REVIEW OF GEOSYNTHETICS AS A BARRIER FOR WATER TABLE

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Abstract:
Rigid pavement structure consists of a concrete surface overlaid by a base surface constituted of hard, durable particles for efficient load distribution, to control drainage, pumping action and volume changes of subgrade. It is important to protect the pavement structure from subsurface moisture as moisture is one of the detrimental factors affecting its service life. Geosynthetics could be used as a potential material to be used as a moisture barrier.

1. INTRODUCTION: An early application to the concept of inclusions for strengthening and stabilizing the soil with natural material was the use of heavy cotton fiber in South Carolina, U.S.A. in 1926. Woven geotextiles came into existence in the early 1960s. A notable example of its use as separator and filter material, in place of granular filters, was in Memphis (1962) by the U.S. Army Corps of Engineers. The 1960s saw the development of new geotextile products such as geotextile nets (geonets), geogrids etc., mainly in the U.K. for soil reinforcement applications. Geosynthetics have been in use since 1970s to improve the performance of paved and unpaved roads on soft subgrade soil. In North America, the demand of geosynthetics has increased from 923 million m^2 to 1300 million m^2 (i.e. by 40.85%) from 2007 to 2017. Worldwide annual consumption of geosynthetics is close to 10^9 m^2 and the value of these materials is approximately US$ 1500 million. (Holtz 199)
Geosynthetics are generally polymeric products used to solve multiple engineering problems. This includes eight main product categories: geotextiles, geogrids, geonets, geomembranes, geofoam, geosynthetic clay liners geocells and geocomposites. Their polymeric nature makes them suitable for use in areas where high level of durability is required. Geosynthetic products most commonly used in roadway systems include geotextiles (woven and non-woven) and geogrids (biaxial and multiaxial). (Zornberg, 2017).

2. OBJECTIVE: The objective was to review functions and applications geosynthetics to be selected as a potential barrier to mitigate the effects of water table on pavements

3. LITERATURE REVIEW: Fig.1 shows a paved road section with locations of possible geosynthetic layers and various functions that geosynthetics can fulfill. These functions include:
1. Separation: When geosynthetics are placed between two dissimilar materials they maintain the integrity and functionality of both materials.
2. Reinforcement: The geosynthetic develops tensile forces intended to maintain or improve the stability of the soil geosynthetic composite.
3. Drainage: Here, drainage parallel to the plane of the geotextile is described. The property called transmissivity is defined as flow parallel to the plane of the geotextile. The geosynthetic allows liquid (or gas) flow within the plane of its structure.

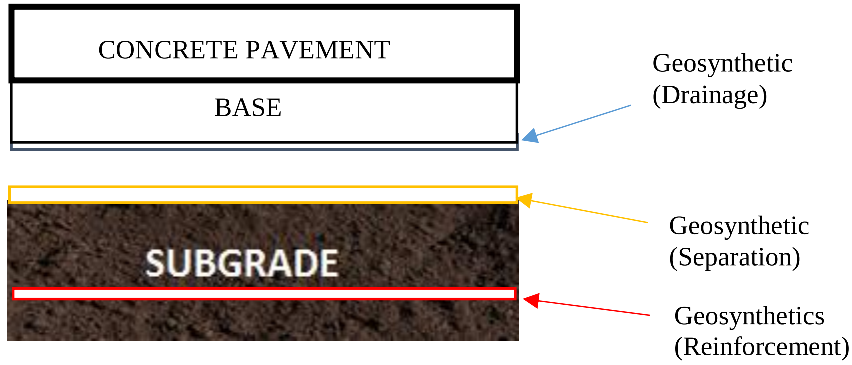

Fig. 1 Schematic cross-section of a paved road

The above mentioned geosynthetic functions are used to enhance the roadway performance in the following four roadway applications: 1) Reinforcement, 2) separation, 3) stabilization of road base and subgrade and 4) lateral drainage.

1. Reinforcement: This concept is like that of reinforcing concrete with steel. It is the improvement of a total system's strength by the introduction of a geosynthetic (which is good in tension) into a soil (that is good in compression, but poor in tension) or other separated material. The structural stability of the soil is greatly improved by the tensile strength of the geosynthetic material. Reinforcement allow embankment & roads to be built over very weak soils.

2. Separation: A major cause of failure of roadways constructed over soft foundations is the contamination of aggregate base material with the underlying soft subgrade soil. This contamination occurs due to two reasons: First, penetration of the aggregate into the weak subgrade due to wheel-load induced stresses and second, the intrusion of the fine-grained soils into the aggregate because of pumping or subgrade weakening due to excess pore water pressure. Hence the contamination decreases the thickness and the bearing capacity of the base layer. Therefore, a geosynthetic could be placed between the aggregate and the subgrade as it acts as an effective separator by preventing mixing of the subgrade and aggregate base course.

3. Stabilization of road base and subgrade: Base stabilization can be defined as the roadway application where geosynthetics are used to maintain the stiffness of the base aggregate materials. Whereas, Subgrade stabilization is defined as the roadway application involving the use of geosynthetics to increase the bearing capacity of soft subgrade soils. If geosynthetic is placed at the interface of base layer to be stabilized and the subgrade layer, it is possible that geosynthetic will fulfill both the requirements simultaneously.

4. Lateral drainage: Presence of moisture in base and subgrade layers, compromises the mechanical properties of soil. They provide gravity induced lateral drainage for saturated condition and suction driven lateral drainage for unsaturated soil. This minimizes the pore water pressure and avoids moisture induced reduction of shear strength and modulus.

For geotextiles as separator layers, the following criteria have been recommended where steady-state flow is anticipated (generally the case when used as a separator layer) (FHWA, 1998):

$O_{95} \leq B\ D_{85}$ (soil)

where, O_{95} = Opening size in the geotextile for which 95 % are smaller, mm

B = Dimensionless coefficient

D_{85} = Soil particle size for which 85 % are smaller, mm

For silts and clays, B is a function of the type of geotextile:
B = 1 for woven and B= 1.8 for nonwoven geotextiles
To ensure that Geotextiles will survive the construction process, minimum geotextile strength and endurance properties are required. They are presented in the following table:

Table 1. Strength property requirements for Geotextiles (Holtz. 1998)

Property	ASTM test method	Units
Grab Strength	D 4632	N
Tear Strength	D 4533	N
Puncture Strength	D 4833	N
Burst Strength	D 3786	kPa

4. DISCUSSION: With the influence of Geosynthetics, there is an improvement in the service life of the pavement. As they could be manufactured according to our needs, its availability is also not an issue. Moreover, they are lightweight, durable and reliable. But, there is an issue about its maintenance as its serviceability could be affected due to clogging. And hence maintenance of geotextiles becomes expensive and inconvenient.

5. CONCLUSION: Geosynthetics have the potential to be used as a cost-effective solution to a variety of engineering problems. The type and the material of geosynthetics to be used depends on the function to be fulfilled and the compatibility of the geosynthetic material with the overlying and underlying pavement materials. The ultimate decision for the selection of a geosynthetic depends on its specification, function and its cost.

6. ACKNOWLEDGEMENTS: This study was supported by the Center for Innovative Grouting Materials and Technology (CIGMAT) and Texas Hurricane Center for Innovative Technology (THC-IT), University of Houston, Houston.

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