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PERFORMANCE OF PAVEMENT USING GEOSYNTHETICS

Praseetha K (construction Engineering And Management),
Department of Civil Engineering,
Meenakshi Sundararajan Engineering College

Abstract: The performance of a pavement is very responsive based on the characteristics of soil subgrade, which provide base for the whole pavement structure. For that reason of utmost significance, the performance is enhanced by adopting proper design and construction schemes.Successful use of Geosynthetics is ensured in a given geotechnical application, as it is not only compatible but effective in improving the soil properties when appropriately placed. Geotextiles have been used in pavements to either extend the service life of the pavement or to reduce the total thickness of the pavement system. So the life of the pavement will increase, which will require less repair and maintenance. The high rate of erosion and poor drainage system in different parts of the country has led to speedy road degradation and extra costs incurred on road rehabilitation; hence the use of geosynthetics is aimed at controlling this phenomenon. The benefits of a geosynthetic material in any application are defined by six discrete functions: separation, filtration, drainage, reinforcement, sealing and protection. The geotextile acts as a filter through which water passes while it restricts fine-grained soil from entering into coarse-grained soil (sand or gravel) and thus prevent their being washed away and forestall failure of the road.

Keywords: Geosynthetics,pavement, soil

I. INTRODUCTION

The behaviour of the soil and rock at the location of any project has a major influence on the success, economy and safety of the work. The economic development of a country is closely related to its road transport infrastructure facilities available. The periodic maintenance of the road is limited due to cost consideration which will disrupt the service and affect the function of the road. By implementing a newer method of enhancing the pavement, the thickness of pavement shall be reduced. The performance of flexible pavements depends upon the quality of subgrades and sub-base stable subgrade and properly draining sub-base help produce a long-lasting pavement. A high level of spatial uniformity of a subgrade and sub-base in terms of key engineering parameters such as shear strength, stiffness, volumetric stability, and permeability is vital for the effective performance of the flexible pavement system. A number of environmental variables such as temperature and moisture affect these geotechnical characteristics, both in short and long term.The subgrade and sub-base work as the foundation for the upper layers of the pavement system and are vital in resisting the detrimental effects of climate, as well as static and dynamic stresses that are generated by traffic. Geotextiles are used for the design and construction of uniform and stable subgrade and sub-base.

Geo synthetics are becoming rapidly popular in construction because of their ability to perform certain necessary functions while offering practical advantages such as:

i. A wide availability of products from the market place
ii. The relative ease of shipping and field handling (flexibility)
iii. Rapid installation techniques, i.e. fast speed of construction, without the need for heavy equipment such as earth-moving machines.
iv. Lightweight in comparison with other construction materials, therefore imposing less stress upon the foundation
v. Durability and long life when properly selected
vi. General environment safety, since they will not degrade.(However, there is possibility of degradation if exposed to sunlight and certain highly corrosive chemicals).

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II. LITERATURE REVIEW

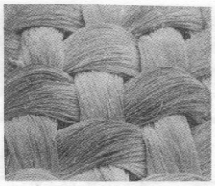
GENERAL:

Pavements either bound or unbound are exposed to repeated, high and focused loads. These can cause precipitate aging and failure of the road construction. Roads & Pavement reinforcement increases the life of service of the roads and highways by decreasing fatigue, reflective, thermal and settlement cracking. Roads & Pavement reinforcement relieves and redistributes stress concentrations in the pavement.

REVIEW OF LITERATURE:

P. Senthil Kumaret.al (2012) Have studied about the effective use of geotextile for unpaved soft subgrade road.The performance of woven and nonwoven geotextile, interfaced between soft subgrade and unbound gravel in an unpaved flexible pavement system, is carried out experimentally, utilizing the California Bearing Ratio (CBR) testing arrangement.

M Rama Krishna et.al (2015) Has evaluate the CBR value for different soil layer with geosynthetics. The evaluation has been made on poorly graded sand with the inclusion of go-grid, geo-textile and geo-composite materials between soil layers in different proportions.



III. TYPES OF GEOSYNTHETICS

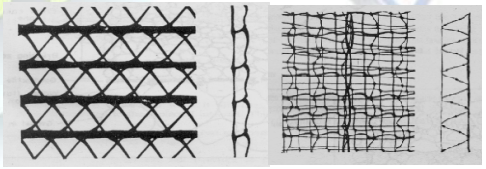
Geosynthetics are usually produced either in sheets or in fabric filaments (fibres) with the major variations in their composition, thickness and strength. These are then further worked upon in the production process to produce the construction geosynthetics group. The different types of this geosynthetics group products are geotextiles (geofabrics), geogrids, geonets, geomembranes, geosynthetic clay liners (GCL), geopipes or geotubes, geocells, geofoams, drainage/infiltration cells and geocomposites.

Below is the description of the above listed materials:

3.1. Geotextile or Geofabrics: Geotextiles form one of the two largest groups of geosynthetic materials. They are indeed textiles in the traditional sense, but consist of synthetic fibres (all are polymer-based) rather than natural ones such as cotton, wool, jute ` Thus, biodegradation and subsequent short lifetime is not a problem. These synthetic fibres are made into flexible, porous fabrics by standard weaving machinery or they are matted together in a random nonwoven manner. Some are also knitted. The major point is that geotextiles are porous to liquid flow across their manufactured plane and also within their thickness, but to widely varying degree. However, the fabric always performs at least one of four discrete functions: separation, reinforcement, filtration and/or drainage. According to ASTM, a GEOTEXTILE is "any permeable textile material used with foundation soil, rock, earth, or any other geotechnical engineering-related material, as an integral part of a man-made project, structure or system"

3.2. Geogrids: Geogrids consist of heavy strands of plastic materials arranged as longitudinal and transverse elements to outline a uniformly distributed and relatively large and grid like array of apertures in the resulting sheet. These apertures allow direct contact between soil particles on either side of the sheet. Geogrids are polymers formed into a very open, gridlike configuration, i.e., they have large apertures between individual ribs in the machine and cross machine directions. Geogrids are (a) either stretched in one or two directions for improved physical properties, (b) made on weaving or knitting machinery by standard textile manufacturing methods, or (c) by bonding rods or straps together

3.3.Geonets: A geosynthetic material consisting of parallel sets of intersecting ribs that form a three-dimensional net-like material. They are used to improve drainage by creating a "thin" plane for water to travel through.



3.4.Geomembranes: A geosynthetic material that is virtually waterproof when used as a fluid barrier. A common application of this is a landfill liner.

3.5.Geocomposite: A material made up of a combination of geosynthetic materials that is used to improve performance by combining the benefits of two types of geosynthetics.

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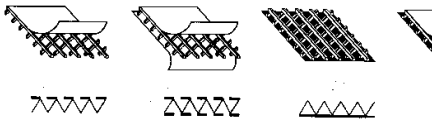


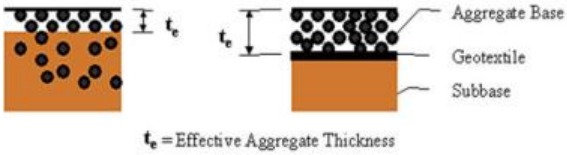
There are virtually hundreds of different types of geosynthetic products available on the market today. Please remember that all geosynthetic materials work in some type of application, but no geosynthetic works in all applications. Therefore, make sure that you have the right geosynthetic product for the right job.

IV. FUNCTIONS OF GEOTEXTILES

The functions of geotextiles are discussed below:

4.1 Separation:

Partitioning of two adjacent but dissimilar materials to prevent intermixing. The nonwoven geotextiles are specially designed products for use in road construction as separation components. They are robust, filter-stable products with high puncture resistance, high tensile strength and high elongation properties. The high elongation capacity of the nonwoven geotextiles ensures excellent resistance to damage. This characteristic of geotextile products allows them to easily accommodate irregular or soft subgrades. When covered with stone, the nonwoven geotextile fibres are reoriented around the stones, preventing damage to the nonwoven structure.



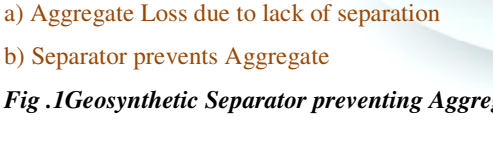
a) Aggregate Loss due to lack of separation

b) Separator prevents Aggregate

Fig .1Geosynthetic Separator preventing Aggregate Loss

4.2 Reinforcement:

Geogrids are reinforcing geosynthetic products manufactured from high tensile strength extruded monolithic flat polymer bars with high strength welded junctions. Geogrid absorbs tensile forces induced into the soil and distributes the stresses through the high tensile strength bars. This transfer of forces takes place by two distinct modes: interlock of the granular soil into the grid apertures which physically restrains movement of the granular base course material and frictional force transfer between the soil and the wide flat bars of geogrid. By absorbing the tensile forces induced by traffic loading on the road surface, the loading is distributed over a larger base area, minimizing localised pressures on the subsoil. But in our project we are using geocomposite as reinforcement, but compare to geocompositegeogrids are act as a good reinforcement in soil.



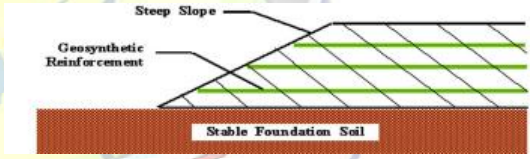


Fig.2 Soil Reinforcement of an Embankment using a Geosynthetic

4.3 Filtration&drainage:

On concrete pavements, cracks and damaged joint seals can allow surface water to penetrate the pavement slab and wash away the subsoil. The hydraulic undermining of the pavement slab can weaken the structure and lead to damage of the paving surface. When the subsoil also is low in permeability and unable to discharge the water that has penetrated the slab, water can build-up at the interface between the slab and the prepared subsoil. Cyclic traffic loading can then subject this water to alternating high and low pressures. This "pumping" action can drive soil out from under the slab, reducing the structural integrity of the pavement. When installed between the pavement slab and its subsoil, geotextile PP mechanically bonded nonwoven geotextiles provide a horizontal drainage path for water to discharge before it can cause damage to the road structure. As the drainage capacities of geotextiles are considerably higher than that of engineered soils and as they are not affected by wash-out, they protect the integrity of the pavement against hydraulic damage. The thick three dimensional geotextile also acts as a

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cushion against traffic vibration, helping to prevent cracking.

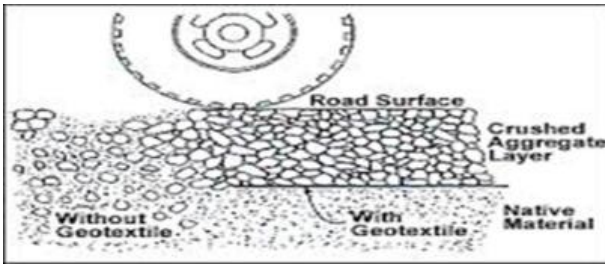

Fig.3 Road surface with and without geotextiles

V. EFFECTIVENESS IN REDUCING THE COST OF INFRASTRUCTURE:

Geosynthetics can be a better and cost effective alternative to other materials in infrastructure development but continue to be underutilized, perhaps due to ignorance of unfamiliarity of civil engineering practitioners with them. The following points merely give illustrations of how the usage of geosynthetics can contribute immensely to the reduction of infrastructure if adequately utilized in the vast areas of application across the spectrum of national development.

- The use of geosynthetics permit the usage of local soil materials (though weak), rather than imported quarry product (which would be costlier), in the place of construction.
- Their advantage of rapid installation techniques lead to reduced periods of construction and therefore, reduced construction costs.
- The light weight of geosynthetics, in comparison with other construction materials, makes them impose less stress upon the foundation, and therefore, less damage over time.
- Their durability and long-life preclude shorter design life spans of projects and the need for rehabilitation and major maintenance operations.
- Geosynthetics are generally very cheap and more cost effective than other materials (for example, when used to fulfil the reinforcement function).
- Geosynthetics provide easy and cost effective way out of difficult situations being usable when other materials are unusable.
- Geotextiles extend the service life of roads. Increase their load carrying capacity, and reduce rutting. These are achieved through the stabilization and separation functions.
- When used to fulfil the filtration process in roads, geotextiles have significant advantages. The removal of water is important to the success of many civil engineering problems. In transportation applications, if the base course does not drain rapidly enough, stress form the traffic loading is transferred to the subgrade with little or no reduction, resulting in accelerated road failure. The removal of water must be performed in a controlled fashion. Otherwise, severe erosion, piping, settlement of soils may result in undermining adjacent structures. To accomplish this task, the drainage system should fulfil two criteria: maintenance (by providing relatively unimpeded flow of water), and filtration of the base soil (by preventing the migration of the soil fines into the drain). These criteria can be met by using several layers of specially graded aggregates. This often proves to be an extremely expensive requirement to meet. The same result can be achieved at a fraction of the cost by using selected geotextiles, which act as filters around the aggregate drainage system. The introduction of geotextile lined drained systems has enhanced the technical properties and economic application of blanket and trench drains under and adjacent to pavement structures
- When used for soil walls, some advantages of geotextile-reinforced walls over conventional concrete walls are the following:

(a) They are economical.

(b) Construction usually is easy and rapid. It does not require skilled labour or specialized equipment. Many of the components are prefabricated allowing relatively quick construction.

(c) Regardless of the height or length of the wall, support of the structure is not required during construction as for conventional retaining walls.

(d) They are relatively flexible and can tolerate large lateral deformations and large differential vertical settlements. The flexibility of geotextile-reinforced walls allows the use of a lower factor of safety for bearing capacity design than for conventional more rigid structures.

VI.CONCLUSION

It is concluded that, when geo synthetics used in pavement applications, help to restrain base material during compaction or loading; they also serve as a separation layer to prevent excess migration and intermingling of pavement layers at interfaces. In pavement overlays, geotextiles provide the added advantages of resisting moisture intrusion into lower pavement layers, thereby maintaining

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high material strengths, retarding reflective cracking in the overlay from existing layers of hot-mix asphalt concrete or from cracks and joints in rigid pavement by acting as a stress absorbing membrane interlayer, and increasing the structural stability by providing for more stable subgrade moisture contents. Thus, when geo synthetics are used within pavement structures for drainage and moisture control, they enhance the pavement structure and lengthen its performance by reducing the influence moisture has on the pavement materials.It is quite economical to introduce the use of geo synthetics as a whole into the Engineering industry. The material should be used also in effective separation of subgrade and sub-base courses in road construction and other engineering constructions.

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