City of Fort Pierce Marina
Island Breakwater Creation

National Conference on Beach Preservation Technology
February 14\textsuperscript{th}, 2013

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OUTLINE

• Background & Project Goals
• Construction
  – Materials
  – Tolerances
  – Site Conditions
  – Installation
• Lessons Learned
Project Location
Original Marina Layout
2004 Hurricane Season
Project Purpose

• Project Goals
  – 100-Yr Storm Protection
  – Positive Environmental Impact
  – Aesthetically Pleasing
Project Layout

- 12 Island Breakwaters & 1 Peninsular Structure
  - Total of 14.66 Acres
- Ecological Enhancements
  - > 12 Acres
    - Oyster Recruitment
    - Mangrove Habitat
    - Juvenile Fish Habitat
    - Shore Bird Habitat
- $18.9 Million Construction Cost
  - NTP Issued February 2012
  - Construction Finishes End of May 2013
Tern Island

- Geometry
  - 10.5 Acres
  - 1,500 ft x 300 ft
- Groin Structures
- Sand Interior
- Ecological Enhancements
  - Living Shoreline
  - Natural Limestone Reefs
  - Roosting Areas
Construction Components

- Geotextile Tubes – 10,700 lf
  - Perimeter Dike for Island Creation
  - Structural Core of Groins
  - Bench for Living Shoreline
- Marine Mattress – 250,000 sf
  - Foundation for Stone Placement & Scour Apron
  - Geotextile Tube Protection
  - Matrix for Oyster Recruitment & Mangrove Plantings

(Courtesy of Tetra Tech)
Geotextile Tubes

- High strength polypropylene, woven geotextile with UV stabilization
- Biologically/chemically inert
- MacTube OS500
  - Approx 500 ppi
- Tube Sizes:
  - 45’ circumference
  - 30’ circumference
  - Custom Lengths; average 100’ lengths
- Tube Schematic
  - Fill Port Spacing
  - Installation Straps
Geotextile Tubes

MacTube Design:

- Tube Geometry – GEOCOPS
- Fabric & Seam Strength (Factor of Safety)
- Fabric AOS - Fill Material Sediment Characteristics
- External Stability Calcs

\[ L = \text{circumference of tube} \]
\[ r = \text{radius of curvature} \]
\[ p_c = \text{pumping pressure} \]
\[ \gamma = \text{density of slurry} \]
Marine Mattress

Compartmental structures composed of high density, flexible, UV stabilized, polypropylene geogrid.

- Dual Project Purpose:
  - Protective Cushion Layer for 2.5 to 5 ton Limestone Boulders
  - Tube Foundation/Scour Protection

- UX T200 – 12” Thickness
  - Width = 5’
  - Lengths ranged from 10’ to 30’
  - Tult = ~113,000 lb/ft

- BX1500 – 6” Thickness;
  - Width = 6.5’
  - Lengths ranged from 5’ to 20’

- Stone Fill:
  - Ranges from 2” to 6” in diameter

- Approx. Weight = 110 pcf (12” x 20’ mat weights ~5.5 Tons)
Marine Mattress: Bi-Axial

Onsite Preparation
Marine Mattress: Uni-Axial

Onsite Preparation
Construction Tolerances

• Geotextile Tubes
  – Horizontal +/- 12”
  – Vertical varied based on application.
• Marine Mattresses
  – Varied based on application.
    • Tube coverage = 3”
    • Perimeter = 0”
    • Interior = 8”-12”
Site Conditions

- **Water Depths**
  - No Impact on mattress and tube installations.

- **Water Clarity**
  - Impacted marine mattress installations.

- **Currents**
  - Impacted tube installations.
Geotextile Tube Installation

• Production Rates
  – 450 CY in approximately 4 hours
  – Corresponds to ~100 LF of 45’ Circ. Tube

• Installation Methodology
  1. Install scour protection.
  2. Deploy tube at slack tide.
  3. Anchor tube.
  4. Fill until design elevation achieved.
Marine Mattress Installation

• Peak Production Rates
  – 70 Top Cover Mats
  – 30 to 40 Perimeter Mats

• Installation Methodology
  1. PVC stakes guide installations.
  2. Crane and lifting bar for rough placement.
Lessons Learned

• Install scour protection at terminal ends of sequential tube installations.
• Incorporate straps into bag designs.
• Site conditions will dictate installation rates.
• Perform periodic inspections.
• Experience a must for tube/mattress installations in adverse conditions with tight tolerances.
Project Benefits

• 100-yr Storm Protection
• Ecological Benefits
  – Living Shorelines
  – Natural Limestone Armor Reefs
  – Roosting Area
• Increase in Revenue
  – Marina Capacity
  – Eco-tourism
Special Thanks

City of Ft. Pierce
Ed Seissiger, Project Manager
John Andrews, PE City Engineer