2.6 Geomembranes and Geotextiles for earth reinforcement

A **geomembrane** is very low permeability synthetic membrane liner or barrier used with any geotechnical engineering related material so as to control fluid (liquid or gas) migration in a human-made project, structure, or system. Geomembranes are impermeable membranes that prevent fluid migration and enhance terrain stability in human projects, systems, or structures. They are made from impermeable geosynthetic material and consist of thin, continuous sheets of polymers. Environmental, geotechnical, hydraulic, transportation, and private development applications use geomembrane.

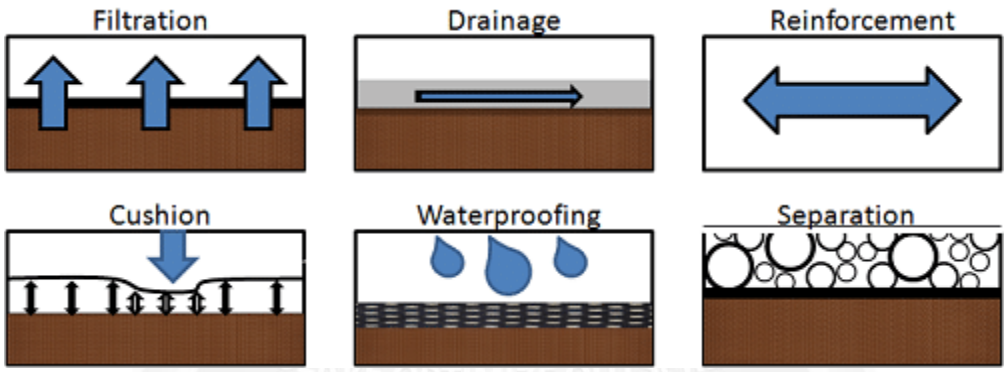
Geotextiles, just as its name implies, is made of nonwoven fabrics and mainly used to the consolidated subsoil. Geomembrane is made of high-density polyethylene, primarily for seepage-proofing.

Geotextiles are those fabrics used in geotechnical applications, such as road and railway embankments, earth dikes, and coastal protection structures, designed to perform one or more basic functions such as filtration, drainage, separation of soil layers, reinforcement, or stabilization.

Geotextiles are made up of polymers such as polyester or polypropylene. They are divided into 3 categories on the basis of the way they are prepared :
1) Woven Fabric Geotextiles
2) Non-Woven Geotextiles
3) Knitted Geotextiles

Functions of Geotextiles

The mode of operation of a geotextile in any application is defined by six discrete functions :



1. Separation

The separation function of geotextile is majorly used in the construction of roads. Geotextile prevents the intermixing of two adjacent soils. For example, by separating fine subgrade soil from the aggregates of the base course, the geotextile preserves the drainage and the strength characteristics of the aggregate material.

2. Filtration

The equilibrium of geotextile-to-soil system that allows for adequate liquid flow with limited soil loss across the plane of the geotextile. Porosity and permeability are the major properties of geotextiles which involve infiltration action.

A common application illustrating the filtration function is the use of a geotextile in a pavement edge drain, as shown in the figure above.

3. Reinforcement

Introduction of geotextile in the soil increases the tensile strength of the soil the same amount steel does in concrete. The strength gain in soil due to the introduction of geotextile is by the following 3 mechanisms :

- Lateral restraint through interfacial friction between geotextile and soil/aggregate.
- Forcing the potential bearing surface failure plane to develop an alternate higher shear strength surface.
- Membrane type of support of the wheel loads.

4. Sealing

A layer of non-woven geotextile is impregnated in between existing and new asphalt layers. The geotextile absorbs asphalt to become a waterproofing membrane minimising vertical flow of water into the pavement structure.

Uses of Geotextile in Construction

The scope of geotextile in the engineering field is very vast. The application of geotextile is given under the heading of the nature of work.

1. Road Work

Geotextiles are widely used in the construction of the road. It reinforces the soil by adding tensile strength to it. It is used as a rapid de-watering layer in the roadbed, the geotextiles need to preserve its permeability without losing its separating functions.

2. Railway Works

The woven fabrics or the non-woven ones are used to separate the soil from the sub-soil without impeding the groundwater circulation where the ground is unstable. Enveloping individual layers with fabric prevents the material from wandering off sideways due to shocks and vibrations from running trains.

3. 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.

4. Drainage

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 filtering mechanism for drainages in earth dams, in roads and highways, in reservoirs, behind retaining walls, deep drainage trenches, and agriculture.

5. 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.

The word “geomembrane” is considered a very low permeability liner made out of synthetic material. A geomembrane is regularly used for the containment of hazardous liquids that can contaminate the ground or surrounding structures if not correctly contained.

Types of Geomembrance

Depending on the parent resin used, several types of geomembranes are available. The most commonly used geomembranes are listed below.

1. PVC Geomembrane

PVC (Polyvinyl Chloride) geomembranes is a thermoplastic waterproofing material made with vinyl, plasticizers, and stabilizers.

When ethylene dichloride is cracked into a dichloride, the result is then polymerized to make the polyvinyl chloride resin used for PVC geomembranes.

PVC geomembrane is tear, abrasion, and puncture-resistant, making them suitable for constructing canals, landfills, soil remediation, wastewater lagoon liners, and tank linings.

The material is also perfect for maintaining potable drinking water and preventing contaminants from entering water sources.

2. TRP Geomembrane

A TRP (Reinforced Polyethylene) geomembrane uses polyethylene fabric for long-term water containment and industrial waste applications.

TRP geomembranes are an ideal choice for soil remediation, landfills, canals, lining temporary retaining ponds, agricultural & municipal applications due to their low-temperature range, chemical resistance, and ultraviolet stability.

3. HDPE Geomembrane

High-Density Polyethylene (HDPE) is characterized by strong UV/temperature resistance, inexpensive material cost, durability, and high resistance to chemicals.

It is the most commonly used geomembrane because it offers higher thickness which other geomembranes don’t. HDPE is the preferred choice for pond and canal lining projects, landfill, and reservoir covers.

Thanks to its chemical resistance, HDPE can be used in storing potable water.

4. LLDPE Geomembrane

LLDPE (Linear Low-Density Polyethylene) geomembrane is made with virgin polyethylene resins which make it strong, durable, and resistant to UV & low temperature.

Engineers and installers who require an impermeable geomembrane usually opt for LLDPE as it offers more flexibility compared to HDPE.

They are used in industrial applications, such as animal & environmental waste containments as well as liquid storage tanks.

5. RPP Geomembrane

RPP (Reinforced Polypropylene) geomembranes are polyester-reinforced liners made from a UV-stabilized polypropylene copolymer that gives the material stability, chemical resistance, and flexibility.

Its strength and durability can be traced to the support it gets with nylon scrim. RPP geomembranes are ideal for long-term water containment and industrial waste applications.

RPP is perfect for municipal applications, evaporation pond liners, aqua & horticulture, and mine tailings.

6. EPDM Geomembrane

EPDM (Ethylene Propylene Diene Monomer) geomembrane has a rubber-like texture that makes for its durability, UV-stability, strength, and flexibility.

They are ideal for extreme weather conditions and for resisting punctures. EPDM geomembranes are easy to install, typically used as surface barriers for dams, liners, covers, backyard landscape, and other irrigation sites.

The following are uses of geomembranes:

- As liners for various waste conveyance canals
- As waterproofing liners within tunnels and pipelines
- As liners for the agriculture industry
- As liners for potable or reserve water (for example, safe shutdown of nuclear facilities)
- To contain and transport potable water and other liquids in the ocean
- As liners for the agriculture industry
- As fish pond liners
- Beneath highways to prevent pollution from deicing salts
- As liners for primary, secondary, or/and tertiary waste piles and solid-waste landfills
- Adjacent and beneath highways to capture hazardous liquid spills
- As liners for sewage sludge, radioactive or hazardous waste liquid
- As linings for emergency spillways
- To contain and transport liquids in trucks