BRCORP
TECHNOLOGY | INNOVATION | INDUSTRY

International Journal of
Advanced Structures and Geotechnical Engineering
ISSN 2319-5347, Vol. 03, No. 03, July 2014

Geo Textile - A Tremendous Invention of Geo Technical Engineering

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Abstract: Filter fabric usually known as Geo textile are a permeable synthetic, textile raw materials .Geo textile are generally used with foundation soil, rock earth or different geotechnical engineering related material. Geo textile plays a significant part in modern technical textile. The use of geotextile in transportation application becomes more popular in modern civil engineering sector. Geotextiles are used in civil engineering earthworks to reinforce of soil, to construct firm bases for temporary and permanent roads and highways, to line ground drains, so that the soil filters itself and prevents soil from filling up the drainpipes and to prevent erosion. The purpose of geotextile is in separation, in drainage, for reinforcement & infiltration. This paper carries the information about the overview of geotextile. For describing the geotextile, the manufacturing process, different application in different sector focusing on civil engineering transportation application, global geotextile market 2012-2016 and the market of geotextile by type, materials, & application are included. The authors have also discussed about the majors players and future of geo market.

Keywords: *Geotextile, Fibers, Fabrics, Properties, Market.*

1. Introduction:

According to the historical record, it is believed that the first applications of geotextiles were woven industrial fabrics used in 1950's. One of the earlist documented cases was a waterfront structure built in florida in 1958. Then, the first nonwoven geotextile was developed in 1968 by the Rhone Poulence company in France. It was a comparatively thick needle –Punched polyester, which was used in dam constraction in france during 1970. ***(Hsu-Yeh Huang and Xiao gao, 2000***). As we know, the prefix of geotextile , geo means earth and the 'textile' means fabric. Therefore, according to the definitions of ASTM 4439, the geotextile is defined as follows: [***Robert M. Koener, 1998***]

Geotextiles are permeable fabrics which, when used in association with soil, have the ability to separate, filter, reinforce, protect, or drain. Typically made from polypropylene or polyester, geotextile fabrics come in three basic forms: woven (looks like mail bag sacking), needle punched (looks like felt), or heat bonded (looks like ironed felt). Geotextile composites have been introduced and products such as geogrids and meshes have been developed. Overall, these materials are referred to as geosynthetics and each configuration—-geonets, geogrids and others—-can yield benefits in geotechnical and environmental engineering design.

The ASAE (Society for Engineering in Agricultural, Food, and Biological Systems) defines a geotextile as a "fabric or synthetic material placed between the soil and a pipe, gabion, or retaining wall: to enhance water movement and retard soil movement, and as a blanket to add reinforcement and separation." A geotextile should consist of a stable network that retains its relative structure during handling, placement, and long-term service. Other terms that are used by the industry for similar materials and applications are geotextile cloth, agricultural fabric, and geosynthetic. ***(http://www.drexel.edu/gri/gmat.htm*)**

2. Raw materials:

Different fribers from both natural as well as synthetic category can be used as geotextiles for various applications. Geotextiles are usually made from one of the four synthetic polymers: polyamide, polyester, polyethylene, and polypropylene or natural materials. *Polyamide* is also known as Nylon 6 and Nylon 6.6. *Polyester* are additives used in the production of polyester are a) catalysts which increase the speed of polymerization b) phosphatic compounds which reduce thermal degradation during processing in the molten stage; and c) ageing inhibitors (including carbon black) which increase the U.V. resistance. *Polyethylene* has two main groups of polyethylene can be identified: - i) Low density polyethylene (density 920-930 kg/m^3) ii) High density polyethylene (density 940-960 kg/m^3). The polymerization of propylene monomers in the presence of specific catalyst produces the crystalline thermoplastic *polypropylene. Natural fibers* in the form of paper strips, jute nets, wood shavings or wool mulch are being used as geotextiles. *Ramie* is the fibers which have silky luster and have white appearance even in the unbleached condition. They constitute of pure cellulose and possess highest tenacity among all plant fribers. *Jute* is a versatile vegetable fiber which is biodegradable and has the ability to mix with the soil and serve as a nutrient for vegetation. However, their life span can be extended even up to 20 years through different treatments and blending. Thus, it is possible to manufacture designed biodegradable jute

geotextile, having specific tenacity, porosity, permeability, transmissibility according to need and location specificity. (***John N.W. 1987)***

3. Manufacturing process of geotextile:

Geotextiles are a permeable synthetic material made of textile materials. They are usually made from polymers such as polyester or polypropylene. The geotextiles are further prepared in three different categories – woven fabrics, non-woven fabrics and knitted fabrics.

3.1 Woven fabrics:

As their name implies, they are manufactured by adopting techniques which are similar to weaving usual clothing textiles. This type has the characteristic appearance of two sets of parallel threads or yarns -- .the yarn running along the length is called warp and the one perpendicular is called weft. The majority of low to medium strength woven geo synthetics are manufactured from polypropylene which can be in the form of extruded tape, silt film, monofilament or multifilament. Often a combination of yarn types is used in the warp and weft directions to optimize the performance/cost. Higher permeability is obtained with monofilament and multifilament than with flat construction only. (***wgbh boston , 1996-12***)

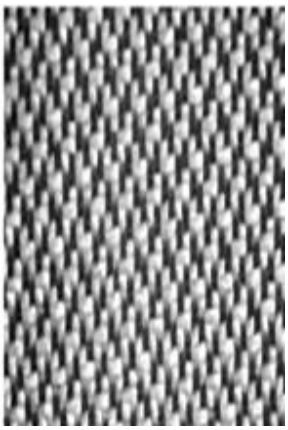

Figure 1*: Woven Geotextile*

Figure 2*: Non-woven Geotextile* ***(wgbh boston , 1996-12)***

3.2 Nonwoven:

Nonwoven geo-synthetics can be manufactured from either short staple fibre or continuous filament yarn. The fibers can be bonded together by adopting thermal, chemical or mechanical techniques or a combination of techniques. The type of fibre (staple or continuous) used has very little effect on the properties of the non – woven geo synthetics. ***(<www@ gmanow.com/pages/desconcept.asp>***) Non-woven geotextiles are manufactured through a process of mechanical interlocking or chemical or thermal bonding of fibres/filaments. Thermally bonded non-wovens contain wide range of opening sizes and a typical thickness of about 0.5-1 mm while chemically bonded non-wovens are comparatively thick usually in the order of 3 mm. On the other hand mechanically bonded non-wovens have a typical thickness in the range of 2-5 mm and also tend to be comparatively heavy because a large quantity of polymer filament is required to provide sufficient number of entangled filament cross wires for adequate bonding. **(<*www@ gmanow.com/pages/desconcept.asp*>)**

3.3 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. An example of a knitted fabric is illustrated in figure. 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.

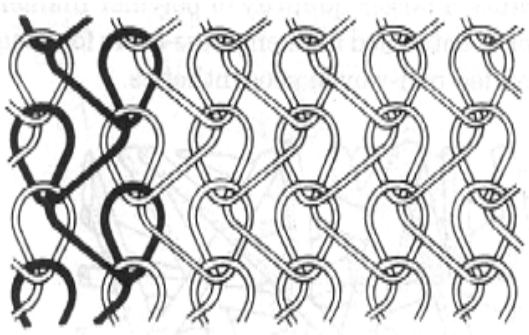

Figure 3*: Knitted Geotextile (****Anand S C, August 2000, 53)***

Apart from these three main types of geotextiles, other geosynthetics used are geonets, geogrids, geo-cells, geo membranes, geo composites, etc. each having its own distinct features and used for special applications.(***Anand S C, August 2000, 53***)

4. Basic function of geotextile:

Geotextiles form one of the two largest groups of geosynthetics. Their rise in growth during the past fifteen years has been nothing short of awesome. They are indeed textiles in the traditional sense, but consist of synthetic fibers rather than natural ones such as cotton, wool, or silk. Thus biodegradation is not a problem. These synthetic fibers are made into a

flexible, porous fabric by standard weaving machinery or are matted together in a random, or nonwoven, manner. Some are also knit. The major point is that they are porous to water flow across their manufactured plane and also within their plane, but to a widely varying degree. There are at least 80 specific applications area for geotextiles that have been developed; however, the fabric always performs at least one of five discrete functions: (***robert holtz d., 1997***)

4.1 Separation (TANFEL Report, 1990)

Geotextiles function to prevent mutual mixing between 2 layers of soil having different particle sizes or different properties. Table 2 shows the required properties for separation:

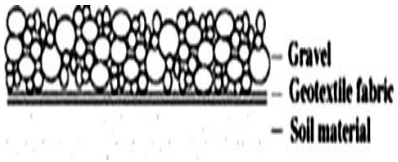

Figure 4*: Illustration of a geotextile fabric separating a gravel layer from the underlying soil material.* ***(~Ohio line/aex-fact/0304.html)***

Table 1*: The required properties for separation* ***(TANFEL Report, 1990)***

In different time	Mechanical	Hydraulic	Long-term Performance
During installation	Impact resistance Elongation at break	Apparent opening size (A.O.S.) Thickness	UV resistance
During construction	Puncture resistance Elongation at break	Apparent opening size (A.O.S.) Thickness	Chemical stability UV resistance
After completion of construction	Puncture resistance Tear propagation resistance Elongation at break	Apparent opening size (A.O.S.) Thickness	Chemical stability Resistance to decay

4.2 Drainage.

The function of drainage is to gather water, which is not required functionally by the structure, such as rainwater or surplus water in the soil, and discharge it. (***TANFEL Report, 1990***)

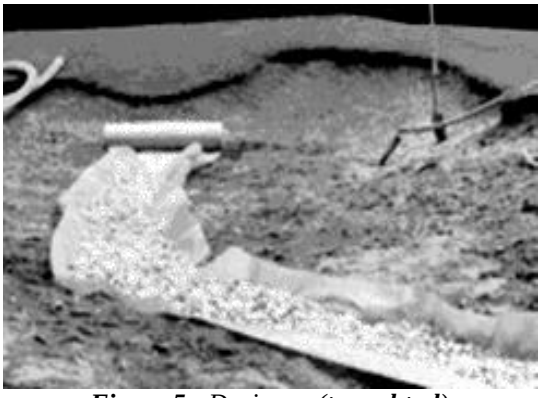

Figure 5*: Drainage (****typar.html****)*

Table 2: *The required properties for drainage* ***(TANFEL Report, 1990)***

Indifferent Function	Mechanical	Hydraulic	Long-term Performance
Permanent drainage function	Influence of normal overburden pressure	Permeability Thickness Apparent opening size (A.O.S.)	Chemical properties of water and soil Chemical stability Decay resistance
Temporary drainage function	Influence of normal overburden pressure	Permeability Thickness Apparent opening size (A.O.S.)	

4.3 Filtration :

Filtration involves the establishment of a stable interface between the drain and the surrounding soil. In all soils water flow will induce the movement of fine particles. Initially a portion of this fraction will be halted at the filter interface; some will be halted within the filter itself while the rest will pass into the drain. The geotextile provides an ideal interface for the creation of a reverse filter in the soil adjacent to the geotextile. The complex needle-punched structure of the geotextile provides for the retention of fine particles without reducing the permeability requirement of the drain. (***www.geofabrics.com.au/bidim.html≠filtration***)

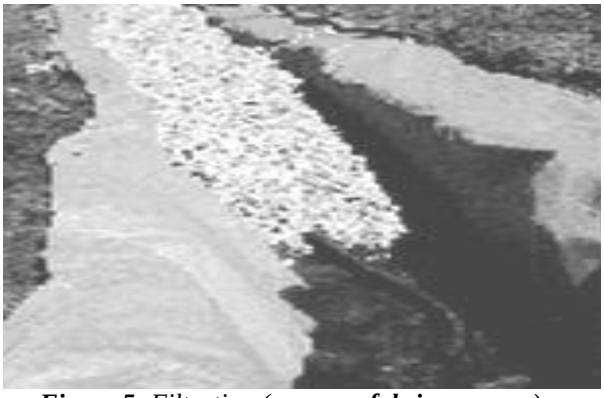

Figure 5: *Filtration (**www.geofabrics.com.au**)*

Table 3: *The required properties for Filtration (**TANFEL Report, 1990**)*

Function	Mechanical filter stability	Hydraulic filter stability	Long-term performance
Permanent filter function	A.O.S. Thickness	Geotextile permeability	Chemical properties of water and soil Chemical stability Decay resistance
Temporary filter function	A.O.S. Thickness	Geotextile permeability	

4.4 Reinforcement

Due to their high soil fabric friction coefficient and high tensile strength, heavy grades of geotextiles are used to reinforce earth structures allowing the use of local fill material. (***www.cofra.com)***

Figure 6: *Reinforcement (**www.cofra.com**)*

Table 4: *The required properties for reinforcement (**TANFEL Report, 1990**)*

When	Mechanical	Hydraulic	Long-term performance
Base failure	Shear strength of bonding system	Hydraulic boundary conditions	Chemical and decay resistance
Top failure	Tensile strength of geotextile Geotextile/ soil friction	Hydraulic boundary conditions	Chemical and decay resistance
Slope failure	Tensile strength of geotextile Geotextile/ soil friction		Creep of the geotextile/ soil system Chemical and decay resistance

4.5 Protection:

Erosion of earth embankments by wave action, currents and repeated drawdown is a constant problem requiring the use of non-erodable protection in the form of rock beaching or mattress structures. Beneath these is placed a layer of geotextile to prevent leaching of fine material. The geotextile is easily placed, even under water. (***http://www.geofabrics.com.au/bidim.html≠embankment***)

Figure 7*: Protection (/**bidim.html≠embankment**)*

Table 5: *The required properties for protection (**TANFEL Report, 1990**)*

Different section	Mechanical	Long-term performance
Tunnel construction	Burst pressure resistance Puncture resistance Abrasion resistance	Chemically stable: pH=2-13 Decay resistance
Landfill and reservoir geomembrane construction	Puncture resistance Burst pressure resistance Friction coefficient	Chemically stable: pH=2-13 Decay resistance
Flat roof construction	Puncture resistance	Chemical compatibility

5. Application of geotextile ***(gregory richardson n., barry christopher r, 1999)***

Civil engineering works where geotextiles are employed can be classified into the following categories –

5.1 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. It allow rapid dewatering of the roadbed, the geotextiles need to preserve its permeability without losing its separating functions.

5.2 Railway Works:

The woven fabrics or non-wovens 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.

Figure 8: *Illustration with geotextile* ***(/stabprod.html)***

Figure 9: Illustration without geotextile(**/stabprod.html)**

5.3 River Canals and Coastal Works:

Geotextiles protect river banks from erosion due to currents or lapping. When used in conjunction with natural or artificial enrockments, they act as a filter. For erosion prevention, geotextile used can be either woven or nonwoven.

5.4 Drainage:

In civil engineering, 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, in reservoirs, behind retaining walls, deep drainage trenches and agriculture.

5.5 Sports field construction:

Caselon playing fields are synthetic grass surfaces constructed of light resistance polypropylene material with porous or nonporous carboxylated latex backing pile as high as 2.0 to 2.5 cm. Astro Turf is a synthetic turf sport surface made of nylon 6,6 pile fibre knitted into a backing of polyester yarn which provides high strength and dimensional stability. It is claimed that the surface can be used for 10 hr/day for about 10 years or more.

5.6 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 and are folded by overlapping to include the pipe or a mass of grit.

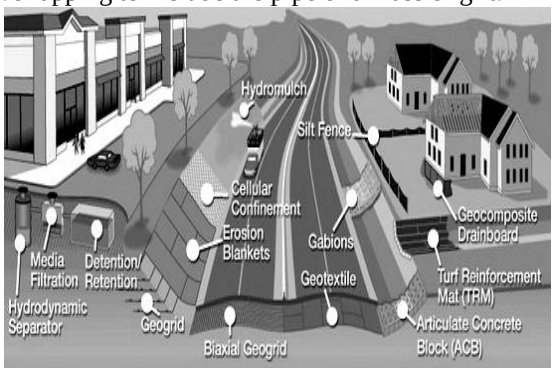

Figure 3*: Application of Geotextiles in Civil Engineering [****blogspot.com****]*

6. Global geotextile market 2012-2016

TechNavio's analysts forecast the Global Geotextiles market to grow at a CAGR of 10.96 percent over the period 2012-2016. One of the key factors contributing to this market growth is the increasing demand for geotextiles in road and railway construction. The Global Geotextiles market has also been witnessing an increased use of natural geotextiles. However, the rise in raw material prices could pose a challenge to the growth of this market. TechNavio's report, the Global Geotextiles Market 2012-2016, has been prepared based on an in-depth market analysis with inputs from industry experts. The report covers the market in Asia, North America, Europe, and the ROW; it also covers the Global Geotextiles market landscape and its growth prospects in the coming years. The report also includes a discussion of the key vendors operating in this market. The key vendors dominating this space include GSE Holding Inc., Officine Maccaferri S.p.A., NAUE GmbH & Co. KG., Royal TenCate N.V. The other vendors mentioned in the report are Fibertex Nonwovens A/S, Fiberweb Plc, Global Synthetics Pty. Ltd., Low & Bonar plc, Propex Operating Company LLC, Tenax Group Inc. ***(Reportbuyer.com, 2012-2016)***

7. Geotextile market by types, materials & application:

Geotextiles market is a major category within the global geosynthetics industry. It is the most dominating market within geosynthetics with a healthy market growth. The geotextiles market report gives a holistic view about the geotextiles industry while covering diverse market segments which include product types, applications, and materials. There has been a drastic usage of geotextiles in civil engineering applications in different parts of the globe; especially in Asia (China). Nonwoven geotextile is the major market segment for global geotextiles industry followed by woven geotextiles. These two types of products cover a major portion of the global geotextiles market with most of the market players involved in manufacturing and supplying of these product types. Some of the major manufacturers developing these product types include TenCate, NAUE, Huesker Synthetic, Fiberweb, and Propex. Knitted geotextiles form a small part of the global geotextiles industry. Polypropylene, polyester, and polyethylene are the major categories within the geotextiles materials market which are used in the production of geotextile products. Over the past few years, polypropylene and polyester have been the favorite materials for geotextile product manufacturers. Road industry is the dominating applications segment within geotextiles market. More than 50% of the market demand is expected to come from this segment. It is estimated that over the next five years, road industry will govern the geotextiles market share as far as applications are concerned. Some other major applications within geotextiles market include erosion control, waste containment, and pavement repair. The geotextiles market report gives a competitive scenario between the major players by evaluating the objectives of their different developments namely Mergers and acquisitions, Partnerships and agreements, New products launch, and Expansions. This gives a holistic view about the long term plans of the key market players in geotextile industry. Furthermore, the report also profile these companies in order to provide elaborative information such as company overview, financials, products and services, developments and strategies these companies are adopting in order to mark their presence in the market. ***(www.researchandmarkets.com)***

8. Major players:

Agru America Inc., Amcol International Corporation, Belton Industries Inc., Carthage MillsContech , Engineered Solutions Llc, E. I. Dupont De Nemours And Company, Fibertex Nonwovens A/S, Fiberweb Plc, Gundle/Slt Environmental Inc., Hov Environment Solutions Private Limited, Huesker Synthetic Gmbh, Kaytech Engineered Fabrics, Leggett & Platt Inc., Low & Bonar Plc, Naue Gmbh & Co. Kg, Nilex, Propex, Strata Systems Inc., Tenax Group, Royal Tencate Nv, The Dow Chemical Company, Thrace Plastics Co. Sa ***(www.researchandmarkets.com)***

9. Future of geotextile:

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 m2/g is possible. This reduction in dimension and increase in surface are a greatly affects the chemical/biological reactivity and electroactivity of polymeric fibers. Because of the extreme fineness of the fibers, there is an overall impact on the geometric and thus the performance properties of the fabric. There is an explosive growth in worldwide research efforts recognizing the potential nanoeffect that will be created when fibers are reduced to nanoscale. (***Rue de stassart 36, b-1050, brussels***)

ACKNOWLEDGEMENT

We are also grateful to *Md. Mamun Hossain* & *Md. Mahabubul Bashar*, Assistant Professor, Department of Textile Engineering, MBSTU helping me in every stage of my work.

10. CONCLUSION

Textiles are not only clothing the human body but also our mother land in order to protect her. Geo textile and related products have many applications and currently support many civil Engineering applications including roads, airfields, railroads etc. (***Geo textile, From Wikipedia, the free encyclopedia***). On the other hand, Geotextiles are effective tools in the hands of the textile engineer that have proved to solve a myriad of geotechnical problems. (***Kahlid a Meccai & Eayad Al Hasan, 2004***). Most of the Textile Engineer do not know briefly about geo technical Engineering. Not only had the civil Engineer had to know about the geotextile briefly but also Textile Engineer. The author tries to develop a clear idea about geo technical engineering. Extensive awareness should be created among the people about the application of geotextiles.. To explore the potential of geotextile more researches are needed in this field.

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[30] http://www.acf-envirs.com/stabprod.html