Application of Geosynthetics in Civil Engineering

by

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Geosynthetics

- A planar product manufactured from polymeric material used with soil, rock, earth, or other geotechnical engineering related materials as an integral part of a man-made project, structure, or system

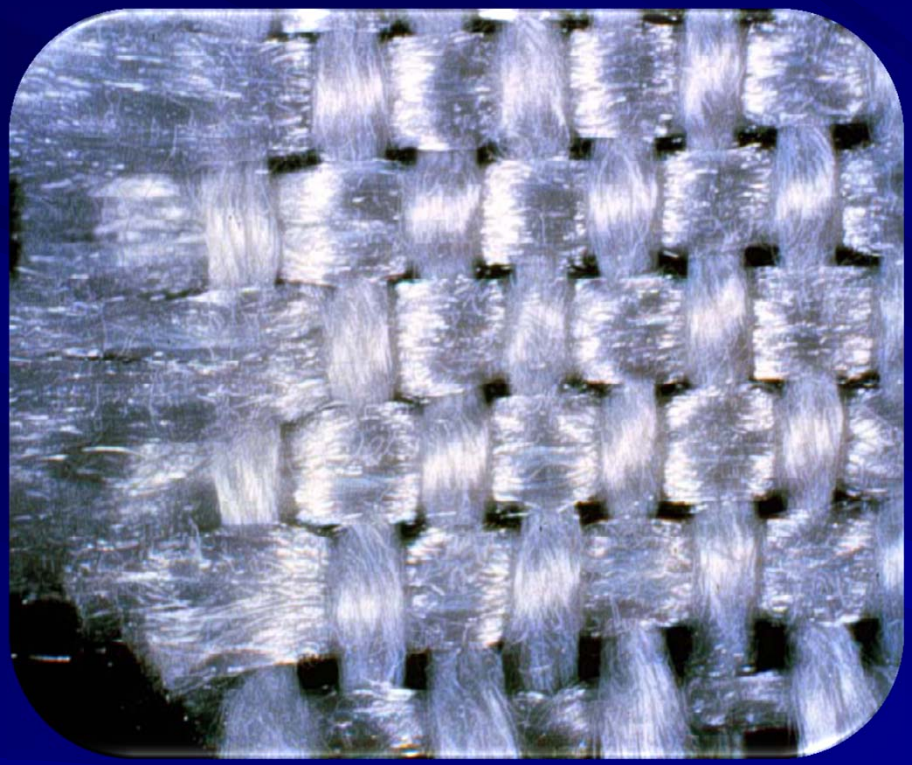
Families of Geosynthetics

- Geotextiles
- Geogrids
- Geonets
- Geomembranes
- Geosynthetic clay liners
- Geopipes
- Geocomposites

Geotextiles

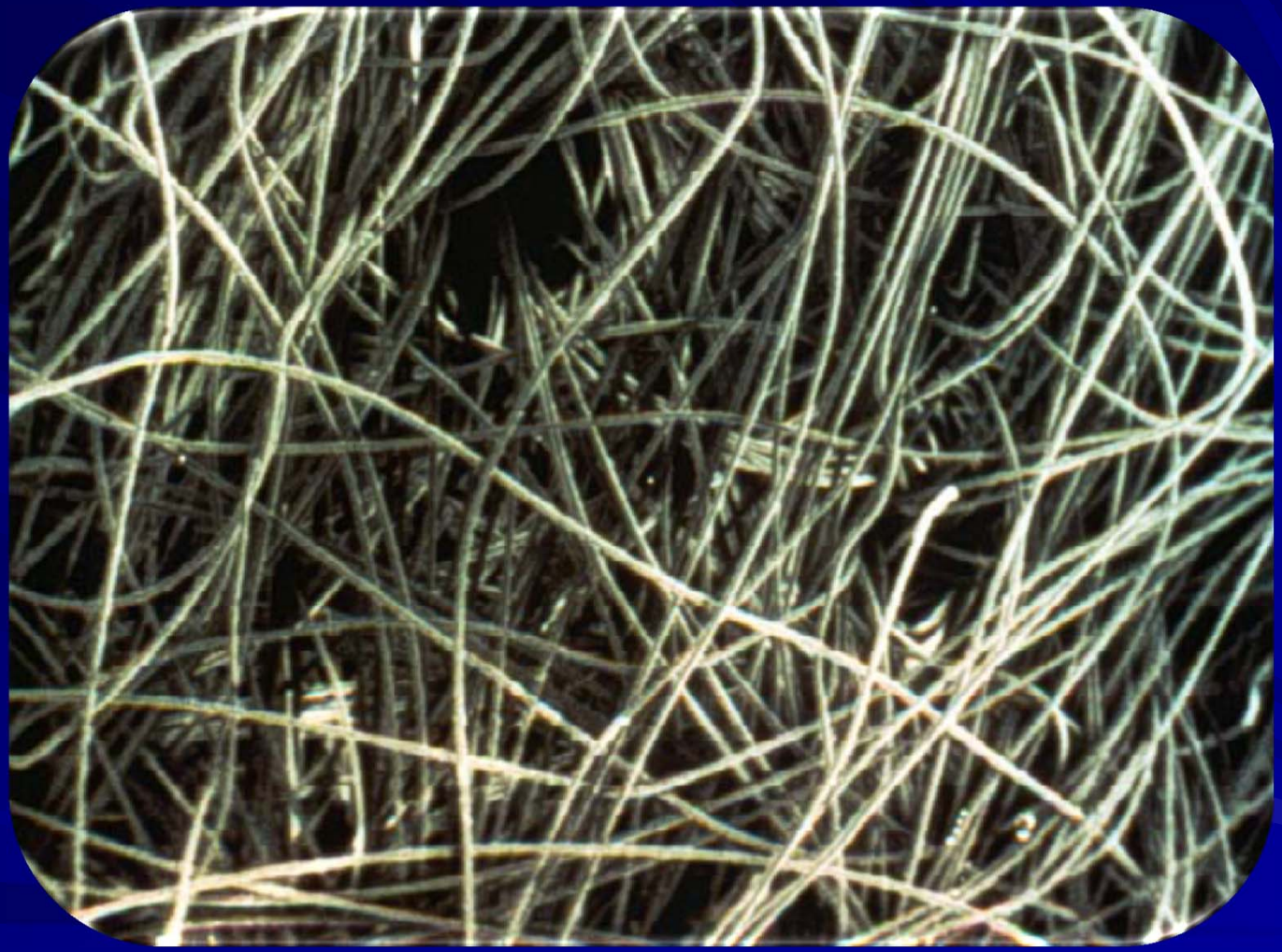
- They are indeed textiles in the traditional sense, but consist of synthetic fibers rather than natual ones such as cotton, wool or silk.
- Thus biodegradtion is not a problem
- They are made into a flexible, porous fabric by standard weaving machinery or are matted together in a random, or nonwoven, manner

Geotextiles



Woven or Knitted Geotextiles

Geotextiles



Non-woven Geotextiles

Geotextiles

Functions

- Separation
- Reinforcement
- Filtration
- Drainage
- Liquid barrier (when impregnated)

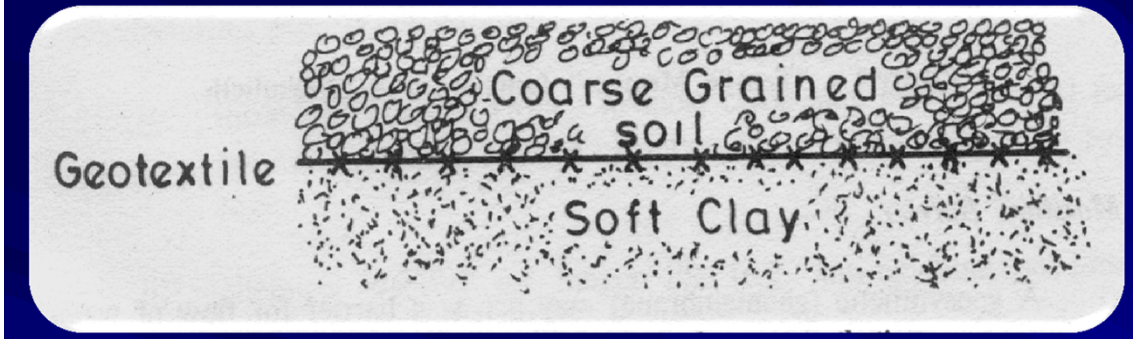
Geotextiles

Design Considerations

- Determine critical function Filtration, Reinforcement, Separation or Drainage
- If Filtration → FOS
- If Reinforcement → Tensile strength and Modulus
- If Separation → Survivability
- Consider long-term performance

Geotextiles

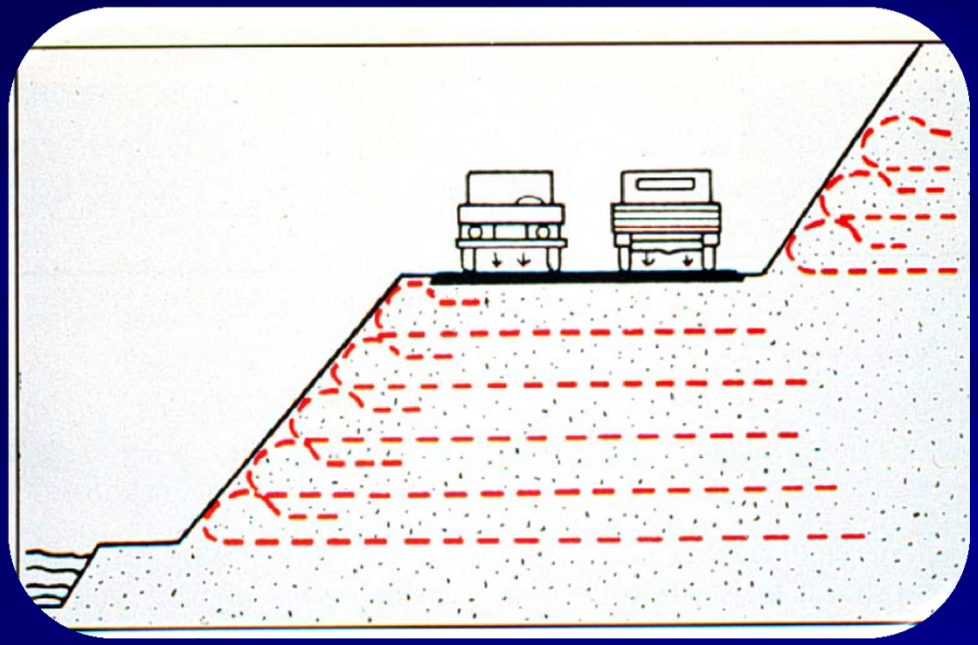
Applications



Separation

Geotextiles

Applications



Reinforcement

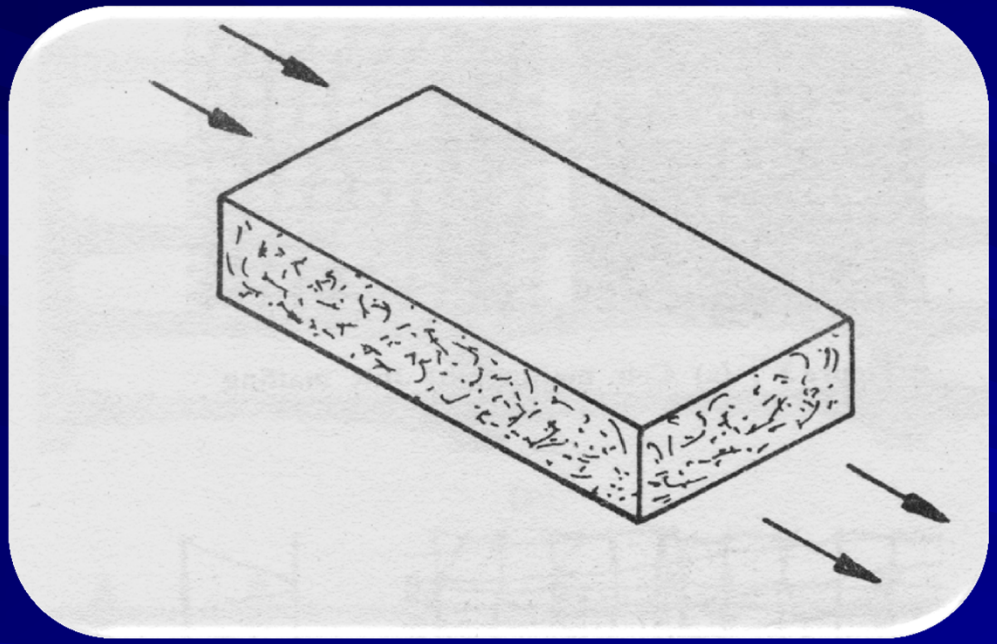
Geotextiles

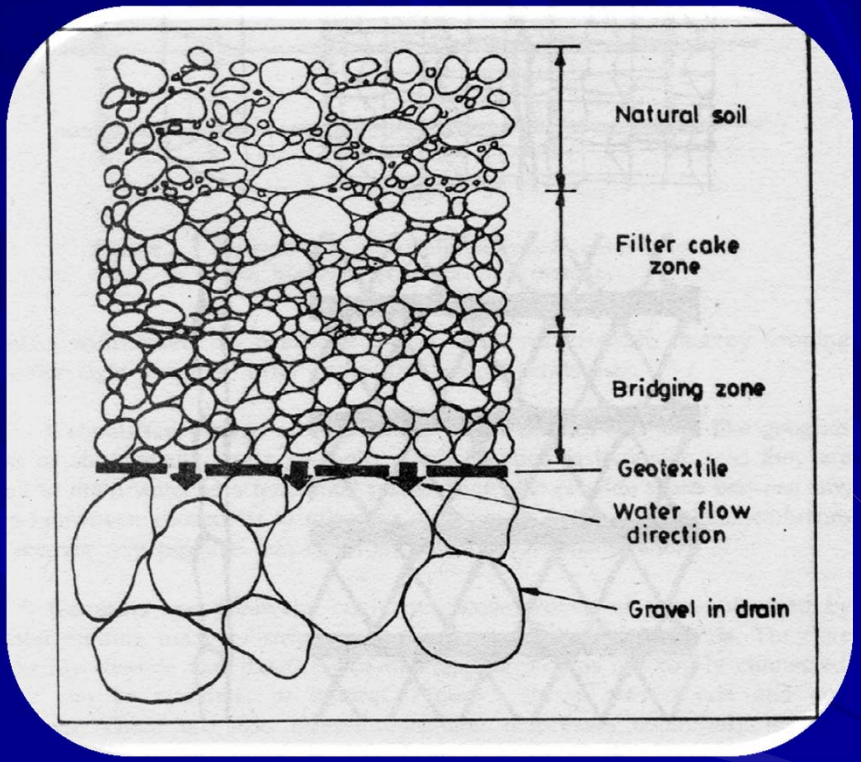
Applications

Reinforcement

Geotextiles

Applications



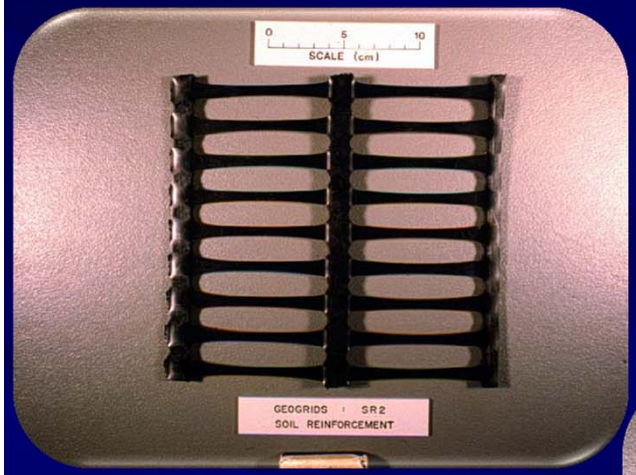


Drainage and Filtration

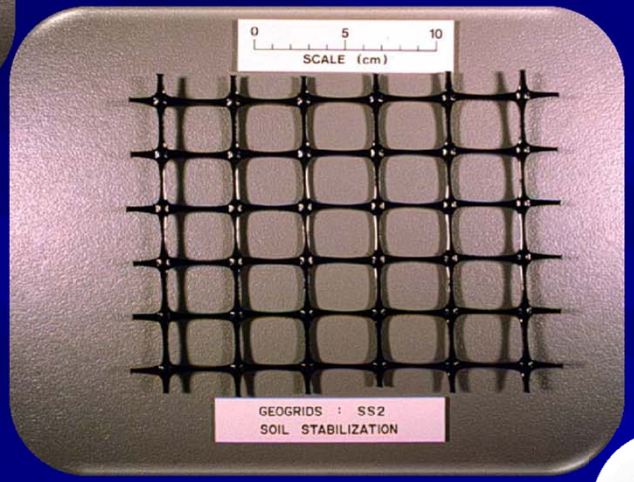
Geogrids

- Geogrids are plastics formed into a very open, gridlike configuration i.e. they have large apertures
- Geogrids are either stretched in one or two directions for improved physical properties or made on weaving machinery by unique methods
- Used primarily as reinforcement of unstable soil and waste masses

Geogrids



Uniaxial Geogrid



Biaxial Geogrid

Woven or Welded Geogrid

Geogrids

Design Considerations

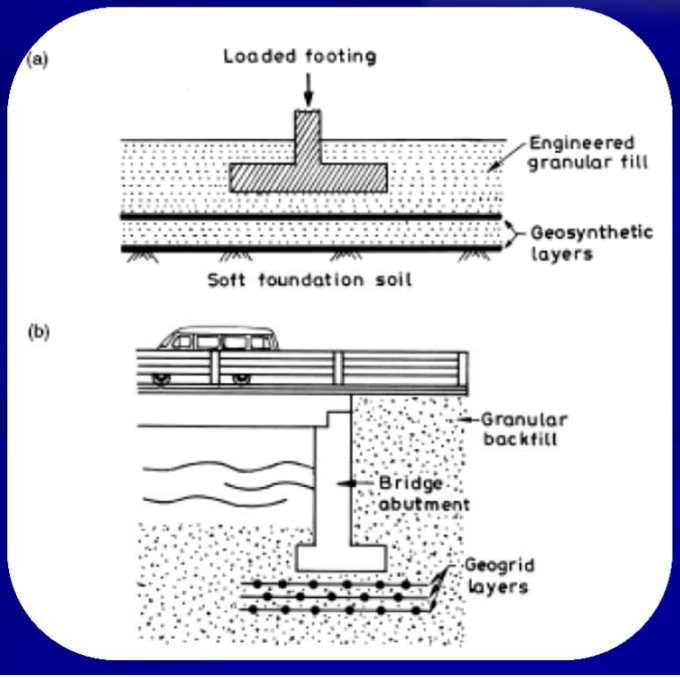
- Consider tensile modulus and strength
- Mechanical interlock with granular fills
- Damage during construction

Geogrids

Applications

Geogrids

Applications



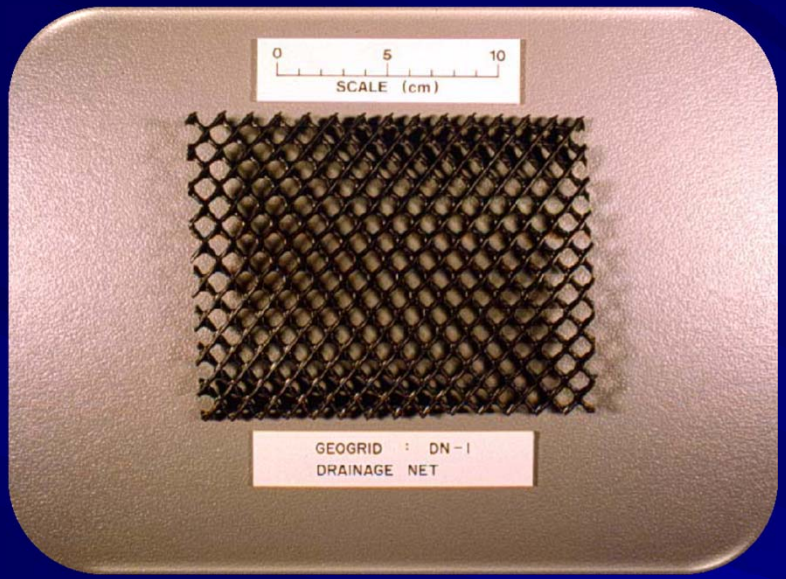
Geonets

- They are usually formed by a continuous extrusion of parallel sets of polymeric ribs at acute angles to one another
- When the ribs are opened, relatively large apertures are formed into a netlike configuration
- Their design function is completely within the drainage area where they have been used to convey fluids of all types

Geonets

- Though they are used for the drainage function but they have high tensile strength
- Generally used along with one or two geotextile matter one at the top and other at the bottom to prevent soil intrusion

Geonets



Geonets

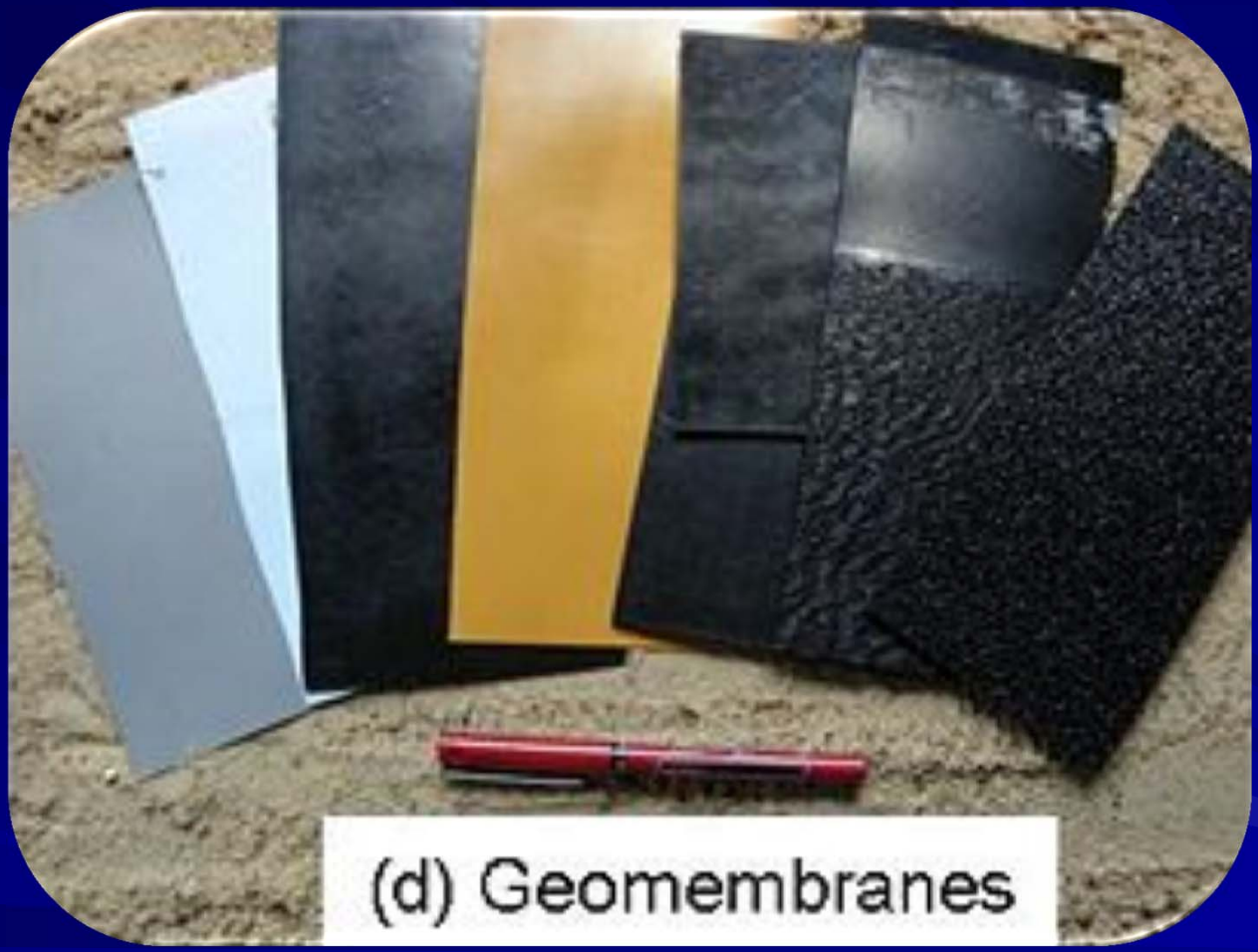
Design Considerations

- Consider the flow rate (which is preferred to transmissivity)
- Normal stress
- Hydraulic gradient

Geomembranes

- The materials themselves are "impervious" thin sheets of rubber or plastic material used primarily for linings and covers of liquid- or solid-storage or disposal facilities
- Thus the primary function is always as a liquid or vapor barrier

Geomembranes



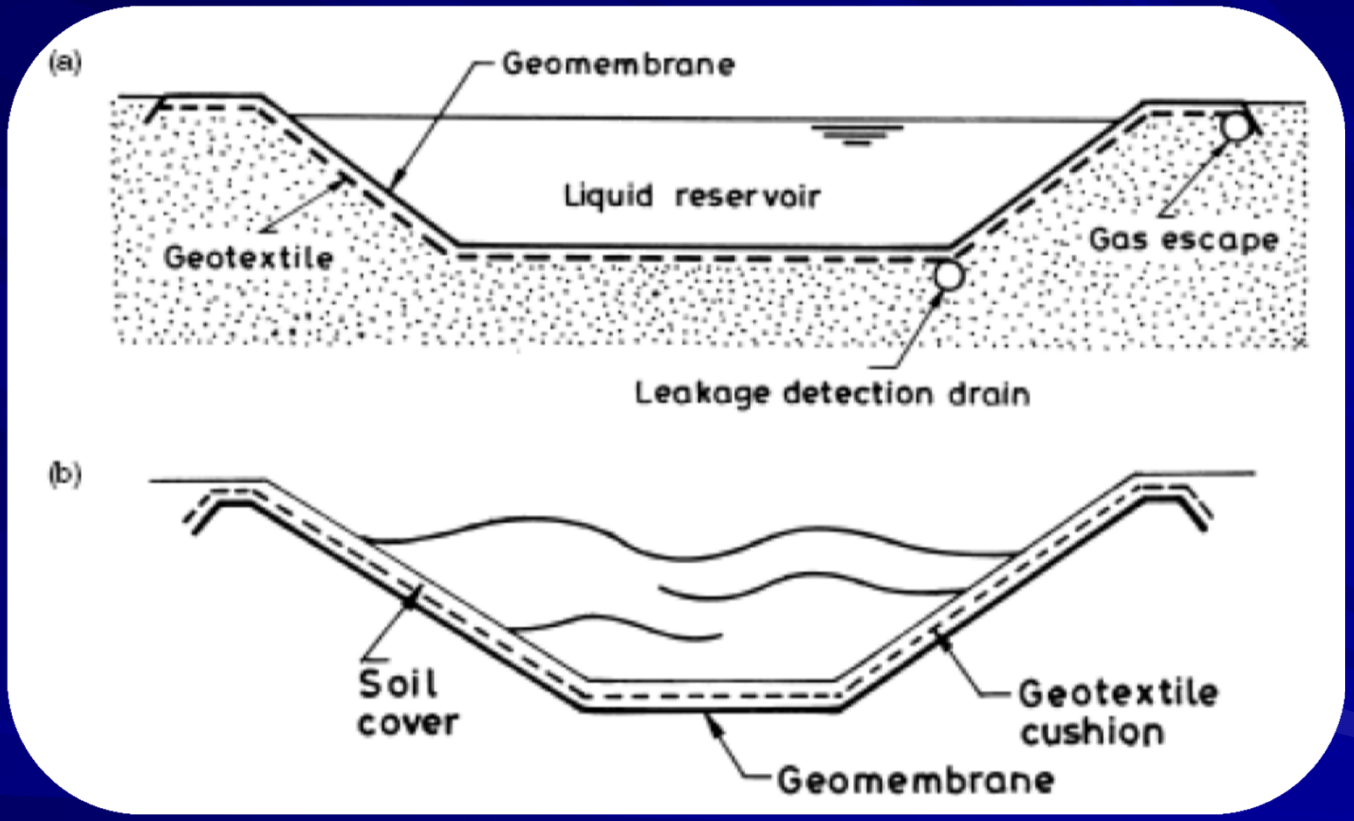
Geomembranes

Design Considerations

- Leakage rates are determined by Quality Control
- Consider compatibility with retained liquid or waste
- Consider Geomembrane as potential slip-surface on slopes
- Consider exposure to long-term environmental agents of weathering (sunlight, air, burrowing rodents)

Geomembranes

Applications



Seepage barrier

Geomembranes

Applications

Installation of Geomembranes

Geomembranes

Applications

Geomembrane and drainage installation

Geomembranes

Applications

Geomembranes

Applications

Geomembranes

Applications

Installation of Geomembrane as Closure

Geosynthetic Clay Liners (GCLs)

- Geosynthetic Clay Liners (or GCLs) are the newest subset within Geosynthetic materials
- They are rolls of factory fabricated thin layers of bentonite clay sandwiched between two Geotextiles or bonded to a Geomembrane
- Structural integrity is maintained by needle punching, stitching or adhesive bonding
- They are used as a composite component beneath a Geomembrane or by themselves as primary or secondary liners providing hydraulic barrier

Geosynthetic Clay Liners (GCLs)

Cross-section sketches of GCL

Geosynthetic Clay Liners (GCLs)

Design Considerations

- **Calculation of flow rate for water storage situations and flow rate, adsorption, and breakout time for both water and solute in waste containment applications**
- **Shear strength calculations for side slopes under all possible interface conditions**

Geosynthetic Clay Liners (GCLs)

Design Considerations

- **Puncture, tear, and loss of bentonite situations considering both the materials above and below the GCL i.e. compatibility of bentonite with retained waste or liquid (potential for deleterious mineralogical alteration)**
- **Survivability during installation considering both the subgrade and the backfill materials**

Geosynthetic Clay Liners (GCLs)

Applications

Installation of GCL

Geosynthetic Clay Liners (GCLs)

Applications

Installation of GCL

Geosynthetic Clay Liners (GCLs)

Applications

Geopipes (or Buried Plastic Pipes)

- Perhaps the original Geosynthetic material still available today is buried plastic pipe
- The critical nature of leachate collection pipes coupled with high compressive loads makes Geopipe a bonafide member of the Geosynthetics family
- The function is clearly drainage

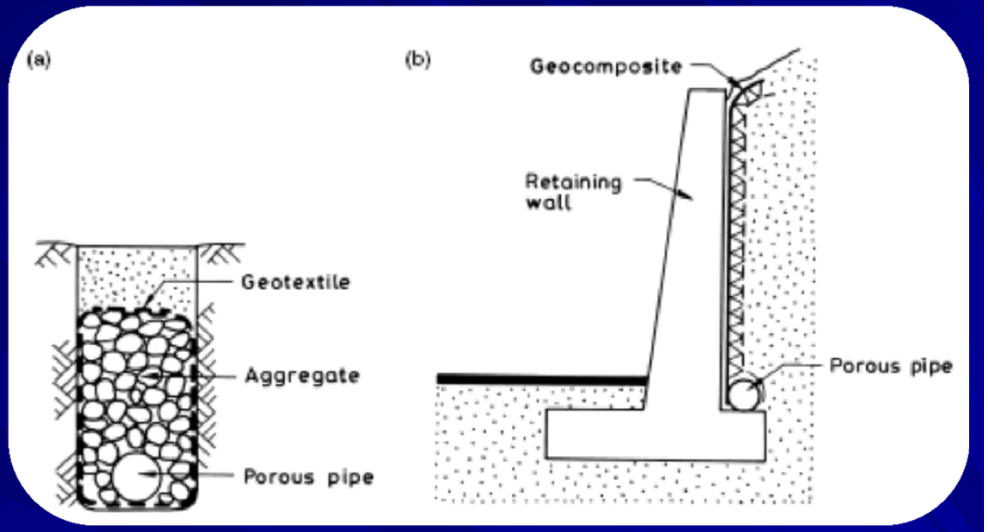
Geopipes (or Buried Plastic Pipes)

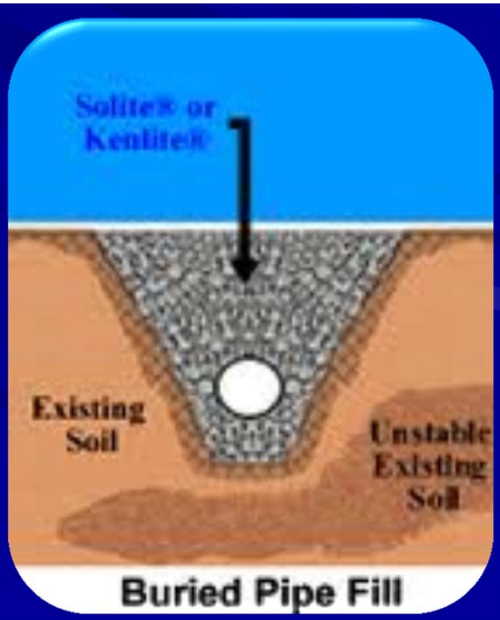
Design Considerations

- External concentrated line or distributed load
- Internal hydrostatic pressure
- Sustained load (creep) resistance
- Stress crack and fatigue resistance
- Impact and abrasion resistance
- Swelling and chemical resistance
- Ultraviolet light resistance

Geopipes (or Buried Plastic Pipes)

Applications





Geopipes (or Buried Plastic Pipes)

Applications

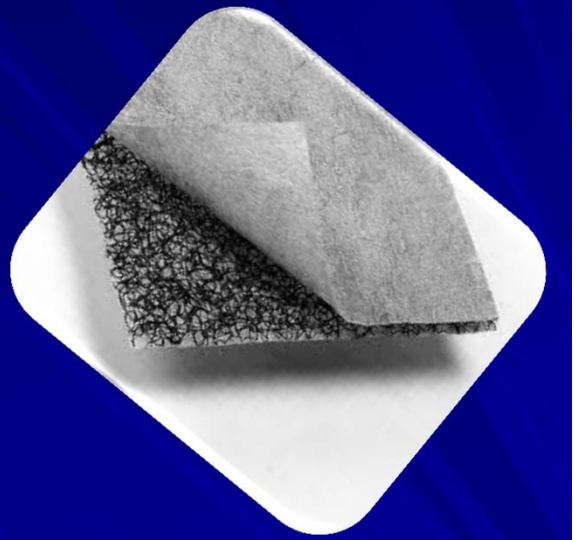
Geocomposites

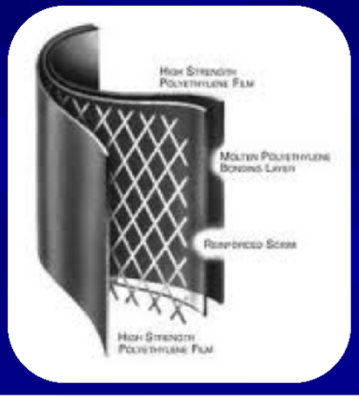
- A Geocomposite consists of a combination of Geotextile and Geogrid; or Geogrid and Geomembrane; or Geotextile, Geogrid, and Geomembrane; or any one of these three materials with another material (e.g., various soils, deformed plastic sheets, steel cables, or steel anchors)

Geocomposites

- This exciting area brings out the best creative efforts of the engineer, manufacturer, and contractor
- The application areas are numerous and growing steadily
- The major functions encompass the entire range of functions listed for Geosynthetics discussed previously: separation, reinforcement, filtration, drainage, and liquid/vapor barrier

Geocomposites





Geocomposites

Applications

Geocomposites

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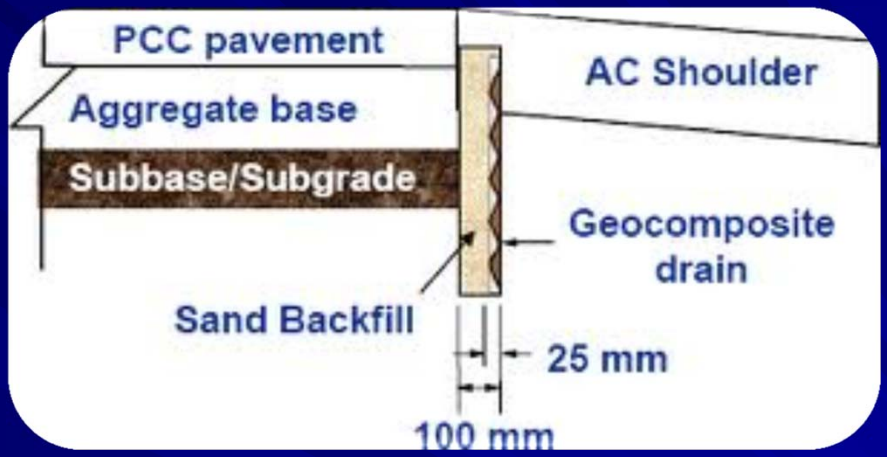
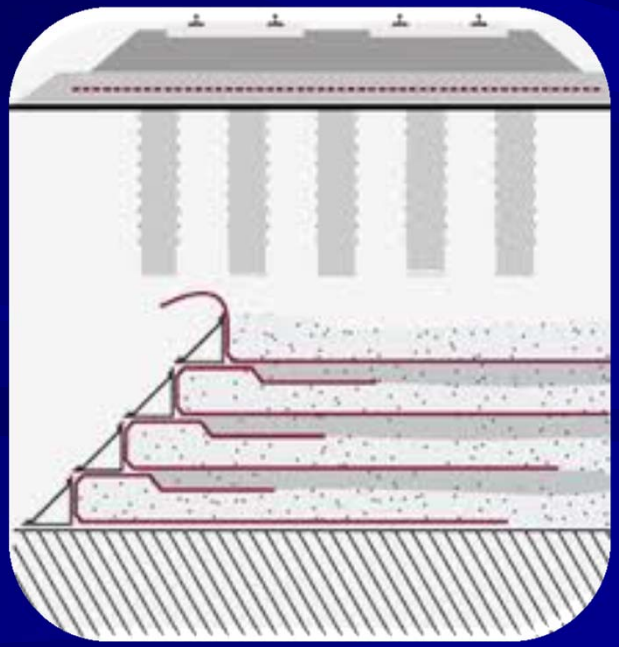
Geocomposites

Applications





Geosynthetics

New Applications

Generation of Solar Energy

Summary

- Determine the function of the Geosynthetic component in question
- Determine the required properties (filtration size, in-plane or cross-plane hydraulic flow capacity, required tensile strength and modulus)
- For Geotextile providing separation only, specify required properties on the basis of "survivability"

Summary

- In specifications, reference required material properties to the standard "INDEX" tests such as Strength (tensile, burst, tear), Filtration (FOS), Permeability and Drainage capacity
- A common (and less than desirable) practice is to specify "Product X or Equivalent"; this begs the question Equivalent what ???
- Better to provide required properties and examples of specific products that will meet the specifications




Thank You