International Geosynthetics Society

8th International Conference on Geosynthetics

Training Course on Geosynthetics

Organised by the IGS Education Committee

International Geosynthetics Society
IGS Education Committee
Training Course on Geosynthetics
8IGG, Yokohama, 2006

Geosynthetics Types and Functions

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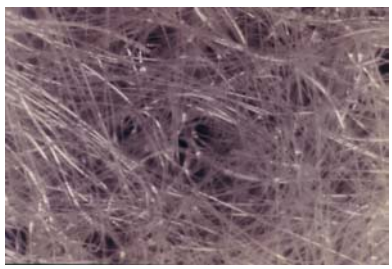
UnB

Geosynthetics Types

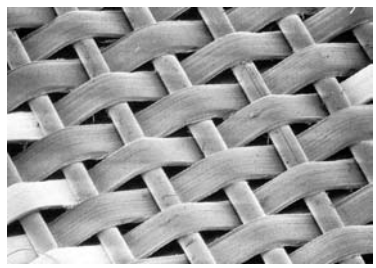
- Geotextiles (woven, nonwoven)
- Geogrids
- Geocells
- Geodrains
- Geofoam
- Geomats
- Geonets
- Strips
- Fibres
- Geomembranes
- Geocomposites

Geosynthetics Types
Geotextiles

Geotextiles are continuous sheets of woven, nonwoven, knitted or stitch-bonded fibres or yarns. The sheets are flexible and permeable and generally have the appearance of a fabric. Geotextiles are used for separation, filtration, drainage, reinforcement and erosion control applications.



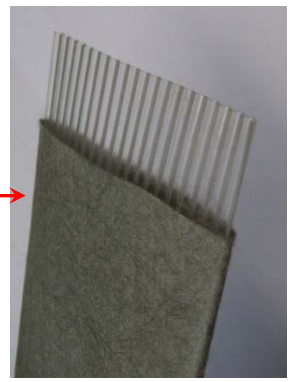
Nonwoven



Woven

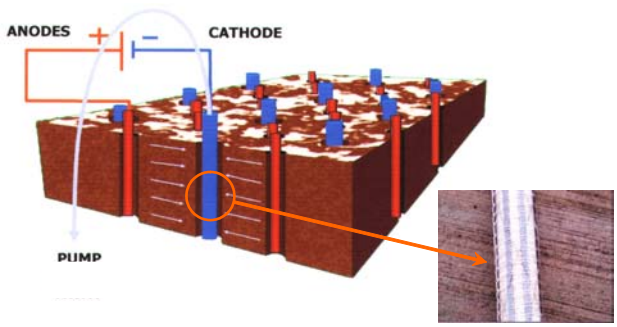
Geosynthetics Types
Geodrains

Geodrains are drainage materials consisting of a plastic core enveloped by a non woven (resin bonded) geotextile.



Geosynthetics Types
Electrokinetics Geosynthetics

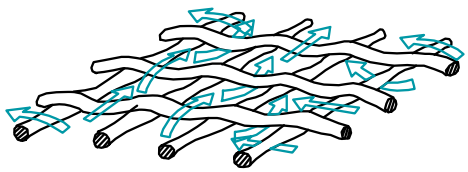
Electrokinetics Geosynthetics are drainage materials incorporating an electrically conductive geosynthetic which produces soil consolidation by electro-osmosis.

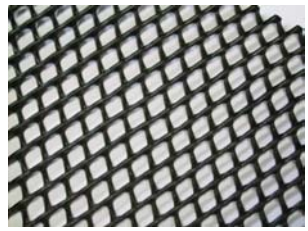


Jones et al. (2005)

Geosynthetics Types
Geonets

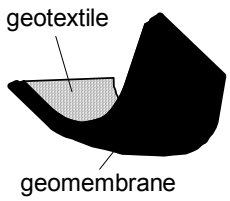
Geonets are open grid-like materials formed by two sets of coarse, parallel, extruded polymeric strands intersecting at a constant acute angle. The network forms a sheet with in-plane porosity that is used to carry relatively large fluid or gas flows.

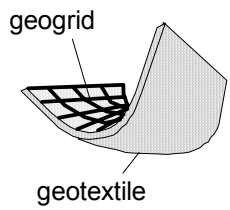




Geosynthetics Types
Geocomposites

Geocomposites are geosynthetics made from a combination of two or more geosynthetic types. Examples include: geotextile-geonet; geotextile-geogrid; geonet-geomembrane; or a geosynthetic clay liner (GCL). Prefabricated drains or prefabricated vertical drains (PVDs) are formed by a plastic drainage core surrounded by a geotextile filter and can also be considered a geocomposite.

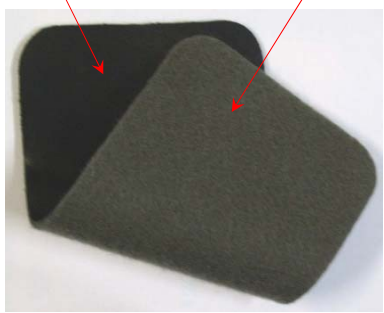




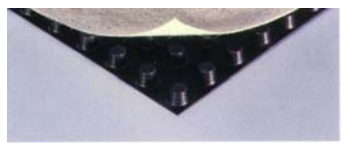
Geosynthetics Types
Geocomposites

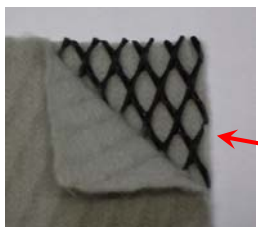
geomembrane

nonwoven geotextile



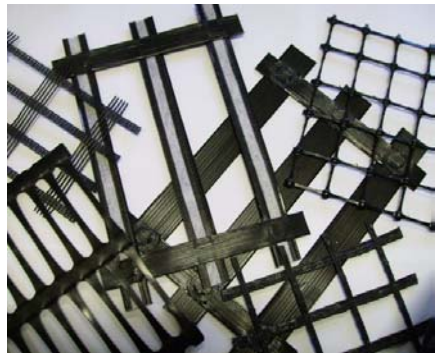
Geosynthetics Types
Geocomposites for Drainage





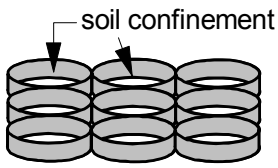
Geosynthetics Types
Geogrids

Geogrids are geosynthetic materials that have an open grid-like appearance. The principal application for geogrids is the reinforcement of soil.



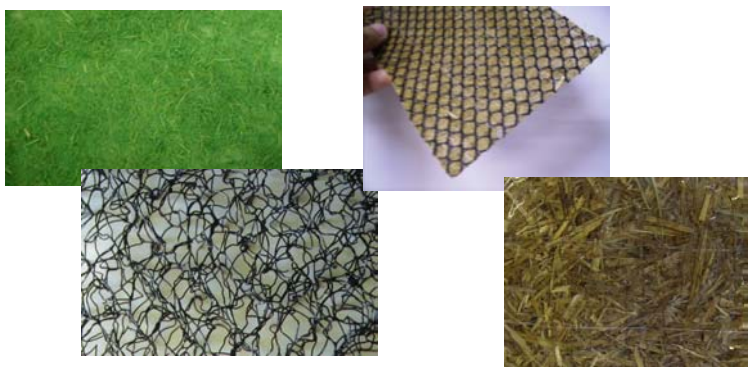
Geosynthetic Types
Geocells

Geocells are relatively thick, three-dimensional networks constructed from strips of polymeric sheet. The strips are joined together to form interconnected cells that are infilled with soil and sometimes concrete. In some cases 0.5 m- to 1 m-wide strips of polyolefin geogrids have been linked together with vertical polymeric rods used to form deep geocell layers called geomattresses.



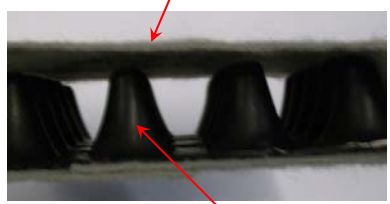
Geosynthetics Types
Geomats

Geomats are three dimensional, permeable, polymeric (synthetic or natural) structures, used for soil protection and to bind roots and small plants for erosion control applications.



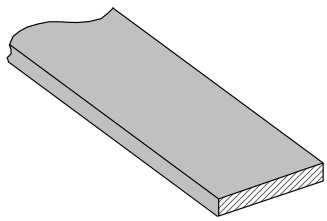
Geosynthetics Types
Geospacers

Geospacers are three-dimensional polymeric structures with large void spaces used in contacts with soil/rock and/or any other geotechnical material in civil engineering applications.



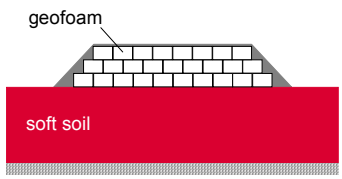
Geosynthetics Types
Geostrips

Geostrips are polymeric material in the form of strips, used in contact with soil/rock and/or any other geotechnical material in civil engineering applications.



Geosynthetics Types
Geofoam

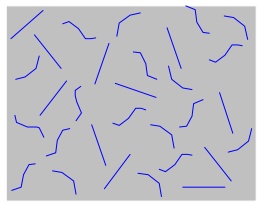
Geofoam blocks or slabs are created by expansion of polystyrene foam to form a low-density network of closed, gas-filled cells. Geofoam is used for thermal insulation, as a lightweight fill or as a compressible vertical layer to reduce earth pressures against rigid walls.



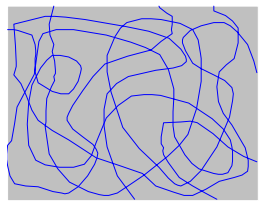
Typical unit weights:
0.12 kN/m^3 to 0.30 kN/m^3

Geosynthetics Types
Fibres

Pieces of **fibres** or continuous fibres or filaments can be mixed to the soil for reinforcement.



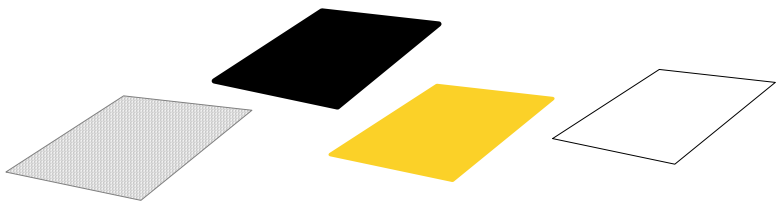
Discrete fibres



Continuous fibres

Geosynthetics Types
Geomembranes

Geomembranes are continuous flexible sheets manufactured from one or more synthetic materials. They are relatively impermeable and are used as liners for fluid or gas containment and as vapour barriers.



Geosynthetics Types
Geomembranes

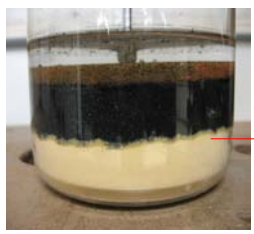
rough surface

smooth surface

Geosynthetics Types
Geosynthetic Clay Liners - GCL

Bentonite: Hydraulic conductivity $\cong 10^{-9}$ cm/s

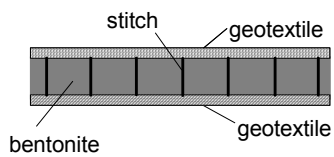
GCL – combination of geosynthetics and bentonite



Bentonite expansion after some time of moistening

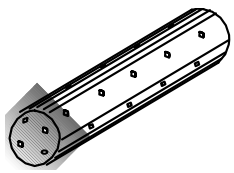
Geosynthetics Types
Geosynthetic Clay Liners - GCL

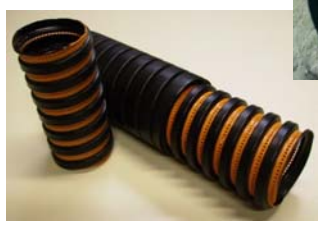
Geosynthetic clay liners (GCLs) are geocomposites that are prefabricated with a bentonite clay layer typically incorporated between a top and bottom geotextile layer or bonded to a geomembrane or single layer of geotextile. Geotextile-encased GCLs are often stitched or needle-punched through the bentonite core to increase internal shear resistance. 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.



Geosynthetics Types
Geopipes

Geopipes are perforated or solid-wall polymeric pipes used for drainage of liquids or gas (including leachate or gas collection in landfill applications). In some cases the perforated pipe is wrapped with a geotextile filter.



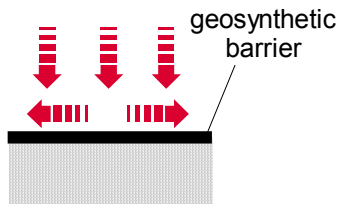


Geosynthetics Functions

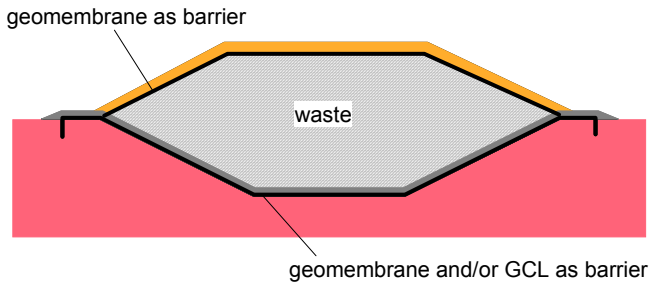
- Barrier
- Drainage
- Filtration
- Protection
- Reinforcement
- Separation
- Surficial erosion control
- Multiple functions

Geosynthetics Functions
Barriers for Fluids and Gases

Fluid/Gas (barrier) containment: The geosynthetic acts as a relatively impermeable barrier to fluids or gases. For example, geomembranes, thin film geotextile composites, geosynthetic clay liners (GCLs) and field-coated geotextiles are used as fluid barriers to impede flow of liquid or gas. This function is also used in asphalt pavement overlays, encapsulation of swelling soils and waste containment.



Geosynthetics Functions
Barriers for Fluids and Gases



Geosynthetics Functions
Barriers for Fluids and Gases

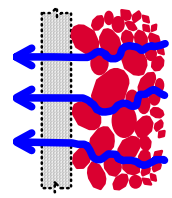
Geosynthetics Functions
Drainage and Filtration

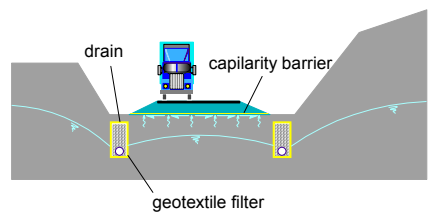
Drainage: The geosynthetic acts as a drain to carry fluid flows through less permeable soils. For example, geotextiles are used to dissipate pore water pressures at the base of roadway embankments. For higher flows, geocomposite drains have been developed. These materials have been used as pavement edge drains, slope interceptor drains, and abutment and retaining wall drains. Prefabricated vertical drains (PVDs) have been used to accelerate consolidation of soft cohesive foundation soils below embankments and preload fills.

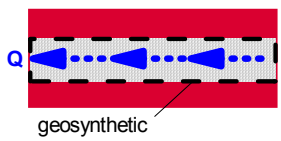
Filtration: The geosynthetic acts similar to a sand filter by allowing water to move through the soil while retaining upstream soil particles. For example, geotextiles are used to prevent soils from migrating into drainage aggregate or pipes while maintaining flow through the system. Geotextiles are also used below rip rap and other armour materials in coastal and river bank protection systems to prevent soil erosion.

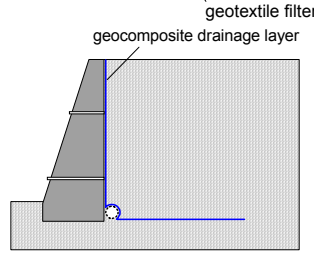
Geosynthetics Functions
Drainage and Filtration

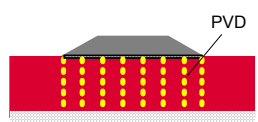
Substituting or in combination with natural draining materials











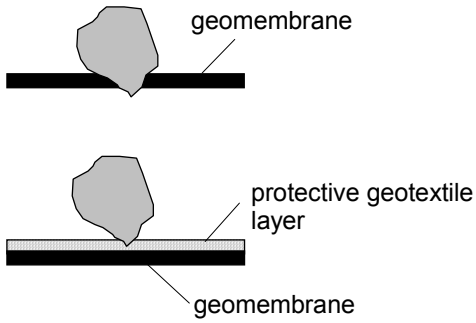
Geosynthetics Functions
Drainage and Filtration

Geocomposite behind a retaining wall
(Photo: Courtesy J.P. Gourc)

Geosynthetics Functions
Drainage and Filtration

Geosynthetics Functions
Protection

Protection: The geosynthetic material is used as a localised stress reduction layer to prevent or reduce damage to a given surface or layer.



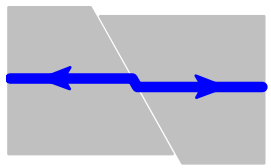
Geosynthetics Functions
Reinforcement

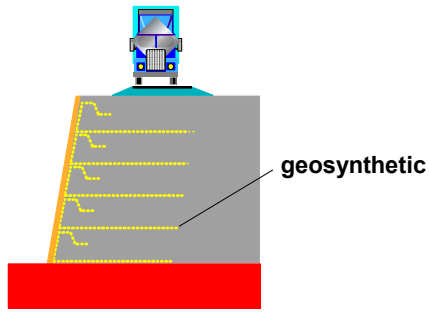
Reinforcement: The geosynthetic acts as a reinforcement element within a soil mass or in combination with the soil to produce a composite that has improved strength and deformation properties over the unreinforced soil. For example, geotextiles and geogrids are used to add tensile strength to a soil mass in order to create vertical or near-vertical changes in grade (reinforced soil walls).

Reinforcement enables embankments to be constructed over very soft foundations and to build embankment side slopes at steeper angles than would be possible with unreinforced soil. Geosynthetics (usually geogrids) have also been used to bridge over voids that may develop below load bearing granular layers (roads and railways) or below cover systems in landfill applications.

Geosynthetics Functions
Reinforcement

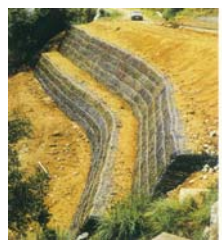
Reinforced mass: stronger and stiffer





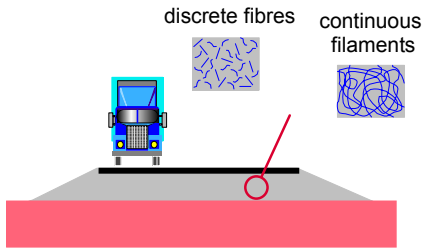
Geosynthetics Functions
Reinforcement

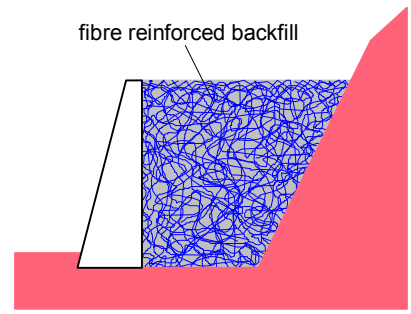
Reinforced Walls and Steep Slopes



Geosynthetics Functions
Reinforcement

Fibre Reinforced Soil

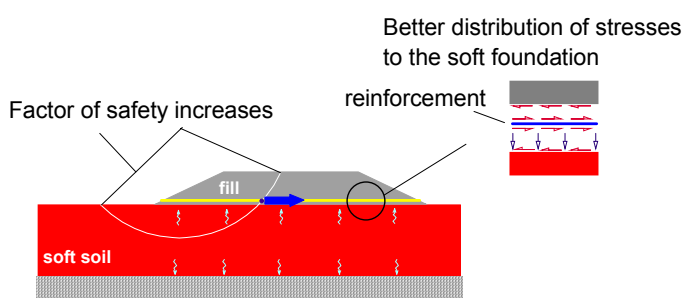




Inca's Civilization

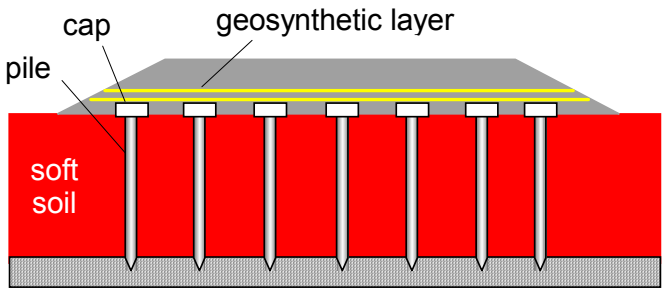
Geosynthetics Functions
Reinforcement

Embankments on Soft Soils



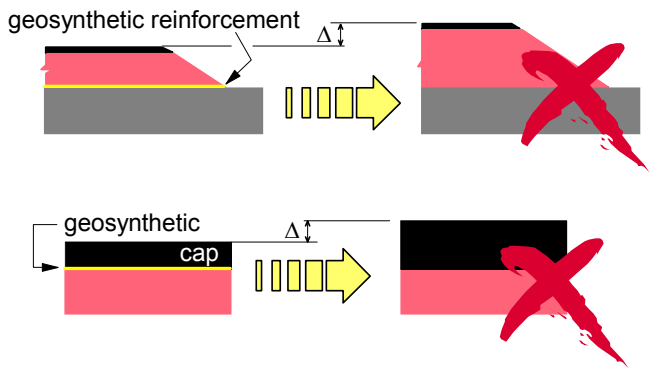
Geosynthetics Functions
Reinforcement

Geosynthetics Functions
Embankment Stabilisation



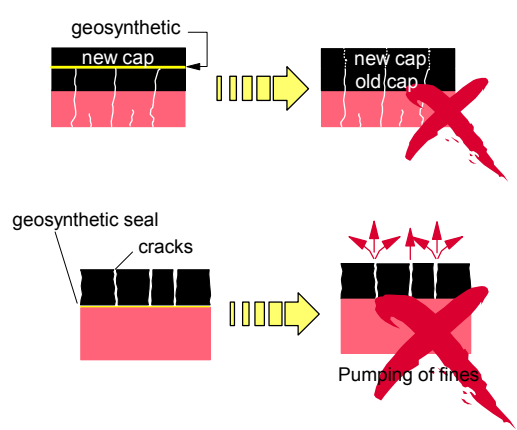
Geosynthetics Functions
Reinforcement

Reinforced pavements/caps



Geosynthetics Functions
Multiple Functions

Pavements: Reflective cracking prevention
Prevention of pumping of fines



Geosynthetics Functions
Multiple Functions

Geogrid application in overlays

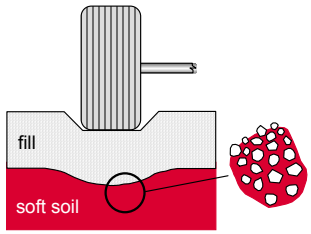
Geosynthetics Functions
Multiple Functions

Geotextile application in overlays

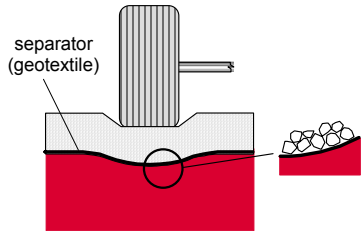
Rezende (2002)

Geosynthetics Functions
Separation

Separation: The geosynthetic acts to separate two layers of soil that have different particle size distributions. For example, geotextiles are used to prevent road base materials from penetrating into soft underlying soft subgrade soils, thus maintaining design thickness and roadway integrity. Separators also help to prevent fine-grained subgrade soils from being pumped into permeable granular road bases.



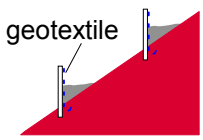
Without geotextile

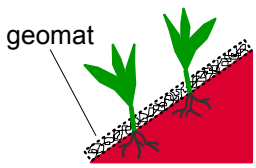


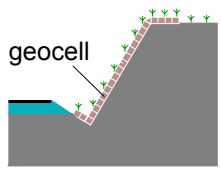
With geotextile

Geosynthetics Functions
Erosion Control

Erosion control: The geosynthetic acts to reduce soil erosion caused by rainfall impact and surface water runoff. For example, temporary geosynthetic blankets and permanent lightweight geosynthetic mats are placed over the otherwise exposed soil surface on slopes. Geotextile silt fences are used to remove suspended particles from sediment-laden runoff water. Some erosion control mats are manufactured using biodegradable wood fibres.







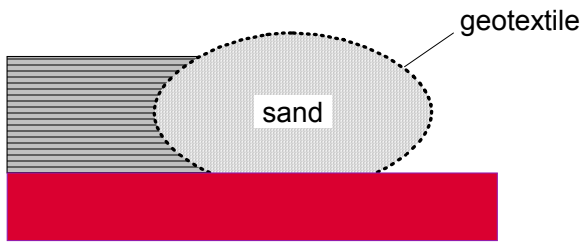
Geosynthetics Functions
Erosion Control





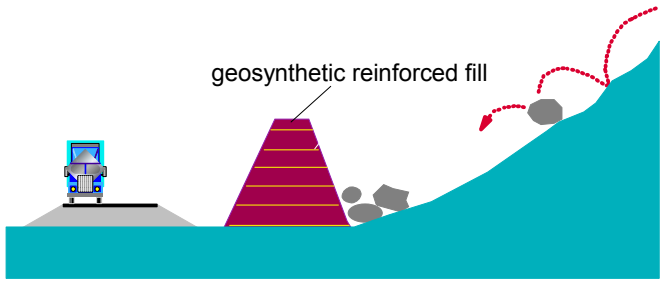
Geosynthetics Functions
Other Functions or Applications

Geotextile Tubes: used for containment, erosion control, water and flood control, etc.



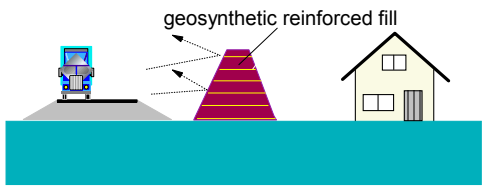
Geosynthetics Functions
Other Functions or Applications

Protection Against Falling Stones and Avalanches

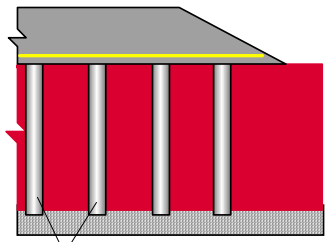


Geosynthetics Functions
Other Functions or Applications

Noise Reduction Barrier

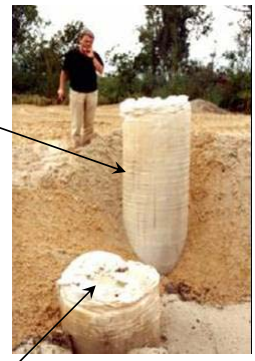


Geosynthetics Functions
Other Functions or Applications



geosynthetic encased columns

geotextile



sand or gravel

Alexiew et al. (2004)

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Thank your for your attention!