BEHAVIOUR OF MODEL PAVEMENTS WITH GEOSYNTHETICS

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DEDICATED

TO

MY PARENTS

CERTIFICATE

This is to certify that the thesis entitled **"BEHAVIOUR OF MODEL PAVEMENTS WITH GEOSYNTHETICS"** submitted by Mr. Anil Dixit to Indian Institute of Technology, Delhi, for the award of the degree of the Doctor of Philosophy is a record of the bonafide research work carried out by him. Mr. Anil Dixit has worked under our supervision for the submission of this thesis, which to our knowledge has reached the requisite standard.

This thesis, or any part thereof has not been submitted to any University or Institution for the award of any degree or diploma.

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ABSTRACT

The relative influence of geosynthetics on the behaviour of unpaved pavements and asphalt concrete overlays is examined in this thesis through a comprehensive laboratory study under static and repetitive loading.

The experimental programme included :

a. Studies of the aspect of retardation of reflection cracking and improvement of asphalt concrete fatigue life by using geogrid in asphalt concrete overlays - **Reflection Crack Retardation** and **Beam Flexure Test Series**.

b. Studies of the behaviour of silt, clay, Water Bound Macadam (WBM) and composite specimens (representing WBM as base and silt/clay as subgrade interface) under static consolidated undrained triaxial compression conditions, with and without geosynthetics inclusion - **Triaxial Test Series**.

c. Studies of the behaviour of two layered model pavement systems with and without geosynthetics inclusion under static and repetitive loading conditions - **Model Test Series**.

Following is the broad summary of the conclusions arrived at.

Based on the experimental studies in the asphalt concrete beams, the improved behaviour of geosynthetic reinforced asphalt concrete beams confirms the tremendous potential benefits of the reinforcement. It was observed that the initiation of micro-cracking started in all the unreinforced beams within the range of 135 to 145 cycles, when the beams were subjected to repetitive loading of frequency of 0.87 Hz. In the case of unreinforced beams wide and distinct cracks occurred in the stressed zone of both the faces of beam very early. The crack reached a height of 4.5 cm at only 1500 cycles. While in reinforced beams, micro-cracks appeared in the range of 250-370 cycles. The cracks were deflected towards right side after reaching the lower interface of geogrid and asphalt concrete and further continuation of load cycles beyond 1500 numbers did not lead to any change in crack growth. Failure pattern in the reinforced beams was of ductile nature while unreinforced beams showed brittle failure. The peak load in all the cases did not change significantly. However, geogrid inclusions did result in an indefinite delay in appearance of cracks at the surface and also in improvement in fatigue life. The most effective position of the placement of reinforcement was observed at the mid-depth of the beam.

From the Triaxial Test Series results it is brought out that the stress-strain behaviour of Delhi silt, kaolinite clay and WBM specimens was generally of ductile nature. The stress-strain behaviour of unreinforced composite specimens (WBM + Delhi silt/kaolinite clay) is not much different from that of Delhi silt/kaolinite clay indicating that the failure is mainly influenced by the latter. However, the strength of the composite specimens (WBM + Delhi silt/kaolinite clay) with non-woven geotextile (GTNW) is significantly higher (1.6 times for WBM + Delhi silt and 1.1 times for WBM + kaolinite clay at an axial strain of 7.5 percent and 10 percent respectively) than without GTNW, demonstrating that the structural contribution of WBM portion is enhanced due to the persence of the reinforcement. The shear strength parameters values are also increased due to the reinforcement in both types of composite specimens.

From the test results of Static Compression tests, in the model test series it is evident that the bearing capacity of reinforced model is increased significantly by the inclusions of geosynthetics. The failure pattern of reinforced models change from punching shear (unreinforced models) to general shear type. The ultimate bearing pressure increases with the increase of loading area. It is evident that geosynthetics are mostly effective at larger deformation levels.

With the limited amount of analysis of static test results, the evaluated ratios of calculated bearing pressure to measured bearing pressure at failure are found in close agreement with those given by Milligan et al. (1989 a).

From the test results of repeated load model test series it is seen that the permanent vertical deformations of the reinforced models reduced substantially (upto 77 percent) and become constant at larger load repetitions. While in the unreinforced models, it increases continuously till failure. The reinforced model can sustain larger number of load repetitions than the unreinforced models at a particular deformation level. The apparent resilient modulus of reinforced models increases with the number of repetitions and is nearly constant at larger number of repetitions.

From the limited model tests results, it is concluded that Geogrid Tensar SS2 (GG-1) and Woven Geotextile (GTW) are the most effective reinforcements than the other geosynthetics. From the analysis of repeated loading model tests, it is found that the value of exponent in the fatigue relationship (after De Groot et al. 1986) depends upon the type of geosynthetics used. In this study, this value is around 0.15 for the unreinforced models while for the reinforced models it varies from 0.17 to 0.29. In general, it can be concluded that by the inclusion of geosynthetics at the interface of the base course and the subgrade the overall performance of the unreinforced model pavement can be increased significantly.

With further substantiation from large scale tests and field trials the data of static/cyclic load tests may be used in future to develop design methods for the reinforced pavements that could be more realistic than the conventional empirical design methods.

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