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USE OF GEOSYNTHESIS IN ROAD CONSTRUCTION

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Abstract: Geosynthetics have been defined by the American society for testing materials committee D35 on geosynthetics as planar products manufactured from polymeric materials used with soil, rock, earth, or geotechnical engineering related materials as an integral part of man-made project, structure or system. Geosynthetics is the term used to describe a range of polymeric products used for civil engineering construction works. The term is generally regarded for these geotextiles, geogrids, geonets, geomembrane, geosynthetic clay liners, geofoam, geocell and geocomposite. The most popular geosynthetics used are the geotextiles and geomembrane.

Keywords: Geosynthetics, Geomembrane, Geogrid, Geonet, Geomat, Geocomposite

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INTRODUCTION

The ASTM (1994) defines geotextiles as permeable textile materials used in contact with soil, rock, earth or any other geotechnical related material as an integral part of civil engineering project, structure, or system.

Geomembrane is an essentially impermeable membrane in the form of manufactured sheet used widely as cut-offs and liners. They are often used to line landfills.
Geotextiles, as permeable textile materials are used in contact with soil, rock, earth or any other geotechnical related material as an integral part of civil engineering project, structure, or system.

A geogrid is a polymeric structure, unidirectional or bidirectional, in the form of manufactured sheet, consisting of a regular network of integrally connected elements which may be linked by extrusion, bonding, and whose openings are larger than the constituents and are used in geotechnical, environmental, hydraulic and transportation engineering applications.

A geonet is a polymeric structure in the form of manufactured sheet, consisting of a regular network of integrally connected overlapping ribs, whose openings are usually larger than its constituents.

A geocomposite is an assembled polymeric material in the form of manufactured sheet or strips, consisting of at least, one geosynthetic among the components, used in geotechnical environmental and transportational engineering applications.

A geomat is a polymeric structure in the form of manufactured sheet consisting of non-regular networks of fibres, yarns, filament, tapes or other elements which may be thermally or mechanically connected and whose openings are larger than its constituents.

A geocell is a polymeric cellular structure consisting of regular open networks of connected strips linked by extrusion or adhesion or other methods

Geotextiles have proven to be among the most versatile and cost-effective ground modification materials. Their use has expanded rapidly into nearly all areas of civil, geotechnical, environmental, coastal, and hydraulic engineering.

LITERATURE REVIEW

Chen W.F and Liew J.Y, (2003)

CONCEPT OF GEOSYNTHETICS

With the advent of polymers in the middle of the 20th Century, a much more stable group of materials became available. These groups of polymer materials, called geosynthetics, have been employed in civil engineering works due to their stability and durability. Geosynthetics were first employed in the 1960s as filters in the United States and as reinforcement in Europe. Geosynthetics have been formulated and are available in a wide range of forms to suit various engineering applications. Often the use of a geosynthetic can significantly increase the safety factor, improve performance, and reduce costs in comparison with conventional construction alternatives. In the case of embankments on extremely soft foundations, geosynthetics can permit construction to take place at sites where conventional construction alternatives would be either impossible or prohibitively expensive**. (Chen W.F and Liew J.Y, 2003)** Geosynthetics are particularly useful in road pavement construction and the earthworks associated with road construction. Geosynthetics used for construction projects are manufactured from synthetic polymers such as polypropylene, polyesters, polyethylene, polyamide (nylon), poly-vinyl chlorides (PVC), and fibreglass. Polypropylene and polyester are the most used. Compared to natural fibres, the polymeric geosynthetics offer long-term durability in the presence of elements commonly encountered in construction (e.g. moisture and other types of corrosive chemicals)

In developing countries, the use of geosynthetics is relatively new but gaining widespread popularity in construction. Geosynthetics are becoming rapidly popular in construction because of their ability to perform certain necessary functions while offering practical advantages such as:

- A wide availability of products from the market place
- The relative ease of shipping and field handling (flexibility)
- Rapid installation techniques, i.e fast speed of construction, without the need for heavy equipment such as earth-moving machines.
- Lightweight in comparison with other construction materials, therefore imposing less stress upon the foundation
- Durability and long life when properly selected
- General environment safety, since they will not degrade. (However, there is possibility of degradation if exposed to sunlight and certain highly corrosive chemicals) **(Okunade, 2010)**

TYPES OF GEOSYNTHETICS

Geosynthetics are usually produced either in sheets or in fabric filaments (fibres) with the major variations in their composition, thickness and strength. These are then further worked upon in the production process to produce the construction geosynthetics group. The different types of this geosynthetics group products are geotextiles (geofabrics), geogrids, geonets,

geomembranes, geosynthetic clay liners (GCL), geopipes or geotubes, geocells, geofoams, drainage/infiltration cells and geocomposites.

Below is the description of the above listed materials:

1. Geotextile or Geofabrics: Geotextiles form one of the two largest groups of geosynthetic materials. They are indeed textiles in the traditional sense, but consist of synthetic fibres (all are polymer-based) rather than natural ones such as cotton, wool, jute ` Thus, biodegradation and subsequent short lifetime is not a problem. These synthetic fibres are made into flexible, porous fabrics by standard weaving machinery or they are matted together in a random nonwoven manner. Some are also knitted. The major point is that geotextiles are porous to liquid flow across their manufactured plane and also within their thickness, but to widely varying degree. There are at least 100 specific application areas for geotextiles that have been developed; however, the fabric always performs at least one of four discrete functions: separation, reinforcement, filtration and/or drainage. According to ASTM, a GEOTEXTILE is "any permeable textile material used with foundation soil, rock, earth, or any other geotechnical engineering-related material, as an integral part of a man-made project, structure or system". (**Wikipedia, 2011**)

2. Geogrids: they are unitized woven yarns or bonded straps. Geogrids consist of heavy strands of plastic materials arranged as longitudinal and transverse elements to outline a uniformly distributed and relatively large and gridlike array of apertures in the resulting sheet. These apertures allow direct contact between soil particles on either side of the sheet. **(Bergado and Abuel-Naga, 2005)**

According to Wikipedia, Geogrids represent a rapidly growing segment within geosynthetics. Rather than being a woven, nonwoven or knitted textile fabric, geogrids are polymers formed into a very open, gridlike configuration, i.e., they have large apertures between individual ribs in the machine and cross machine directions. Geogrids are (a) either stretched in one or two directions for improved physical properties, (b) made on weaving or knitting machinery by standard textile manufacturing methods, or (c) by bonding rods or straps together. There are many specific application areas, however, they function almost exclusively as reinforcement materials. Modern geogrids were invented by Dr. Brian Mercer (Blackburn, UK) in the late 1970s. Dr. Mercer devised and patented the stretched sheet method of production which results in a stiff polymer grid and avoids the bonding of separate elements required in a woven or knitted grid. Subsequent development by Dr. Mercer led to the uniaxial (single direction stretch) geogrid with rectangular apertures and the biaxial (two way stretch) geogrid with virtually square apertures.

3. Geonets: A geosynthetic material consisting of parallel sets of intersecting ribs that form a three-dimensional net-like material. They are used to improve drainage by creating a "thin" plane for water to travel through. (**Kercher, 2011**)

4. Geomembranes**:** A geosynthetic material that is virtually waterproof when used as a fluid barrier. A common application of this is a landfill liner.

5. Geocomposite**:** A material made up of a combination of geosynthetic materials that is used to improve performance by combining the benefits of two types of geosynthetics.

Summary

Geosynthetics in Transportation Engineering

Geofoam has found application in transportation as super lightweight fill, with its density of 24 to 48 kilograms per cubic meter (kg/m3), compared to densities of other lightweight materials ranging from 800 to 1120 kg.m3. Geofoam's lightweight makes it viable option for landslide repair, and for embankments on soft, compressible deposits. Geofoam is also used for thermal insulation of pavements and foundations. Geogrids have been used for soil reinforcements in embankments and walls, subgrade stabilization, and embankment base reinforcement. Geogrids are characterized by integrally connected elements with in-plane apertures (openings) uniformly distributed between the elements. The apertures allow the soil to fill the space between the elements, thereby increasing soil interaction with the geogrid and ensuring unrestricted vertical drainage. All these applications are not only in highway, but also in railroad track construction and rehabilitation.

Geosynthetics in Pavement Structures

Applications of geosynthetics within pavement structures have been primarily in the areas listed below:

- Pavement surface layer reinforcement (asphalt concrete overlays of existing asphalt concrete and Portland cement concrete surfaces)
- Rehabilitation of pavement surfaces, reflective crack treatments, spot repairs, etc
- Geotechnical reinforcement of unbound (flexible) bases, soft subgrade, embankments on soft foundations etc.
- Encapsulation and separation of materials
- Drainage applications, water control, granular drain performance (filters), piping resistance, clogging prevention etc.,
- Moisture control.

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