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UTILIZATION OF COIR GEOTEXTILE TO OVERCOME THE PAVEMENT RUT AND FATIGUE LIFE

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Abstract: The pavement undergoes premature failure much before their design life due to many reasons. The design of the pavement layers to be laid over sub grade soil starts off with the estimation of sub grade strength and the volume of traffic to be carried. The rutting and fatigue are considered to be the distress parameters in pavement design. The aim of the paper is to determine the stress developed in the pavement is based on the geogrid position of the pavement. In this study a geotextile (coir mesh) layer is added above the subgrade level as a reinforcement layer/separation layer to improve the stress distribution transferring to the subgrade and decrease the surface deformation, fatigue, rutting and cracking in pavement. The aim of this study is to overcome the rut and fatigue life of pavement after placing a geotextile coir layer over the subgrade in the pavement. In this work the ANSYS STRUCTURE SOFTWARE is used to evaluate (pavement strain) the effect of geotextile layer over the subgrade.

Index Terms - *Subgrade strength, rutting, fatigue, pavement strain, ANSYS STRUCTURE*

I. INTRODUCTION

Most of the civil engineering structures involves some type of structural elements that are in direct contact to ground. The process in which soil influence the motion of structure or vice-versa then it is termed as soil structure interaction. Rutting is the deformation in the pavement due to seasonal change and the repetitive loading undergone by the pavement layer. The width and depth of the rut of the pavement widely affect the structural characteristics of the pavement. The geotextile layer (coir) placed above the subgrade improve the stress distribution, rutting and fatigue failure in the pavement. The ANSIS STRUCTURE software is used for the analysis of stress and strain developed in the pavement. It is said to be an empirical method of analysis used for pavement .As per IRC 37(2012) rutting propagates at the subgrade layer and fatigue cracking initiates at the bottom of bitumen layer which are considered as the two important distress in the pavement.

II. LITERATURE REVIEW

Mandal and Sah (1992) the study conducted pertains to the efficiency of horizontal geogrid reinforcement in improving clay subgrades. The maximum percentage reduction in settlement with the use of geogrid reinforcement below compacted saturated clay was reported as 45% and it occurs at a distance of one fourth of the width of foundation from its base.

Refeai et al.,(2001) studied about the effect of relative density and moisture content on the resilient behavior of subgrade of soil in Saudi Arabia, different samples were collected and the relative density and moisture content was determined.it is concluded that the density and moisture content is responsible for the stress on the MR behavior.

K K Babu (2007) utilisation of coir geotextiles for unpaved roads and embankments developed the study to explore the possibility of utilizing COIR geotextiles for the construction of unpaved roads and embankments, after studying the functions and mechanism of coir geotextiles as separators, reinforcement, and for filtration / drainage

Ekwulo et al., (2009) have performed the layered elastic analysis of pavements designed using three known CBR methods; the Asphalt Institute, the National Crushed Stone Association and the Nigerian CBR methods were carried out to evaluate their fatigue strain and rutting deformation characteristics. The elastic properties of the materials were determined. It was concluded that flexible pavements designed using the three known CBR methods are prone to failure due rutting deformation and recommended the use of mechanistic procedures in the design of flexible pavements in developing tropical countries. The study was carried out with the layered elastic analysis software EVERSTRESS.

Behiry et al.,(2013) stated that the tensile and compressive strain increase with increase in axle load and decreases with increasing asphalt layer modulus thus the trucks should have weight with in its limit, the base thickness and subgrade resilient modulus were the key elements in the control and provide an equilibrium between the fatigue and rutting life.

Mendoza et al., (2013) studied the California Bearing Ratio with variables including compaction energy, permeability, and the elastic behavior of a material. These variables were evaluated through FEM (Finite Element Method) simulations while several geotechnical parameters known in practical geotechnics were varied. These FEMs were prepared for fine soils and include an elastoplastic model. The evaluation shows that the CBR depends not only on Young's modulus (a parameter commonly correlated with the CBR), but also appears to depend on compressibility due to compaction energy. In addition, the CBR is a function of permeability as indicated by differences found between drained and untrained.

Siang et al.,(2013) discussed bout various resilient behavior of various material with high rigidity, high plasticity and it is considered that the resilientmodulus (Rm) important parameter in the design of flexible and rigid pavement and also it affects the stiffness and flexibility of the material.

Zumrawi (2013) developed an empirical relationship between CBR values and soil index properties of cohesive soils as road subgrade. However;it is always difficult for highway engineers to obtain representative CBR values for design of pavement. Over the years, many correlations had been proposed by various researchers in which the soil index properties were usedto develop these correlations

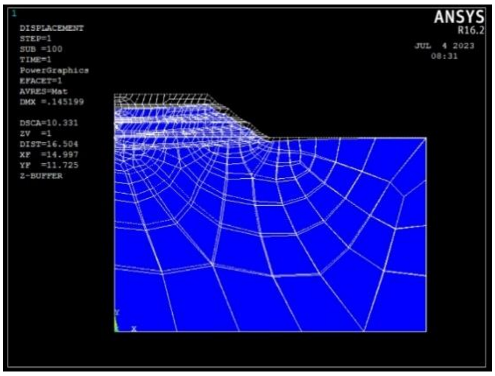
III. EXPERIMENTAL STUDY

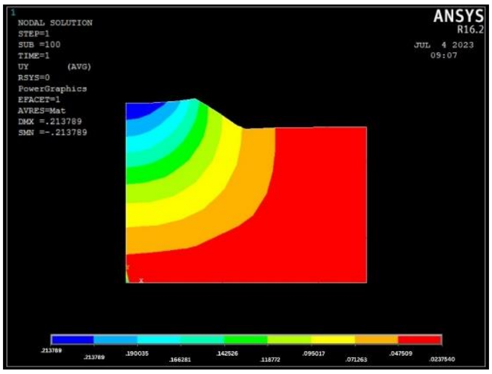
The properties of the soil is considered to play a major role for the investigation study. Red soil mixed with clay is collected from UDUMALPET ,TAMILNADU is taken as sample for the thesis. The properties of soil is determined by conducting experiments. Liquid limit test (IS 2720-PART5 1985),plastic limit test (IS 2720-PART5 1985),plasticity index ,specific gravity (IS2720 PART 3 1980) sieve analysis (is 2720 part 1 1983),modified proctor test(IS2720 PART 71850),california bearing ratio test (IS 2720 PART 16 1979) is conducted to determine the soil character.In this thesis , Geotextile material was placed between base layer and subgrade in an paved structure and it was that reinforcement improved stress distribution transferred to the subgrade, and decreased degradation of base course and surface deformation accumulation. Geotextile layer when used in pavement layer can change the stiffness, durability, reflective cracking, fatigue, and rutting resistance of pavement, as well as surface deformation, and applied stress on subgrade. The subgrade soil mostly yields low CBR value 2-5%. In the CBR method of pavement design (IRC: 37-2012) the total thickness of pavement increases exponentially with a decrease in the CBR value of subgrade soil which in turn increases the cost of construction. So, it has been tried to use the geotextile material for increasing the bearing capacity of the subgrade. Use of geogrid increases the CBR value of the subgrade and thereby reduces the pavement thickness considerably up to 40% .

ANSYS STRUCTURE analysis was carried out on two conditions of pavement, one reinforced and the other unreinforced, with both subjected to an impulsive wheel loading. The significant improvement in pavement behaviour is obtained by placing a geotextile layer at the above the subgrade interface. In fact, the obtained results show that geotextile reinforcement can provide a relevant contribution to the reduction of permanent deformations. In this thesis, the vertical and horizontal movements of particle are analysed and compared the stress distribution between the pavement layer with geotextile and without geotextile layer. When number of geotextile layer is increased to compare the difference in the stress distribution in the pavement layer and it is also analysed using ANSYS for the comparative study and is concluded that when the layer increases above the subgrade the stress is reduced nearly 50%.

IV. RESULTS AND DISCUSSIONS

- Using the ANSYS ver. (5.4) finite element program and the following conclusions can be drawn With the inclusions of reinforcement, the horizontal displacement reduced by about (81%), while the vertical displacement reduced by (32%). This shows that the reinforcement may be considered as important role in reducing horizontal and lateral movements.
- The effect of geotextiles stiffness modulus on horizontal and displacement is quite significant. Higher values of geotextile modulus will have relatively little effect on vertical displacement.
- The maximum displacement occurred at the toe of embankment for both horizontal and vertical movement, then decrease gradually to a negligible value for the layer reinforced case.
- The reinforcement reduces the shear stress developed in the foundation soil by 50%.





Model for geogrid above subgrade in ANSIS

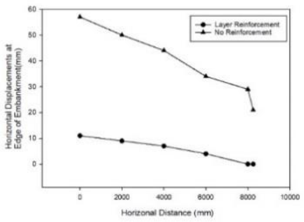


Figure (9): Variation of Horizontal Displacements with Horizontal Direction along Ground Surface.

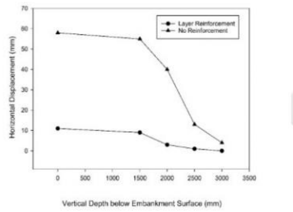


Figure (5): Variation of Horizontal Displacement with Vertical Depth below Embankment Surface.

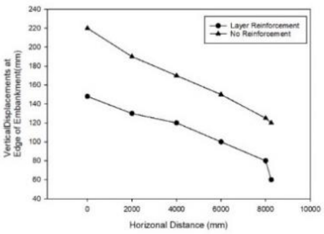


Figure (10): Variation of Vertical Displacements with Horizontal Direction along Ground Surface.

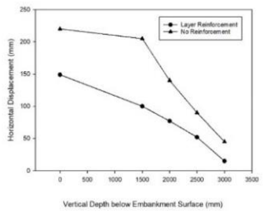


Figure (6): Variation of Vertical Displacement with Vertical Depth below Embankment Surface.

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