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RESEARCH ARTICLE

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APPLICATIONS OF GEOSYNTHETICS IN ROADS AT WATER LOGGING AREA

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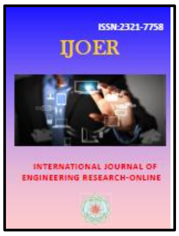

ABSTRACT

This study was primarily concerned with the use of geotextile, a geosynthetic membrane to strengthen the foundation of a flexible pavement. Three soil samples were collected from FUTA environs and all of the samples underwent primary soil tests such as natural moisture content, sieve analysis, compaction and California bearing ratio (CBR) test to determine the geotechnical properties of the samples. In carrying out the project, a flexible pavement model using tested soil samples was constructed with the geotextile material incorporated. The slope of the model was 4% to serve as camber and for proper drainage. From the pavement model test, the average moisture content of the three soil samples used as sub-grades in the model with geotextile were 29%, 21% and 20.% for samples labelled A, B and C. A control sample of A without geotextile in the pavement model had a moisture content of 29% after being exposed to same external weather conditions of rainfall and sunshine for 8 weeks. These moisture content results were compared with the natural moisture content values of the samples. It was found that the 3 soil samples with geotextile had lower moisture content and the sub-bases were properly separated from their respective sub-grades, as opposed to sample A without the geotextile material. Geotextile material design and selection should be based on sound engineering principles as they will serve the long-term interest of both user and industry. The use of geotextiles should be incorporated into the construction of roads as they are economical in reducing the stress of 'borrowing to fill', enhance strength of the sub-grade and increase service life of the roadway.

INTRODUCTION

Geosynthetics have been defined by the American Society for Testing and Materials (ASTM) Committee D35 on geosynthetics 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 Geomembrane is an essentially impermeable membrane in the form of manufactured sheet used widely as cut-offs and liners. They are often used to line landfills.

Geotextiles, as permeable textile materials are used in contact with soil, rock, earth or any other geotechnical related material as an integral part of civil engineering project, structure, or system.

A geogrid is a polymeric structure, unidirectional or bidirectional, in the form of 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.

OBJECTIVES AND SCOPE OF THE PROJECT

Use of existing, state-of-the-practice geosynthetic applications by transportation agencies

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should expand in the new millennium with further implementation of life-cycle economics and mechanistic design practices. The greatest future benefit of geosynthetic materials is likely to be realized in pavement structures. The new millennium is expected to bring definition of the mechanistic contributions of various geosynthetics used within a pavement structure, as well as a clearer valuation of immediate and life-cycle cost and benefits. Furthermore, future pavement design procedures are likely to incorporate geosynthetics for various functions, and perhaps will assume use of geosynthetics for some functions unless clearly eliminated by the design process.

Certainly, new highway applications of geosynthetics will emerge in the future, as will be the different geosynthetic materials and composites. Products may be developed for enhanced economics and performance of existing applications or for new applications. In addition, applications of geosynthetics will be improved as other technologies are refined. Geosynthetics are well suited to achieving better performance with less-select soil. The versatility and usage of geosynthetics will be enhanced as in situ and rapid soil testing procedures are developed, refined, and implemented by transportation agencies.

This work shall be limited to the use of geosynthetics as a soil stabilizer in road construction. It would involve the collection of soil materials and determination of their geotechnical properties both soaked and unsoaked after which the geotextile would be incorporated into the soil sample and their geotechnical properties also determined in both the soaked and unsoaked conditions.

RESEARCH METHODOLOGY

Geotextile filters are used between the soil and drainage or armoring medium. Typical drainage media include natural materials such as gravel and sand, as wellas geosynthetic materials such as geonets and cuspated drainage cores. Armoringmaterial is often riprap or concrete blocks. Often, an armoring system includes asand bedding layer beneath the surface armor. The armoring system can be consideredto act as a "drain" for water seeping from the protected slope.

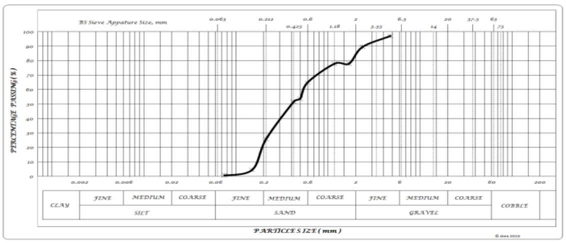
The materials that were used for this investigation are clayey, organic and lateritic soils. For the laboratory tests, three soil samples were collected. Organic soil and clayey soil were gotten from Apatapiti layout, Akure and Laterite gotten from Akure-Lagos Expressway opposite FUTA North Gate. The materials were gotten in polythene to prevent loss of moisture to the atmosphere. Analysis was carried out in order to ascertain the physical and engineering properties of the samples.

RESULTS AND DISCUSSION

For the purpose of identification, classification and determination of engineering characteristics of the materials used, the laboratory tests were performed on the three samples collected. After which the samples were used as test sub-grades in the pavement model.

PARTICLE-SIZE DISTRIBUTION

This test was performed on the natural soils and the results are shown in the appendix. They were used for the classification of the samples.



Graph1: Particle size distribution graph for Sample A

ATTERBERG LIMIT TEST

The Atterberg Limit test was performed on the soil samples. The result for each soil samples are shown in appendix II. The results show that Sample A has a liquid limit 35%, plastic limit17.% and plasticity index 18%%, Sample B has a liquid limit of 38.7%, and plastic limit of 23.4% with plasticity index 15.3% and Sample C has a liquid limit 60.22%, plastic limit 25.9% and plasticity index 34.32%. The graphs of the liquid limit for the respective soil samples are plotted in appendix II.

LIQUID LIMIT OBSERVATIONS:

SAMPLE A:

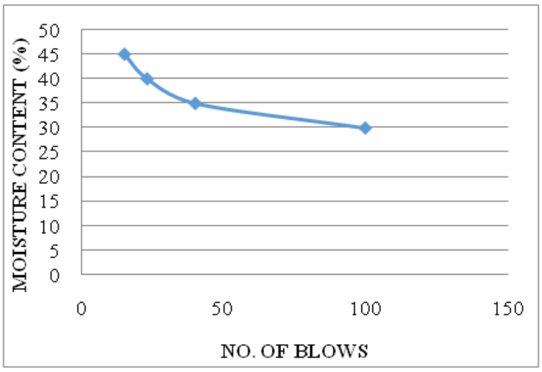
Table 1 Liquid limit observations for sample A

S. No.	Amount of water added (ml)	Moisture content (%)	No. of Blows
1	25	25	100
2	30	30	40
3	34	34	25
4	39	39	15

SAMPLE B:

TABLE 2 : Liquid limit observations for sample B

S. No.	Amount of water added (ml)	Moisture content (%)	No. of Blows
1	30	30	100
2	36	36	40
3	39	39	23
4	44	44	15

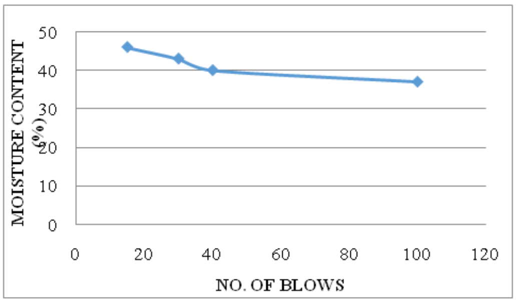


Graph 2: Liquid Limit For Sample B

SAMPLE C:

TABLE 3. Liquid limit observations for sample C

S. No.	Amount of water added (ml)	Moisture content (%)	No. of Blows
1	37	37	100
2	40	40	40
3	43	43	30
4	46	46	15



Graph 3: Liquid limit for sample C

PLASTIC LIMIT OBSERVATIONS:

SAMPLE A:

TABLE 4: Plastic Limit Observations For Sample A

Trail No.	Container No.	Wt. of Container(W_1)	Wt. of wet soil+ Container(W_2)	Wt. of Dry soil + Container(W_3)	Plastic limit =Moisture content (%)
1	28	34	100	87.95	16%

SAMPLE B:

TABLE 5 Plastic Limit Observations For Sample B

Trail No.	Container No.	Wt. of Container(W_1)	Wt. of wet soil+ Container(W_2)	Wt. of Dry soil + Container(W_3)	Plastic limit =Moisture content (%)
1	28	36	100	78.11	21.18%

SAMPLE C:

TABLE 6: Plastic Limit Observations For Sample C

Trail No.	Container No.	Wt. of Container(W_1)	Wt. of wet soil+ Container(W_2)	Wt. of Dry soil + Container(W_3)	Plastic limit =Moisture content (%)
1	28	34	106.9	98.98	11.18

When liquid limit falls between this category below:

L.L < 35 = (L) Low Plasticity

L.L = (35-40) = (I) Intermediate Plasticity

L.L = (50-70) = (H) High Plasticity

This implies that Sample A has intermediate plasticity, Sample B has low plasticity and sample c has high plasticity.

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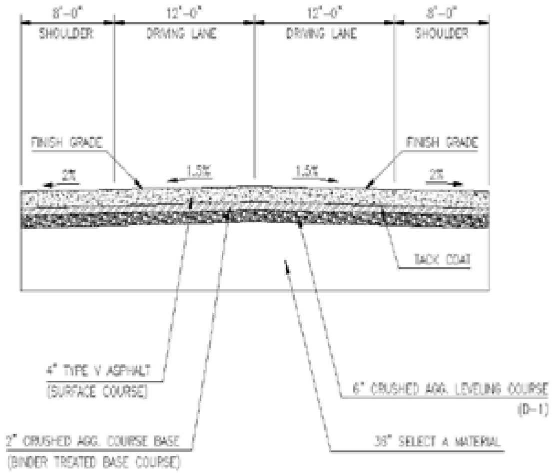

TYPICAL FRONTAGE ROAD CROSS-SECTION

COST ANALYSIS

COST ANALYSIS OF SUBGRADE WITHOUT GEOSYNTHETICS: Let us consider a 4 lane road and its cross sectional dimensions are as follows.

Top width of the pavement=12m

Depth of the pavement=1m

Bottom width of the pavement=14m

Cross sectional area of the pavement =13 m^2

Volume of sub grade for one km= 13*1000=13000 m^3

Bulk density of soil sample = 1660 kg/m^3

Moisture content of soil sample at site=3%

Dry mass density of soil sample = 1770 kg/m^3

Optimum moisture content for soil =17%

Volume of soil that can excavated for filling one cubic meter of soil at sub grade

= 1660/1770=1.06 m^3

Total volume of soil sample required to be filled sub grade for 1 km length

=13000*1.06=13780 m^3

Weight of water that can be available in site = 53 liters

Weight of water required for filling 17% moisture content =300 litres

Amount of water to be added to the soil = 247 litre = 0.247 m^3

Total amount of water required for 1 km length =3403.66 m3

Excavation and transportation Cost of 1 m^3 soil =200 Rupees

Total cost of soil for filling 1 km length = 13780*200 =29, 26,183 Rupees

Transportation cost of 1 m^3water = 50 Rupees.

Total transportation cost of water = 3403.66*50 =1, 70,183 Rupees

TOTAL COST FOR EXCAVATION AND TRANSPORTATION OF SOIL AND WATER FOR FILLING SUBGRADE FOR 1 Km LENGTH = 29, 26,183 Rupees

COST ANALYSIS OF SUBGRADE WITH GEOSYNTHETICS :

When we used geosynthetics in sub grade according to IRC we can reduce 30% by volume.

Here in this case I preferred geo grids for placing in sub grade of pavement.

The cost of geogrid for1 square meter = 60 Rupees

Total quantity of geo grid is required for 1 km length = 12500 m^2

Total cost of geo grids for 1 km length = 12500*60=7, 50000 Rupees

Total volume of soil of soil is required for filling sub grade = 9100 m^3

Volume of soil is to be excavated and transported from the site = 9646 m3

Transportation and excavation cost of soil = 9646*200=19, 29,200 Rupees

Total volume of water to be transported = 2382.56 m3

Cost of transportation of water= 2382.56*50=1, 19,128 Rupees

TOTAL COST FOR EXCAVATION AND TRANSPORTATION OF SOIL AND WATER FOR FILLING SUBGRADE WITH GEOSYNTHETICS FOR 1 Km LENGTH= 27, 98,328 Rupees.

Hence, we can save 27,855 Rupees per k.m..

CONCLUSION AND RECOMMENDATION

CONCLUSIONS:

From the above analysis

- It is evident that first sample without geo textile and second sample with geo textile are poor in the properties like Liquid Limit, plastic limit and also lower dry-density values comparative to third sample with geo textile in more number of layers.
- The C.B.R values of third sample are three times better than remaining two samples.
- The low C.B.R values exhibited by the first and second samples indicates that the subgrade had a weak bearing strength and is susceptible to erosion on exposure to precipitation (or) surface runoff thereby encouraging and

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exerting rutting and deformation of pavement.Hence the third sample is preferred for the subgrade.

- There is a considerable decrease of 30% by volume of soil by replacing with geotextiles in subgrade of soil pavements.Hence the quantity of soil required for laying 4 lane road for 1km is 10902m3 and the total cost of construction without replacement of geotextiles in soil is Rs.29,26,183/- and with replacement is 27, 98,328/-.So we can save approximately Rs. 27,855 per km.
- Not only in the economic point of view, by placing with geotextiles, we can arrest the coarse particles which are trying to be penetrated to greater depth when load is applied on it.
- From the tests we have done on both soil samples, it is of economic benefit to introduce the use of geotextiles in road construction as it reduces the act of "borrowing to fill" when the in-situ soil can easily be enhanced by use of geosynthetics.
- When the Atterberg limit tests were performed on the soil samples, the results show that Sample without geotextile has a liquid limit 35%, plastic limit17.% and plasticity index 18% and sample with geotextile has a liquid limit 60.22%, plastic limit 25.9% and plasticity index 34.32%. Therefore, the soil with geotextiles is more useful for pavements than soil without geotextiles.
- With the usage of geotextiles in soils, the load acting on soil is taken as a distributed load when compared to load acting on soil in normal pavements, which is taken as a point load.
- Geo textiles in soils act as a reinforcement in pavements.

RECOMMENDATIONS

- This project has been able to show the beneficial functions of geotextiles in road construction as sampled on the various soil types.
- From the results, it is quite economical to introduce the use of geosynthetics as a whole into the Engineering industry.
- The material should be used also in effective separation of sub grade and sub-base courses in road construction and other engineering constructions.

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