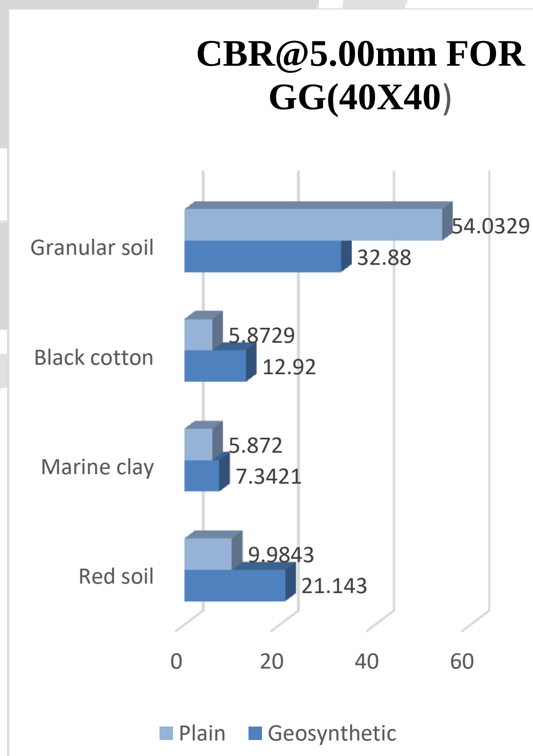


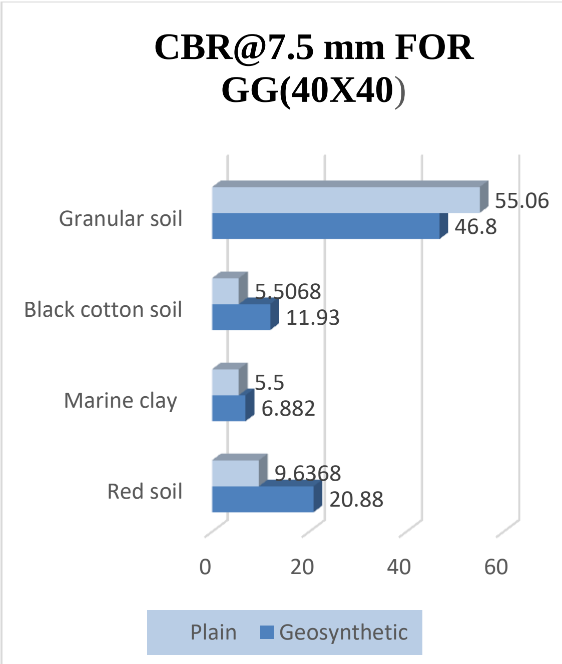
Chart-5: Comparison of CBR values for different penetrations with GT

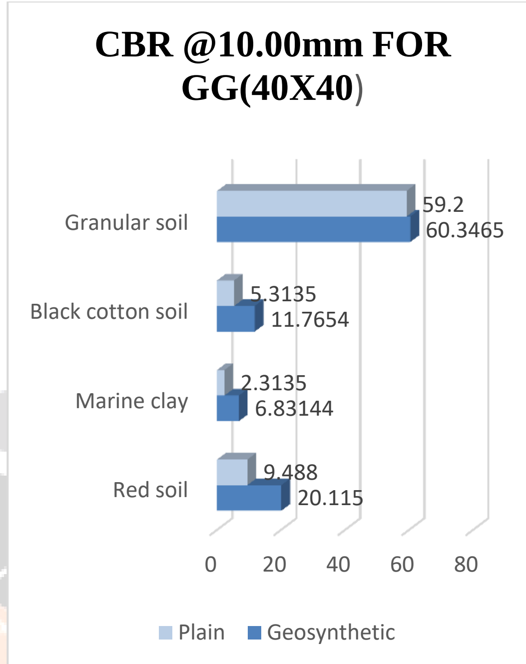
From the above comparison charts it can be incurred that the strength had very slightly improved only for Red laterite soil as it is a stiffer clay. The rest all soils responded negatively which is due to the compression of non-woven geotextile under load.

4.5.2 Geogrid (40x40)









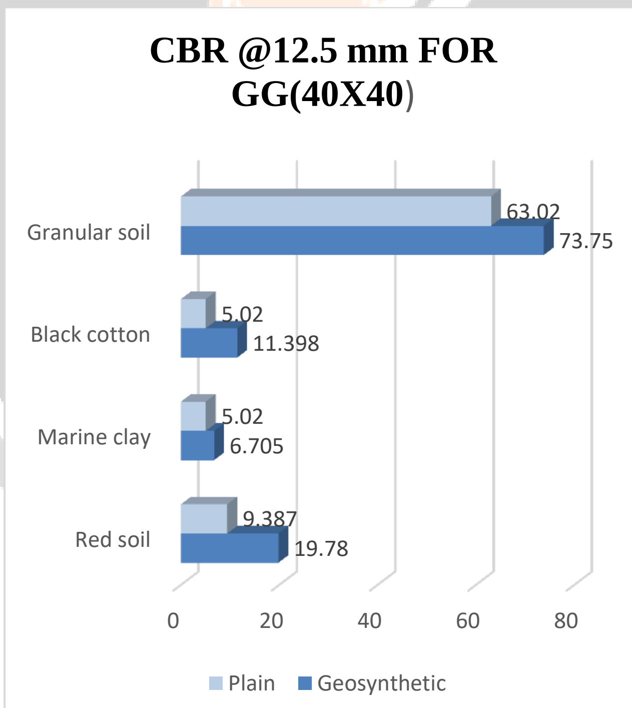


Chart-6: Comparison of CBR values for various penetrations with GG 40x40

From the above graphs it has been observed that the soils have shown good proportional increments for the penetrations of 2.5mm and 5mm. it can also be observed that Granular soil had a drastic improvement of strength even at 12.5mm penetration.

4.6 Future scope of the work

It is expected that the use of geosynthetics will become increasingly routine, and that geosynthetics will be the standard material of choice for several applications. It can be used in environmental engineering for landfill projects. It can also be applied in railway construction which includes antifiltration, anti-seepage,drainage,protection and reinforcement needle punched staple fiber nonwovens were used as filtration for subgrades.

5. CONCLUSION

Granular soil had shown improvement in the CBR values for Geogrids and had nearly doubled for the penetrations of 2.5mm and 5mm for geogrids, this implies the applications of Geogrids for pavements in case of Granular soil can reduce the thickness of the layer by almost half of the original depth.

The Granular soil have shown higher CBR values. This had happened due to the fact that sands consisted of high amount of coarse grains as compared to that of soils which had higher fines and were clayey.Black cotton soil had tripled its strength when the Geogrids 40x40 were used for reinforcing this soil. We can use these formats of Geogrids for Black cotton soils for construction of low volume roads at a cheaper cost for the same amount of traffic.

All the three clayey soils i.e. the red laterite, Marine clay and the black cotton soil have positively responded to the Geotextile in contradiction with the Sandy soils. The Geotextile being the non-woven type was being compressed when the load was being imposed on soils.

The clayey soils when consisted high moisture in them, Geotextile can be a remedy as well as reinforcement. This is stated as the Geotextile was absorbing water from the soils and also the soils were high in clay content which turned them stiff, thereby improving the load bearing capacity of the soil.

Marine clay had shown good improvement i.e. the load bearing capacity had doubled when the 40x40 Geogrid was used for reinforcing it. In all other cases of Geogrids the strength improvement was not so high as compared to the 40x40 Geogrid.

Geogrids when no other economically feasible soils are available in the nearby areas. Also care is to be taken that the boundaries of the sand stratum had stiffer soils with high fines to prevent the flowing of sand particles when high moisture is induced. This will form our basis for the further research for economically constructing pavements on a weaker subgrade, sub-base and base soils in combinations with various reinforcing methods.

Some of our future research ideas include the use of Geocells for holding the sands in place and also trying to prevent the expansion of clayey soil. Also woven Geotextiles will be implied to check for CBR value improvement and the cost feasibility in comparison with the Geogrids and the non-woven type of Geotextile.

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