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Geosynthetics and Their Use in Road and Subgrade: A Review

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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 25.7%, 20.4% and 18.7% for samples labelled A, B and C. A control sample of A without geotextile in the pavement model had a moisture content of 30.6% 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.

Keywords-
Geotextile,Geosynthetics,FlexiblePavement, Compaction , California Bearing Ratio.

I. INTRODUCTION

Geo synthetics 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. Geosynthetics is the term used to describe a range of polymeric products used for Civil Engineering construction works. The term is generally regarded to encompass eight main products categories. They include geotextiles, geogrids, geonets, geomembrane, geosynthetic clay liners, geofoam, geocells and geocomposite. The most popular geosynthetics used are the geotextiles and geomembrane. The ASTM (1994) defines geotextiles as permeable textile materials used in contact with soil, rock, earth or any other geotechnical related material as an integral part of civil engineering 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. A geonet is a polymeric structure in the form of manufactured sheet, consisting of a regular network of integrally connected overlapping ribs, whose openings are usually larger than its constituents. A geocomposite is an assembled polymeric material in the form of manufactured sheet or strips, consisting of atleast, one geosynthetic among the components, used in geotechnical environmental and transportation engineering applications. A geomat is a polymeric structure in the form of manufactured sheet consisting of non-regular networks of fibres, yarns, filament, tapes or other elements which may be thermally or mechanically connected and whose openings are larger than its constituents. A geocell is a polymeric cellular structure consisting of regular open networks of connected strips linked by extrusion or adhesion or other methods Geotextiles have proven to be among the most versatile and cost-effective ground modification materials. Their use has expanded rapidly into nearly all areas of civil, geotechnical, environmental, coastal, and hydraulic engineering.

II. OBJECTIVE

The objective of this study is to extend a Pavement's lifespan, and enables the construction of a pavement with a reduced quantity of base course material without sacrificing pavement performance. We will study the properties of Soil at different layers in a flexible pavement, i.e. subgrade, sub-base & base course. And analyze the behavior of soil with & without geosynthetic material by finding out the CBR values. Also to prove the use of geosynthetic material in flexible pavements helps in enhancing the properties of pavements and provides various characteristics like: filtration, drainage, separation, reinforcement, durability, service life & cost reduction. The soil in which it is to be used is characterized on the basis of tests performed: liquid limit, plastic limit, optimum moisture content, minimum dry density, CBR tests, and specific gravity. Then the material is placed in the sub-grade layer at different heights and is tested to obtain best values of CBR. The combined results are then used to design pavements using design software.

III. LITERATURE REVIEW

[1] MOUNES ET AL. (2011) A guide to the main uses of geosynthetics in pavements. More often than not, pavement systems fell into two broad categories: flexible and solid pavements. Just like other frameworks, these systems are susceptible to suffering of many kinds. In order to minimize pavement erosion, several techniques, such as geosynthetic reinforcement, are applied. In the next analyses, a significant number of papers discuss the use of certain geosynthetics on pavement constructions. The study is designed to share and evaluate the findings from various research on the use of geosynthetics in flexible pavements. Additionally, this research focuses on three important ways geosynthetics are used in the pavement structure: they are referred to as a fluid barrier, strain absorption, and strengthening agent. This research has described the advantages of infusing roadways with geosynthetics. The methods in which geosynthetic materials are employed in pavements to meet many goals, including waterproofing, strain absorption, and reinforcing, were found to be widespread. The waterproofing aspect is affected significantly by the adhesive in the bitumen and seal coat, which impregnate the geosynthetic material. As a strain-absorbing agent, the stiffness of the geosynthetic is less than the stiffness of the surrounding materials, but in the reinforcing function, the stiffness is greater than the stiffness of the surrounding materials. In general, geosynthetics may be employed in AC layer to affect the stiffness, durability, reflective cracking, fatigue, and rutting resistance as well as surface deformation and the application of subgrade stress. It was also said that the properties that impact the behavior of the geosynthetics include the stiffness of the geosynthetics, the area the geosynthetics is applied in, the structural composition of the pavement, and the layer thickness of the pavement structure.

[2] Benmebarek et al. (2015), A numerical technique was used on the embankment in order to enhance its effectiveness in strengthening the locally weakened zones. This article gives a numerical simulation of embankments reinforced with geosynthetics across locally weak zones using PLAXIS algorithm. The case study focuses on restoring the embankment that runs 11 km over Chott El Hodnasabkha soil in Algeria, which traverses an 11 km portion of the road. Throughout the summer, this salt flat is completely dry. However, during the winter, it is covered with water. The soil's characteristics as described in the results and geotechnical investigations include extreme compressibility, low bearing ability, and a modest degree of inclusion. The goal of this document is to analyze how ground strengthening using geosynthetics affects embankment settling in locations with a compromised soil base. The compressibility parameter of the locally weak field, the geosynthetic stiffness, the locally weak morphology of the field, and the angle of friction of embankment fill are all examined to determine their influence on the parameters of interest.

[3] Cantré et al. (2013), Dredged materials and geosynthetics combined in the test dike plant for German Dredgdikes. Researchers are exploring different dredged materials in the South Baltic Sea area in connection to their possible use in constructing dikes with collaborators from Poland and Germany. In Germany, a pair of massive experimental dikes were constructed, while in Poland, two others were created. In reality, an exhaustive research system has been devised, and a rigorous tracking procedure will be put in place. This study describes installation techniques for dredged materials, and details geotechnical characteristics that will be evaluated and controlled in order to manage material quality. Natural water content of the organic soils, their homogenous structure, and the values of the proctor make it difficult to anticipate the compact potential. There were no obvious variations between the three various compaction methods during the installation, and hence on-site efficiency was selected to compress using a caterpillar. The review shows that the roller compactors generally have worse compaction out comes, however there are a few exceptions. On the whole, the compactness of the soil was fairly minor. Also, other methods to enhance compaction, such as simple in situ mixing procedures, would need to be studied further in order to verify their efficacy.

[4] Moayed, et al. (2011), This work seeks to investigate the effects of using geosynthetics on developing the two-layered soil loadsettlement characteristics. While on unpaved roads, the thickness of the subbase sheet has to be determined alongside the function of the geogrid and geotextile. Since bearing ratio tests are employed in so many road construction projects, this test is in current usage. The bearing ratio of two layers of soil was checked: a granular layer (as the subbase layer) at the top, and a thin clayey layer (as the foundation) at the bottom (as the subgrade layer). Three-layer soil was tested under varied conditions, such as nonreinforced and reinforced with geogrid and geotextile, and the results were assessed under varying conditions as well (subbase). To assess the geosynthetic separation effect, the reinforcing factor was placed on the interface between the top granular layer and the clayey layer. The soils were compacted to achieve maximum water quality in both studies (both granular and clayey soil layers). In other words, the graphs were placed on top, and then compared. In fact, this research acknowledges the need of classifying the differences between geogrids and geotextiles in two different layers of soil. Based on the results, the reinforced soil sample exhibited a stronger compressive strength than the unreinforced soil sample. As the thickness of the subbase increases, the geosynthetic inclusion's influence on the foundation reduces. We also noticed that, owing to interlocking with aggregates of the subbase sheet, geogrids had more activity than geotextiles.

[5] Rajagopal et al. (2014), A review of the literature on reinforced geosynthetic road pavement constructions. To explore the effectiveness of geosynthetic materials in a flexible pavement system, field plate load tests and a series of laboratory plate load experiments were conducted. The rise in the modulus of the reinforced section may be seen as an indicator of the pavement's increased strength. This article will document the state of the research, as well as the laboratory and field testing, analysis of the data, and practical use of this data for the design of flexible pavements. Poor quality building materials, insufficient compaction, insufficient preparation of the subgrade, overloading, and so on contribute to the early failure of pavement constructions. In order to increase the pavement's lifespan, two alternatives are offered. One way to increase the thickness of the pavement layers is to use a thicker base layer, and the other way is to use a more rigid sub-base layer. This lowers the stresses which are passed to the underlying layers. Some studies indicate that improving the pavement layers' strength and stiffness may lead to a more efficient approach for reducing pavement stresses, resulting in increased pavement life.

[6] Laurinavičius et al. (2006),geosynthetics are used to enhance the Lithuanian asphalt concrete road pavements, which is then used in research and assessment of such pavements This work is dedicated to describing the primary roles of geosynthetics in asphalt concrete constructions, and it also presents findings from research into asphalt concrete pavements that are reinforced with geosynthetics. The current study is investigating the influence of geosynthetics as well. The findings of the study have uncovered the reological parameters (defined in relation to geosynthetics) whose values are directly linked to geosynthetics. Income/expenditure calculations use regressive equations to predict the depth of ruts. These equations use elasticity modulus and asphalt concrete viscosity as input. According to the results of the statistical investigation, the equations are correct. These results apply to the overall quality of the geosynthetics that are employed in asphalt concrete pavement applications. Geosynthetics has been discovered to be closely linked to rutting development throughout the hot season. Two geosynthetic-influenced properties of asphalt concrete have been discovered to exist. During various seasons of the year, this impacts the size of strains.

[7] Zornberg, et al. (2010), North American contributions in pavements. Flexible pavement systems have long been reinforced using geosynthetics. Despite the strong data demonstrating the beneficial role of geosynthetic reinforcements in road construction, it remains unknown how these reinforcements act in various environments and processes. For the most part, it has been challenging to determine the appropriate design parameters for geosynthetics due to the difficulties in determining the respective performance enhancing features. Informed research has been done with the aim of determining the regulating processes and relevant characteristics of geosynthetics.

IV. CONCLUSION

From the above analysis taken on both soil sample and material it is of economic benefit tontroduce 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 geosynthetic 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.

Geotextiles are effective tools in the hands of the civil engineer that have proved to solve a myriad of geotechnical problems. With the availability of variety of products with differing characteristics, the design engineer needs to be aware of not only the application possibilities but also more specifically the reason why he is using the geotextile and the governing geotextile functional properties to satisfy these functions. Design and selection of geotextiles based on sound engineering principles will serve the long-term interest of both the user and the industry.

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