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A Study on Geosynthetic Material in soil Reinforcement

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Abstract: *The use of geosynthetics is to improve the performance of foundation when constructing on soft compressible foundation soil. The material properties of geosynthetic are important to their use in various applications. Geosynthetics have become well established construction material for geotechnical and the environmental application in most part of the world. They are constituted of manufactured material, new product and application which are developed on a routine basic to provide solution to routine and critical problem. This report focus on recent advances on geosynthetics product, application and design methodologies required for reinforcing soil and environmental protection work, embankments on soft foundation, steep slopes, and for the backfills of retaining walls and abutments. The geosynthetic product have helped designers and contractor to solve several types of engineering problem where the use of geosynthetic material geogrids and gujcon is conventional construction material would be restricted or considerably more expensive.*

Keywords: *Geosynthetics , Geogride , Road , Foundation , Landfill*

I. INTRODUCTION

An extensive and good quality road network is one of the major parameters for the development of a country's social and economic condition. The basic necessity for a good quality road structure is good and strong sub grade over which the road is constructed. But in many parts of the country, the sub-soil is of poor quality due to low strength and high compressibility. Also there is scarcity of good quality conventional construction material for subbase and base of the road structure. So there is a necessity for improving some alternative road construction materials which can improve the bearing strength of the subgrade soil by replacing the by geogrid as reinforcement at the interface of the soil. In the present study, an attempt has therefore been made to carry out CBR tests in Laboratory, keeping soil, and geogrid in standard CBR mould with proper compaction and with different configuration of soft soil, by varying their thicknesses and placing the geogrid sheet at their interface. The geogrid sheet has been used to give reinforcement' and separation' functions in the system. Improvement of subgrade, as reflected by CBR values, has been obtained soft soil and further improvement has occurred with use of geogrid. Geosynthetics are those polymeric materials which are used buried in earth or soil, in order to enhance the properties for specific applications.

II. LITERATURE REVIEW

The increases the bearing capacity of the sub-grade, reduce The differential settlement of the pavement, increases the life of the pavement. The reduces cost due to saving incurred in the reduction of the special fill material.. Geo-grid are reinforcement can be Used to prevent or reduce rutting caused by the bearing capacity failure of the base or sub-grade And by the lateral movement of the sub-grade material. The woven and non-woven geotextiles are being extensively used for improvement and strengthening of soft sub-grade soil. This chapter describes the various research work carried out by the earlier researchers on the Use of geogrid in road construction works.

- 1) *S. A. Naeini & R. Ziaie Moayed* in their study prepared three types of soil sample with Different percentage of bentonite on which California Bearing Ratio tests were carried with Or without geo-grid reinforcement in one or multilayered. The result shows that increase in The plasticity index decreases the California Bearing Ratio value in both soaked and unsoaked Condition California Bearing Ratio can be considerably increased by using geogrid Reinforcement in two layers when compared with unreinforced, but less value when Compared with one layered reinforcement. The geogrid placing at layer two there is a Considerable increase in CBR value compared with unreinforced soil in Both condition soaked and un-soaked .By using two layers of geo-grid at layer 1 and 3, unsoaked California Bearing Ratio value increases compared with unreinforced soil.
- 2) *Rakesh Kumar and P.K. Jain* in their study of ground improvement techniques found that the construction of granular piles in expansive soil improves the load carrying capacity of the soil. They made an attempt to investigate the improvement of load carrying of granular pile with and without geogrid encasement through Laboratory model tests and Found that the load carrying capacity of granular pile increases by casing the pile with geogrid.

III. GEOSYNTHETICS

Types Of Geosynthetics

A. Geotextile

- 1) Geotextiles are defined as any permeable textile used with foundation soil, rock, earth, or any other geotechnical engineering structure, or system. They are typically the most used geosynthetic material purposes. These are fabric or cloth place the threads or yarns in the fabric: either woven or non in rolls up to approximately 5.6m (18 ft.) W

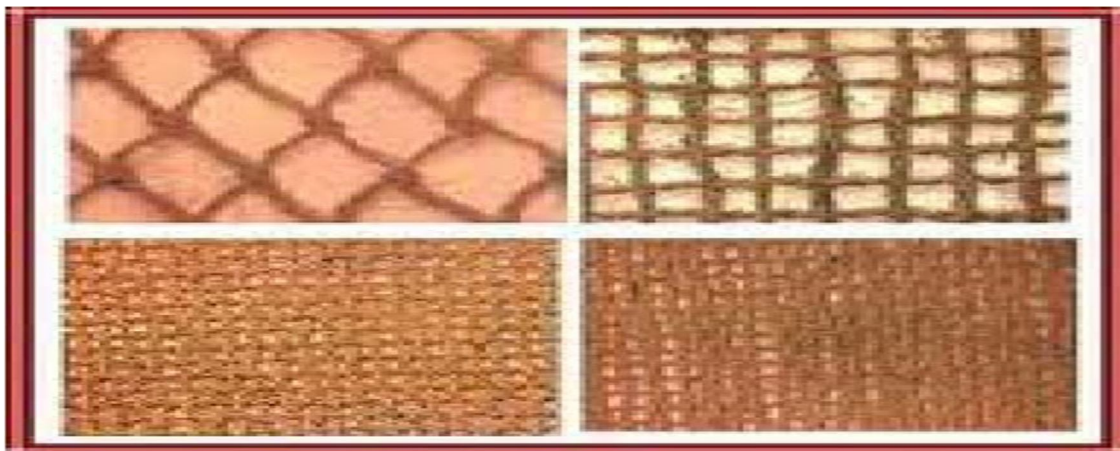


Fig-1. GEOTEXTILE

- 2) *Woven Geotextile*: These cloth-like fabrics are formed by the uniform and regular interweaving of These products have a threads or yarns in two directions as regular visible construction pattern. Woven geotextiles are used for soil separation, reinforcement, filtration, load distribution and drainage.
- 3) *Non-Woven Geotextile*: These products do not have any visible thread pattern. Non- woven geotextiles are used for soil stabilization, load distribution, separation, and drainage but not for soil reinforcement such as in retaining walls. Non-Woven Geotextile have a relatively high strain and stretch considerably under load (about50%).



Fig-2. Roadbed Reinforcement and Protection

B. Geogrid

- 1) Geogrid is used to reinforce soils and similar materials. They are commonly used to reinforce retaining walls, as subsoils well as subbases or below roads or structures. Soils pull apart under tension. Compared to soil, geogrids are strong in tension.
- 2) Geogrids are formed by regular network of tensile elements with sufficient size to allow interlock with the surrounding fill materials. Geogrids primary purpose of geogrids Reinforcement.
- 3) Manufactured Geogrids can be in three ways: extrusion, knitting or weaving, and welding. The geogrids also called integral geogrids are manufactured with integral junctions by extruding and orienting polymeric.
- 4) Geogrids may also be manufactured of multifilament polyester yarns, joined at the crossover points by knitting or weaving processes and then encased with a polymer coating. Welded geogrids are manufactured by over points.



Fig-3.Geogride

C. Geocell

- 1) Whereas geotextiles and geogrids are shown in Figure below. Geocell are typically formed from polyethylene sheets. They are meant to contain soil, gravel or other fill material within their maze of cells or pockets to allow water movement. They are used on slopes with soft and may be porous subgrades and in erosion control in channels.
- 2) Geocell used over top of a geotextile or geogrid. While they come in compact bundles when collapsed, they typically cover an area 2 when expanded.

D. Geonets

- 1) The geonet is a geosynthetic material similar in structure to a geogrid consisting of integrally connected parallel sets of ribs overlying similar sets at various angles for in-plane drainage of liquids. The geonet is material similar in structure to a geogrid, consisting of integrally connected parallel sets of ribs overlying similar sets at various angles for in-plane drainage of liquids.

E. Geocomposites

- 1) Geocomposites are geotextile filters surrounding a geonet. Geocomposites in Some of the functions as blanket drains, edge drains and wick drains panel drains. Blanket drains is used as Leachate, Infiltration collection and removal layers within landfill. Edge drains are generally used adjacent to pavement structures which helps collect and remove lateral seepage from the road base.

F. Geomembranes

- 1) They are impervious thin sheets of rubber or plastic material primarily are used for linings and covers of liquid. Thus the primary function is always as a liquid or vapor barrier.
- 2) Geomembranes are relatively impermeable when compared to soils or geotextiles. Geomembranes are divided into two general categories they are - Calendered and Extruded.
- 3) Calendered type materials used are chlorosulphonated polyethylene, polyvinylchloride, chlorinated polyethylene and polypropylene.

G. Geosynthetic Clay Liner

- 1) Geosynthetic clay liner include a thin layer of finely-ground bentonite clay. Geosynthetics clay Liner are manufactured by sandwiching the bentonite within or layering it on geotextiles and/or geomembranes. The bondings of the layers are done with stitching, needling and/or chemical adhesives.

H. Geof foam

- 1) Geof foam is used within soil embankments built over soft, weak soils
- 2) Used under roads, airfield pavements and railway track systems which are subjected to excessive freeze-thaw condition
- 3) Geof foam Used beneath on-grade storage tanks containing cold liquids.

I. Geopipe

- 1) The specific polymer resins that are used in the manufacturing of plastic pipes are high-density polyethylene (HDPE), polyvinyl chloride (PVC), polypropylene (PP), polybutylene (PB), acrylonitrile butadiene styrene (ABS), and cellulose acetate buytrate (CAB)
- 2) Geopipe is a wide variety of civil engineering applications for these products. These include interceptor drains, leachate removal systems, and highway and railway edge drains.

IV. FUNCTIONS OF GEOSYNTHETICS

A. Separation

- 1) They means keeping two layers of soil (with different functions) apart in order to prevent in mixing and thus deterioration of their functions in the structure. We generally see such requirement most frequently in case of transportation flat foundation constructions.

B. Strength

It involves improvement of a total system's strength created by the introduction of a Geosynthetic into a soil. Applications of this function are in reinforced soil walls and ailway steep soil slopes; they can be combined with facings to create vertical retaining walls.

C. Drainage

- 1) Drainage is the function that allows for adequate liquid flow without soil loss, within the plane of the geosynthetic. The applications of Drainage for these different geosynthetics are retaining walls, sport fields, dams, canals, reservoirs.

D. Filtration

- 1) Filtration is the function that allows for adequate liquid flow without soil loss, across the planeof the geotextile. Filtration applications are highway under drain systems, retaining wall drainage, and landfill leachate collection systems

E. Protection

- 1) Geosynthetics can protect from abrasion and perforation.The geosynthetics material geotextile can act as a cushion over geomembrane and prevent or reduce any kind of damage to the geomembrane layer during construction.

F. Containment

- 1) Containment Some geosynthetics material can be used as relatively impermeable barrier to prevent liquids or gases. It can also be used as noise barrier.

G. Erosion Control

- 1) Geosynthetics material can be employed to prevent or reduce erosion of soil due to rainfall and surface water runoff. The use of geosynthetics material to prevent loss of soil particles frome water erosion.

V. METHODOLOGY

A. CBR Test With Soil

CBR tests of soil are carried out in a standard CBR mould as per IS: 2720 (Part XVI)—1979.

Here, specimen is prepared by soil &geogrid with water content of 9 % (OMC). The specimens Are compacted in the mould by heavy compaction rammer.

B. Bearing Ratio Tests Of Soil

Preparation of Test Specimen

- 1) Remoulded Specimen
- 2) Prepare the remoulded specimen for Proctors maximum dry density which C.B.R> is required. Maintain the specimen at OMC or the field moisture as required. The material used should pass 20 mm I.S. sieve but it should be retained on the 4.75 mm I.S. sieve. The specimen Prepare either by dynamic compaction or by Static compaction.

C. Static Compaction

- 1) Take a soil 4.5 to 5.5 kg of and mix thoroughly with the water required.
- 2) Fix the Extension collar & base plate to the mould. Insert the spacer disc over the base.

- 3) Place the filter paper on the top of the spacer disc-Compact the mix soil in the mould using light compaction or heavy compaction. Compact the soil in 3 equal layers for light compaction , each layer being given 55 blows by the 2.6 kg rammer. 5 layers for heavy compaction compact the soil in, 56 blows to each layer by the 4.89 kg rammer.
- 4) The mould Turn upside down & remove the base plate and the displacer disc.
- 5) The mould weight with compacted soil and determine the bulk density and dry density.
- 6) Put filter paper on the top of the compacted soil plate on to it.

D. Static Compaction

- 1) The Calculate the weight of the wet soil at the required water content to give the desired density When occupying the standard specimen volume in the mould from the expression.

$$W = (\text{desired dry density}) \times (1+w) V$$

Where,

W = Weight of the wet soil

w = desired water content

V = Volume of the specimen in the mould.

= 2250 cm³ {mould available in laboratory.}

- a) Take the weight W of the mix soil and place it in the mould.
- b) The Filter paper place and the displacer disc on the top.
- c) Keep the mould assembly in static loading frame and the compact by pressing the displacer disc till the level of disc reaches the top of the mould.
- d) Some time keep the load and then release the load. Remove the displacer disc.
- e) The test may be conducted for unsoaked conditions.
- f) The Put annular weights to produce a surcharge equal to weight of base material and pavement expected in actual construction. Each of the 2.5 kg weight is equivalent to 7 cm construction. A minimum of two weights should be put.

E. Procedure for Penetration Test

- 1) The mould assembly Place with the surcharge weights on the penetration test machine.
- 2) The penetration piston Seat at the center of the specimen with the smallest possible load, but in no case in excess of 4 kg so that full contact of the piston on the sample is established.
- 3) The stress and strain dial gauge Set to read zero. After apply the load on the piston so that the penetration rate is about 1.25 mm/min.
- 4) Penetration piston Seat at the center of the specimen with the smallest possible load, but in no case in excess of 4 kg so that full contact of the piston on the sample is established.
- 5) Dial gauge set the stress and strain to read zero.
- 6) Load readings Record at penetrations of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10 mm. Note the maximum load & corresponding penetration if it occurs for a penetration less than 12.5 mm.
- 7) Detach the mould from the loading equipment. Top 3 cm layer Take about 20 to 50 g of soil from the and determine the moisture content.

F. Interpretation and Recording

C.B.R. of specimen at 2.5 mm penetration

C.B.R. of specimen at 5.0 mm penetration

- 1) The C.B.R. values are usually calculated for penetration of 2.5 mm and 5 mm. Generally the C.B.R. value at 2.5 mm will be greater that at 5 mm and in such a case/the former shall be taken as C.B.R. for design purpose.
- 2) If C.B.R. for 5 mm exceeds that for 2.5 mm, the test should be repeated. If identical results follow, the C.B.R.
- 3) Provinding ring factor : 1.051

$$\text{C.B.R.} = (\text{PT/PS}) \times 100$$

Where,

PT=Corrected unit test load corresponding to the chosen penetration from load penetration curve

PS = Standard load for the same penetration taken from the table above.

Table: Penetration Data

Extensometer /Dial Gauge	P.R Reading	(DIVISION X FACTOR =LOAD)	Kg
0	00	00	00
0.5	5	5 x 1.051	5.255
1	6	6 x 1.051	6.306
1.5	35	35 x 1.051	36.785
2	62.5	62.5 x 1.051	65.688
2.5	73	73 x 1.051	76.723
3	80	80 x 1.051	84.08
4	90	90 x 1.051	94.59
5	98	98 x 1.051	102.998
7.5	115	115 x 1.051	120.865
10	126	126 x 1.051	132.426

CBR value 2.5 mm penetration = (Test load/Standard load) x 100
 = (PT/PS) x 100 = (73/1370) x 100 = 5.32 %

CBR value 5.0 mm penetration = (Test load/Standard load) x 100
 = (PT/PS) x 100 = (98/2055) x 100 = 4.76

G. Bearing Ratio Tests With Soil

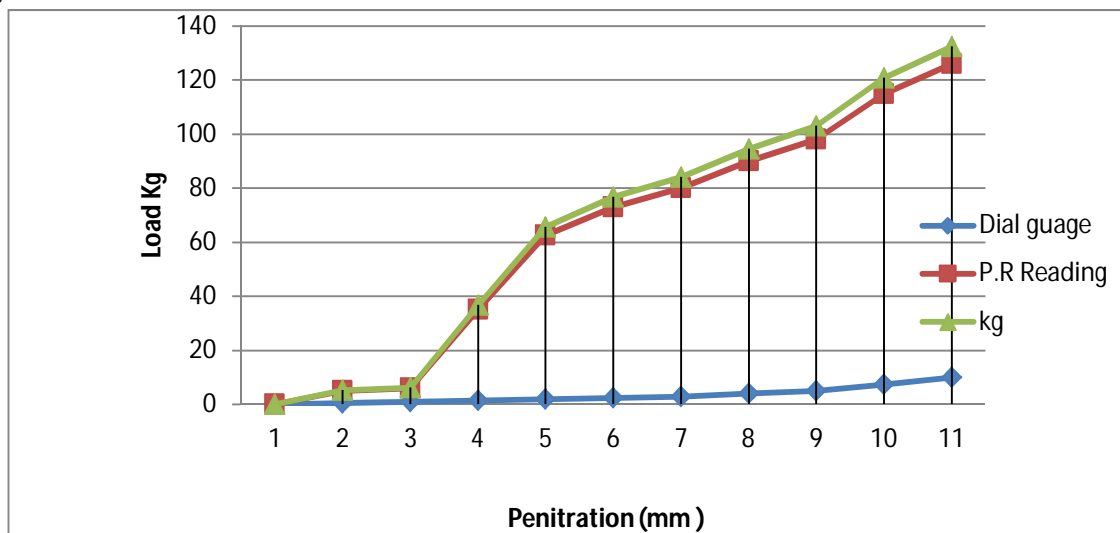


Fig-4: Bearing Ratio Test With Geogride

H. Test Procedure

- 1) Take sample of 5 kg soil.
- 2) Place the filter paper at the bottom of specimen.
- 3) Placing soil layer and then after place geogrid soil specimen.
- 4) Provide proper compaction to each layer of soil before placing of geogrids.
- 5) Provide proper compaction to each layer of soil before placing of geogrids.
- 6) Then specimen placed in CBR equipment.
- 7) Take plunger and touch it to the top of seating load with slotted weight.
- 8) Then fix a proving ring and dial gauge at 0o position.
- 9) Start CBR equipment and apply load.



Fig-5.Placing Geogride

- a) Note down the reading of proving ring and dial gauge at 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, and 10 mm.
- b) Plot the chart of LOAD vs. PENETRATION data.

TABLE : 2 Soil with Geogride

SR NO.	Dial GAUGE	PENETRATION	(DIVISION X FACTOR= LOAD)	LOAD (Kg)
1	0	0	00	0
2	0.5	25	25 x 1.051	26.27
3	1	47	47 x 1.051	49.39
4	1.5	69	69 x 1.051	72.51
5	2	86	86 x 1.051	90.38
6	2.5	107.5	107.5 x 1.051	112.98
7	3	121	121 x 1.051	127.17
8	4	152.5	152 x 1.051	160.27
9	5	197	197 x 1.051	207.17
10	7.5	224	224 x 1.051	235.42
11	10	240	240 x 1.051	252.24

Proving ring calibration factor = 1.051 kg`

CBR value 2.5 mm penetration = (Test load/Standard load) x 100
 = (PT/PS) x 100 = (107.5/1370) x 100 = 7.84 %

CBR value 5.0 mm penetration = (Test load/Standard load) x 100
 = (PT/PS) x 100 = (197/2055) x 100 = 9.60 %

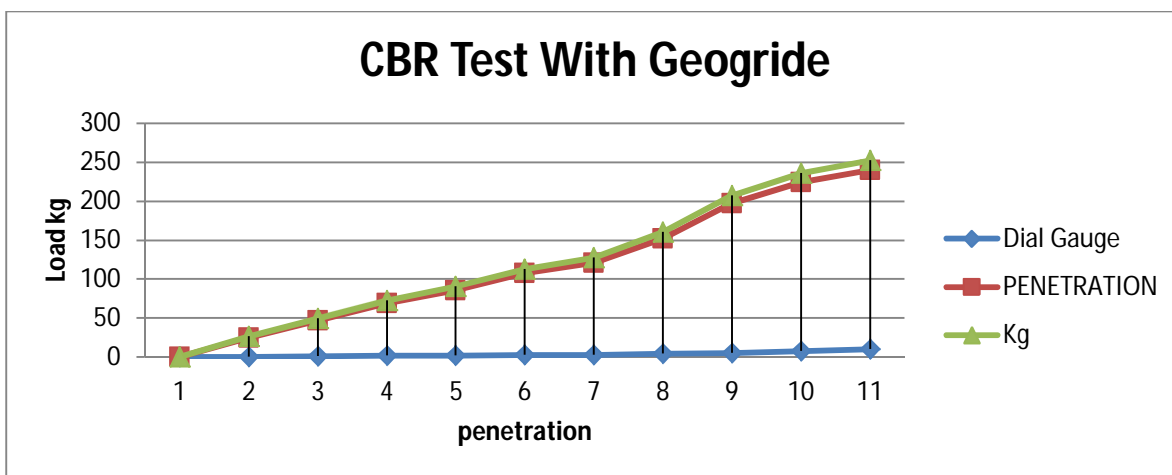


Fig-6.CBR TEST WITH GEOGRIDE

Table : 3 .COMPARISON

MOLDING WATER CONTENT OF SOIL 9 % (OMC)	CBR (%) AT PENETRATION OF	
	2.5MM	5.0MM
SOIL	5.32	4.76
GEOGRID	7.84	9.60

VI. CONCLUSION

- A. Geosynthetics have great potential to be used as cost-effective solutions for several engineering problems.
- B. This paper presented recent advances in geosynthetic products, on the utilization of these Materials in reinforced soil structures and in environmental applications.
- C. Manufacturing of geosynthetics products allows incorporating recent advances in material Sciences. From test performed it is clearly evident that increasing the percentage of CBR and load Bearing capacity of soil.
- D. Physical and strength characteristics of the soil are improved. Test show that placing the layer of GEOGRID at top, middle and intermediate of soil sample gives the most effective results.
- E. From the test the shear capacity, dry density and CBR increased while permeability and penetration decreased on introduction of geogrid.
- F. The stress-strain behaviour of sub-grade soils under static load condition improved Considerably when geogrid was provided at optimum position.
- G. From this paper, we conclude that the use of geosynthetic materials increases the service life Of a road way and can be cost effective in terms of long term performance. The use of geosynthetics also helps in Strengthening of soil slopes.

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