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Effectiveness of using geo textiles in flexible pavements

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ABSTRACT :

This project is being developed for use in of Virudhunagar District. It is around 20Kms in length. The sub grade must be stable, unyielding, properly drained and free from volume changes due to variation in moisture. If not, it leads to failure of pavement. Normally, pavement fails due to the reasons such as structural, functional, or materials failure, or a combination of these. But in the study area, it is observed that, the pavement failure is under the category of structural failure. To overcome this failure, it needs to improve the sub grade soil bearing capacity. In this project Synthetic Non-woven geotextiles (GT) were placed at different depth of soil and the improvement in soil bearing capacity are checked by CBR and UCC test. From this study, single layer of GT introduced at the centre (mid depth) shows better performance than those samples with the GT layer at other depth. Indian Geotechnical Conference – 2010, GEOtrendz December 16–18, 2010 IGS Mumbai Chapter & IIT Bombay

1. INTRODUCTION :

In Sivakasi-Sattur State Highway-187 (SH-187), the sub grade consists of High Plasticity Inorganic Clay (CH). Because of its high swelling and shrinkage characteristics, the soil has been a challenge to the highway engineers. The soil is very hard when dry, but loses its strength completely when in wet condition. Due to the alternate wetting and drying process, vertical movement takes place in the soil mass. All these movements lead to failure of pavement, in the form of settlement, heavy depression, cracking and unevenness. To overcome these effects there are various methods are available to enhance the performance of road such as chemical stabilization, compaction, and replacement of sub grade and soil reinforcement. Soil reinforcement is a technique in which we introduce reinforcing membranes between the soils. Synthetic Geotextiles are the textile like material, either woven or non-woven, manufactured from either polyester or polypropylene. Polypropylene filaments and staple fibers are used in manufacturing nonwoven geotextiles. These have the functions of separation, soil reinforcement and stabilization. Synthetic Geo textiles are introduced between the subgrade for two aspects. One is to improve bearing capacity and another is to improve drainage efficiency. On these aspects, the common perception is that the fabric reinforcement has to stay on or in soil during the entire period of the expected life of the structure and also separate various grades of soil. Under extraneous loads, both the pore water and the top layer of the soil are forced out of their positions. Khalid et al. (2004) discussed that the overview of the current geotextile technologies and highlights the functions geotextiles perform in enhancing the performance and extending the service life of paved roads. Three key application areas of geotextiles, construction of pavements, in asphalt concrete overlays and for drainage systems along with impetus on the current design methodologies available in geotextile design and selection are addressed. Cleveland et al. (2002) observed that the primary objective of this research project was to evaluate geotextiles placed under or within hot mix asphalt (HMA) overlay to reduce the severity or delay the appearance of reflection cracks. Richardson et al. (1998) focus on a review of the design of geocomposite drainage layers to satisfy these design considerations and demonstrate how geocomposite drains can be designed to control these stresses to ensure stability. Kathleen et al. report evaluates the effects of subsurface drainage features on pavement performance through a program of inspection and testing of the subsurface drainage features present in the Long-Term Pavement Performance (LTPP) SPS-1 and SPS-2 field sections. The report will be of particular interest to engineers in the public and private sectors with responsibility for the design, construction, and rehabilitation of highway pavements. Basheer (2009) assist pavement design engineers in the selection of an appropriate subgrade Enhancement Geotextile (SEG), formerly called Subgrade Enhancement Fabric (SEF), and in determining the functions it is expected to provide for improving the overall performance of flexible and rigid pavement sections. Sanyal discussed Jute-based geosynthetics is finding increasing acceptability among geotechnical engineers primarily because of its ecoconcordance, facility of production of tailor-made fabrics and price competitiveness. The paper also discusses the mechanism of erosion control on surface and in the riverbanks followed by a case study in a river in West Bengal. In another case study on strengthening of sub-grade in a road also in West Bengal, the mechanism of functioning of Jute Geotextile has been discussed. Both the case studies confirm suitability of Jute Geotextile in such applications. Guyer (2009) covered the physical properties, functions, design methods, design details and construction procedures for Geotextiles as used in pavements and drainage applications. Geotextile functions described include pavements, filtration and drainage. Yang (2006) used two design methods to quantify the improvements of using Geotextiles in pavements. One was developed at Virginia Tech by Al-Qadi in 1997, and the other was developed at Montana State University by Perkins in 2001. 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 Geotextiles is used for the design methods. The effects of three flexible pavement design parameters were evaluated; and their impact on the results was investigated. Button (1989) investigated about Geotextiles (engineering fabrics) and they were installed at four locations in Texas to evaluate their potential as costeffective measures to reduce or delay reflection cracking in asphalt concrete overlays. Test pavements were 0.25 mile long with the fabric installed edge to edge and results, based solely on these test pavements, indicate that geotextiles are not cost-effective methods in addressing reflective cracking. Recommendations are made to maximize the probability of success when geotextiles are installed to reduce or delay reflective cracking. Bushey (1976) concluded that all reflection cracks are greater than ¼ inch wide in hot mix asphalt overlays. Here an attempt is made to use Non woven Geotextiles as reinforcing membranes to improve the performance of sub grade and the improvement in soil bearing capacity are checked by CBR and UCC test. The problems in the SH-187 were identified by sight observation and the discussion with official staff member. The problems identified are,

1. Rutting - Longitudinal cracks formed under the wheel loading area. Settlement of sub grade due to the continuous loading under the wheels than other area of road cause rutting.

2. Pot holes - Commonly elliptical holes in the road. These are the developed stage of rutting.

3. Reflective cracking - These are the cracks formed due to the new overlay's movement which was laid on the old road. Small thickness of new overlays with Dense Bituminous Macadam causes the reflective cracking.

4. Due to the damages in the road the total travelling time will be increased. Large size pot holes leads to the damage of vehicle parts like tyre abrasion.

With the tensile strength of the fabric, the soil layer remains in position. In order to show the performance of Geotextiles in the sub grade soil we conduct California Bearing Ratio (CBR) test and Unconfined Compression (UCC) test at various depths. We note down the improvement in both two values of sub grade soil with Geotextiles. Our objective is to improve the sub grade bearing capacity and to reduce the pavement thickness with increased CBR values.

2. **EXPERIMENTAL PROGRAM** :Study Area The study area is Sivakasi-Sattur state highway-187. The distance between Sivakasi and Sattur is about 17 km. After 14 km from Sivakasi SH-187 joins with NH-7 (MaduraiKanyakumari National Highway). Remaining 3 km are in the NH-7. This project was developed for SH-187 of 14 km length. In this first 6 km are in the Sivakasi divisional highway office control and the remaining is in the Sattur divisional highway office control. It contains 13 small size pipe culverts (1.6m), 18 medium size pipe culverts (3.2 m) and two major bridges (20m). Properties of Soil Sample The soil sample is collected from the Sivakasi-Sattur state highway-187 at three places, 1.5 m below the ground level at 4 km interval. By the sight observation it is found that sample contains clayey particles mostly. So that instead of Dry sieve analysis, wet sieve analysis is conducted Non-woven Geotextiles For experimental work the Geotextiles strips were made available from the local manufacturer, Garware Wall-Ropes Ltd., Pune Type of Geotextiles: Multifilament Non Woven. Pore size : less than 75 microns. Bursting strength : 5500 kPa. Type of fiber : Polypropylene Permeability : 31 Lit/ m2 / sec. Trade name : GWF (T) 52 – 240. Weight : 240 gm/ m

3.Experimental Setup Two tests (California Bearing Ratio test, Unconfined Compression test) were carried out to determine the performance of Geo textiles in Sub grade as mentioned earlier.

CBR Test 5 kg of oven dried soil sample was taken of size passing through 4.75mm. Optimum water content was added and sample was prepared to CBR mould by the standard procedure. Soil sample was alone tested to find out the CBR value of existing soil. Then Geotextiles were introduced at different depths of sample. First Geotextiles were placed in single layer at three different depths such that 3cm, 6cm, 9cm respectively from top. Then GT were placed in double layer such that 3cm & 6cm, 3cm & 9cm, 6cm &9cm respectively from top.

UCC Test Soil sample was prepared as in the CBR test and compacted into Proctor mould. Then the test sample was taken out by using sampling tube. Fig 5 and 6 shows the extraction and testing of soil sample. Soil sample was tested initially without GT. Then Geotextiles introduced at various depths as in the CBR test

Pavement Thickness California State Highway Department (CSHD) gives the following recommendations for calculating thickness of pavement for State highway. Load (P) = 4500 Kg. Tyre pressure (p) = 6 Kg/cm2 Thickness of Pavement = {P[(1.75/CBR)-(1/pπ)]}1/2 The pavement thickness was calculated by using above formula for various CBR values.

4.RESULTS AND DISCUSSION From the test results we can see that the CBR value for the actual soil sample is 1.37 which is very less. It requires nearly 75 cm thickness of pavement. When we introduce the Geo textiles at various depths of soil sample the CBR value get increase. Among them single layer of Geo textile at centre shows the better performance. With this the CBR value increases up to 2.42 .So the pavement thickness also reduced by 54 mm. UCC test give the maximum stress upto which the soil can withstand the load without any failure. Beyond that value it will undergoes failure. Soil sample alone gave less value of stress in UCC. But soil sample with Geotextiles gave better stress value. Here also the sample with Geotextile at centre gave higher value among them.

5. CONCLUSION The CBR and UCC value gets varied with the use of Non Woven Geotextile introduced at different depths of soil sample. A single layer of GT introduced at the centre (mid depth) shows better performance than those samples with the GT layer at other depth. When the GT is introduced in the mid depth, the UCC and CBR value of the corresponding sample are 0.484 N/mm2 and 2.42 respectively.

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