GEOSYNTHETICS AND REINFORCED SOIL STRUCTURES

Different Types of Geosynthetics and Their Applications

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RECAP OF PREVIOUS LECTURE

• Introduction
• Historical background
• Early applications
• Functions of geosynthetics
• Types of geosynthetics
OUTLINE OF 2\textsuperscript{nd} LECTURE

- TYPES of geosynthetics
  - CONTINUED
- TYPICAL APPLICATIONS
TYPES OF GEOSYNTHETICS

- Geotextiles
- Geogrids
- Geonets
- Geomembranes
- Pre-fabricated vertical drains (PVD)
- Geosynthetic Clay Liner (GCL)
- Geocells (3-d confinement)
- Geocomposites & Geo-others
GEONETS

- Geonets are also planar products
- Consists of ribs in two directions
- Apertures are of diamond shape
- Ribs in the two directions are at different planes
- Thickness of geonets is larger than that of geogrids
- Geonets are also referred to as geospacers
TYPICAL GEONETS

Ribs at two horizontal planes
GEONET APPLICATIONS

• Erosion control – ribs act as small check dams to slow down the surface runoff – decreases erosion potential of water

• Drainage layers – water flows along the geonet because of large thickness
Boulder net laid on Konkan railway line in Western ghats – functions as guide for loose boulders and vegetation support
Laying of boulder net

Vegetation growth after two seasons

Courtesy: M/s Garware Wall Ropes Ltd., Pune
Anchor trench at the top of the slope, 1m deep, 0.5m wide, filled with soil
GEOMEMBRANES

• Thick impervious plastic sheets
• Thickness .5 mm to 3 mm approximately
• To contain liquids and gases

Rough surface texture  Smooth – double sided membrane
APPLICATIONS OF GEOMEMBRANES

• Landfill lining
• Canal lining
• Tunnel lining
Geomembrane in a landfill

Types and Functions of Geosynthetics
Canal lining using geomembranes

Concrete lining of surface

geomembrane

Anchor trench
Tunnel lining for moisture protection
Pre-fabricated vertical drains to accelerate the pre-consolidation of soft clay soils

\[ T_v = \frac{C_v t}{d^2} \]

\[ T_v \Rightarrow f(U\%) \]

\[ t = T_v d^2 \]

\[ C_v \]

\[ T_v = \text{time factor} \]
\[ t = \text{time} \]
\[ C_v = \text{coefficient of consolidation} \]
\[ d = \text{drainage path length} \]
\[ U\% = \text{degree of consolidation} \]
Reducing the flow path length to accelerate rate of consolidation
PVDs for pre-consolidation

Corrugated plastic core for drainage

Geotextile filter
Pore water flows laterally to the wick drains and is carried through the core

Connection arrangements for wick drain installation
Installation of PVDs at a construction site – notice the connection of PVD with the anchor plate
PVD being pushed into the ground

Types and Functions of Geosynthetics
General view after installation of PVD’s at a site
Geosynthetic Clay Liners

- Consist of a core of bentonite clay sandwiched between layers of thick non-woven geotextile
- Applied below and above geomembrane layers in landfills
- Self-repair mechanism
- Bentonite expands when flid leaks through punctured geomembrane – closes the gap
Geosynthetic Clay Liner

Geotextile layers

dry bentonite powder
GEOCELL – 3d confinement product

Plan view showing the mechanism of confinement

Iso-metric view of a geocell layer
Photograph of an expanded geocell
Advantages

• Easy to transport
• Any fill material can be used
• All round confinement to soil
• Semi-rigid layer (very stiff support)
• Spreads loads over a large area
• Excellent support even under cyclic loads.
APPLICATIONS

- Erosion control
- Steep slopes and retaining walls
- Sub-base support
  - Road bases
  - Railway tracks
  - Container yards
Use of geocells for construction of unpaved road Factory

Preparation of ground

Stapling to join different geocells

Stretching of the geocell layer

Stone aggregate filled in geocell pockets

Compaction by a 10 tonne roller

Types and Functions of Geosynthetics
Geocells used for construction of a steep slope
Vegetation taking root through geocell pockets
IITM students standing on a geocell supported soil
Typical Container yard – heavy loads, usually constructed on soft marine clays near the shore.
Typical mud wave formation in container yards due to heavy loads and extremely soft subgrade soil
Geotextile separator being laid on the ground surface at a container yard
Geocell layer laid on the geotextile separator and filled with stone aggregate
Container yard 3 years after geocell treatment
Some more pictures of the same yard

Perfectly level surface – minor damage in paver blocks
Polymeric erosion control mats
Geocomposites

- Combination of two different types of geosynthetics to take advantage of each
Geo-others

- Geodrains
- Lightweight fills
- Geopipes
- Geotextile bags & soil encapsulation
- Gabions
- Geosynthetic Encased Stone Columns
- Many others – left to the imagination of engineers
Drainage boards for use in Retaining Walls
Light-weight fill cum drainage medium

Thick medium made of polystyrene beads

Types and Functions of Geosynthetics
Gabions filled with stones
Gabions filled with sand bags

SAND FILLED GEOBAGS

PLACEMENT OF GEOBAGS

TYING OF ROPE GABIONS

FINAL VIEW

Types and Functions of Geosynthetics
Light-weight drainage medium

Made of used rubber tyres and other industrial wastes
Encased Stone Column

Bearing capacity enhanced by

Passive pressure +
Additional confinement

Geosynthetic encasement

Stone column

Sectional

Types and Functions of Geosynthetics
Construction of Encased Stone Column

Alexiew et al. (2005)

Types and Functions of Geosynthetics
Load settlement curve for stone columns encased in non-woven geotextile

![Graph showing settlement vs. pressure for stone columns encased in non-woven geotextile](image)
Latest Trends

• Vacuum consolidation
• Encased stone columns
• Electro Kinetic geosynthetics
Questions
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