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Performance Evaluation of Geosynthetics Geotextile Based Pavement Using CBR Test

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Abstract- Two design methods were used to quantify the improvements of using geotextiles in pavements. In this study, a comprehensive life cycle cost analysis framework was developed and used to quantify the initial and the future cost of 25 representative low volume road design alternatives. A 50 year analysis cycle was used to compute the cost-effectiveness ratio when geotextiled is used for the design methods. The effects of three flexible pavement design parameters were evaluated; and their impact on the CBR results was investigated.

Keywords- LCCA, AASHTO, Pavement Material.

I. INTRODUCTION

Use of Geo Textile has become one of the most significant practices in pavement design and construction nowadays. It has already proved to be beneficial in almost all conditions except a few. Pavement with each and every variation of traffic volume has to face problems like depression on surface, cracks, unstable sub base, drainage and seepage etc depending upon various factors such as soil properties, sub base properties etc. In this paper Geo textile of woven type has been used at various depths in the CBR mould and thus CBR values have been recorded which varied accordingly [1].

Geosynthetics are an established family of geomaterials used in a wide variety of civil engineering applications. Many polymers (plastics) common to everyday life are found in geosynthetics. The most common are polyolefins and polyester; although rubber, fiberglass, and natural materials are sometimes used. Geosynthetics may be used to function as a separator, filter, planar drain, reinforcement, cushion/protection, and/or as a liquid and gas barrier. The various types of geosynthetics available, along with their specific applications, are discussed in subsequent sections [2, 3, and 4].

II. INDIAN SCENARIO

The economic development of a country is closely related to its road transport infrastructure facilities available. Especially in an under developing country, the rural roads connecting agricultural villages is vital in improving the rural economy [5].

It is known that the option of unpaved roads are economical for low traffic volume in such areas, however, when unpaved roads laid on soft sub-grade undergoes large deformations, where the periodical maintenance of the rural road is limited due to cost considerations, which may disrupt the service and affect the function of the road. In such situations, comparing various other methods, geosynthetics can be utilized to improve not only the performance of the unpaved road by increasing the life time, but also, minimizing the maintenance cost as well as reducing the thickness of the road.

India has one of the largest road networks in the world, aggregating to about 33 lakh km at present. However many of the existing roads are becoming structurally inadequate because of the rapid growth in traffic volume and axle loading. At locations with adequate subgrade bearing capacity/CBR value, a layer of suitable granular material can improve the bearing capacity to carry the expected traffic load. But at sites with CBR less than 2% problems of shear failure and excessive rutting are often encountered.

The ground improvement alternatives such as excavation and replacement of unsuitable material, deep compaction, chemical stabilization, pre loading and polymeric geo synthetics etcare often used at such sites. The cost of these processes as well as virgin material involved is usually high and as such they are yet to be commonly used in developing nations like India. In this context natural fiber products hold promise for rural road construction over soft clay [6,7].

III. GEOTEXTILE CHARACTERISTICS

Textiles were first applied to roadways in the days of the Pharaohs. Even they struggled with unstable soils which rutted or washed away. They found that natural fibers, fabrics, or vegetation improved road quality when mixed with soils, particularly unstable soils. The first use of textiles in American roadways was in the 1920s. The state of South Carolina used a cotton textile to reinforce the underlying materials in a road with poor quality soils. Evaluation several years later found that the textile was still in good workable condition. When synthetic fibers become more available in the 1960s, textiles were considered more seriously for roadway construction and maintenance. During the past thirty years, geotextiles have been known to be good for improving the performance of paved or unpaved roads.

Both woven and nonwoven geotextiles can be effectively used in the separation/stabilization of primary highway, secondary or low volume roads, unpaved and paved (access roads, forest roads, haul) roads, parking lots, and industrial yards [8, 9].

Geotextiles are polymer fabrics used in the construction of roads, drains, harb our works, and break waters, and for land reclamation and many other civil engineering purposes. Geotextiles, a newly emerging field in the civil engineering and other fields, offer great potential in varied areas of applications globally.

Woven geotextiles: Consist of monofilament, multifilament, slit-film and/or fibrillated slit-film yarns - often in combinations - that are woven into a geotextile on conventional textile weaving machinery using a wide variety of traditional, as well as proprietary, weaving patterns. The variations are many and most have a direct influence on the physical, mechanical and hydraulic properties of the fabric. The resulting woven geotextiles are typically flexible, exhibit high strength, high modulus, low elongation, and their openings are usually direct and predictable [10, 11].

Fig 1. Woven geotextiles.

Following are the major characteristics of geotextiles considerable to this project:

- **Physical Properties:**
  Specific Gravity, density, thickness stiffness etc.
- **Mechanical Properties:**
  Tensile strength, flexibility, compatibility, tearing strength, bursting strength, puncturing strength etc.
- **Endurance Properties:**
  Elongation, abrasion resistance, clogging length, and flow etc.

IV. FUNCTIONS OF GEOTEXTILE IN PAVEMENT CONSTRUCTION AND DESIGN

1. **Reinforcement:**
   Strengthening of soil slopes, RE Wall for bridges approach, Construction on soft soil, Reinforcing pavement layers are some major uses of Geotextile.
2. **Drainage:**
   This is an important function of Geotextile by virtue of which the drain off in rainy season becomes easy
3. **Separation:**
   Partitioning between two adjacent layers but of different materials to prevent intermixing.
4. **Filtration:**
   Geotextile is also suitable for the process of filtration which is required for stability of the pavement

V. LITERATURE REVIEW

J.G. Zorn Berg (2014): In this study, he has conducted the several comparative studies of geosynthetics in geotechnical projects. It updates the information provided by Zornberg (2012). For each type of geotechnical project, the following aspects are discussed: (i) some difficulties in their design, (ii) a creative approach to address the difficulties using geosynthetics, and (iii) a recent project illustrating the creative use of geosynthetics.

Specifically, this paper addresses the creative use of geosynthetics in the design of earth dams, resistive barriers, unsaturated barriers, veneer slopes, coastal protection systems, foundations, bridge abutments, retaining walls, embankments, and pavements. Pardeep Singh, K.S.Gill (2012)

Mayura M. Yeole, Twinkal P.Thakur, Yogita Gaurav, Yash Agarwal (2018): They discussed the paper discusses the problem of the soft soil and solution to overcome it. The use of geotextile as a reinforcement in soil in the emphasizing point of research which is been reflected into the paper. The test California bearing ratio been performed to check the behaviors of soil when induced/combined with geotextile.

They performed Modified Proctor Teston to the soil with and without geotextile for the reading of the OMC and MDD which are 14.35% for pure soil and 11.38 % for the soil with geotextile. Thus the reading obtained are been used in finalizing the CBR test methodology. The test that where performed where for soaked condition that has been taken at different depth with different layer of the geotextile material.

Taylor M. Goldman (2011): He did research for three-year, project aimed at determining the benefits of using geosynthetic reinforcements to improve the performance of flexible pavements constructed over poor subgrade soils. The test site, known as the Marked Tree site, is an 850-ft (258-m) long segment of low-volume frontage road along Highway63 in the town of Marked Tree, Arkansas.

The site, constructed in 2005, consists of seventeen 50-ft (15.2-m) long flexible pavement test sections with various types of geosynthetic reinforcements (woven and nonwoven geotextiles, and geogrids), which were all positioned at the base-subgrade interface, and two different nominal base course thicknesses [6-in (15.2-cm) and 10-in (25.4-cm)].

One section in each nominal base course sector was left unreinforced to allow for monitoring of the relative performance between reinforced and unreinforced sections of like basal thicknesses. The different sections were evaluated in this study using deflection-based, surficial testing conducted between 2008 and 2011, as well as subsurface forensic investigations conducted in October 2010. Signs of serious pavement dstress appeared in some of the test sections in the spring of 2010.

Distress surveys revealed that all of the failed sections [defined herein as sections with average rut depths > 0.5 in (1.3 cm)] had nominal base thicknesses of 6-in (15.2-cm) and were reinforced with various geosynthetics. None of the sections with 10-in (25.4- cm) nominal base thicknesses had failed despite receiving more than twice the number of ESALs as the 6-in (15.2-cm) sections.

VI. TYPES OF GEOTEXTILES

Geo-goods are an absorptive fabricated object understands goods texts. The geo goods' are farther adapted in tern ion extraordinary categories – interwoven fabrics, non-wreathed fabrics and purled fabrics.

1. Woven Fabrics:
Large numbers of geo-work in with wreathed type, whichever mayhap carve into specific categories stationed upon their scheme of creating. As their name implies, they are mass-produced by adopting techniques that simulate weaving expected sportswear textiles. This type has the peculiarity presentation of two sets of parallel gear or yarnsthe yarn goes the piece is selected warp and the one standing is chosen weft.

The manhood of low to music concentration interlaced geo fruit are created from polypropylene whichever mayhap in the form of extruded tape, silt film, monofilament or multifilament. Often a consolidation of yarn types is used in the warp and weft directions to revise the performance/cost. Higher permeability is obtained with monofilament and multifilament than with flat plan only.

2. Non-Woven:
Non wreathed geo-fruit perhaps mass-produced from each of two small principal fibber or continued tendril yarn. The fibbers mayhap refreshby adopting thermal, actinic or unchanging techniques or a sequence of techniques. The type of fibber (principal or unbroken) used has very rarely acted on the properties of the known – interlinked geo fruit. Non-interlaced geotextiles are fabricated about a deal with of automatic interlocking or synthetic or thermal bonding of fibbers/threads.

Thermally fettered non-intertwined consist of the wide area of opportunity sizes and a commonplace width of nearby 0.5-1 mm instant synthesized secured non-interwoven are similarly heavy regularly in the order of 3 mm.

On the separate hand, unchangingly fettered on-interwoven have a quintessential density in the cover of 2-5 mm and also tend afterlife similarly hard in as much as a massive length of polymer wire have to arrange plentiful collection of entangled tendril cruise wires for suitable bonding.

3 Knitted Fabrics:
Knitted geo-synthetics are produced applying that movement whatever is adopted from the clothes textiles labour, i.e. that of knitting. In this deal with interlocking, a course of loops of yarn simultaneously has no choice. An illustration of a crocheted texture is embossed in see. Only a very few webbed types are produced.

All of the sewn geo-synthetics are formed by employing the knitting approach scrupulously another scheme of geo-synthetics creates, in the manner that weaving. Apart from the particular triple main types of geotextiles, separate geo-synthetics used are geo-nets, geo-grids, geo-cells, geomembranes, geo composites, etc. each having its own diverse mug and used for memorable applications.

VII. FLEXIBLE PAVEMENTS

An amenable sidewalk organization is frequently unflappable of special layers of the component with enhancing excellence data proud site the depth of heat from trade loads is high and pare condition texts Firstly locus the heat fervour is low. Flexible tars perchance analyzed as a multilayer system lower packing. A common soft road edifice consists of the face lecture and concealed base and sub-base lectures.

Each of the particular layers forces basic subsidy and bilge. When hot mix bitumen (HMA) is used as the expanse class, it is the strictest (as restrained by volatile modulus) and may contribute divine (hold width) to sidewalk effectiveness.

The elemental layers are less brisk but are though decisive to asphalt vigour yet effluent and dip protection.

VIII. LIFE CYCLE COST ANALYSIS

Life Cycle Cost Analysis perchance routine control the contact in the team dance and cost when geotextiles are consolidated in roads. The assessment of sidewalk appearance is a decisive mediates the wheel of life cost structure.

The strength to foresee the extra life or the agonize levels of a tar branch allows engineers, planners, and avenue agencies to plan before for care and repair activities, allocate for prospect expenditures, and run the show around the gauge of the particular improvement activities.

IX. RESULT AND ANALYSIS

1. California Bearing Ratio (CBR) test:
The test was accordance with AASHTO T-193, ASTM D 1883-05. The Results (CBR) were for a type with use the geotextile and without geotextile (A) and type (B) shown in a table (1)

Table 1. The value of CBR without geotextiles

The data		Added clay (10%)	Added clay (12.6%)	Added clay (14.3%)	Added clay (16.6%)
CBR test type B without geotextile	Soaking	53.9 %	111.7 %	156 %	97.4%
	Un soaking	50.0 %	115.8 %	120 %	134.6 %
The data		Added clay (5%)	Added clay (6.4%)	Added clay (7.3%)	Added clay (8.7%)
CBR test type A without geotextile	Soaking	56 %	52.4 %	58 %	57.5 %
	Un soaking	45.8 %	56.5 %	56.6 %	55.5 %

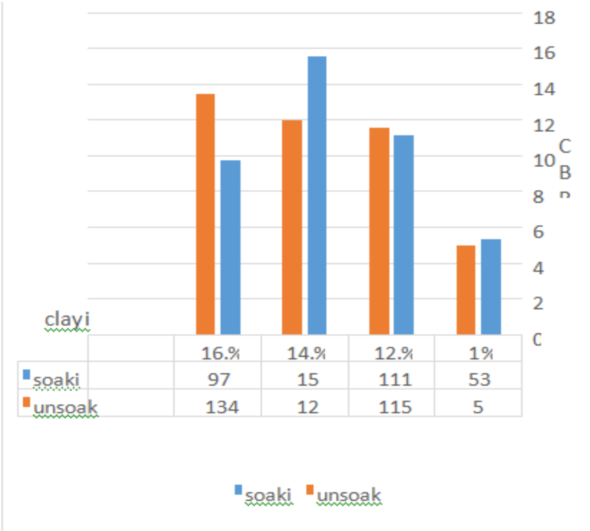

Fig 2. CBR value for RCA type B.

IX. CONCLUSIONS

This study focused on the performance of geotextiles and their effect on the California Bering ratio (CBR) aggregates and soils used in this research and the following was conclude based on the findings of this study:

Clay soils with a liquid limit (39%), plastic limit (24%), shrinkage limit (5%), Plasticity Index (15%) specific weight (2.6) and CBR (54%), and these soils are consider of the type (A -2-6) According to AASHTO soil classification system, the soil is organic silty clay with low plasticity This study is classify as a subgrade layer by the unified soil classification system.

Recycled aggregates were used after conducting the sieve analyses test for it according to the Iraqi standard for roads and bridges of the two types (A, B) for the sub base-layer. The geotextiles used are of the non-woven type (50 pressed) where they were Tensile Strength (50N), Thickness (0.58mm), Puncture strength (275 N), and Permeability (7.19* 10-6).

The sub-base layer that contains a geotextile is stronger, stiffer, and gives more strength than the sub-base layer that does not contain a geotextile; Geotextiles improve recycle aggregate interlock in road infrastructure stabilization through subbase restraint and base reinforcement applications.

In this study, 40% recycled aggregate was used, which represents the sub base layer, and the clay used at 60%, which represents the subgrade layer, with geotextiles placed in different layers it was found that the CBR values are much greater than the standard specifications and thus the thickness of the sub-base layer can be reduced when designing.

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