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GEO TEXTILES: FUNCTIONS, MATERIAL AND ITS APPLICATIONS

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Abstract: *Geotech segment comprises of technical textile products used in Geotechnical applications pertaining to soil, rock, earth etc. This class of product is loosely called Geotextiles. However Geotextiles particularly refers to permeable fabric or synthetic material, woven or non-woven, which can be used with geotechnical engineering material. Geotextiles are manufactured from polypropylene, polyester or polyethylene. The principal functions performed by Geotextiles are: separation, Reinforcement, filtration and drainage, and protection. Geotextiles are being extensively used in various civil engineering projects to facilitate, ensure better performance of the structure and reduce maintenance in long run.*

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1. INTRODUCTION

The fabrics in geo textiles are permeable fabrics and are used with soils having ability to separate, filter, protect or drain. Geotextiles have been defined as woven, knitted or nonwoven fabrics having application in civil engineering, such as interfacing of the fabric with soil to give reinforced structures (e.g. road bed reinforcement) or enhancing hydraulic properties for water transport, modification and improvement of soil.

The development production and use of geotextiles for modification and improvement of soil purposes have taken place in USA, Japan and Western Europe. Geo textile in civil engineering require many qualities like high strength, elongation without rupture under loads and repetitive stresses, flexibility, high abrasion resistance, resistant to contaminated ground water and fungal attack. Geotextiles are often laid over large areas and such cases a large fabric width has obvious advantages. Geotextiles are preferably woven in largest possible fabric width. For serial production, projectile weaving machine with a nominal weaving width upto 12 m and a maximum weft insertion rate of 1200 m/min are available. The weft insertion rate and speed depend on yarn count, yarn quality, style and fabric width.

2. TYPES OF GEOTEXTILE

Geotextile fabrics are classified according to their use for civil engineering application. It is broadly divided into two groups:

i. Geomembranes: These are mostly used in water proofing linings of canals, reservoirs and earth filled dams.

ii. Geotextiles: These are mainly used in earth crust i.e. soil.

Some definitions and terminology used by civil engineers are as under:

i. ***Geo-cells*:** It is 3D mattress structure filled with soil/rock to form pad for foundations on loose soils or compressible soils.

ii. ***Geo-composites*:** It is products using two or more Geotextiles . Geo-textiles, Geo-grids and Geo-membranes in laminated composite form.

iii. ***Geo-grid*:** Deformed or non-deformed net like polymeric materials-biaxial or uniaxial. In Geogrid, plastics filaments and tapes etc formed into a very open, grid like configuration having large apertures

iv. ***Geo-membrane*:** Geomembranes are impermeable membranes used widely as cut-offs and liners. Liner barrier impervious membrane used to control fluid migration. Until recent years, geomembranes were used mostly as canal and pond liners; however, one of the largest current applications is to the containment of hazardous or municipal wastes and their leachates. Liner barrier impervious membrane used to control fluid migration. Materials to be compatible with fluid-acidic, alkaline, etc. Products such as film coated or impregnated geo-textiles, film-fabrics composites.

v. **Geo-synthesis:** Includes Geo-textiles, Geo-grids, Geo-membrane, and geo-composites.

vi. **Geo-textiles:** Any permeable textile (natural jutes or synthetic) used in foundation and ground engineering. It may be knitted in successive stitches using mono or multi filament to make cloth or jointed by hot pressing.

Practically all types of textile fabric structures are used as geotextile. Both woven and nonwoven of natural and manmade synthetic fibres are produced. Generally woven geotextiles are made of multifilament polypropylene with plain or twill weave. Woven geotextile have great advantages in comparison with nonwoven geotextiles as regards tensile strength. The maximum tensile strength of woven fabric is 8 times higher than nonwoven fabric. Nonwovens shows approx.4-5 times higher elongation. Types of nonwoven fabric which are widely used as geotextiles are staple fibre needle punched fabrics, needle punched spunbonded fabrics and heat–sealed spunbonded fabrics. Geotextiles can range from under 40 GSM to over 3000 GSM which mainly used in landfill end uses.

3. FUNCTION OF GEO-TEXTILE

The principal functions performed by geotextiles are:

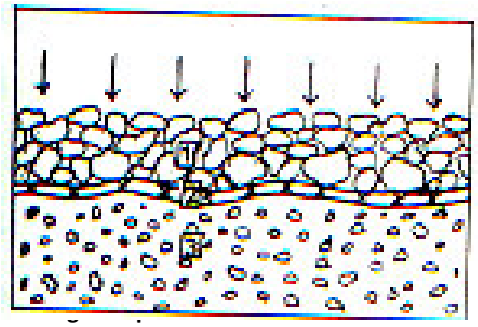
1. Separation or confinement
2. Reinforcement
3. Filtration and drainage, and
4. Protection

Four main function of geotextile may be grouped in the following categories:

i. Separation or Confinement: Separation is aimed at keeping two dissimilar materials (for instance sand and crushed stone) apart (Fig. 1). In other words, the fabric prevents the

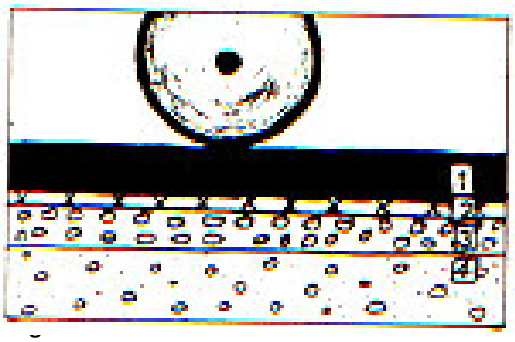
contamination of one material by another. Major use of geotextile is in roadways, railways and parking area where the material used to form the base of construction is supported from the soil below

ii. Reinforcement: The purpose of geotextiles in the reinforcement function is to reinforce the weak sub-grade or subsoil. Geotextile can reduce the level of stress in the soil by spreading and evening the stresses when used to form a foundation. Reinforcement of the ground or slope can be prevented with the use of geotextiles (Fig. 2). The mechanical properties of fabric such as tensile strength and elongation can be very useful for geotextiles of this type.



(Adopted from ref. no. 4)

1. Coarse Gravel 3. Fine Sand
2. Geotextile



(Adopted from ref. no. 4)

1. Road base coarse 3. Sub base
2. Geotextile 4. Natural Soil

iii. Filtration and Drainage: When geotextile placed between two layers, one coarse grained and other fine grained, the fabric allow free passage of water from one layer to another. The purpose of geotextile with reference filtration and drainage is simply to retain soil while allowing the passage of water (Fig.3).

The geotextile rapidly channel water from soil to various outlets and thereby provides higher a shear strength of soil and hence stability. High permeability property of fabric is very useful for the purpose. Good permeability of the fabric is essential for filtration and drainage.

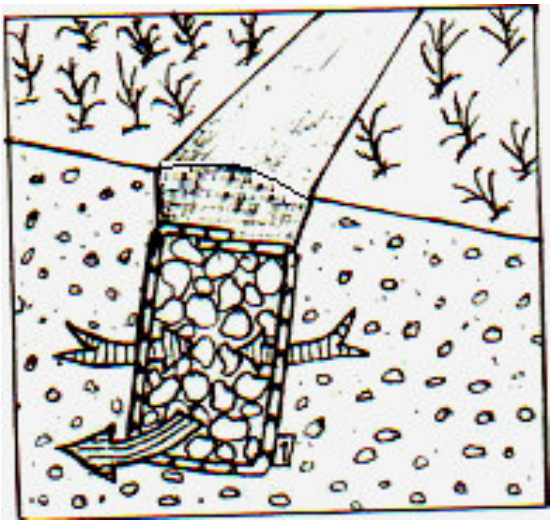


Fig.3: Drainage & Filtration Function

(Adopted from ref. no. 4)

1. Geotextile

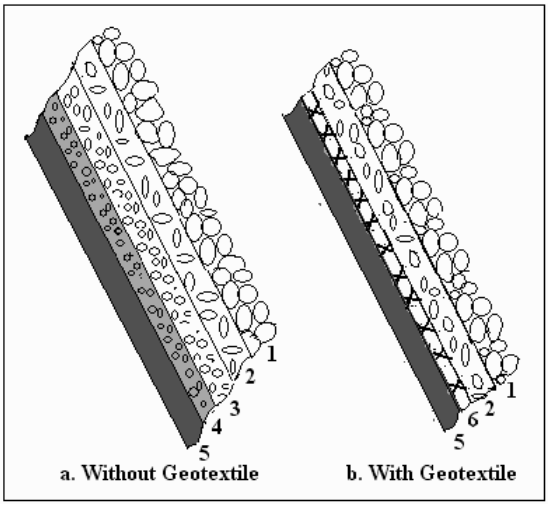


Fig.4: Erosion Control

(Adopted from ref. no. 2)

1. Primary Armour
2. Secondary Armour
3. Course filter
4. Fine Filter
5. Base Soil
6. Geotextile

iv. Protection: Geotextile protect the soft soil, protection of natural slope and land fill**.** Major application of geotextile in the fields of erosion control (Fig.4). Lining is used for cushioning and protection of membrane used for applications such as land fill (Fig 8). Geotextiles can also be impregnated with polymeric or mineral sealing materials to provide flexible barriers to mixture.

4. RAW MATERIAL

For the purpose of manufacturing geotextiles, the raw material (fibres) should have good resistant to acids, alkalis, oxidizing agent, microorganism, temperature (cold & hot) and UV radiation. To fulfill above requirement, man-made fibres are most suitable raw material for geotextiles. High strength, high modulus, extra creep resistance and chemical inertness are the essential properties of geotextile fibres. Mechanical and dimensional stability and biodegradability is the next greatest importance.

Depending on the uses, filament yarns, monofils and tapes of polyamide, polyester, polypropylene, polyethylene and polyacrylic are used in the making of geotextile. Sometimes, spun fibre yarns made from these raw materials are also used. The inertness towards chemicals, low specific gravity, lower cost of volume ratio and easy processbility of

the polypropylene fibres are probably the main reason behind it's popularity. Where the decomposition of the textile is desired in the longer term (e.g. plantation etc.); natural fibres such as jute ,coir, ramie and selawan fibres can be used.

5. SELECTION OF SUITABLE GEOTEXTILE

Selection of a suitable geotextile for a particular use is always based on its ability to fulfill the functional requirement. In order to choose the right geotextile, it precise function must be known:

a. It will be used for separation or reinforcement or hydraulic or protection functions etc.
b. It will be subjected to high or low stresses.
c. Subsoil is soft or firm.
d. Plants will be planted with shallow or deep roots etc.

All above are important factor, which have a bearing on the choice of geotextile and the raw material. Because only a correct chosen textile will satisfy the requirements.

6. PROPERTIES OF GEOTEXTILES TO BE TESTED

The properties of a geotextile depend on it's end use with different functions such as separation, reinforcement, filtration and drainage. Properties required for the following various functions:

1. Separation – combined properties of reinforcement and filtration
2. Reinforcement – strength, extension under load, degradation with time.
3. Filtration – permeability, porosity of fabric etc.
4. Drainage – transmissivity (water flow in line)

Proper selection of geotextiles for a particular application is only possible if there exists a foolproof testing and evaluation method. The following properties relevant to their functions of geotextile to be tested as per requirement:

a) Mechanical

i. Surface Related dimensions, ii. Thickness, iii. Tensile Strength,
iv. Tensile Modulus, v. Seem Strength, vi. Bursting resistance,
vii. Soil fabric Friction, viii. Tension Creep, ix. Tear resistance,
x. Puncture resistance etc.

b) Hydraulic

i. Permeability, ii. Transmissivity, length wise and Crosswise in the plane of the geotextile,

iii. Permittivity, vertical to geotextile, iv. Opening width/diameter of pores

c) Durability

i. UV Stability, ii. Abrasion resistance, iii. Chemical resistance,

iv. Biological resistance (rottenness, fungi) etc.

7. APPLICATIONS

Geotextiles have wide application in almost all geotechnical and hydraulic projects. It reduces both construction costs and construction time. Financial advantages result from easier maintenance and longer intervals between repairs.

Major application of geotextile in the fields of erosion control (Fig.4), reclamation and improvement, stabilization and improvement of bearing capacity of subgrade, road construction (Fig.5), railway construction (Fig.6), stabilization of riverbanks (Fig.7), canal lining and costs (Fig.8), protection of natural slops (Fig.9), applications in dams, protection of embankments (Fig.10) etc. Other applications are: environmental applications, coastal protection, control of liquefaction, vegetation growth for gardening and erosion, water proofing on roof and tanks, lining of ponds, foundation protection under vibration or seismic conditions and pipe coat protection etc.

In road construction, the function of geotextile is to separate the soil by differing particle size, so that when subjected to dynamic stress or as water passes through, the two soil types cannot mix. It reduce the construction costs; improved ride comfort less repair and maintenance cost.

Geotextile brings major benefits in railway construction. In railway construction, by using geotextiles the static as well as dynamic forces must be transferred from the rails via the sleepers to the gravel layer and into the earth below. The load bearing capacity also enhanced. During the vibrations it also prevents to mix the different courses in the railway embankment.

In riverbank and coast stabilization, the geotextile prevent erosion in newly built banks and sloping sections from sliding down. This can be checked by using a suitable geotextile. The synthetic material such as polypropylene yarn/fabrics used to control erosion and natural

fibre yarns/fabrics permitsplants/vegetation to grow in the slope to stabilize it with the help of it's roots. The geotextile made using natural fibres allow the penetration of plant roots. After a time, when the root system hold the soil, the natural fibres rots away and soil is stabilized by roots network.

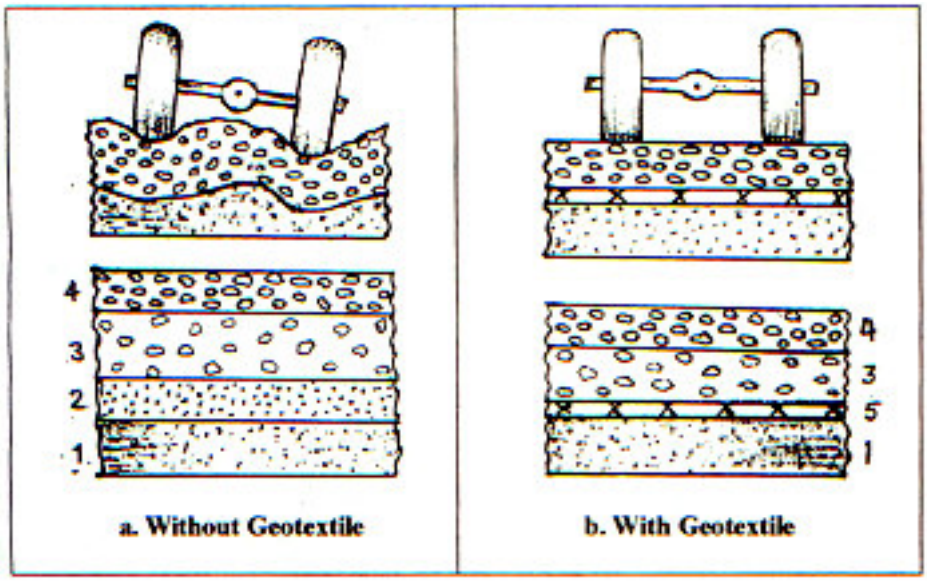


Fig.5: Application in Roads
(Adopted from ref. no. 4)
1. Natural Soil
2. Sand Filter
3. Sub-base
4. Base Course

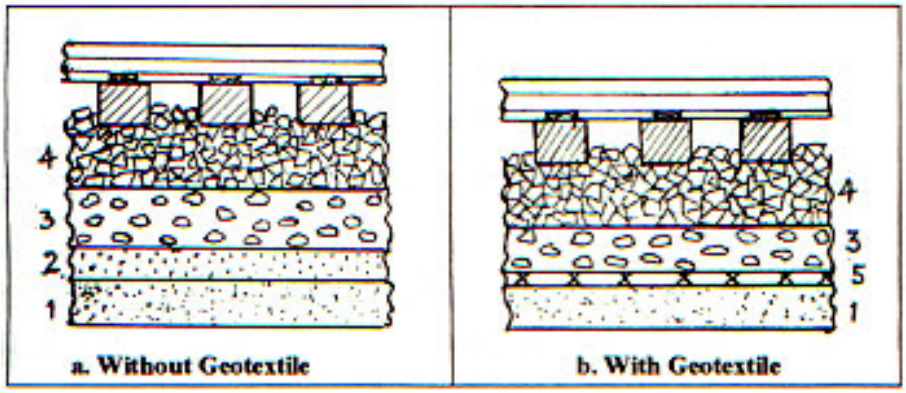


Fig.6: Application in Railways
(Adopted from ref. no. 4)
1. Natural Soil
2. Sand Filter
3. Base Course

Every day, civil engineers demanding new geotextile having enhanced properties. They want construction faster, simpler, safe and economical. It is up to construction and textile engineers jointly to specify the properties of the geotextiles. The task of the textile engineer is to make these fabrics economically with the right properties.

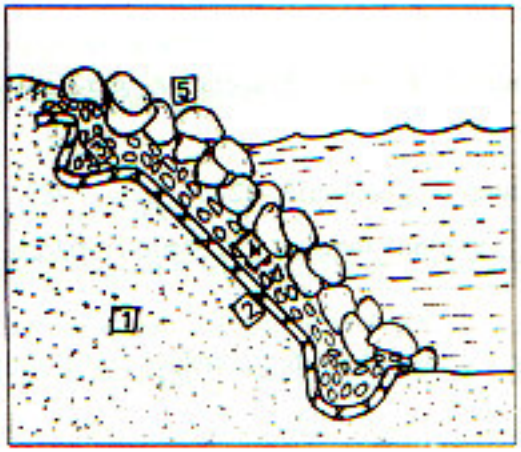


Fig.7: Riverbank Stabilization

(Adopted from ref. no. 4)

1. Subsoil
2. Geotextile
3. Anchorage
4. Subbase
5. Riprap

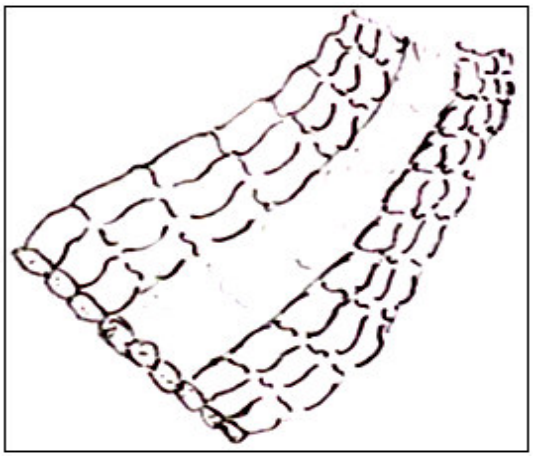


Fig. 8: Canal Lining

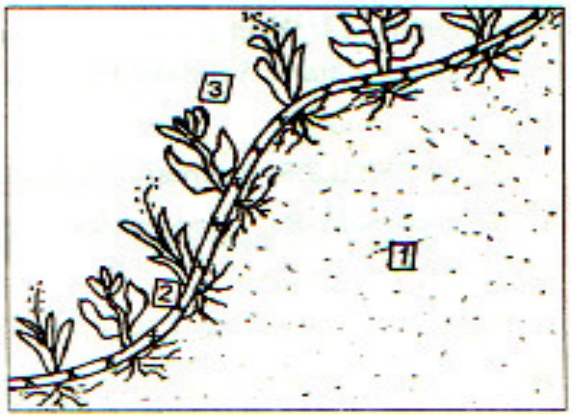


Fig.9: Protection of Natural Slopes

(Adopted from ref. no. 2)

1. Embarkment
2. Geotextile (Coir Netting)
3. Plants

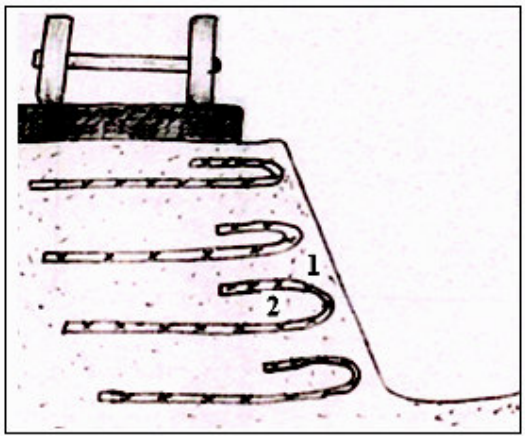


Fig.10: Steep Embankment Stabilization

1. Embankment
2. Geotextile

8. CONCLUSION

A geotextile is a permeable textile material that is used with foundation, soil, rock, earth, etc to increase stability and decrease wind and water erosion. It's main functions are: separation (cofinement), reinforcement, protection, filtration and drainage. Geotextile can be successfully used in new projects and also in repair works. They are also capable of providing instance solution under distress situations. Mostly, woven and nonwoven of

natural and manmade synthetic fibres are used for geotextile purposes. The cost of geotextile in many countries is a limiting factor for its speedy growth. Geotextile made from coarse natural fibres can be used as cost effective solutions in some countries. Further research and development efforts are needed to improvement of the production, product quality and scope of applications.

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