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RECLAMATION

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Introduction to Geosynthetics



What are Geosynthetics?

Geo = earth

Synthetic = human made

Geosynthetics = human made materials (polymers) used with soil, rock, earth or other geotechnical materials as an essential part of a project, structure or system.



Types & Functions

Type	Separation	Reinforcement	Filtration	Drainage	Containment
Geotextiles	X	X	X	X	
Geogrid		X			
Geonet				X	
Geomembrane					X
GCL					X
Geofoam	X				
Geocell	X	X			
Geocomposite	X	X	X	X	X

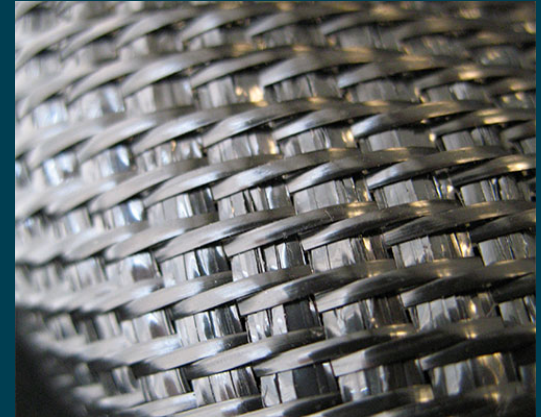


Geotextiles

Two Types

Woven

- Used for separation, reinforcement and drainage.
- Used with pavement, roads, railroads, structures, and rip rap.
- Strength is support, stabilization, and drainage to prevent erosion and or collapsing of the ground around a road, railroad, etc.



Nonwoven

- Used for separation, reinforcement, and filtration.
- Used with drains, geomembranes, aggregate
- Reclamation mainly uses as a cushion to protect geomembranes from being punctured by aggregate, the subgrade, etc.



Geomembranes

- Function: contain liquids or gases. Reclamation uses geomembranes in canals, ponds, reservoirs, dam faces, and roof tops to prevent water from seeping into unwanted areas.
- The primary makeup of most Geomembranes is any of the following polymers.
 - HDPE, LLDPE, PP, PVC, CSPE, or EPDM
- Additives are used to improve properties required for durability, UV exposure, etc.
 - Carbon Black is a pigment that is used for UV stabilization.
 - Plasticizers impart flexibility to prevent punctures and tears
 - Biocides to kill organic material



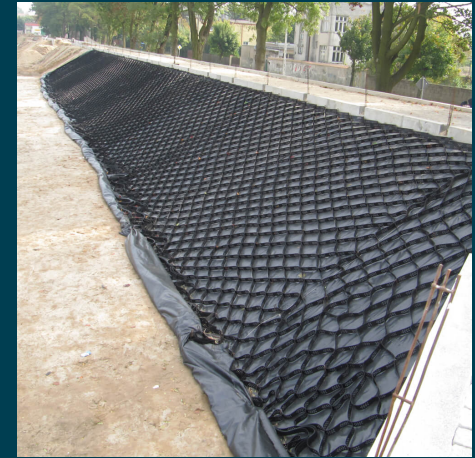
Geonet

- Geonets are grid like materials consisting of parallel sets of ribs overlaying other parallel sets of ribs at various angles. They are often sandwiched between GT's.
- The function of a geonet is to laterally drain liquids or gases within the plane of the material.
 - Example – used under sports fields or putting greens to prevent sitting water.
- Two main types of geonets used.
 - Triplanar - these types are used whenever drainage is required under high loads.
 - Biplanar – these types of geonets are used to transport large fluid or gas flows under very minimal loads such as leak detection layers in ponds.



Geocell

- Geocells are a three-dimensional structure much like a honeycomb that is meant to be filled with aggregate, soil, etc. (See images to the right)
- Function
 - Separation
 - Reinforcement
 - Both
- Reclamation has used these to retain a coble/gravel mixture on the side slope of a detention pond to protect the underlying geomembrane liner from UV degradation and mechanical damage.
- Primary Use
 - Reclamation : canals and ponds
 - Soil stabilization, erosion control, and structural reinforcement for load support.



Geosynthetic Clay Liner

- Geosynthetic Clay Liners (GCL's) are hydraulic barriers that generally consist of bentonite clay sandwiched between two geotextiles or geomembranes.
- GCL's are primarily used in landfill applications in place of compacted clay (CC) liners or geomembranes.
 - Fast + Easy to Install
 - Very low conductivity, swell to 15 times size when hydrated.
 - Self healing up to 70 mm holes.
 - Low cost when CC is not available.
 - Maximize capacity compared to CC
- Reclamation has used GCL's in canals and ponds.
 - 12 in min. soil cover to provide seal
 - Soil cover sloughs from side slopes
 - Cover significantly reduces capacity



Geogrids/Geofoam

Geogrids

- Geogrids are used to reinforce soils or other materials.
 - Retaining walls
 - Side slopes
 - Reinforce soils or other base materials below roads or other structures.



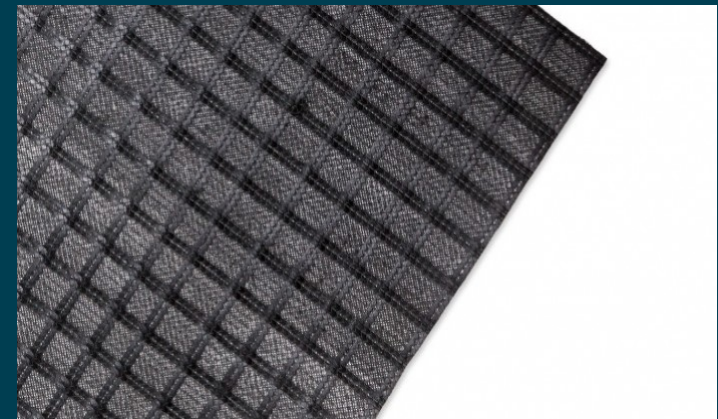
Geofoam

- Geofoam is large blocks of expanded polystyrene (EPS).
 - Slope stabilizer
 - Retaining wall backfill
 - Road embankments
 - Pavement insulation



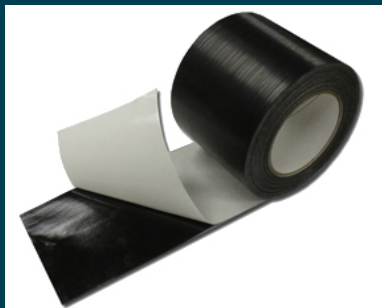
Geocomposite

- Geocomposite – a combination of any of the previous discussed geosynthetic materials.
- The goal of a geocomposite is to combine the best properties of the different types of materials to find an optimal low-cost solution to a specific problem.
 - Geocomposite can provide separation, reinforcement, filtration, drainage, and containment.
- Geocomposite Examples
 - Geotextile-Geonet Geocomposite
 - Geotextile-Geomembrane Geocomposite
 - Geomembrane-Geogrid Geocomposite
 - Geotextile-Geogrid Geocomposite



Repair Techniques

- Geomembranes
 - Heat Welder – more economical in most situations and creates strong bond.
 - Adhesive - messy
 - Adhesive Tape – strong bond, pipe boots



Repair Techniques

- Geotextiles
 - Heat Welder – preferred method that creates strongest bond.
 - Stitching – must be used in wet weather as welding won't work.



Degradation Mechanisms

- Any mechanism that causes chain scission, bond breaking, loss of additives, extraction, or mechanical damage will lead to degradation.
 - UV light
 - Radioactive
 - Biological (animals, fungi or bacteria)
 - Chemical
 - Thermal (expansion and contraction)
 - Oxidative
 - Ozone
 - Vandalism



Canal Lining Research



Project Scope

- Research Question

- Canal Lining Demonstration Project began in 1991 (6 reports between 1991 and 2001).
- Goal was to study non-traditional liners in canals with high seepage rates (35-50%).
- Current question: how are the test sections performing after up to 25 years of service?

- Team & Partners

- Jay Swihart & Mike Walsh (BOR)
- George Koerner (GRI)



Project Approach

- Test Sections (Arnold, North, and Ochoco)
 - 24 test sections installed 1991 to 2001
 - 7 test sections removed from the study
- Report
 - Failure analysis (7 test sections)
 - Condition Assessment (17 test sections)
 - Sample Coupon Testing (GRI)
 - Correlation between properties and performance
 - Benefit/Cost Analysis



Project Results

- Exposed Geomembrane



- Advantages
 - Can be durable (25+ years)
 - Low cost
 - Initial construction
 - Effectiveness (90%)
- Disadvantages
 - Maintenance
 - Difficult
 - Higher cost
 - Service conditions
 - Soil migration
 - Liner Uplift + whales
 - Capacity reductions
 - Varying B/C ratio



Project Results

- Concrete (reinforced & unreinforced)



- **Advantages**
 - Durable (50 years)
 - Maintenance
 - Low cost
 - Easy
 - Prevent
 - Soil migration
 - Canal failure
- **Disadvantages**
 - Low effectiveness (seepage reduction)
 - estimated 70%
 - Fairly Expensive



Project Results

• Concrete over Geomembrane



- **Advantages**
 - Durable (50 years)
 - Effective (95%)
 - Maintenance
 - Easy
 - Low cost
 - Prevent
 - Soil migration
 - Liner degradation
 - Liner uplift
 - Canal failure
- **Disadvantages**
 - Expensive



Project Results

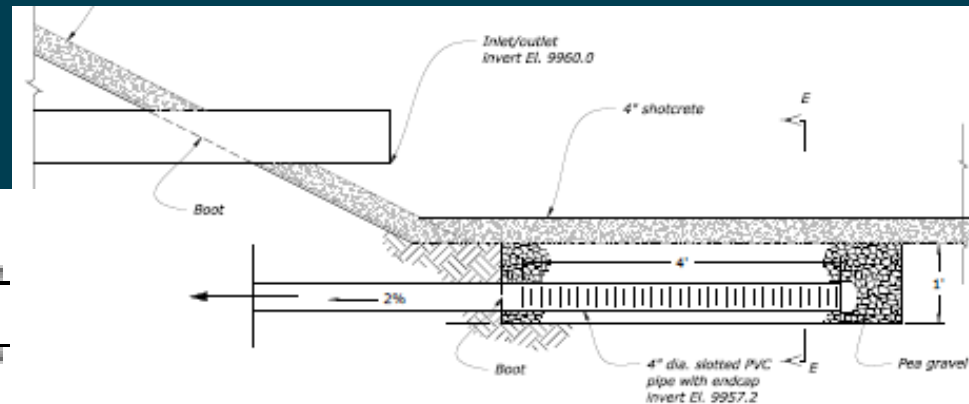
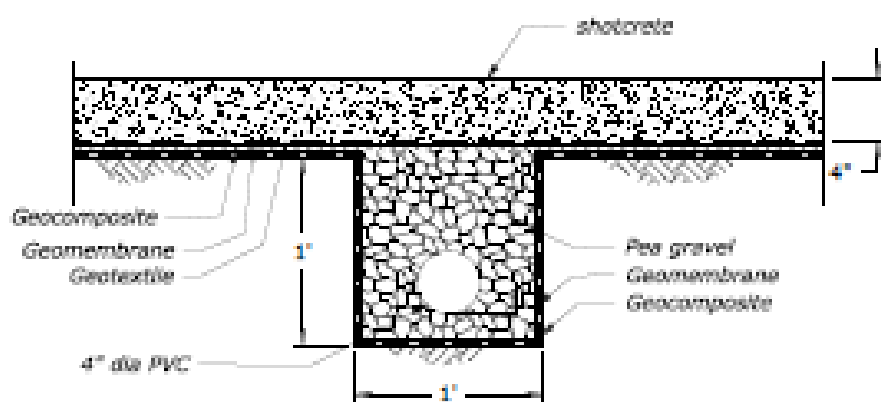
Liner Type	Durability (years)	Effectiveness (%)	Maintenance (\$/ft ² ·yr)	B/C Ratio
Concrete	50	70	0.005	3.0-3.3
Concrete over Geomembrane	50	95	0.005	3.5-3.7
Exposed Geomembrane	15-30	90	0.010	2.2-3.8

- Concrete over geomembrane provides consistently high B/C ratio and highest effectiveness (main goal).



WTP Detention Pond

- This slide is intended to highlight how geosynthetics can be used in conjunction with each other.
- The following liner system is being used in a water treatment plant detention pond. The pond is utilized as a storage pond in case the plant is at capacity, there is down time for maintenance, exit streams are dropping in quality for an unknown reason, etc.
- From top to bottom – 1. Shotcrete cover 2. Geotextile 3. Geomembrane 4. Geotextile-Geonet Geocomposite Leak Detection Layer 5. Geomembrane 6. Geotextile-Geonet Geocomposite.



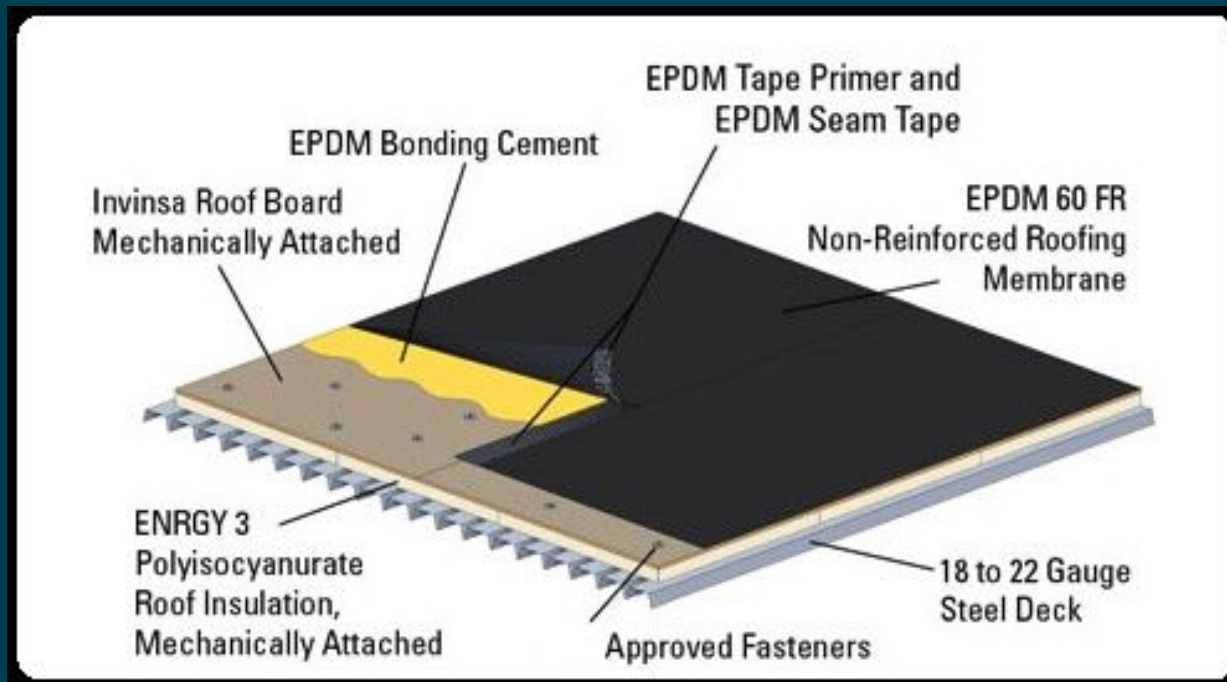
Dam Seepage Reduction

- Using geosynthetic materials to reduce seepage through the face of a dam.
- This dam is made from steel plates coated with a protective paint.
- Problems that have arisen.
 - Corrosion of the steel face
 - Movement and heaving of the steel plates
 - Cracking
- This solution utilizes batten strips as well as a proprietary technology to tension the material down to the face of the dam. Wind is obviously a concern in an application like this where in a canal it wouldn't be as much of an issue.



Elevator Shaft Roof Repair

- Reclamation is involved in roof repair projects that involve finding a waterproof and weatherproof solution to roofing. This project involved fixing a leaky roof over the top an elevator shaft in a hydroelectric plant.
- EPDM is often used as it is very weatherproof, durable and flexible at both high and low temperatures.



Thank you!
Questions?

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Cathodic Protection



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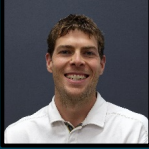
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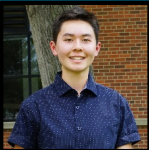
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