OVERVIEW OF GEOSYNTHETICS

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What are Geosynthetics

The generic term to all synthetic and natural materials used in geotechnical and man-made applications.

The use of geosynthetics materials has two main objectives:
- to do the job better
- to do it more economically
Why Textiles

- Textiles perform the function: separation, filtration, drainage, reinforcement.
- Textiles are more reliable than soil.
- Textiles can be engineered as per functional requirements.
- Easy for transportation
- Can be laid during inclimate weather.
- Cost effective
Families of Geosynthetics

- Geotextiles
- Geogrids
- Geotubes
- Geonets
- Geomembrane
- Geosynthetic clay liner
- Geofoams
- Geocell
- Geocomposites
**Without Terram**

Granular layer

Intermixing of granular layer with soft subgrade

Soft subgrade

**With Terram**

Granular layer

Terram geotextile

Terram maintains the boundaries between adjacent soil layers

Soft subgrade
Separation component

Granular layer

Terram geotextile

Terram prevents intermixing of soil layers

Soft subgrade
Filtration component

Granular layer

Terram geotextile

Terram allows controlled passage of excess pore water

Soft subgrade
**Confinement component**

Granular layer

Terram geotextile

Terram confines lateral movement of granular material

Soft subgrade
Figure 5-2 Possible reinforcement functions provided by geosynthetics in roadways: (a) lateral restraint, (b) bearing capacity increase, and (c) membrane tension support (after Haliburton, et al., 1984).
Retaining Walls
Installation of geogrids
Cross section of a RE Wall
Geomembrane
Geocell
Geofoam

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Geofoam
## Growth of Geotextiles

<table>
<thead>
<tr>
<th>Year</th>
<th>Volume, ‘000 tonnes</th>
<th>Value, US $ mln</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>196</td>
<td>565</td>
</tr>
<tr>
<td>2000</td>
<td>255</td>
<td>740</td>
</tr>
<tr>
<td>2005</td>
<td>319</td>
<td>922</td>
</tr>
<tr>
<td>2010</td>
<td>413</td>
<td>1203</td>
</tr>
</tbody>
</table>
## Market of geosynthetics in India

<table>
<thead>
<tr>
<th>Type</th>
<th>Value, Rs cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woven geotextiles</td>
<td>85</td>
</tr>
<tr>
<td>Nonwoven geotextiles</td>
<td>67</td>
</tr>
<tr>
<td>Geogrids and others</td>
<td>35</td>
</tr>
<tr>
<td>Geomembrane/Geocomposites (PVDs)</td>
<td>54</td>
</tr>
<tr>
<td>Agricultural geotextiles</td>
<td>31</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>272</strong></td>
</tr>
</tbody>
</table>
Case Study I: Embankment Construction on Soft Soil for National Highway

Problem:
- Embankment upto 6 m high to be constructed on soft soil.
- 3 km of 6 km road have very soft soil upto 9 m depth.
- Removal and disposal of semi-liquid may pose major environment problem.
Sub –soil Condition

- Clay in saturated condition with very low shear strength
- Liquid limit above 100-%
- Plastic limit : 40-42%
- Density: 1.5-1.6 g/cc
- Coeff. of consolidation: 1.0-1.25 m²/year
Solution to Problem

- Install PVDs and stage loading of the embankment fill to accelerate consolidation process.
- Use a suitable geotextile basal reinforcement considered necessary for stability during embankment construction.
- Geotextiles act as a separator between the embankment fill and drainage filter blanket.
Case Study No II on State Highways

Problem:

- Rut depths of 200 -300 mm were observed.
- Every year new road is constructed.
- A non-uniformity in load spreading phenomena occurs.
Load Spreading Phenomenon of Subbase on Sub Grade
Properties of Soil

- Black cotton soil
- Clay (<0.002mm) ; 62%
- CBR (%)
  - unsoaked 7.8%
  - soaked 1.8
- Undrained cohesion : 52.5 kN/m²
- Free Swell (%) 93
Cross-section of Geotextile Reinforced Road
Status of Road in Sept, 2003
Status of Road in Sept, 2004
Status of Road in Sept 2005
Case Study III:

Erosion control Measures
For the Bhagirathi river
Prachin Mayapur at Nabadwip in
the district of Nadia,
West Bengal
Photographs of Bhagirathi river Before Geotextile Installation
Photographs of Bhagirathi river Before Geotextile Installation

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Solutions to Problem

- Analyzing the site conditions,
- Collection of samples from the sections of river
- Testing of soil samples for its grain size distribution
- Design and recommendations given by Dr S.Y.Mhaiskar of Sardar Patel College of Engineering
Proposed cross section for Erosion Control

River bed

Geotextile in river bed with appropriate overlap on the bank

Soil Filled bags 1.5 m. x 1.0 x 1.0 m.

30 m.

Rubble Pitching

Slope 1.5 H: 1V

Geotextile on Banks with appropriate overlap in the bed and bank top
## Specification of Geotextile recommended

<table>
<thead>
<tr>
<th>Parameters</th>
<th>KP-70</th>
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<tbody>
<tr>
<td>Mass per unit area (g/m²)</td>
<td>240</td>
</tr>
<tr>
<td>Tensile strength, kN/m (D-4595)</td>
<td>warp</td>
</tr>
<tr>
<td></td>
<td>weft</td>
</tr>
<tr>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>45</td>
</tr>
<tr>
<td>% Elongation at break (IS-1969)</td>
<td>warp</td>
</tr>
<tr>
<td></td>
<td>weft</td>
</tr>
<tr>
<td></td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>22</td>
</tr>
<tr>
<td>Grab Tensile strength, (N) (ASTM D-4632)</td>
<td>warp</td>
</tr>
<tr>
<td></td>
<td>weft</td>
</tr>
<tr>
<td></td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>1400</td>
</tr>
<tr>
<td>Trapezoidal Tearing Strength, N (ASTM D-4533)</td>
<td>warp</td>
</tr>
<tr>
<td></td>
<td>weft</td>
</tr>
<tr>
<td></td>
<td>800</td>
</tr>
<tr>
<td></td>
<td>500</td>
</tr>
<tr>
<td>Water permeability, (D-4491) lils/m²/sec</td>
<td></td>
</tr>
<tr>
<td>At 5cm water head</td>
<td>8</td>
</tr>
<tr>
<td>Index Puncture Resistance, (N) (ASTM D-4833)</td>
<td></td>
</tr>
<tr>
<td>Apparent Opening Size (mm) (D-4751)</td>
<td>&lt;75 microns</td>
</tr>
</tbody>
</table>
Photographs of Geotextile Installation
Photographs of River after Geotextile Installation
NAIP Project on Rubber Dam

To Develop Suitable Fabric Substrate for Flexible Rubber Dams
A Rubber Dam consists of four parts

- A rubberized fabric dam body
- A concrete foundation
- A control room housing (inflation & deflation mechanisms)
- An inlet / outlet piping system
RUBBERIZED FABRIC DAM BODY
TENTATIVE LAYOUT OF COMPOSITE MATERIAL

- Cover compound
- Friction compound
- Fabric

- Fabric
- Friction compound
- Cover compound

- 1 mm each
- 1.5 mm each
- 0.5 mm each
- 2.5 mm
CONCRETE FOUNDATION

- Head wall
- Head wall extension
- Apron
- End sill
- Side wall
INFLATION & DEFLATION MECHANISM
ADVANTAGES OF RUBBER DAM

- Short construction period
- Easy maintenance and repair
- Long span and adaptable to different slopes
- Low project life cycle cost
- Earthquake resistant
- Adaptable to adverse condition
- Environmental friendly
Conclusion

- Geosynthetics meet variety of civil engineering functional requirements.
- Their applications are increasing continuously.
- In Indian Scenario, engineers still lack the confidence of using geosynthetics.
THANK YOU