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ROAD CONSTRUCTION BY USING GEOSYNTHETICS MATERIAL

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Abstract

The high rate of erosion and poor drainage system in different parts of the country has led to rapid road degradation and extra costs incurred on road rehabilitation so 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 such as filtration, drainage, separation, reinforcement, sealing and protection. Geosynthetics were 1'st employed in the 1960 as filters in the US and as reinforcement in Europe. The geotextile act as a filter through which water passes while it restricts fine-grained soil from entering into coarse-grained (Sand or Gravel) and thus prevent their being washed away and forestall failure of the road. This work shall be limited to the use of geosynthetics as a soil stabilizer in construction of road. It would involve the collection of soil materials and determination of their geotechnical properties both soaked and unsoaked after which the geotextile would be fitted into the soil sample and their geotechnical properties also determined in both the soaked and unsoaked conditions. The result would be analysed and the effect of the geotextile. On the tested soil sample would be evaluated and the appropriate recommendations would be made for their excellent use.

Index Terms: *GEOSYNTHETICS1, GEOTEXTILE2, STABILAZATION3.*

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1. INTODUCTION

In ancient times various types of materials have been added to soil in order to increase its stability, for use as construction material. But these materials such as plant fibres, jute, wood shavings and cotton are bio-degradable and therefore have short service life. In only a few decades, geosynthetics for example geotextiles, geogrids, and geomembranes. This joined the list of conventional civil engineering construction materials. With the advent of polymers in the middle of the 20'th Century. A much more stable set of materials became available,These groups of polymer materials are called as geosynthetics, have been employed in civil engineering works due to their stability and durability.

Geosynthetics have been formulated and are available in a wide range of forms to suit various engineering applications. The use of a geosynthetic can significantly increase the safety factor, improve performance, and reduce costs in comparison with conventional construction materials.

In the case of embankments on extremely soft foundations, geosynthetics can allow construction to take place at sites where conventional construction alternatives would be either impossible or prohibitively expensive. Geosynthetics are particularly useful in pavement construction and the earthworks associated with road construction. Geosynthetics used for construction projects are manufactured from synthetic polymers such as polypropylene, polyesters, polyethylene, polyamide (nylon), poly-vinyl chlorides, and fibreglass. Polypropylene and polyester are the most used in geosynthetics. Compared to the natural fibres, the polymeric geosynthetics offer long-term durability in the presence of elements commonly encountered in construction.In developing countries, the use of geosynthetics is relatively new but gaining extensive popularity in construction. Geosynthetics are becoming rapidly popular in construction because of their ability and other advantages.

2. TYPES OF GEOSYNTHETICS

Geosynthetics are usually produced either in sheets or fibres with the major variations in their composition, thickness and strength. These are then further worked upon in the production process to produce geosynthetics groups. The different types of this geosynthetics group products are geotextile, geogrids, geomembranes, geosynthetic liners, geofoams, drainage and infiltration cells and geocomposites. Geofoam has found application in transportation as super lightweight fill, compared to densities of other lightweight material. Geofoam's lightweight makes it viable option for landslide repair and for embankments on soft, compressible deposits. Geofoam is also used for thermal insulation of pavements and foundations. Geogrids have been used for soil reinforcements in embankments and walls, subgrade and sub base stabilization, and embankment base reinforcement. Geogrids are characterized by connected elements within plane openings uniformly distributed between the elements. The apertures allow the soil to fill the space between the elements, thereby increasing soil interaction with the geogrid. All these applications are not only in highway construction, but also for rehabilitation purpose.

2.1 Geotextile: Geotextile 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. 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 varying thickness, but to widely varying degree.

2.2 Geogrids: they are unitized woven yarns or bonded straps. Geogrids consist of heavy strands of plastic materials arranged as longitudinal and transverse elements to outline a uniformly distributed and relatively large and gridlike array of apertures in the resulting sheet. These apertures allow direct contact between soil particles on either side of the sheet.

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

2.4 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.

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.

3. PROCEDURE OF GEOSYNTHETICS USES IN ROAD CONSTRUCTION

3.1 Separation:

One of the most common uses of geosynthetics is to provide separation of two layers having different soil properties. Separation is the placement of a flexible geosynthetic material, such as porous geotextile, between different materials so that the integrity and functioning of both the materials can remain undisturbed or even improved. Using a road as an example, the separator will prevent the aggregate base course from sinking into weaker subgrade material and preventing fine aggregate in the subgrade from pumping up into the aggregate base course. If aggregate loss or pumping occurs, the strength of the pavement can be drastically reduced as shown in below figure which shows the reduced "effective" thickness of the aggregate in base course.

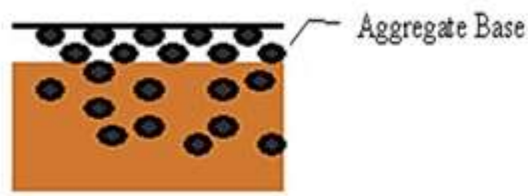

Fig-1:Aggregate Loss due to lack of separation

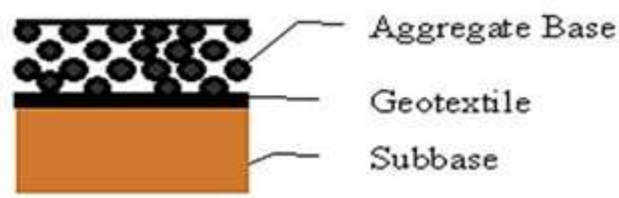

Fig-2:Separator prevents Aggregate Loss

3.2 Filtration:

In this application, the geosynthetic acts as a filter by preventing material from washing out while allowing the water to flow through it. The most common uses of this application are geotextiles which wrap around an side drain and vertical drain, geotextiles placed under erosion control devices, and geotextiles used behind structure such as retaining walls and embankment etc.

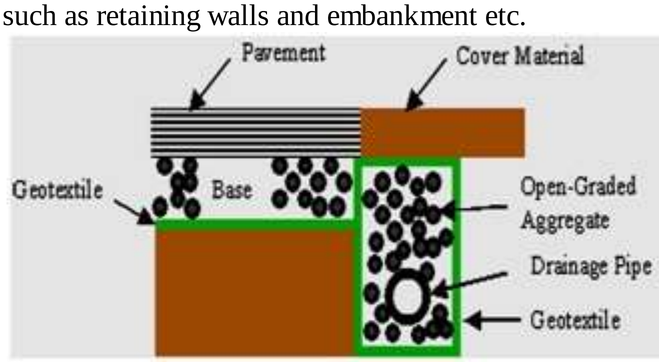

Fig-3: Edge Drain in road construction

3.3 Drainage:

Although filtering applications are commonly referred to as drainage applications, they are different. Drainage applications refer to situations where the water flows within the plane of the geosynthetic product in the plane of drainage system. In filtration applications, the water flows across the plane of the materials. Although certain types of geotextiles provide some in-plane drainage system, most drainage situations require a geo-composite drainage product such as prefabricated sheet drains that provide a much greater drainage capacity.

A geotextile provides fluid transmission when it collects a liquid and conveys it within its own plane, towards the outlet. Water may be conveyed vertically or horizontally. Drainage is related to the role of filtration and is a function of the permeability of a geotextile and its pore opening size. The permeability involved in the fluid transmission function is the permeability in the plane of the geotextile. In order to accomplish this function of transmission or drainage, a bulky geotextile or a composite system is needed. In other words in addition to permeability is the thickness of the geotextile material.

3.4 Reinforcement:

In this application, the structural stability of the soil is greatly improved by the tensile strength by geosynthetic material. This concept is similar to that of reinforcing concrete with steel and makes RC structure. Since concrete is weak in tension, reinforcing steel is used to strengthen it. Geosynthetic materials function is similar as the reinforcing steel by providing tensile strength that helps to hold the soil.

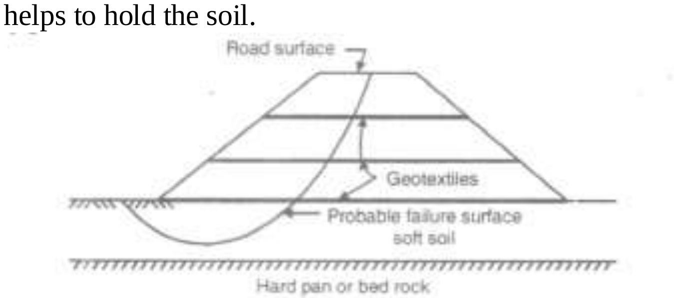

Fig-4:Reinforcement function of geotextile in road embankment

Reinforcement provided by geotextiles or geogrids allows embankments and roads to be built over very weak soils. It allows for steeper embankments to be constructed. The geotextile layers are placed across the potential rotational failure plane to carry the tensile forces that cannot be carried by an unreinforced soil mass of the embankment and sides.

3.5 Sealing:

The barrier or containment function involves the use of an impervious geosynthetic for situations where structures require a water-proofing membrane, or to function as a no-leak ground coating for liquid and solid waste disposal sites and the top capping seal. This function is best performed by a geomembrane. A non-woven geotextile performs this function when impregnated with asphalt or other polymeric mixes rendering it relatively impermeable to both cross-plane and in plane flow. The classic application of geotextile as a liquid barrier is paved road rehabilitation. Here, the non wicker geotextile is placed on the existing pavement surface following the application of an asphalt tack textile. The geotextile absorbs asphalt to become a waterproofing membrane minimizing vertical flow of water into the pavement structures.

3.6 Protection:

The protection function relates to including a protective geosynthetic for strength or resistance to surrounding conditions as part of a geocomposite in a situation where the material used to provide a major function, for example drainage, is vulnerable to conditions present in the surrounding environment. Some geosynthetic and natural barriers need to be protected against drainage system.

3.7 Erosion control:

The erosion control function is disturbed with the geosynthetics to hold surfaces in place and prevent erosion. Some geosynthetics permit protective vegetation to grow through the fabric so that a natural resistance to erosion develops. The geosynthetic may be designed to gradually decompose or degrade.

4.GEOSYNTHETICS NEED TO BE USED TO IMPROVE THE PERFORMANCE OF THE EXISTING SOILS

4.1. Non-Uniform Consistency:

Soils are made up of different types of particles such as gravel, sands, silt, clay and possibly organic materials. Many times, the consistency of the soil types of particles can vary throughout the length of the project. This can have a significant effect on such factors as drainage, settlement, frost heaves, etc.

4.2. Unstable Soils:

In areas where soils consist of clays, silts and organics, especially in areas that drain poorly, the subgrade may be unstable. As a result, the unstable soil is not able to provide adequately support for a road or embankment.. all of which can create problems.

4.3. Moisture Problems:

Depending upon the consistency of the soil, the presence of moisture can create such problems such as loss of strength, swelling or shrinking, and frost heave. The availability of moisture reduces the strength.

4.4. Tensile Strength

Most soils can resist forces that compress the material. However, soils cannot resist forces that pull the soil apart tensile force. In situations where the existing soils exhibit one or more of the above-mentioned problems, traditional alternatives include:

remove and replace poor soils, soil stabilization, use of piles or cassions, and or installation of complex drainage systems. These solutions can be very costly and time consuming. Another potential solution is to use geosynthetics. Unlike soils, geosynthetics are manufactured specifically to provide consistent properties that can be designed by the manufacturer and specified by the user. Other benefits include ease of construction, increased life of the structure and reduced maintenance requirements.

In many cases, the use of geosynthetics will allow for the utilization of lower quality fill materials, less fill material, or reduce the amount of necessary excavation. In these cases, geosynthetics can reduce the overall cost of the project. Since geosynthetics can increase the life of a road and reduce the long-term maintenance requirement, local agencies should consider amending their design and construction ordinances to require the use of geosynthetics in new road construction and rehabilitation projects. Although this requirement will slightly increase the cost of the project, it should provide long-term cost savings to the agency when it has to maintain the facility such as road, embankment, etc.

5. ADVANTAGES:

1. The use of geosynthetics material permits the usage of local soil materials.
2. Easy and rapid for construction.
3. Rapid installation techniques
4. Reduced time of construction.
5. Reduced construction costs.
6. It does not require skilled labour.
7. It does not required specialized equipment.
8. Many of the components are prefabricated allowing relatively quick construction.
9. 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.
10. Their durability and long-life preclude shorter design life spans of projects and the need for rehabilitation and major maintenance operations.
11. Geosynthetics are generally very cheap, more cost effective than other materials.
12. Geotextiles extend the service life of roads.
13. Increase their load carrying capacity.
14. They are relatively flexible and can tolerate large lateral deformations and large differential vertical settlements.
15. The flexibility of geotextile-reinforced walls allows lower factor of safety for bearing capacity design than for conventional more rigid structures.

6. FUTURE SCOPE

This work shall be limited to the use of geosynthetics as a soil stabilizer in road construction. It would involve the collection of soil materials and determination of their geotechnical properties both soaked and unsoaked after which the geotextile would be incorporated into the soil sample and their geotechnical properties also determined in both the soaked and unsoaked conditions.The result would be analysed and the effect of the geotextile on the tested soil sample would be evaluated and the appropriate recommendations would be made for their best use.

7. CONCLUSIONS

1. From the above study economic benefit to introduce the use of geotextiles in road construction as it reduces the act of borrowing to fill" when the in-situ soil can easily be enhanced by use of geosynthetics.
2. Geotextiles are effective tools in the hands of the civil engineer that have proved to solve geotechnical problems. With the availability of variety of products with differing characteristics, the design engineer needs to be aware of not only the application possibilitiesbutalso more specifically the reason for using the geotextile and the governing geotextile functional properties to satisfy these functions.
3. Design and selection of geotextiles based on sound engineering principles will serve the long-term interest of both the user and the industry also.
4. This study project has been able to show the beneficial functions of geotextiles in construction of road as sampled on the various soil types.
5. From research gotten it is quite economical to introduce the use of geosynthetics as a whole into the Engineering industry.
6. The material should be used also in effective separation of subgrade and sub-base courses in road construction and other engineering constructions works.

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