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Geosynthetics Materials: Recent Advancements for ground Improvements.

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ABSTRACT: Geosynthetics are man-made materials used to improve Ground conditions.. The material properties of geosynthetics are important to their use in various applications like canal lining, used for increasing bearing capacity and permeability of soil, reducing settlement of soil, soil reinforcement, soil stabilization etc.Geosynthetics have become well established construction materials for geotechnical and environmental applications in most parts of the world. This paper focuses on recent advances on geosynthetics products, applications and design methodologies required for reinforcing soil, ground improvement and environmental protection work.

Key Words: Geosynthetics, woven, non-woven, geo-textiles, geogrids, roads.

1. INTRODUCTION:

India is a vast country with varying climatic and teprature conditions. The resulting diverse nature of sub-soil conditions creates problem for construction engineer. To improve the sub-soil conditions in adverse location, civil engineer traditionally depending upon the conventional material like brick, cement ,steel etc.But situations arises when non-uniformity and non-availability of soil occurs at construction site and also some technical limitations of building conventional structure on weak soil leads the civil engineer to search for alternative solution. One such alternative has emerged as popular material in recent year is geo-textiles commonly described as geosynthetics.

Geosynthetics have been increasingly used in geotechnical and environmental engineering for the last 4 decades. Over the years, these 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.

Geosynthetics:

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 [1].

Geosynthetics are typically made from petrochemical-based polymers ("plastics") that are biologically inert and will not decompose from bacterial or fungal action [2]. 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 [3].

Geosynthetics are currently being defined as civil engineer material that are synthesized for use with geological materials like soil ,rock or any other geological engineering related material to improve or modify the behavior of civil engineering works.

2. 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 behind concrete seawalls, under precast concrete erosion control blocks, beneath large stone riprap, and in other erosion control situations. [4].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 [5].

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%) [6].

Fig 1: Woven Geotextile

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.

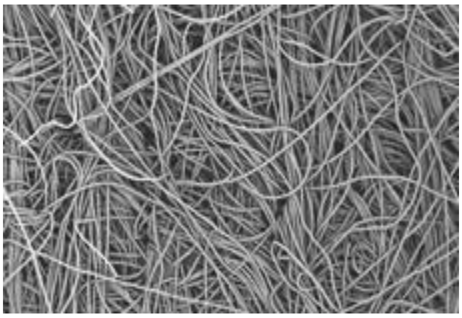

Fig 2: Non-Woven Geotextile

B. Geo-Grids

A geo-grid is a planner structure formed by a regular network of tensile elements with apertures of sufficient size to allow interlocking with surrounding soil or aggregate. Geo-Grids are open grid-like materials of integrally connected polymers, as shown in Figure 3. . 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 [7].

Fig 3: Geogrids

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C. Geomembranes

A geomembrane is a continuous membrane type barrier of low permeability to control fluid migration and would be used for lining ponds, pits etc to control leachate. They may be used over top of a geotextile. Material could be asphaltic or polymeric or combination of both.[8]

D. 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].Geonets are formed by a continuous extrusion process into a netlike configuration of parallel sets of homogeneously interconnected ribs. There are three categories of geonets. The following are illustrated:[10]

- *Biplanar geonets:* These are the original and most common types and consist of two sets of intersecting ribs at different angles and spacings. The ribs themselves are of different sizes and shapes for different styles. (Figure 4.)

Fig 4: Biplanar Geonets

- *Triplanar geonets:* These have parallel central ribs with smaller sets of ribs above and beneath mainly for geometric stability.(Figure 5.)

Fig 5: Triplanar Geonets

- *Other geonets:* These newer geonet structures have either box shaped channels or protruding columns from an underlying support network.(Figure 6).

Fig 6: Box shaped Geonets

E. 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.Figure7.shows typical geo-composite such that geonet is sandwiched with gomembrane layers.

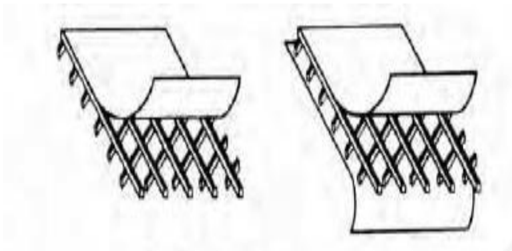

Fig 7: Combination of Geonet with geomembrane

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3. FUNCTIONS

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. Geosynthetics have five primary functions:

A. Fluid Transmission

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. This is conventionally termed as drainage function and is useful in strip drain and chimney drain.

B. Filtration

A Geosynthetics act as filter if it allows liquid to flow perpendicular to its own plane,while preventing most of the soil particles from being carried away by the current.

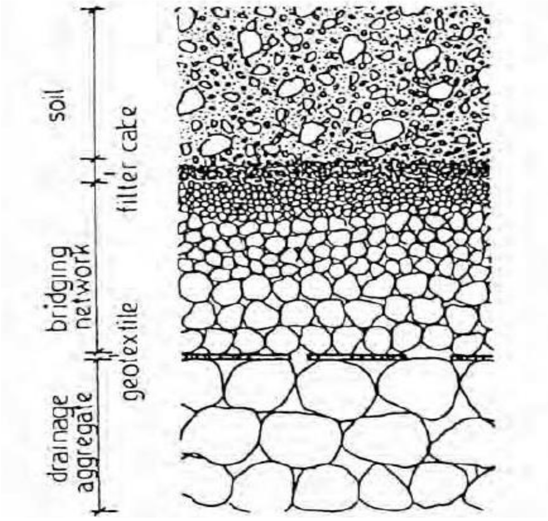

Fig 8: Filteration fuction of Geosynthetics

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 [11]. Figure 8.shows the typical filteration function of geosynthetics

C. Separation

When geosynthetic material is placed between fine soil and coarse material like gravel, stone ,etc.it prevents the fine soil and coarse material from moving under the action of repeated loads. 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 [12]. 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. shown in Figure 9.

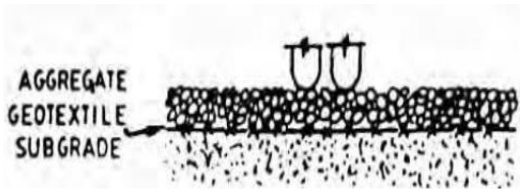

Fig 9: Separation function of Geosynthetics

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 reduces earth pressure behind retaining structures. Geosynthetics material can be used as-

- Tensioned membrane when placed between two material for eg:-Between two layers of pavement.Shown in Figure 10.

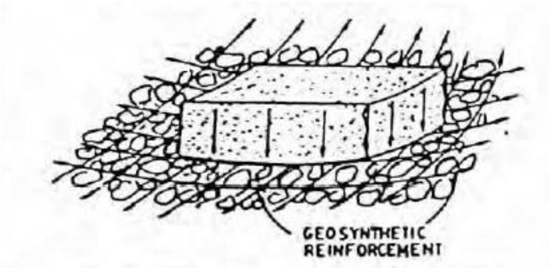

Fig 10: Tensioned Membrane function of Geosynthetics

- As tensile member in a reinforced soil structure to provide tensile modulus and strength.shown in Figure 11.

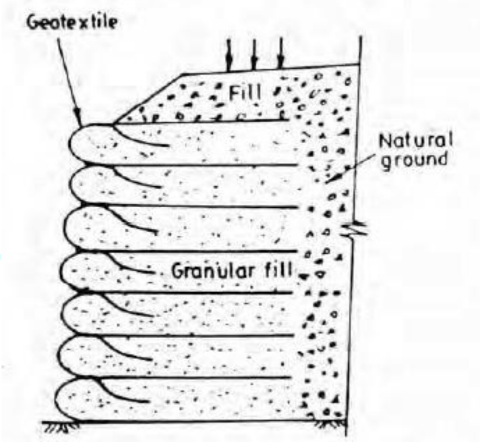

Fig 11: Tensile Membrane function of Geosynthetics

E. Moisture Barriers

A geosynthetics(Geomembrane) may be act as moisture barrier for flow of water or other fluid. Seepage of water from canals can be controlled by placing a geomembrane at the base and along the sides of the canal.

F. Protection/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 [13]. They are spread on the slope in the form of grids or mats and they prevent erosion until vegetative growth occurs and later degrade. Also 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.shown in Figure 12.

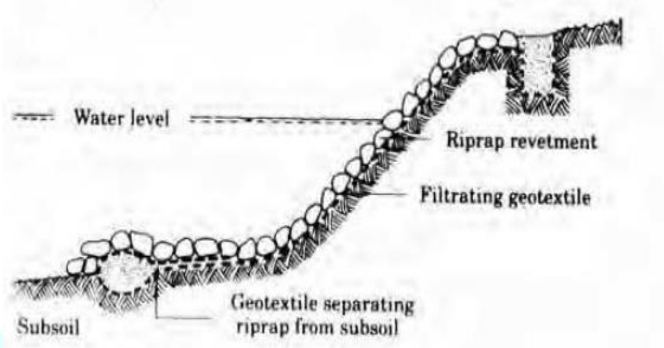

Fig 12: Erosion control and Protection of slope using geosynthetics layers

4. CONCLUSION

Geosynthetic materials used as cost-effective solutions for many civil engineering problems.As there is limited mineral sources and access to these sources is also limited so geosynthetic materials partially replacing those conventional material which are used for ground improvements. This paper presented recent advances in geosynthetic products, on the utilization of these materials in 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. 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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