GEOTEXTILES: APPLICATION IN ROAD CONSTRUCTION & EROSION CONTROL

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Abstract : This study has been undertaken to learn the various & useful applications of geotextiles in road construction & erosion control. Geotextile applications are changing rapidly as research shows results and manufacturing processes improve. Geotextile and their application in road construction, maintenance and erosion control were discussed in detail. Fundamental considerations in design and installation were also discussed. India is a large producer of jute. Jute is a low cost, renewable, biodegradable and ecofriendly natural product. Jute-based geo-synthetics is finding increasing acceptability among geotechnical engineers primarily because of its eco concordance, facility of production of tailor-made fabrics and price competitiveness. However civil engineers are still apprehensive about its long- term effectiveness on account of its bio-degradability .Applications of Jute geotextiles in ground improvement, Improvement in Pavement Performance, Erosion Control of Denuded Slopes and in Drainage and Filtration Application presents an interesting picture.

Index Terms **- Durability, geotextiles, erosion, fabric.**

I. INTRODUCTION

A geotextile is any permeable textile material used with foundation, soil, rock, earth, etc. that is an integral part of a constructed project, structure or system. It may be made of synthetic or natural fibers. In contrast; a geomembrane is a continuous membrane-type liner or barrier. It must have sufficiently low permeability to control migration of fluid in a constructed project, structure or system. A geotextile is designed to be permeable to allow the flow of fluids through it or in it, and a geomembrane is designed to restrict the fluid flow. Geotextile related materials are fabrics formed into mats, webs, nets, grids, or formed plastic sheets. They are considered to be different from geotextiles.

Geotextiles have proven to be among the most versatile and cost-effective ground modification materials. Their use has expanded rapidly into nearly all areas of civil, geotechnical, environmental, coastal, and hydraulic engineering. They form the major component of the field of geosynthetics, the others being geogrids, geomembranes and geocomposites. The ASTM (1994) defines geotextiles as permeable textile materials used in contact with soil, rock, earth or any other geotechnical related material as an integral part of civil engineering project, structure, or system.

Geotextile products are most commonly used in temporary and rural unpaved road construction, and research on geotextiles in this area is well established. The basis behind their use is that by placing a geotextile between the weak subgrade soil and the aggregate fill, the unpaved road construction will be established. Acting as a support membrane, the geotextile provides local reinforcement and a physical barrier to the intermixing of the aggregate and subgrade soil. It also provides sufficient fiction to limit lateral sliding of the aggregate and restrains the subgrade sub-base from downward and lateral movement in the rut and the subgrade soil from upward and lateral movement between the ruts. Using geotextiles in rural road construction improves the quality of rural roads, increases the lifespan of the road and reduces the cost of repair. Geotextiles also allow the road to withstand natural climatic events like floods or monsoon destruction and help to balance the local ecosystem with the use of natural geotextiles such as jute.

II. GEOTEXTILES WITH APPLICATIONS

Geotextiles are produced using synthetic fibres or yarns commonly made from polypropylene or polyester. These materials do not absorb water or support the growth of fungus or mildew, are chemically resistant to pH levels 1–14, and are stable up to 150°C. Geotextiles made of these materials have a life expectancy of more than 200 years when they are buried. If the geotextile is to be exposed for more than about 30 days, it will require UV stabilization owing to the breakdown of these polymers in UV light. The most common stabilization method is to add carbon black during fibre and yarn production.

The filtration and flow properties of a nonwoven geotextile can be affected by heat burnishing. This process, in which the geotextile is passed over a heated roller, makes the geotextile thinner and less fuzzy. Different design aspects must be considered as to the degree of burnishing allowed. Most manufacturers of nonwoven geotextiles burnish the surface somewhat to decrease roll sizes and increase loading for shipping purposes. This material satisfies the requirements of the vast majority of specifications, but too much or too little burnishing may adversely impact the performance of the geotextile.

In separation functions geotextiles keep fines in the subgrade from migrating into the base course. Tests show that it takes only about 20% by weight of subgrade soil mixed into the base course to reduce its bearing capacity to that of the subgrade. This problem usually is due to the movement of large amounts of water. When large loads cross the surface of the roadway they set up a pumping action which accelerates this water movement and soil particle migration, and speeds up the failure of the road. Two important criteria for selecting a geotextile for separation are permeability and strength. The geotextile used for separation must allow water to move through it while retaining the soil fines or sand particles. It should let water pass through it at the same rate or slightly faster than the adjacent soil. It must also retain the smallest soil particle size without clogging or plugging.

In selecting a specific geotextile for separation we must consider its basic strength properties. Be sure to take into account how its physical properties will survive the construction process as well as how it will survive the pressures of traffic on the gravel cover and enhance the life of the road. These strength properties are described in manufacturers' literature and design manuals in a variety of terms including burst and abrasion resistance, and puncture, grab, and tearing strength.

III. GEOTEXTILES FOR ROAD CONSTRUCTION

Geotextiles are large sheets that save our earth soil in rainy days & binds strongly. It is mostly used for filtration and separation in the road constructions. It protects from migration of small gravels & sand aggregates. Geotextiles are thin & strong membrane fabric which is used to reinforce soil & prevent from damage. Geotextiles are mostly used in road construction, especially to fill gaps between the roads to improve soil structure. Geotextile makes poor soil more beneficial for use and then easy to build in difficult places also. Geotextile are ideal materials used for Construction & infrastructure like roads, buildings, dams and many more.

It improve & stability and decreases the process of wind & water erosion. It helps to prevent the erosion of soil but allows the water to drain off. A geotextiles made from synthetic or natural fibres associated with soil thin pieces. It improves soil characteristics such as Friction or movement restraint, Support of loads and Changes in bearing failure plane.

Geotextiles can be used for:

1. For improvement of Paved & unpaved roads in airport roads
2. On landfills and stone base courses
3. For Land breaks filling with small geotextile portions.
4. Beneath sidewalks and sand drainage layer
5. Under the parking lots & curb areas.
6. To enhance greenish environment and recreational facilities captured on beneath retaining wall structures
7. Improving soil capping due to reinforce & pipe trenches

Geotextiles are a polymers & synthetic made from textile materials named as polyester. The Geotextiles are effectively successful materials to improve road quality. It is divided into following types:

1. Geotextile of Woven Fabrics
2. Non-woven Fabrics
3. Knitted Fabrics

The performance of pavements constructed on soft soils can be improved using jute geotextiles. Jute fabric when used as separator prevents the penetration of subgrade material into voids of granular base course. The permeability characteristic of the fabric also aids in faster dissipation of pore pressures and ensures better drainage which results in better long term performance of the pavement. Provision of fabric enables subgrade develops its full bearing capacity and thus controls rutting. Jute geotextile was used as a separator between subgrade and sub-base layers. Results showed negligible settlements of the pavement after six months under traffic and no signs of surface distress observed in the treated test section.

IV. GEOTEXTILES FOR EROSION CONTROL

Geotextiles can be used many ways for erosion control. One of these is with riprap along stream banks, lake shores, and other bodies of water to keep finer soils beneath the riprap from eroding. Geotextiles recommended for erosion control should have permeability, resistance to abrasion, and high resistance to ultraviolet rays as primary considerations. Erosion control covers a variety of conditions from high velocity stream flow to heavy wave action, to less severe conditions.

All conditions should be considered before selecting a fabric. The following instructions describe how to install geotextiles on stream banks and similar steep slopes. These may be modified for applying geotextiles in less severe conditions such as rip rapping in ditches. Geotextile/riprap installations may also be used in specifically designed systems to protect against scouring around bridge piers and abutments, and in other water installations. To install geotextiles for any riprap system:

– Before starting, review such design considerations as wave action, bank steepness, etc.
– Identify soils by particle size and permeability as these will determine certain geotextile specifications.
– Identify the size of riprap planned for this application.
– Review past weather and climate conditions for such information as levels of ice, wave action, and amount of sunlight for their effect on riprap/geotextile installations. Ultraviolet rays in sunlight deteriorate most synthetic materials. If exposure to ultraviolet rays is anticipated, select a geotextile with high resistance to ultraviolet rays.
– Depending on the type of installation and the care it will need, you may have to consider abrasion to ensure that the geotextile will survive installation.

3.1 Geotextile Fabrics

Geotextile fabric comes in three main forms: Non-Woven Geotextiles, Woven Geotextiles, and Coir Geotextiles. Each of these materials has its own unique properties making it perfect for the various applications in which it is used. In addition, each geotextile will typically feature a different weight or strength to help meet both light weight requirements and high strength applications.

Non-woven Geotextiles:

Our non-woven are made from 100% needle punched polypropylene, which is cheaper and more popular than other materials. It is U.V. Stabilized with carbon black, lengthening the life of the fabric. Nonwoven geotextiles are perfect for filtration applications requiring drainage, stabilization or other water filtering requirements.

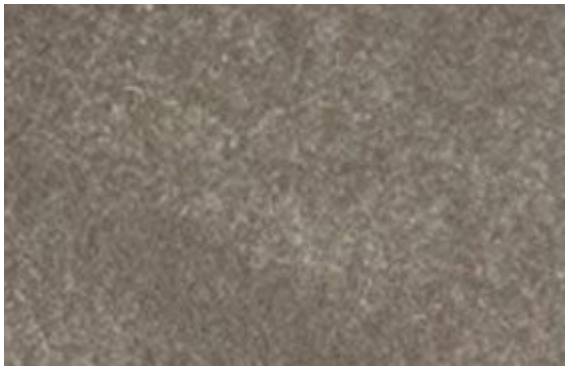

Figure 1: non-woven geotextile

Oven Geotextiles:

Our woven geotextiles are also made from polypropylene, but in slit film or monofilament form. Slit Film is a thin/wide sheet of plastic and Monofilament is oval/round shaped yarn. Both materials are extruded, slit, stretched to align molecular chains, and finally put on a loom to be woven. This geotextile fabric is best used for road construction, with rip rap, heavy erosion, embankments, and steep slopes.

Figure 2: woven geotextile

Coir Geotextiles:

Coir is a natural product made from coconut fiber. The most common uses for coir are sediment control and soil bio-engineering. Because coir is 100% natural, it is also biodegradable. They support growth and development of vegetation and can be made and used for short term, temporary, or semi-permanent applications.

Figure 3: woven geotextile

IV. RESEARCH METHODOLOGY

The Geotextile is unrolled directly on the smoothly graded soil surface. It should not be left exposed to W deterioration for more than 1 week in case of untreated Geotextiles, and for more than 30 days in case of W protected and low UV susceptible polymer Geotextiles. The Geotextile should be loosely laid, free of tension, folds, and wrinkles. When used for stream bank protection, where currents acting parallel to the bank are the principal Erosion forces, the Geotextile should be placed with the longer dimension (machine direction) in the direction of anticipated water flow. The upper strips of the Geotextile should overlap the lower strips. When used for wave attack or cut and fill slope protection, the Geotextile should be placed vertically down the slope, and the upslope strips should cover the down slope strips. Stagger the overlaps at the ends of the strips at least 5 feet. The Geotextile should be anchored at its terminal ends to prevent uplift or undermining. For this purpose, key trenches and aprons are used at the crest and toe of the slope.

Erosion is caused by a group of physical and chemical processes by which the soil or rock material is loosened, detached, and transported from one place to another by running water, waves, wind, moving ice, or other geological sheet and bank Erosion agents. Clayey soils are less erodible than fine sands and silts.

However, for aesthetic or economic reasons, articulated concrete mattresses, gabions, and precast cellular blocks have also been used to cover the Geotextile. The velocity of the current, the height and frequency of waves and the erodibility of the bank determine whether bank protection is needed. The Geotextiles used in bank protection serve as a filter.

On the basis of field studies, conducted in the past by CRRI, it has been concluded that shallow sacrificial slides constitute a significant proportion of landslides in areas with moderate rainfall intensity and where soil cover is medium cohesive in nature. Surficial slides extend to only a couple of meters below the slope surface and originate as a result of erosion from down flowing water over the denuded slopes. If erosion is allowed to proceed unchecked, there is every possibility that the damage may spread laterally thus increasing the depth of erosion, eventually resulting in a much larger damaged slope area. Vegetative turning represents one of the most important corrective measures. In the case of freshly exposed cutting made for road construction, vegetative turning is important, even as a preventive measure. In the case of deep-seated slides, however, vegetative turning is only one of the techniques among available corrective measures and as such it can prove to be effective only when conjointly implemented with other corrective measures. Based on several field trials carried out by the Institute, the use of jute geogrid technique has been developed for treatment of erodible slopes as a part of landslide correction works.

IV. CONCLUSION

Certain fundamental considerations are necessary for success in any application of Geotextiles. We must know the soils to select the proper geotextile in road construction and maintenance. In many installations, permeability may override concern for durability and resistance to bursting, puncturing and tearing. In other installations, such as a separator in a road where the geotextile will be subjected to severe loads, durability is of concern.

– Permeability should also always be considered in separation uses to allow moisture to move freely through the system. This avoids excessive hydrostatic pressures which cause soil failure.

– Most geotextile system failures result from improper installation, improper selection of fabrics, a change of conditions from the original design, or a combination of these factors.

– In the present realm of growing global emphasis on adoption of bio-technical measures, Jute Geotextile deserves encouragement due to its several striking attributes. Of all the ingredients of natural geosynthetics, jute happens to be the best spendable fiber that ensures making of customized fabric to meet site-specific requirements.

– JGT is also the most droppable of all geosynthetics—a property essential for control of surficial soil erosion. Its low extensibility and high initial strength helps in enhancing the bearing capacity of soil.

– When selecting a Geotextile a designer must take into account not only the mechanical and hydraulic properties of the Geotextile at the point of manufacture, but the proven longevity of the properties in the site environment, both prior to installation and for the duration of the design.

Thus, the use of Geotextiles manufactured from the bi-products of other manufacturing processes must be undertaken with extreme caution as the long term performance can never be fully known.

REFERENCES

[1] Scholz, M. Wetland Systems to Control Urban Runoff; Elsevier: Amsterdam, The Netherlands, 2006.

[2] Narejo, D.B. Opening size recommendations for separation geotextiles used in pavements. Geotext. Geomemb. 2003, 21, 257–264.

[3] Newman, A.P.; Pühmeier, T.; Kwok, V.; Lam, M.; Coupe, S.J.; Shuttleworth, A.; Pratt, C.J. Protecting groundwater with oil-retaining pervious pavements: Historical perspectives, limitations and recent developments. Quart. J. Eng. Geol. Hydrogeol. 2004, 37, 283–291.

[4] Pratt, C.J.; Mantle, D.G.; Schofield, P.A. UK research into the performance of permeable pavement, reservoir structures in controlling stormwater discharge quantity and quality. Water Sci. Technol. 1995, 32, 63–69.

[5] Tota-Maharaj, K.; Scholz, M. Artificial neural network simulation of combined permeable pavement and earth energy systems treating storm water. J. Environ. Eng. ASCE 2012, 138, 499–509.

[6] Miklas Scholz. Water Quality Improvement Performance of Geotextiles Within Permeable Pavement Systems. Water 2013, 5, 462-479; doi: 10.3390/w5020462

[7] Sanyal–Control Of Bank Erosion Naturally- A Pilot Project in Nayachara Island in the River Hugli (National Workshop on Role of Geosynthetics in Water Resources Projects at New Delhi,1992)— Sanyal & Chaudhury–Appraisal Of Performance (All India Seminar on Applications of Jute Geotextiles in Civil Engineering at Kolkata,India 2002)