SOME ASPECTS OF COASTAL PROTECTION

12th CPDAC meeting 3 Mar 2011 in Bhubaneshwar

By-
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EXPERIMENTAL STUDIES

Interaction of Tsunami with vegetation

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Is it role of vegetation?

Tsunami Heights = 3-4m

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DESIGN QUESTIONS

Greenbelt Parameters
EXPERIMENTAL INVESTIGATIONS

BG=0.25m:D=1.65mm:SP=37.5mm(RE)  BG=0.25m:D=1.65mm:SP=37.5mm(RE)  BG=0.25m:D=5.5mm:SP=37.5mm(RE)

BG=0.825m:D=5.5mm:SP=75mm(ZG)

SP/Dt=3.75
SP/Dt=7.5
SP/Dt=12.5

Reduced Velocity, Vr

(RE) ~V(D)/f

SP/D ~3.75: Proximity Effect Predominant
Vr~4.0: Wake Effect Predominant

RESISTANCE IN TERMS OF Darcy's f/in STEADY UNIFORM FLOW

SP/D=3.75
SP/D=7.5
SP/D=12.5
SP/D=25
SP/D=3.75

Reduced Velocity, Vr

(V(D)/f)~4.0

Froude Number

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

0.3 0.4 0.5 0.6 0.7 0.8 0.9

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Utility of the newly proposed Relative Rigidity
A Design Example

<table>
<thead>
<tr>
<th>Properties</th>
<th>Oak tree[Light]</th>
<th>Casurina[Medium]</th>
<th>Mangrove[Heavy]</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>9Gpa</td>
<td>14Gpa</td>
<td>18.5Gpa</td>
</tr>
<tr>
<td>Dt</td>
<td>0.267 m</td>
<td>0.267 m</td>
<td>0.267 m</td>
</tr>
<tr>
<td>λ</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>f₁</td>
<td>0.3037</td>
<td>0.37</td>
<td>0.43</td>
</tr>
<tr>
<td>Vr</td>
<td>51.9</td>
<td>41.6</td>
<td>36.2</td>
</tr>
<tr>
<td>SP/Dt</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>RR</td>
<td>3.87</td>
<td>4.02</td>
<td>3.98</td>
</tr>
<tr>
<td>Design BG</td>
<td>120 m</td>
<td>80 m</td>
<td>60 m</td>
</tr>
</tbody>
</table>

Characteristics of an ideal seawall are

- Less reflection and Run-up
- Optimum use of coastal space
- Less or no wave overtopping
- Lower crest elevation
- Less maintenance costs

This objective may be achieved by considering a front shape of the structure, which forms the main objective of the present study.
It is evident that a seawall as a coastal protection measure should be effective with an optimum use of the coastal space, with less or no wave overtopping by maintaining a lower crest elevation.

This in fact can also enhance the scenic beauty of the oceanic view.

Hydrodynamic characteristics of different shapes of Seawalls

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EXPERIMENTAL INVESTIGATIONS

- Model (VW): Vertical wall
- Model (CPS): Circular cum parabolic seawall, (Weber, 1934)
SUMMARY AND CONCLUSIONS

Various configurations of seawall tested and compared

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Number</th>
<th>Low/Good</th>
<th>High/Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run-up</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic Pressure</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflection</td>
<td>3</td>
<td>LOW/GOOD</td>
<td></td>
</tr>
<tr>
<td>Overtopping</td>
<td>4</td>
<td></td>
<td>HIGH/POOR</td>
</tr>
</tbody>
</table>

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DIFFERENT TYPES OF ARMOUR BLOCKS

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‘KOLOS’ artificial armour units

KOLOS
- Modified version of DOLOS armour units.
- Re-designed the DOLOS units by reducing the distance between the vertical arms
- Reduced susceptibility to fail at the junction of the horizontal and vertical arm due to wave action.
‘KOLOS’
Dimensions

<table>
<thead>
<tr>
<th>WEIGHT (tonnes)</th>
<th>12</th>
<th>8</th>
<th>5</th>
<th>4</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLUME (m³)</td>
<td>5.0</td>
<td>3.33</td>
<td>2.083</td>
<td>1.667</td>
<td>0.833</td>
</tr>
<tr>
<td>A (m)</td>
<td>0.659</td>
<td>0.576</td>
<td>0.493</td>
<td>0.457</td>
<td>0.363</td>
</tr>
<tr>
<td>B (m)</td>
<td>1.055</td>
<td>0.922</td>
<td>0.789</td>
<td>0.732</td>
<td>0.581</td>
</tr>
<tr>
<td>C (m)</td>
<td>3.297</td>
<td>2.881</td>
<td>2.465</td>
<td>2.287</td>
<td>1.836</td>
</tr>
<tr>
<td>D (m)</td>
<td>0.188</td>
<td>0.164</td>
<td>0.141</td>
<td>0.130</td>
<td>0.104</td>
</tr>
<tr>
<td>E (m)</td>
<td>2.473</td>
<td>2.161</td>
<td>1.849</td>
<td>1.715</td>
<td>1.362</td>
</tr>
<tr>
<td>S (m)</td>
<td>0.419</td>
<td>0.383</td>
<td>0.328</td>
<td>0.304</td>
<td>0.242</td>
</tr>
<tr>
<td>S1 (m)</td>
<td>0.274</td>
<td>0.239</td>
<td>0.205</td>
<td>0.190</td>
<td>0.151</td>
</tr>
</tbody>
</table>

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‘KOLOS’
Establishment of stability coefficient
(breakwater trunk and head sections)

Breakwater sections with trunk slopes 1 in 1.5, 1 in 2 and 1 in 2.5 armoured with KOLOS

<table>
<thead>
<tr>
<th>Trunk Slope</th>
<th>Hudson’s stability coefficient for trunk (Kₜ)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zero Damage</td>
</tr>
<tr>
<td>1 in 1.5</td>
<td>23</td>
</tr>
<tr>
<td>1 in 2.0</td>
<td>19.5</td>
</tr>
<tr>
<td>1 in 2.5</td>
<td>14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trunk Slope</th>
<th>Hudson’s stability coefficient for head (Kₜ)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zero Damage</td>
</tr>
<tr>
<td>1 in 1.5</td>
<td>6.5</td>
</tr>
<tr>
<td>1 in 2.0</td>
<td>4.5</td>
</tr>
<tr>
<td>1 in 2.5</td>
<td>3</td>
</tr>
</tbody>
</table>

Breakwater heads section with slope 1 in 1.5 armoured with KOLOS

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Testing Of Breakwater TRUNK Sections
(for the establishment of stability coefficient of KOLOS)

Testing Of Breakwater HEAD Sections
(for the establishment of stability coefficient of KOLOS)
ARTIFICIAL BEACH NOURISHMENT

Offshore Breakwater

Inlet channel

Northern Groin

Submarine Tunnel
BEFORE SAND BYPASSING
January 2002

AFTER SAND BYPASSING
October 2002

BEACH WON

A VIEW OF SHORELINE NEAR GANDHI STATUE

A VIEW ON NORTH SIDE OF GANDHI STATUE
(BEFORE SAND BYPASSING)
January 2002

FORMATION OF BEACH ON NORTH SIDE OF GANDHI STATUE
(AFTER SAND BYPASSING)
October 2002
The erosion and accretion is estimated from 1986 to 2002, i.e., over a period of 16 years with the satellite imagery data using GIS software.

The rate of erosion is about 4m per year and the accretion is 6m per year.

The extent of erosion in the northern side is 33.59 hectares compared to the accretion on southern side of 30.71 hectares.
GEO-SYNTHETICS

GEO-Tubes

Cross-section showing installation of the Mirafi ® Geotube ® in a typical sand dune
Filling operation of the Mirafi ® Geotube ® : Fill Material is pumped into the tube, displacing the water. Typical water/sand ratio during pumping is 90% water, 10% sand.

GEO-BAGS protection for Island of Sylt, Germany
Location map of the site

WEST BENGAL

STATUS OF THE COAST in mid 2007

Usage of Ballas on the western side of the coast near the road near Chandpur

Usage of Ballas on the eastern side of the coast near the road near Chandpur

High tide penetration into the sand dunes

Dhiga beach - view towards east of SeaHawk hotel
Initial section considered

Completed Structure

Revised section adopted
STATUS OF THE COASTAL PROTECTION FROM MID 2007 TO EARLY 2008

MEASUREMENT CAMPAIGN-TIDAL INLETS
MORPHOLOGICAL CHANGES AT SHAR INLET (1990 – 2007)

SHAR Tidal Inlet Temporal Analysis

(a) - 28Mar/9550 (FW)
(b) - 23Nov/9990 (NE)
(c) - 28Mar/9650 (NF)
(d) - 21Apr/9604 (FW)
(e) - 14Apr/97054 (NT)
(f) - 2007
(g) - 2007
Inlet Management at SHAR inlet

A pilot project aims at assessing

1. Functional
2. Structural

NIOT
IIT, Dept of Ocean Engg
IIT, Dept of Civil Engg

✓ Analysis of morphological changes
✓ Field investigations
✓ Numerical Modelling
✓ Design of Geotextile based training jetties
✓ Implementation and post monitoring

SPECIFIC RECOMMENDATION OF THE WORKSHOP (AUG 2010)

➢ Selection and specification of geo-synthetic properties for various applications (revetments, shore protection, breakwaters, geo-systems, etc.)
➢ Influence of fill-ratio on performance on design and performance of geo-systems
➢ Influence of fill material on performance (sand, mud, silt materials, clay, coarse materials, saturated, unsaturated, etc.)
➢ Hydraulic interactions; reflection, transmission, permeability, roughness
➢ (More) Uniformity in stability formulations and limits of application in various applications (on slope, offshore, submerged, emerged, singular, stacked, etc.)
➢ Internal (in-)stability of system (internal migration)
➢ Scour prediction and protection
- Stimulating research in field of geo-systems
- Clear definition of applicability of woven and non-woven materials and proper guidelines
- Durability of geo-synthetics and geo-systems for tropical weather conditions
- Accuracy of placement of geo-systems
- Review of construction techniques (uniform pumping geo-tubes, anchoring, filling and releasing geo-containers-stacking units, etc.)
- Techniques for the removal of damaged units.
- Construction specifications
- Quality control (strength of seams and length effect)
- Cost effectiveness of geo-systems compared to conventional structures
- Monitoring techniques
- Involving clients in research and systematic monitoring
- Preparing (and regular updating) of design guidelines
- Improving exchange of knowledge (forming of working groups within IAHR or similar organisations)
- Organizing a forum/platform for contacts and exchange of information

THANKS FOR YOUR KIND ATTENTION

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