DESIGN AND CONSTRUCTION OF ANCHORED BULKHEADS WITH SYNTHETIC SHEET PILES
SEABROOK, NEW HAMPSHIRE

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Geotechnical Engineer

and

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Structural Engineer

US Army Corps of Engineers, Concord, Massachusetts
Authority: Section 227 of the Water Resources and Development Act of 1996 (WRDA 96); Administered by ERDC

- Research & Development: Advance the state of the art of coastal erosion control technology
- Encourage and achieve the development of innovative solutions to the erosion control challenge
- Communicate findings to the public, state, and local coastal managers
Design and construction of anchored bulkheads with synthetic sheet piles, Seabrook, New Hampshire

Hampton-Seabrook Harbor, adjacent to the mouth of the Blackwater River, located in coastal New Hampshire, USA
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Objectives:
- Replace lost intertidal sands
- Reduce sand migration into the Harbor
- Prevent shoreline erosion

Constraints
- Innovative Components
- Ability to remove
- Dredging window of time, November through March
- Cost
- 50-year design life

Solutions:
- Install cofferdams across the eroded channel using synthetic sheeting
- Dredge sand from the shoaled areas of the River to encourage flow
- Use the dredged sand to fill between the cofferdams to restore the sand flats
Subsurface Conditions

- Medium dense fine sand
- Field SPT = 20
- No obstructions
• Synthetic Sheeting

  – Vinyl: Made of virgin or recycled plastic or combination (recycled, with virgin veneer)
    • High tensile strength
    • Less brittle
    • 10+ years of case histories of use

  – Fiber Reinforced Polymer (Fiberglass) Glass fibers embedded in resin matrix such as polyester, polyurethane, or vinyl ester.
    • High flexural strength
    • More brittle
    • Limited number of projects
**DESIGN AND CONSTRUCTION OF ANCHORED BULKHEADS WITH SYNTHETIC SHEET PILES, SEABROOK, NEW HAMPSHIRE**

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*Note:* Longitudinal (along) and Transverse (across) refer to fiber direction.
Design Considerations

- Inadequate shear strength or section depth
- Lack of interlock strength
- Limitation on cantilevered length: recent failures during construction
- Longevity: UV resistance, cold
- Lack of standardized tests, data and guide specifications
- USACE Engineering & Construction Bulletin, 2002-31 October 2002:

for use. In the meantime, vinyl sheet piling should not be used in applications where life safety and widespread property damage are at stake in the event of failure.
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- Selected Design for each of the two bulkhead
  - Double rows of sheets, FRP or heavy vinyl: No cantilever
  - Galvanized steel tiebacks and waler: Reliability
  - Single Waler: No diving (winter)
  - Scour protection: Protect toe
  - Drain holes: Reduce loads
Design Parameters

- 50-year low tide
- 50% drainage in fill
- 12’ depth to mudline (22 feet sheet length)
- 2 tons horizontal load per linear foot
- Tiebacks 6’ spacing
- 200 psf surcharge
Seabrook Harbor
Slope Stability Analysis
Analysis Method: Bishop (with Ordinary & Janbu)
Slip Surface Option: Fully Specified
Component Details

- **Waler:** 2 x 10” galvanized steel
  Channels on the outside

- **Tiebacks:** 18’ long, 2.25” galvanized steel tiebacks with turnbuckle,
  Oversized to allow for corrosion

- **Drains:** 2 x 2” dia holes with wire mesh/geotextile backing, located under water to prevent freezing
Recent Examples Viewed

- Fiberglass
• Recent Examples Viewed
  • Vinyl
• Construction
  – October 2004 – April 2005 (within the November-March dredging window)
  – Two barges, three cranes, clam shell, dozer, supply boats, Crew of 20
  – Hydraulic Dredge
  – Hydraulic vibratory hammer
  – Design called for vinyl or fiberglass; Contractor Submitted fiberglass sheeting with polyurethane resin (delivery and QC problems resulted in switch to different manufacturer and polyester resin)
  – Total length of two bulkheads = 1,700 feet
  – Sheet panel length = 27 feet (5 feet cut off to obtain required 22 feet)
  – Construction cost = $3 million
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20/10/2004
DESIGN AND CONSTRUCTION OF ANCHORED BULKHEADS WITH SYNTHETIC SHEET PILES, SEABROOK, NEW HAMPSHIRE

16/11/2004
DESIGN AND CONSTRUCTION OF ANCHORED BULKHEADS WITH SYNTHETIC SHEET PILES, SEABROOK, NEW HAMPSHIRE
## DESIGN AND CONSTRUCTION OF ANCHORED BULKHEADS WITH SYNTHETIC SHEET PILES, SEABROOK, NEW HAMPSHIRE

**MATERIAL:** FRP

### WEST BULKHEAD - EAST WALL

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Field Issues & Lessons Learned
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Instrumentation
DESIGN AND CONSTRUCTION OF ANCHORED BULKHEADS WITH SYNTHETIC SHEET PILES, SEABROOK, NEW HAMPSHIRE
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<th>Average Angle</th>
<th>Direct Distance</th>
<th>Inverse Distance</th>
<th>Average Distance</th>
<th>Elevation</th>
<th>Deformation From Initial Reading</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1+38 E</td>
<td>39°39'35&quot;</td>
<td>39°39'39&quot;</td>
<td>39°39'37&quot;</td>
<td>88.24</td>
<td>88.24</td>
<td>88.24</td>
<td>1.77</td>
<td>E 0.069/N 0.00</td>
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<td>2</td>
<td>1+38 E</td>
<td>39°39'36&quot;</td>
<td>39°39'42&quot;</td>
<td>39°39'39&quot;</td>
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<td>88.24</td>
<td>1.77</td>
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<td>1+38 E</td>
<td>39°39'39&quot;</td>
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<td>39°39'40&quot;</td>
<td>88.245</td>
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<td>1.77</td>
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</table>

Change from initial (inches) 0.83

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<tr>
<th>Reading Number</th>
<th>Location</th>
<th>Direct Angle</th>
<th>Inverse Angle</th>
<th>Average Angle</th>
<th>Direct Distance</th>
<th>Inverse Distance</th>
<th>Average Distance</th>
<th>Elevation</th>
<th>Deformation From Initial Reading</th>
</tr>
</thead>
<tbody>
<tr>
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<td>39°34'54&quot;</td>
<td>39°35'00&quot;</td>
<td>39°34'57&quot;</td>
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<td>110.035</td>
<td>110.03</td>
<td>1.82</td>
<td>E 0.044/N 0.00</td>
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<tr>
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<td>110.03</td>
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<td>1.82</td>
<td>E 0.044/N 0.00</td>
</tr>
</tbody>
</table>

Comments

Note: Initial Readings (1+38E 39°42'19" - 88.24 / 1+60E 39°36'19" - 110.03)

Third reading on completed wall
• Conclusions
  – Pick the right application. Despite some manufacturers’ claims, steel it is not!
  – Synthetic sheeting can be very cost effective (50% of cost of steel is possible)
  – Conservatism in design is recommended because of scarcity of test data.
  – Construction sequence is crucial to avoid overstressing the material
  – Synthetic sheeting is here to stay

• Current Needs
  – Standard (full scale panel) test methods & corresponding data
  – Standard guide specifications
  – Long term performance data (longevity)
  – Greater number of quality manufacturers
  – Information exchange among designers (USACE, NAVY, Others)
  – A committee to facilitate the exchange and develop standards
& our final product....
DESIGN AND CONSTRUCTION OF ANCHORED BULKHEADS WITH SYNTHETIC SHEET PILES
SEABROOK, NEW HAMPSHIRE

Thank you

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