Study of effectiveness of geotextile and its mechanical behaviours contributing to India's market trends and development

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***ABSTRACT**:*
Geotextile an synthetic pervious textile material accustomed to improve the soil characteristics. Once related to soils, it's flexibility to separate, filter, reinforce, protect and drain. They are good materials for several infrastructural works like roads, harbours, landfills, drainage structures, and different construction projects. The researchers have tried to grant an outline of the recent trends within the use of geotextiles and its related products in civil engineering applications in India. Our review has data for manufacture of geotextiles in India and their properties, testing instrumentality and specifications for geotextiles in India, applications of geotextiles in India, analysis on geotextiles in India, and the use of geotextiles made from natural fibres and materials in India. This analysis is completely supported by secondary knowledge collected through numerous sources like analysis papers, journals, websites and newspaper articles.

Keywords *- Geotextiles, geosynthetics, Key market trends.*

I. Introduction

Geotextiles have tried to be among the versatile and cost-efficient ground modification materials. Their use has enlarged quickly into nearly all areas of civil, geotechnical, environmental, coastal, and civil engineering. They consist the major component of the field of geosynthetics, the others being geogrids, geomembranes and geocomposite. Geotextiles are porous textile materials employed in contact with soil, rock, earth or the other geotechnical related material as an important part of engineering project or structure. On the basis of their structure, geotextiles could also be generally classified into woven and nonwoven. Woven geotextiles are produced by the interlacement of warp and yarn yarns, which can be of spun, multifilament, fibrillated or of slit film. Nonwoven geotextiles are produced through a method of mechanical interlocking or thermal bonding of fibers/filaments.

Mechanical interlocking of the fibers/filaments is achieved through a method referred to as "needle punching". Needle-punched nonwoven geotextiles are widely used style of geotextile in our country as well as in the world. Interlocking of the fibers/filaments might even be achieved through "thermal bonding". Heat-bonded geotextiles ought to be used with caution, as they're not appropriate for filtration applications or road stabilization applications over soft soils.

Types of Geotextile

Geotextiles are composed of polymers like polyester/ polypropylene. They're divided into three types:

- **Woven Fabric Geotextiles**
  They are commonly found geotextiles of the woven kind and produced by adopting the techniques that are almost like weaving usual clothing textiles. This sort has the characteristic look of two sets of parallel threads or yarns. The yarn running alongside the length is termed as warp and the one running perpendicular is termed as weft.
- **Non-Woven Geotextiles**
  Non-woven geotextiles are composed from either continuous filament yarn or short staple fiber. The bonding of fibers is completed using thermal, chemical or mechanical techniques or a mixture of techniques.
- **Knitted Geotextiles**
  Knitted geotextiles produced by the method of interlocking a series of loops of yarn along. All of the Knitted geosynthetics are composed by using the knitting technique in conjunction with another methodology of geosynthetics manufacture, like weaving.

Functions of Geotextiles

The mode of operation of a geotextile in any application is defined by six distinct functions:

1. Reinforcement

The strength gain in soil due to the introduction of geotextile is by the subsequent three mechanisms:

• The effects of frictional restraint between geotextile and soil aggregate.
• The potential surface failure plane is forced to develop an alternate higher shear strength surface.

2. Sealing

A layer of non-woven geotextile is inseminated in between existing and new asphalt layers. Asphalt is absorbed by geotextile to become a waterproofing membrane which helps in minimizing vertical flow of water into the pavement structure.

3. Separation

The separation of geotextile is majorly utilized in the development of roads. Geotextile prevents the intermixing of two adjacent soils between subgrade in rail road and stone base in unpaved and paved roads and airfields.

It also prevents the intermixing of two adjacent soils between landfills and stone base courses and between geomembranes and sand drainage layers.

4. Filtration

The equilibrium of geotextile-to-soil system that permits for adequate liquid flow with restricted soil loss across the plane of the geotextile. Porosity and permeability are the most important properties of geotextiles that involve infiltration action.

Uses and applications of Geotextile in Construction

- Drainage
  The use of geotextiles to filter the soil and an additional or less single size granular material to move water is more and more seen as a technically and commercially viable alternative to the conventional systems. Geotextiles perform the filtering mechanism for

drainages in earth dams, in roads and highways, in reservoirs, behind retentive walls, deep drainage trenches, and agriculture.

- River, Canals and Coastal Works
  Geotextiles shields river banks from erosion due to currents or lapping. Once used in conjunction with natural or artificial enrockments, they act as a filter.
- Road Work
  Geotextiles are wide employed in the development of road. It reinforces the soil by adding strength to it. it's used as a fast de-watering layer within the bed, the geotextiles needs to preserve its permeability without losing its separating functions.
- Railway Works
  The woven materials or the non-woven ones are accustomed to separate the soil from the sub-soil without hindering the ground water circulation wherever the ground is unstable. Enveloping individual layers with fabric prevents the material from wandering off sideways because of shocks and vibrations from running trains.
- Agriculture
  It is used for mud management. For the development of muddy paths and trails, employed by cattle or light-weight traffic, nonwoven fabrics are used and are rolled-up by overlapping.

II. Research Methodology

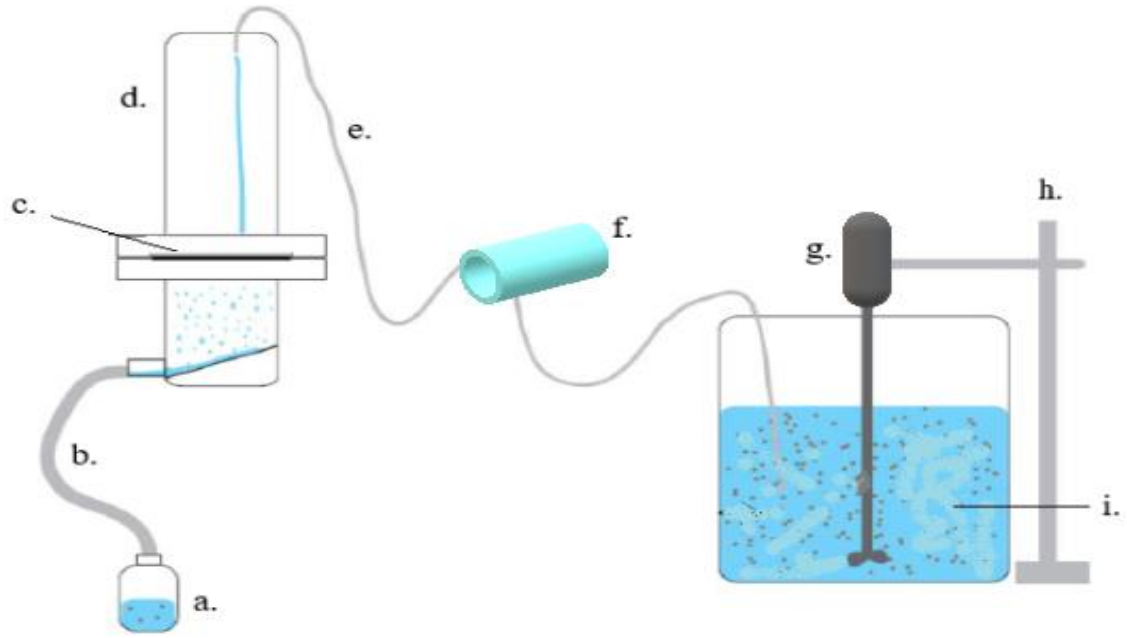
With reference to the research paper "Geosynthetic Filters for Water Quality Improvement of Urban Storm Water Runoff", we had done a research on a laboratory setup for geotextile filtration testing.

At first, a laboratory column setup was assembled to test the efficiency of geotextile filtration for storm water runoff. Then, the setup included a pump, a mixer, a 40-L plastic tub, tubing, 500-mL plastic sampling containers, the nonwoven geotextile filter, a rubber screen for filter support, and a Plexiglas column.

A simulated storm water solution was pumped into the top of the Plexiglas column containing a geotextile filter and effluent samples were collected at the bottom of the column. A hydrometer test was conducted on the soil to determine the particle sizes of the fine-grained soil.

Diagram:

Fig.: Laboratory setup demonstrating Principle of Geotextile filtration



where,
a. Sampling bottle
b. Outlet tube
c. Geotextile filter
d. Plexiglas column
e. Inlet tube
f. Pump
g. Mixer
h. Mixer stand
i. Influent suspension

Through the above diagram, six effluent samples were collected at every 30 minutes time interval (because rainfall events between 30 minutes occur at a higher frequency), and the concentrations of all six samples were used to calculate an effluent EMC value for each test as per the below EMC formula:

$$EMC = \sum \frac{Ci\ Qi\ \Delta Ti}{Qi\ \Delta Ti}$$

Where,
Ci = pollutant concentration of each sample within an event i;
Qi = runoff flow rate of the sample;
Δt = time interval between the samples

Below is the table for six sample readings:

Time	Flow Rate (Q) (l/s)	Concentration (mg/L)	Δt (sec)	Qi (L/S)	Ci (mg/L)	Qi Ci Δt (mg)	Qi Δt (L)
10:30 am	0	0	NA				
11:00 am	2.1	3.2	1800	1.05	1.6	3024	1890
11:30 am	4.7	4.5	1800	3.4	3.85	23562	6120
12:00 pm	8.1	5.8	1800	6.4	5.15	59328	11520
12:30 pm	9.0	4.4	1800	8.55	5.1	78489	15390
01:00 pm	8.8	3.8	1800	8.9	4.1	65682	16020

$\sum$Qi Ci Δt (mg) = 230085
$\sum$Qi Δt (L) = 50940

Calculation involved:

Event Mean Concentration, EMC = $\sum \frac{Ci\ Qi\ \Delta Ti}{Qi\ \Delta Ti}$

= 230085 (mg) / 50940 (L)

= 4.516 mg/L

Interpretation:

The EMC value of 4.516 mg/L indicates that the pollutant concentration in the rainfall and that the rainfall is instantaneously well-mixed throughout.

III. Market Trends and development

1. Geotextiles are made from synthetic polymers, mainly including polypropylene, polyester, polyethylene, etc., which are very less likely prone to decay under biological and chemical processes. This feature makes geotextiles useful in the construction and maintenance of roads. During the past decade, there had been considerable growth in the usage of geotextile in the construction industry, worldwide. These materials are permeable textile structures used mainly in construction applications. The possible applications of geotextiles in the construction sector have been successfully developed. They offer high benefits in terms of economics, performance, and durability. These materials are used in road, highway, earth dam, railroad, industry, stabilization of soil, control of drainage, tunnel construction, etc. Thus, the above-mentioned factors are expected to drive the geotextile market over the forecast period.

2. Acknowledging the significant role of geo-textiles in addressing traditional civil engineering solutions, especially in Northeast India, the Indian government has set aside ₹427 crore for use between 2016 and 2020 to promote and increase the use of geo-textiles

in road construction, hill protection and lining of reservoirs for water retention.

3. The Union Ministry of Textiles has with active involvement of the eight north-eastern state governments formulated a Scheme for Promotion and Adoption of Geo-textiles in the Northeast where there is clearly a high demand in sight of frequent damage to infrastructure due to heavy rain and landslides.

4. It has already initiated the mechanism for appointing a project coordinating agency for the scheme by issuing an expression of interest (EoI) in this regard in September 2017. India also allows 100 per cent FDI under the automatic route to facilitate integration of state-of-the-art technology in manufacturing processes and end products.

5. The Union government conjointly offers import concessions for technology upgradation fund schemes up to five per cent on specific machinery.
Additionally, several state governments have their own concessions on land registration, electricity, stamp duty fees and so on to invite investments and entrepreneurs in this field. Geo-synthetics are also gaining currency across the world in the waste management industry as they offer isolation and protection (preventing seepage) to the surrounding soil substrate. By any yardstick, geo-technical textiles are poised to command a big domestic market if sustained efforts to popularise them are continued.

6. Geotextiles Market size was over USD 4,195 million in 2016 and industry expects consumption at over 9,045 million square meters by 2024.
Growing demand for purposeful and high performance textiles in agriculture, road construction and erosion control applications along with increasing development in construction industry is likely to accelerate the geotextiles market growth.

7. These products have gained popularity owing to their superior benefits such as liquid repellency and mechanical strength. Global construction industry expenditure amounted over USD 10 trillion in 2016 which is likely to have a positive impact on the product demand. Rising investments by government in public utility infrastructures owing to increasing industrialization is likely to drive the market size.

8. According to TechSci report, “India Geotextiles Market By Type, By Material, By Application, Competition Forecast & Opportunities, 2012 - 2026” geotextiles market in India is forecasted to grow at CAGR 12% during 2016 - 2025. Ongoing and upcoming highway projects under green highway mission by Ministry of Road Transport and Highway (MoRTH), coupled with increasing investments to improve and expand road and railway networks across the country area, expected to fuel demand for geotextiles in India through 2026.

9. In FY2018, USD36.02 billion was allotted to the country’s transport sector, which includes shipping, road and rail. Whereas, budget allocation for highways in the road sector increased from around USD8.65 billion in FY2017 to USD9.68 billion in FY2018. The said factors are expected to drive demand for geotextiles in India through 2026.

10. Railway is one amongst the quickest rising application areas for geotextiles in India, as upcoming metro rail, bullet train and high speed train projects in the country are expected to fuel geotextile demand during 2017-2026.

11. Polyester is used for producing geotextiles is predicted to witness quickest growth among all the materials used for producing geotextiles within the country.
Garware Wall Ropes Ltd., TechFab India Industries Ltd are among the leading companies in geotextiles market in India.

IV. Limitations of Geotextile

1. Long-term performance of the formulated resin being employed to create the geosynthetic should be assured by using additives such as antioxidants, ultraviolet screeners, and fillers.

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

3. There are some limitations with usage of jute geotextile. Installation is typical and required experienced contractors. Installation needs experienced contractor to ensure soil stabilisation and erosion protection. Due to difficulties in designing with material whose strength falls speedily to microorganism attack. Its strength and durability are too restricted for harsh application like steep slopes, higher altitude slopes or waterways. It conjointly doesn't perform well with heavy water flow and degrades too quickly in humid weather condition. It delays seed germination due to reduction in soil temperature.

V. Conclusion

Geotextiles or geosynthetics that belong to the technical textiles family possess high potential in numerous geotechnical and civil applications on road construction, railway track-bed stabilization, soil stabilization, erosion management, reinforcement, separation and drainage. Application domain is huge and has been increasing throughout the world. Apart from the regular uses, geosystems created with geotextiles like geotextile tubes, bags, containers etc. are playing a proactive role in hydraulic, coastal, offshore engineering and river protection works as eco-friendly, construction-friendly and cheaper alternatives of traditional protection and engineering solutions that typically are difficult, short live and not eco-friendly. The applications of geotextiles or geosynthetics in the form of geocontainer, geobag, geomat, geotube etc in numerous coastal and marine structures are highlighted as measures of coastal protection and coastal engineering works, followed by real-life ventures in our country and abroad. It must be remembered that because of the distinctiveness of majority of the coastal and marine structures mentioned, the installations of geotextiles/geosystems are application specific and need sound understanding of nature of problem to be solved, the behaviour of material to be employed, the optimum utilization of machineries concerned without creating so much environmental impact. Actual field trials are recommended before final application. The global geotextile market is portraying strong growth, also being additionally extremely competitive. In Indian scenario, the use of sand-filled geotextile tubes and geobags for the coastal protection works is within the developing phase.

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