# Geosynthetics Materials and Applications for Soil Reinforcement and Environmental Protection Works

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***Abstract- The use of geosynthetics is to improve the performance of foundations when constructing on soft compressible foundation soils. The material properties of geosynthetics are important to their use in various applications. Geosynthetics have become well established construction materials for geotechnical and environmental applications in most parts of the world. They are constituted of manufactured materials, new products and applications which are developed on a routine basis to provide solutions to routine and critical problems. This paper focuses on recent advances on geosynthetics products, applications and design methodologies required for reinforcing soil and environmental protection work. The geosynthetics products have helped designers and contractors to solve several types of engineering problems where the use of conventional construction materials would be restricted or considerably more expensive.***

***Keywords- Wovens, Non-Wovens, Knitted, Biogradable, Nets, grids, Membranes***

## I. Introduction

Geosynthetics are man-made materials used to improve soil conditions. These are artificial fabrics used in conjunction with soil or rock as an important part of man-made materials. The word is derived from:

***Geo*** = earth or soil + ***Synthetics*** = man-made [4].

Geosynthetics are typically made from petrochemical-based polymers (“plastics”) that are biologically inert and will not decompose from bacterial or fungal action [8]. While most are essentially chemical inert, some may be damaged by petrochemicals and most have some degree of susceptibility to ultraviolet light (sunlight). Geosynthetic materials are time and temperature dependent [7].

Geosynthetic materials are placed on or in soil to do one of four things (some may perform more than one of these functions simultaneously):

• **separation/confinement/distribute loads**
- improve level-grade soil situations such as roads, alleys, lane ways
- improve sloped-grade situations such as banks, hillsides, stream access points

• **reinforce soil**
- soil walls, bridge abutments, box culverts/bridges, and soil arches

• **prevent soil movement** (piping) while letting water move through the material
- such as in drainage systems and back fill around water intakes

• **controlling water pressure** allowing flow (drainage) in the plane of the material
- such as on foundation walls to allow water to move down to perimeter drains

## II. Types Of Geosynthetics

There are many geosynthetics materials available which can be used for different purposes. Few of the geosynthetics materials are as follows:

### *A. Geotextiles*

Geotextiles are defined as “any permeable textile used with foundation soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a human-made project, structure, or system”. They are typically the most used geosynthetic material for agriculture purposes. These are fabric or cloth-like materials that are classified based on the method used to place the threads or yarns in the fabric: either woven or non-woven. Geotextiles typically come in rolls up to approximately 5.6m (18 ft) wide and 50 to 150m (160 to 500 ft) long [2].

#### *1) Woven*

These cloth-like fabrics are formed by the uniform and regular interweaving of threads or yarns in two directions as shown in Figure 1, below. These products have a regular visible construction pattern, and where present, have distinct and measurable openings. Woven geotextiles are typically used for soil separation, reinforcement, load distribution, filtration, and drainage. They can have high tensile strength and relative low strain or limited elongation under load (typically up to 15%) [9].

**Figure 1: A Typical Woven Geotextile**

*2)Non-Woven*

These felt-like fabrics are formed by a random placement of threads in a mat and bonded by heat-bonding, resin-bonding or needle punching, as shown in Figure 2, below. These products do not have any visible thread pattern. Non-woven geotextiles are typically used for soil separation, stabilization, load distribution, and drainage but not for soil reinforcement such as in retaining walls. They have a relatively high strain and stretch considerably under load (about 50%).

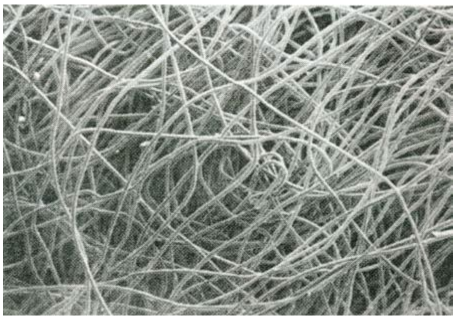

**Figure 2: A Typical Non-Woven Geotextile**

*B. Geo-Grids*

Geo-Grids are open grid-like materials of integrally connected polymers, as shown in Figure 4. . They are planar polymeric material consisting of regular open network of connected tensile elements with square or rectangular openings. The linkage between the tensile elements can be extrusion, bonding or interlacing. They are used primarily for soil reinforcement. Their strength can be greater than the more common geotextiles. Geogrids have a low strain and stretch only about 2 to 5% under load [1].

**Figure 3: A Typical Geogrid**

*C. Geocells or Geowebs*

Geocells or geowebs have 'depth' as shown in figure 4. They are typically formed from polyethylene sheets and expand out like an accordion when opened up to use. They are meant to contain soil, gravel or other fill material within their maze of cells or pockets and may be porous to allow water movement. They are used on slopes with soft subgrades and in erosion control in channels. They may be used over top of a geotextile or geogrid. While they come in compact bundles when collapsed, they typically cover an area 2.5m (8 ft) wide by 6 to 12m (20 to 40 ft) long when expanded[10].

**Figure 4: A Typical Geocell**

*D. Geomembranes*
Geomembranes are polymer sheets used to control fluid movement. These resemble thick, flexible plastic sheets and are smooth surfaced. These materials have very low permeability and would be used for lining ponds, pits etc to control leachate. They may be used over top of a geotextile.

*E. Geosynthetic clay liners (GCLs)*
Geosynthetic clay liners (GCLs) are geocomposites that are prefabricated with a bentonite clay layer typically incorporated between a top and bottom geotextile layer or bonded to a geomembrane or single layer of geotextile. When hydrated they are effective as a barrier for liquid or gas and are commonly used in landfill liner applications often in conjunction with a geomembrane.

*F. Geonets*
Geonets are open grid-like materials formed by two sets of coarse, parallel, extruded polymeric strands intersecting at a constant acute angle. The network forms a sheet with in-plane porosity that is used to carry relatively large fluid or gas flows [9].

*G. Geocomposites*
Geocomposites are multi-layered geosythetics attached or bonded to each other comprising of combinations of geotextiles, geomembranes, geogrids and geonets by themselves. They are integrally connected units of geotextiles and geonets or geotextiles and geomembranes or geotextiles, geomembranes and geogrids. The individual elements of geocomposites are properly bonded/stitched/fused to each other, they function as single integral units and not as individual geosynthetics placed one over the other in the field, in which slippage can occur between individual components.

## III. Applications Of Geosynthetics

Geosynthetics are strong, durable and flexible materials. They do not crack or separate from the soil even if the soil settles and are superior to concrete or metallic material. Geosynthetics are very versatile and can perform many functions and some individual materials can simultaneously perform two or more functions. The applications of the geosynthetics materials in various fields are considered really important. Some of the applications of geosynthetics are discussed as under:

*A. Separation*
Porous geosynthetics when sandwiched between two soil types with vastly different particle sizes perform the function of keeping them separate and prevent the mixing of particles. For example, when road pavements are constructed, a base course material that is often gravel sized is placed directly on the subgrade soil. If the subgrade is soft clay, the gravel will tend to penetrate into subgrade soil under traffic load resulting in a mixed soil [3]. The performance of the base course deteriorates with time due to mixing. This can be prevented by placing geosynthetics at the interface between the subgrade and the base course. It prevents mixing and results in improved pavement performance.

*B. Filtration*
Porous geosynthetics, when located in between two soil layers, one fine grained and the other coarse grained, through which water is flowing, perform the function of a transition filter [6]. They allow water to pass through them without passage of fine particle of soil along with the water. Geosynthetics can be used in place of transition filters of soil, if suitable soil is not available near the construction site.

*C. Drainage*
Porous geosynthetics with high in-plane permeability perform the functions of drains where these are placed within a soil mass to intercept seeping water and carry it rapidly along the in-plane direction without migration of fine particles.

*D. Reinforcement*
Geosynthetics with high tensile strength perform the function of reinforcement in a soil mass when these are placed in single or multi layers to improve the engineering behaviour of the soil mass. Soil by itself behaves well under compression but is poor in tension and the performance of the soil is enhanced by the tension carrying capacity of geosynthetics. This improves the bearing capacity of soft soil, enhances stability of steep slopes and reduce earth pressure behind retaining structures.

*E. Hydraulic Barriers*
Geosynthetics that are impermeable in the cross-plane and in-plane directions perform the function of hydraulic barriers when placed in a soil mass by preventing seepage of water through the soil mass. Seepage of water from canals can be controlled by placing a geomembrane at the base and along the sides of the canal.

*F. Surface Erosion Control*

Geosynthetics can be used for temporary or permanent erosion control measures along side slopes. Temporary erosion control geosynthetics comprise of natural biodegradable fibers such as jute [5]. They are spread on the slope in the form of grids or mats and they prevent erosion until vegetative growth occurs and later degrade. Permanent erosion control geosynthetics are porous synthetic polymeric products that furnish erosion control, aid vegetative growth and become entangled with the vegetation to provide reinforcement to the root system.

*G. Protection*

Geosynthetics are used to prevent an under laying layer from damage that may occur due to presence of angular material such as gravel and stones above the layer.

## IV. Conclusion

Geosynthetics have great potential to be used as cost-effective solutions for several engineering problems. This paper presented recent advances in geosynthetic products, on the utilization of these materials in reinforced soil structures and in environmental applications. Manufacturing of geosynthetics products allows incorporating recent advances in material sciences. Therefore, the expectation is that innovations in products, types and properties will continue to take place, adding to the already vast range of applications of these materials.

The use of geosynthetics has also led to major advances in environmental applications. While

geosynthetics has been used in a number of applications in environmental project. Overall, the use of geosynthetics has led to major advances towards the construction environmental systems that are cost effective but that provide enhanced environmental protection.

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