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**ABSTRACT**

Geotextile a newly emerging field in the civil engineering and other fields, offer great potential in varied areas of application globally. It plays a significant part in modern pavement design and maintenance techniques. Ideal materials for infrastructure works, roads, harbors and many others.

Growth in use of geotextiles worldwide for transportation application. Geotextiles have been used for thousands of years. Geotextiles were used in roadway constructions in the days of the Pharaohs to stabilize roadways and there ages. Textiles are not only clothing for human body, but also for our motherland in order to protect her. Geotextiles has proven to be among the most versatile and cost-effective ground modification material.

Geotextiles should fulfill certain requirements like it must permit material exchange between air and soil without which plant growth is impossible, it must allow rain water to penetrate the soil from outside and also excess water to drain out of earth without erosion of soil. To obtain all these properties in geotextiles, the proper choice of textile fiber is of paramount importance.

**KEYWORD:** GEOTEXTILES, WATER TORDRAIN, 1.Wovenfabrics, 2.Non-wovenfabrics, 3.Knitted fabrics.

**INTRODUCTION**

The concept of inclusions for strengthening and stabilizing soil dates back to 3000 B.C. during which time records are available of its use in countries like the present day Iraq and ancient China. An early application (1926) with natural material was the use of heavy cotton fabric as a separator to stabilize roads in South Carolina, U.S.A. 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. The first nonwoven needle-punched geotextile was produced by a company in France. Chemie Linz in Austria was one of the early leaders in geotextile technology producing needle-punched nonwoven geotextiles under the trade name Polyfelt. Geotextiles were originally intended to be an alternative to granular soil filters. The original, and still sometimes used, term for geotextiles is filter fabrics. Work originally began in the 1950s with R.J. Barrett using geotextiles behind precast concrete seawalls, under precast concrete erosion control blocks, beneath large stone riprap, and in other erosion control situations. The discipline of geosynthetics began many years before it had a name. The terms "geotextile" and "geosynthetics" were not coined until Dr. JP Giroud used those terms in a seminal paper and presentation at an engineering conference in Paris in 1977. The significance of that conference led to it being known, after the fact, as the First International Conference on Geosynthetics (1 ICG). In this article for Land and Water Magazine, Geosynthetica's Chris Kelsey provides a look at some of the highlights in and history of geotextiles over the past 40 years.

Geotextiles: Geotextile the word is divided into two parts, that is "geo" means earth and "textile" means fabric so it is nothing but a fabric laid beneath the pavement to mainly increase stability. The ASTM (4439) defines geotextiles as: "A permeable textile material that is used with soil, rock, earth, or any geotechnical related materials to increase stability of soil and decrease water erosion "Geotextiles should fulfill certain requirements like it must permit material exchange between air and soil without which plant growth is impossible,

It must allow rain water to penetrate the soil from outside and also excess water to drain out of earth without erosion of soil. Geotextiles are widely used in geotechnical and structural applications such as roads and railways, earth structures, drainage and filtration systems, hydraulic works and many other applications. The use of geotextiles is well-known, and is becoming an increasingly integrated part of structural designs and solutions. The idea is not new; in fact, stabilizing and reinforcing structures using straw or wood has been done for more than a 1,000 years.

**Manufacture:** Geotextile and related products are manufactured from four synthetic polymers, which, in the order of development, are Polyethylene (1931), Polyamide (1935), Polyester (1941) and Polypropylene (1954). The yarn used to produce a woven geotextile may be monofilament or multifilament or their combinations. However, slit film tapes have recently become the most common form of yarn used for the manufacture of woven geotextiles. Nonwoven geotextiles are produced by needle-punching (mechanical bonding), Thermal bonding (by heat), Chemical bonding, and the last being the least common method.

#### **Characteristics of Geotextiles:**

**PHYSICAL PROPERTIES:** 1. Specific gravity, 2. Weight, 3. Stiffness, 4. Density

**MECHANICAL PROPERTIES:** 1. Tensile strength, 2. Tearing strength, 3. Flexibility, 4. Frictional resistance, 5. Tenacity

**HYDRAULIC PROPERTIES:** 1. Porosity, 2. Permeability, 3. Permittivity, 4. Turbidity soil retention

**DEGRADATION PROPERTIES:** 1. Biodegradation, 2. Hydrolytic degradation, 3. Chemical degradation

**ENDURANCE PROPERTIES:** 1. Elongation, 2. Abrasion resistance, 3. Clogging length and flow

#### **GEOTEXTILE TYPES**

The geotextiles are prepared in three different Categories: 1. Woven fabrics, 2. Non-woven fabrics, 3. Knitted fabrics. **Woven fabrics** Woven Geotextiles are most commonly used in applications that require increased support and stabilization. This will include implementation under dirt roads, rip rap, driveways or other areas with increased traffic. The woven geotextile saves on aggregate placement and repair costs based on constructing and maintaining an unpaved roadway. Soft subgrades, covered with the appropriate geotextile, stabilize access or haul roads by spreading applied loads over a wider foundation, reducing rutting and preventing contamination by the subgrade soil. This will allow better traffic flow; improve the roadway's long-term use and lower maintenance costs. The California Bearing Ratio (CBR) is used to measure a subgrade's strength. ADS woven geotextiles are able to perform different functions based on the subgrade's strength. The functions range from reinforcement on weak subgrades, which have a CBR  $\leq 3\%$ , to separation on firm foundation soils, which have a CBR  $\geq 8\%$ . Stronger woven geotextiles will be used on weaker subgrades and a less robust woven geotextile can be used on a better soil. The woven silt fences are recognized by the EPA as a Best Management Practice (BMP) and offer UV resistance, strength and hydraulic properties.

#### **Non-woven fabrics**

One of the most popular options for drainage, filtration and stabilization is the Nonwoven Geotextile Fabric. Constructed from a felt-like fabric, these geotextiles are light in weight and able to both filter and reinforce construction areas. Nonwoven geotextiles are commonly used in ditches, around pipes, underneath drains, or in other areas dealing with high levels of runoff or site drainage. By contrast to the nonwoven materials above, Woven Geotextiles are most commonly used in applications that require increased support and stabilization. This will include implementation under dirt roads, rip rap, driveways or other areas with increased traffic.

#### **Knitted Fabrics**

Knitted geosynthetics are manufactured using another process which is adopted from the clothing textiles industry, namely that of knitting. In this process interlocking a series of loops of yarn together is made. Only a very few knitted types are produced. All of the knitted geosynthetics are formed by using the knitting technique in conjunction with some other method of geosynthetics manufacture, such as weaving.

#### **APPLICATION**

Geotextiles are widely used in geotechnical and structural applications such as roads and railways, earth structures, drainage and filtration systems, hydraulic works and many other applications. To assist designers

and users, several application standards have been established. One of the main goals of the European standardisation work is to establish harmonised standards that provide guidelines on how to specify the relevant characteristics of geotextiles and geotextile-related products when used in various applications. The list of harmonised application standards is presented in Figure 4.1.

	EN13249	Construction of roads and other trafficked areas
	EN 13250	Construction of railways
	EN 13251	Earthworks, foundations and retaining walls
	EN 13252	Drainage systems
	EN 13253	Erosion control works
	EN 13254	Construction of reservoirs and dams
	EN 13255	Construction of canals
	EN 13256	Construction of tunnels and underground structures
	EN 13257	Solid waste disposals
	EN 13265	Liquid waste containment projects

#### Road Works:

The basic principles of incorporating geotextiles into a soil mass are the same as those utilized in the design of reinforced concrete by incorporating steel bars.

$CF_1$  = factor for subsoil conditions:

Corr. factor $CF_1$	Subsoil conditions (- / CBR %)
1	Firm subsoil CBR $\geq 3$
1.2	Medium subsoil $1 < \text{CBR} < 3$
1.4	Weak subsoil CBR $\leq 1$

$CF_2$  = factor for construction conditions:

Corr. factor $CF_2$	Construction conditions (-)
0.9	Low construction traffic and low compaction impact
1.1	Normal construction traffic and normal compaction impact
1.3	Heavy construction traffic and heavy compaction impact

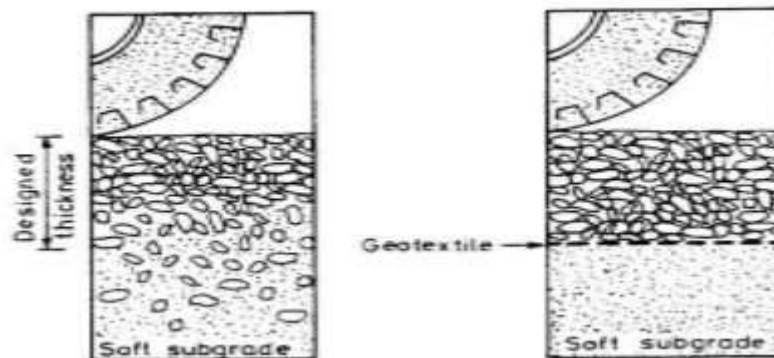
$CF_3$  = factor for traffic load:

Corr. factor $CF_3$	Traffic load (-)
1	Normal - Access roads, small roads (<500 vehicles per day)
1.25	High - Medium and high-volume roads (>500 vehicles per day)

For typical road constructions using geotextiles as filtration and separation elements to prevent intermixing of aggregate and subsoil, the required Energy Index model has been setup, with the specific description of the correction factors. The correction factors for road construction installations are regarded to be functions of: CF (subsoil conditions, construction conditions, traffic load, filling/aggregate material), where

EI basis: For road construction installations with an expected lifetime of up to 25 years, the basic requirement is set to 1.75 kN/m. Using this model, the required Energy Index is between 1.6 and 6.4 kN/m depending on the conditions.

For permanent installations, the durability aspect should be considered, and the requirements in this relation should be specified. A geotextile with the functions “filtration” and “separation” is to be installed in a permanent road construction, according to the following information: Road: permanent road with low traffic Subsoil: clayey sand with a CBR of 2%. Construction conditions: is to be installed using normal machinery and Acts as a separator to prevent two dissimilar materials (subgrade soil sand aggregates) from intermixing. Geotextile and geogrids perform this function by preventing penetration of the aggregate into the subgrade (localized bearing failures) Soft subgrade soils are most susceptible to disturbance during construction activities such as clearing, grubbing, and initial aggregate placement.



*Concept of geotextiles separation Figure: 4.2 Concept of geotextiles separation*

The system performance may also be influenced by secondary functions of filtration, drainage, and reinforcement. The geotextile acts as a filter to prevent fines from migrating up into the aggregate due to high pore water pressures induced by dynamic wheel loads.

It also acts as a drain, allowing the excess pore pressures to dissipate through the geotextile and the subgrade soils to gain strength through consolidation and improve with time.

## RAILWAYWORKS

The woven fabrics or non-woven fabrics are used to separate the soil from the sub-soil without impeding the ground water circulation where ground is unstable. Enveloping individual layers with fabric prevents the material wandering off sideways due to shocks and vibrations from running trains.

- Track Bed Design
- Reinforced Earth Embankment
- Formation Rehabilitation

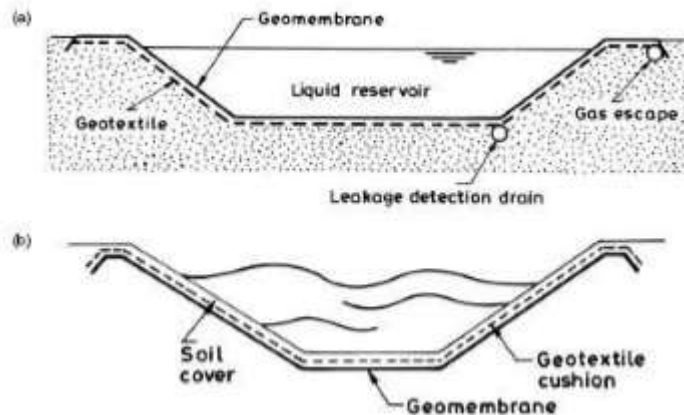


**Figure: 4.3 Example of railway construction River Canals and Coastal Works:**

When used in conjunction with natural or artificial enrockments, geotextiles act as a filter. The woven fabrics are recommended in soils of larger particle size as they usually have larger pore size. Non-woven fabrics are used where soils such as clay silt are formed.

Liquid containment and conveyance facilities, such as ponds, reservoirs and canals, are required in several areas including hydraulic, irrigation and environmental engineering. Unlined ponds, reservoirs, and canals can lose 20–50% of their water to seepage. Traditionally, soil, cement,

concrete, masonry or other stiff materials have been used for lining ponds, reservoirs and canals. The effectiveness and longevity of such materials are generally limited due to cracking, settlement and erosion. Sometimes the traditional materials may be unavailable or unsuitable due to construction site limitations, and they may also be costly.



**Figure: 4.4 Canal construction - installation and design**

**Drainage:**

The use of geotextiles to filter the soil and a more or less single size granular material to transport water is increasingly seen as a technically and commercially viable alternative to the conventional systems. Geotextiles perform the filter mechanism for drainages in earth dams, in roads and highways.

**Sports field construction:**

Geotextiles are widely used in the construction of Caselon playing fields and Astro turf. Caselon playing fields are synthetic grass surfaces constructed of light resistance polypropylene material. Astro Turf is a synthetic turf sport surface.

**Agriculture:**

It is used for mud control. For the improvement of muddy paths and trails those used by cattle or light traffic, nonwoven fabrics are used.

**JUTE GEOTEXTILE**

In India jute is easily and widely available so basically the roads are constructed using jutes rather than synthetic fibers. Let's see some more things about jute geotextiles. Jute Geotextiles (JGT) is a natural variant of man-made geotextiles loosely called 'Geo-synthetics'.

*Figure: 5.1 Jute Plants*

**ADVANTAGES OF JUTE GEOTEXTILE**

- Abundant quantity (INDIA is producing 20 lakh mt of jute per year).
- Great moisture retention capability.
- Bio-degradable properties.
- Lower cost compare to synthetic geotextile.
- High initial tensile strength.



*Figure: 5.2 JUTE FIBRES*

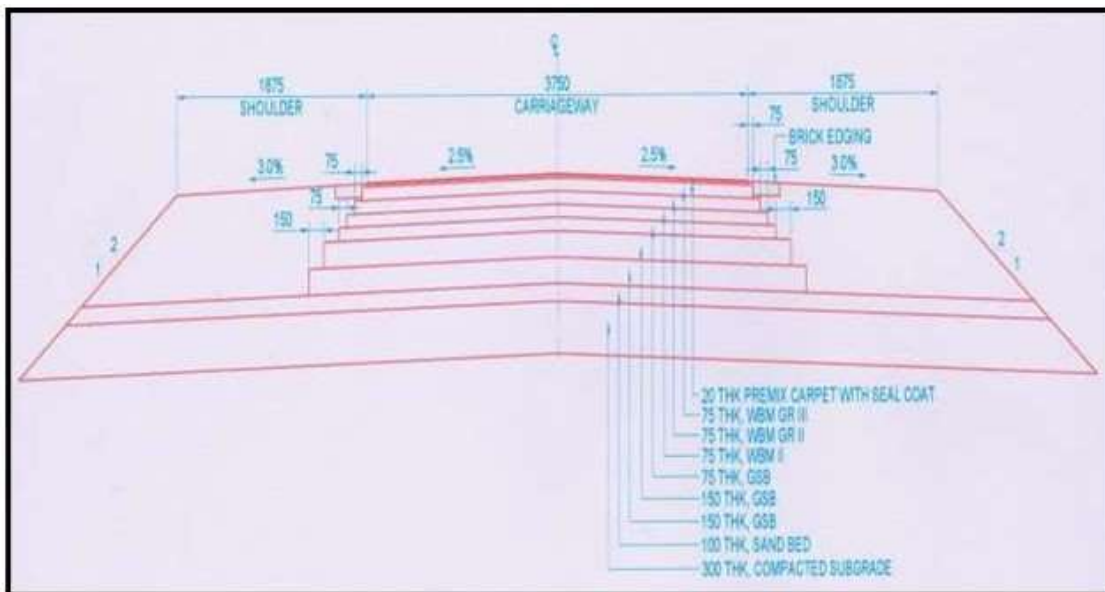
**Use of Jute Geotextiles for Improving Performance of PMGSY Roads**

- To study the use of jute geotextile in the road pavement (Benefit of JGT of varying strength as an agent for improvement in load bearing capacity of the subgrade, specifically the subgrade CBR and overall improvement in pavement performance)
- Role of open weave JGT as bio-engineering protective measure by facilitating growth of vegetation on the embankment slopes and earth shoulders
- DPR for 10 Pilot project under varying soil/ climatic conditions was prepared jointly by CRRI & JMDC for 5 States namely West Bengal, Assam, Orissa, Madhya Pradesh and Chhattisgarh
- However, due to certain technical and administrative problem only 5 roads could be completed.

**Use of Jute Geotextiles (JGT) for Improving Performance of Rural Roads**

- To study the use of jute geotextile in the road pavement as a drainage layer, bioengineering measure for shoulders and earthen slopes, improving the pavement performance and reducing the pavement crust thickness
- Pavement sections as per IRC Practice, Thinner pavement sections without JGT and Test sections incorporating different varieties of JGT
- Pilot project taken up in 5 PMGSY roads across five states under varying soil/ climatic conditions

**TYPICAL ROAD SECTIONS ADOPTED IN PMGSY PROJECT**



*Figure: 5.3 Pavement cross section with IRC-SP-20*



*Figure: 5.4 Laying of bitumen treated jute geotextile in West Bengal*



*Figure: 5.4 Slope protection with Jute Geotextile*

### Details of Ten Selected Roads for Pilot Project Using JGT

Sl. No.	State	Name of the Road	Length (km)
1	Odisha	Jadupur to Mahanangal, Kendrapara District	5.50
2	Odisha	MDR 14 to Chatumari, Jajpur District	4.00
3	Madhya Pradesh	Berasia to Semrakalan Approach Road, Bhopal District	5.10
4	Madhya Pradesh	Gehlwan village to PMGSY road, Raisen District	3.14
5	Chhattisgarh	Kodavabani to Khursi Road, Bilaspur District	4.80
6	Chhattisgarh	Kherajiti to Ghirghosa road, Kawardha District	5.50
7	West Bengal	Notuk to Dingal Road, West Midnapore District	4.80
8	West Bengal	Nandanpur to Marokhana High School Road, Hooghly District	6.20
9	Assam	Rampur Satra to Dumdumia, Nagaon District	4.20
10	Assam	UT Road to Jorabari, Darang District	4.60
Total Length			47.84

*Table 2.8 Road using JGT*

#### Advantages and Disadvantages



#### Advantages of Geotextiles

The manufactured quality control of geosynthetics in a controlled factory environment is a great advantage over outdoor soil and rock construction. Most factories are ISO 9000 certified and have their own in-house quality programs as well.

The thinness of geosynthetics versus their natural soil counterpart is an advantage insofar as light weight on the subgrade, less airspace used, and avoidance of quarried sand, gravel, and clay soil materials.

The ease of geosynthetic installation is significant in comparison to thick soil layers (sands, gravels, or clays) requiring large earthmoving equipment.

Published standards (test methods, guides, and specifications) are well advanced in standards-setting organizations like ISO, ASTM, and GSI.

Design methods are currently available in that many universities are teaching stand-alone courses in geosynthetics or have integrated geosynthetics in traditional geotechnical, geoenvironmental, and hydraulic engineering courses.

When comparing geosynthetic designs to alternative natural soil designs there are usually cost advantages and invariably sustainability (lower CO<sub>2</sub> footprint) advantages.

#### Disadvantages of Geotextiles

Long-term performance of the particular formulated resin being used to make the geosynthetic must be assured by using proper additives including antioxidants, ultraviolet screeners, and fillers.

Clogging of geotextiles, geonets, geopipe and/or geocomposites is a challenging design for certain soil types or unusual situations. For example, loess soils, fine cohesion less silts, highly turbid liquids, and microorganism laden liquids (farm runoff) are troublesome and generally require specialized testing evaluations.

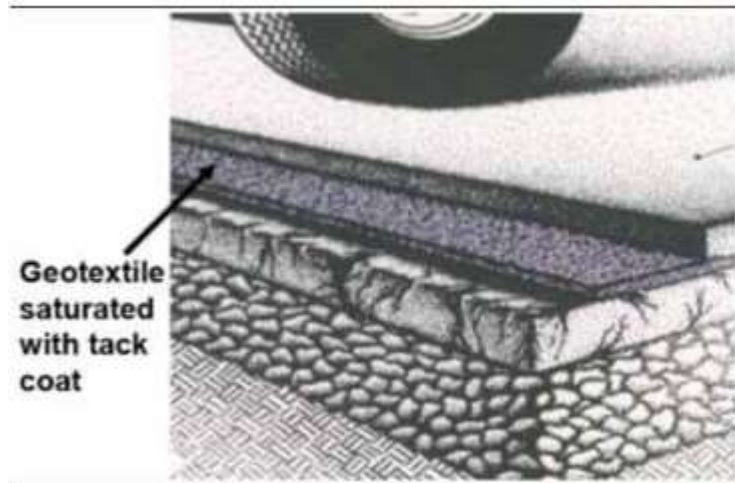
### SUMMARY AND CONCLUSION

To summarize, the Project focused on these applications:

- Trench Drain
- Underdrain
- Base or Subbase Separation
- Base or Subbase Stabilization
- Base or Subbase Capillary Barrier
- Base or Subbase Reinforcement
- Subgrade Restraint

Note the existence of mitigation of reflective cracking, an important application not focused on in this report. Mitigation of crack propagation is performed by a nonwoven geotextile used immediately beneath a pavement overlay. Under normal conditions, an asphalt layer is subjected to thermal cracking (due to environmental stresses) and reflection cracking (due to load-induced stresses). The geotextile acts as a stress relieving interlayer, dissipating stresses before the crack induces stresses in the overlay. In addition, when a geotextile is impregnated with asphalt or other polymeric mixes, it becomes relatively impermeable to both cross-plane and in-plane flow. As shown in Figure 6.1, the nonwoven geotextile is placed on the existing pavement surface following the application of an asphalt tack coat.

The geotextile has been reported to not only prevent cracks in the overlay but also act as a waterproofing layer, minimizing migration of water into the pavement structure. Figure 6.1:



*Figure 6.1: Geotextile used for the pavement overlay*

Geotextile used for mitigation of crack propagation into the pavement overlay. Another common application for high strength geotextiles is global reinforcement. A geotextile placed for this application helps to prevent deep-seated, rotational failures. Determination of an appropriate geotextile for global reinforcement is highly project- and material- specific, and requires a rigorous design procedure. Multiple layers of geotextile may be required. Due to the nature of the application, a simplified set of selection guidelines does not apply. Therefore, reinforcement for global stability is not addressed in this project.

Results from the national surveys indicate widespread use of geotextiles for various applications in roadway design. Both sets of results indicate that some confusion remains regarding geotextiles and their applications; however, project responses indicated a major lack of understanding. This result is important in reinforcing the importance of developing the deliverables targeted with this project—guidelines for including geotextiles in design and an educational program to get the information to working engineers.

## CONCLUSION

Textiles are not only for clothing the human body but also our motherland in order to protect her. Extensive awareness should be created among the people about the application of geotextiles. Geotextiles are effective tools in the hands of the civil engineer that proved to solve a myriad geotechnical problems. To explore the potential of geotextile more researches are needed in this field.

The report is unusual in that it documents the use of a geotextile type of fabric and its performance over a 35 year period.

The initial purpose of the test, 35 years ago, was to determine if and which fabric would perform effectively as a geotextile in a separation application under an unpaved road.

Mere usage of Geosynthetics will not ensure good performance. Proper selection of Geosynthetics, Proper selection of Geosynthetics, correct design and quality correct design and quality assurance are essential.

## RECOMMENDATION FOR FUTUREWORK

The results of this study indicate that strength and stiffness of the junctions and tensile members mainly contribute to the performance of geosynthetics when used as subgrade stabilization, and the relative contribution of these material properties depends on the thickness of the base course aggregate layer and the anticipated rut depth. Practitioners who wish to use geosynthetics as subgrade stabilization should consider specifying minimum values for material properties that correlated with good performance of the test sections. These minimum values can be categorized by the severity of the site conditions, ranging from moderate to severe, as demonstrated in the two

phases of this project. Further work is necessary to more confidently specify minimum values for geosynthetic material properties associated with good rut performance. The specified properties are mutually important, and products having only one of the specified properties may not perform well. Further research is necessary to determine the combined effect of these properties as they relate to subgrade stabilization of a greater variety of base thicknesses and subgrade strengths. Information from that research could be used to augment or determine specific design parameters for a wider range of subgrade stabilization applications.

Despite the fact that the woven and non-woven geotextiles performed well in the field study, it is unknown which material properties are directly responsible for their performance. Intuitively, surface friction properties and tensile strength of the materials plays an important role however, additional work is needed to evaluate the effect individual geotextile properties have on their performance. When looking to future generations of geotextiles, an examination of the role of nanotechnology in the functional enhancement of geotextiles is in order.

By reducing fiber diameter down to the nanoscale, an enormous increase in specific surface area to the level of 1000 m<sup>2</sup>/g is possible.

Due to the reduction in dimension and increase in surface area greatly affects the chemical/biological reactivity and electro activity of polymeric fibers.

There is an overall impact on the geometric and the performance properties of the fabric because of the extreme fineness of the fibers.

There is an explosive growth in worldwide research efforts recognizing the potential Nano effect that will be created when fibers are reduced to nanoscale.

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