Coastal and River Erosion Control

Erosion

Definition:

Erosion is the process by which individual soil particles are dislodged from the soil mass and carried away by a transporting medium.

The soil erosion takes place when the water with velocity higher than the scouring velocity of the soil, comes in contact with the soil surface.
Problem

Problem
• Polymer Rope Gabions

• Steel Gabions

• Geotextile bags and Geotextile Tubes

Structures using Gabions and Geofabric Forms
Revetments

- **Armour layer** – Provides basic protection against wave action
- **Filter**
  - Supports the armour
  - Prevents washing out of underlying soil
  - Allows water to flow through the structure
- **Toe protection** – Prevents displacement of seaward edge of the revetment
Armour layer

- Quarry stone / Graded riprap / Field stone / Concrete rubble
- Concrete armour units – tribars, tetrapods, dollos, concrete blocks
- Concrete mattresses
- Gabions & mattresses filled with stone
- Geotextile bags / geotextile containers filled with sand

Groins

- Built perpendicular to shore (or river bank) to interrupt the normal transport of sand alongshore.
- Sediments accumulate on the U/S side of groin
- Protects a short stretch of beach on the D/S
Groins

- Silting

Dykes

- Flood protection dikes
- Containment dikes
- Spur dikes
- Under water dikes
- Dike breach repair
Coastal Structures

- Off shore breakwaters
- Beach nourishment
- Shoreline structures
- On shore and off shore stability berms
- Coastal and sand dune protection

➢ Erosion & Scour Protection

- Bridge piers and piling
- Tunnels
- Pipe line crossings
- Utility cable crossings
- Walls
- Abutments
- Foundations
- Wharf support
- Offshore drill rig supports
- Rock groins and jetties
- Wind erosion
Use of Polymer Rope Gabions
Advantages Flexible Rope gabions Over Large Stone

• Smaller size stones can be used

• Gabions can be tied together for higher resistance

• Gabions are pervious

Flexibility advantages

• Polymer rope gabions are flexible

• Low bending stiffness due to structure of the rope

• Can adapt to irregular surfaces

• Can accommodate differential settlement

• Can accommodate movements
Use of Steel Wire Gabions

• Gabions are flexible wire mesh baskets/cages
• Factory fabricated boxes, with diaphragms at 1m c/c.
• Supplied at site in collapsible form
• Steel Box Gabions filled with stones to form variety of monolithic structures
• Double Twist – Continuous pairs of wire mechanically Twisted (three one half turns)
• Double Twist Mesh – Thicker dia. wire at the edges called “Selvedge / Edge Wire”

• Soft Annealed Mild steel wire
• Provided with Heavy Coating of Zinc
• In aggressive environments, 0.5mm thk PVC Coating is also provided.
Use of Steel Wire Gabions

Importance of Surface Preparation

Geotextile

Concentrated flow along this channel
Granular Filter vis-à-vis Geotextile

**Granular Filters**
- Quality control difficult
- Installation difficult
- Discontinuities/contamination
- Large volume
- Intimate contact with surface

**Geotextile Filters**
- Assured quality
- Easy installation
- Continuity
- Conserves granular material
- Requires surface preparation prior to laying

Geotextile Filter Criteria

- Soil retention/tightness
- Permeability
- Clogging resistance
- Survivability
- Durability
Geotextile tubes and Bags

What are the Geotextile Forms?

- Geotextile Bags
- Geotextile Tubes
- Geotextile Mattresses
Benefits of using Geotextile systems

- Reduction in work volume.
- Reduction in execution time.
- Reduction in construction cost.
- The use of local materials, low skilled labor and locally available equipment.
- Simple processing.
- The elements can be tailor made.

Fabrication

Manufactured by sewing multiple sheets of high strength woven polyester or polypropylene fabrics with high strength seams.
DESIGN STRENGTH OF THE GEOTEXTILE

The Geotextile fabric used to construct the tubes is designed to:

• Have a design permeability to relieve excess water pressure
• Resist the pressures of filling and the active loads without seams or fabric rupture,
• Resist erosive forces during filling operations,
• Resist puncture and tearing, and resist degradation from ultraviolet light.

Swaminarayan Mandir, Tithal
Coastal Protections
Swaminarayan Mandir, Tithal

Completed Sea Wall
Gabion Walls

SMC Tapi River Training
SMC Tapi River Training

SMC – RANDER - TAPI RIVER
PCMC – MULA RIVER

Gabion Mattress
Gabion Mattress

![Image of Gabion Mattress in action](image1.jpg)

Gabion Mattress

![Image of Gabion Mattress in action](image2.jpg)
SMC Tapi River Training

Reliance Retaining Wall
Teesta Diversion Channel Works

Teestha
ONGC Gandhar - Geobags
ONGC Gandhar - Geobags

FLOOD CIRCLE, PILIBHIT, UP

Series of Studs constructed along the bank of Sarada River, Pilibhit Flood Circle, UP
FLOOD CIRCLE, PILIBHIT, UP

Series of Studs constructed along the bank of Sarada River,
Pilibhit Flood Circle, UP

Project: River Training Work, Sharda River, Kutiaqbar
Client: Flood Circle, Lakhimpur Khiri
Project: River Training Work, Sharda River, Kutiaagbar
Client: Flood Circle, Lakhimpur Khiri

Geotextile containment systems in tubular forms filled with locally available sand which are formed in-situ on land or in water to protect shore and marine environments.

FEATURES:
Material: Woven Geotextile
Diameter: 3 m to 5 m
Length: 20 m to 40 m
Fill Material: Sand Slurry
• **Proven Method:**
  - Protecting Shorelines
  - Rebuilding Beaches
  - Reclaiming Land &
  - Other Marine works

• Sea Sand as fill material – hence better method for places with less stone availability

• **Durable**
• **Easy to install**
• **Highly Flexible**
• **Cost Effective**

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**Geotextile - Type**

Woven Multifilament  Woven Slit Film

[Courtesy : Robert M. Koerner, Designing With Geosynthetics]
Geotextile - Type

Non Woven Needle Punched  Non Woven Heat Bounded

[Courtesy : Robert M. Koerner, Designing With Geosynthetics]

FILLING MECHANISM OF GEOTEXTILE TUBES
DESIGN ASPECTS

\[ D = \text{Theoretical Diameter of the Geotextile tube} \]

** APPROXIMATE DIMENSIONS OF FILLED GEOTEXTILE TUBE **

[Ref: Lawson C. R (2006)]

DISTRIBUTION OF CIRCUMFERENTIAL TENSION

[Ref: Lawson C. R (2006)]
INSTALLATION

- Base Preparation
- Laying of Geotextile Bags
- Spreading of Geotextile Tubes

HYDRAULIC - FILLING METHOD
INSTALLATION

Geotextile Tube after Installation

Laying of Geotextile Bags & PP Gabions

Armour Layer – PP Rope Gabions

SEA WALL - AFTER COMPLETION
OTHER CASE STUDIES


SHORE PROTECTION USING GEOTEXTILE TUBES AT INS HAMLA, MALAD, MUMBAI
CASE HISTORIES

2. Reclamation Using Geotextile Containers, Hazira, Gujarat:

Need:
- Development Plan - Reclamation to create port back-up facility
- Shore protection system to retain the reclaimed land and to protect the back-up yard

Solution:
- Geotextile Containers (Size: 4m x 1 m x 1m)
- Armour with conventional system - stones

TYPICAL LAYOUT

![Image of typical layout](image.png)
TYPICAL CROSS-SECTION

Typical Cross - Section of Protection System

RECLAMATION USING GEOTEXTILE CONTAINERS, HAZIRA
RECLAMATION USING GEOTEXTILE CONTAINERS, HAZIRA
- **Sub-grade Preparation**
- **Laying of Garmat® with overlaps of 300mm**
- **Anchoring at the top**
- Held in position using the ‘U’ pins of minimum depth 300mm staggered at 2 m c/c.
- **A 100mm thick fertile soil containing seedlings**
Clay balls being prepared for laying on the slopes

Clay balls being laid from rope ladders
Clay being laid on slopes of the embankment

Garmat® installed
Grass sods installed and being watered

Sea Wall Embankment at Pentha, Odisha

INTRODUCTION
INTRODUCTION

• The shore line near the village has advanced about 500 metres since 1999.

<table>
<thead>
<tr>
<th>Year</th>
<th>Distance of shoreline from existing earthen embankment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>200 m</td>
</tr>
<tr>
<td>2006</td>
<td>100 m</td>
</tr>
<tr>
<td>2007</td>
<td>20 m</td>
</tr>
<tr>
<td>2008</td>
<td>10 m</td>
</tr>
<tr>
<td>2009</td>
<td>5 m</td>
</tr>
<tr>
<td>2011</td>
<td>Shore line over-ran the old embankment</td>
</tr>
</tbody>
</table>

Traditional methods

• Traditional method of protection of embankment using ‘Bullah piling’ and big resin PVC sand bags (2m x 1m 1 m) dumping was being done every year.
As a permanent solution to protect the existing embankment, the habitation of Pentha and adjoining villages and immediate cultivable land, sea wall of 505 meters with geotextile tubes as core was conceptualised.

The project is funded by the World Bank under Integrated Coastal Zone Management Project (ICZMP).

The designs are prepared by Dept. of Ocean Engineering IIT Madras and the GWRL has been awarded the work.
Sea Wall Embankment at Pentha, Odisha

Early Design (Pre-Phailin)

- Core - Geotextile tubes of 3 meter dia & 20 m length
- Armour layer – 2 m x 1 m x 1 m polymer rope gabion

Sea Wall Embankment at Pentha, Odisha

Then came Phailin

- Work awarded on 24-07-2013 and Phailin hit on 12-10-2013
- Modification in the design due to advancement of shoreline towards existing embankment.
- Alignment of protection work is shifted towards the embankment.

Sea Wall Embankment at Pentha, Odisha

Final Design

* 100 m stretch is with sheet pile at the toe where excavation is not possible up to -3 m

Sea Wall Embankment at Pentha, Odisha

Current Status

• The installation of all geotextile tubes have been already completed and the project is in the finishing stage.
Sea Wall Embankment at Pentha, Odisha

Current Status

Installation pictures

Garware Wall Ropes Limited | 2015

Sea Wall Embankment at Pentha, Odisha

Current Status

Installation pictures

Garware Wall Ropes Limited | 2015
Thank You

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