
USACE Workshop
November 21st, 2013

By: Jenna Phillips
Emphasis on “Green” or “Nature-Based” Engineering Solutions for Resiliency

- Oyster Habitat
- Artificial Reef Habitat
- Seagrass Beds
- Coastal Dune Habitat
- Shorebird Habitat
- Mangroves
OUTLINE

- Background & Project Goals
- Construction
  - Materials
  - Tolerances
  - Site Conditions
  - Installation
- Lessons Learned
Project Location
Project Location

- Indian River Lagoon
- Ft. Pierce Inlet
- Downtown Waterfront
Original Marina Layout
2004 Hurricane Frances
2004 Hurricane Season
Project Funding

- City applied for FEMA public funding assistance for the amount exceeding the City’s insurance coverage

- FEMA’s Hazard Damage Mitigation program provides funding for improvements that reduce the magnitude and cost of damages from future storms

- According to FEMA, Hurricane Frances had a recurrence interval of approx. 9 years
  - Low recurrence interval was key in showing that substantial island construction could be economically justified

- Hurricane Frances was just one of four damaging storms to hit FL which helped to shift the political landscape to allow more robust solutions
Project Evolution & Timeline

- September 2004 – Hurricanes Frances
- Feb 2005 – Plans for restoration begin
- Nov 2006 – Numerical modeling work begins
- Feb 2007 – Physical model testing at Queens University in Canada
- August 2009 – project went before FL Governor & Cabinet for final approval. Board set moratorium on subsequent large filling projects until 2 years post-construction monitoring
- Dec 2010 – US Army Corps issues permit with special conditions
- Late 2011 – Project went to bid
- Feb 2012 – NTP issued
Project Purpose

- Project Goals
  - 100-Yr Storm Protection
  - Positive Environmental Impact
  - Eco-Tourism/Aesthetically Pleasing

Physical Model – Queens University
City of Fort Pierce

Waterfront Protection Project

Dock Reconfiguration, Dredging, and Storm Protection Habitat Islands

1. Veterans Park
2. Community Center
3. Amphitheater
4. Art Gallery
5. Boat Ramp Area
6. Tourist Information Center
7. Tiki Bar
8. Marina Square
9. New Public Library

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TETRA TECH CC, INC.
Project Layout

- 12 Island Breakwaters & 1 Peninsular Structure
  - Total of 14.66 Acres
- Ecological Enhancements
  - Oyster Recruitment – 1.28 Acres
  - Mangrove Habitat – 1.54 Acres
  - Juvenile Fish & Shorebird Habitat
  - Native Plantings
- $18.9 Million Construction Cost
  - NTP Issued February 2012
  - Construction Finished End of July 2013 – Phase I
  - Phase II replacement of dock structures
Design Criteria

100 Yr Storm Event:
- Fetch Length: 22 km
- Water Depth: 12 to 18 ft
- Design Wave Ht: 6.2 ft
- Wave Period: 5.1 sec
- Surge Elev: +10.5’ NGVD

For 50 Yr Event:
- Limit interior wave ht to < 1.15 ft
- Promote water quality/flushing within marina basin
Tern Island

- Island Geometry
  - 10.5 Acres
  - 1,500 lf x 300 ft
- 7 Groin Structures
- Sand Backfill in 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
Geotextile Tubes

- High strength polypropylene, woven geotextile with UV stabilization

- MacTube OS500
  - Approx 500 ppi

- Tube Sizes:
  - 45’ circumference
  - 30’ circumference
  - Custom lengths
Geotextile Tubes

MacTube Design Considerations:

- Tube Geometry – GEOCOPS
  - Fabric & Seam Strength (Factor of Safety)
  - Pumping pressures
  - Sediment characteristics of fill material (upland borrow site)

- External Stability Calcs
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

- Mattress Types:
  - BX EG 027 – 6” Thickness
  - UX EG115 – 12” Thickness
Marine Mattress

- **Mattress Dimensions:**
  - Width = 5’ & 6.5’

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

- **Approx. Weight = 110 pcf (12” x 20’ mat weights ~5.5 Tons)**
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; $V = 2 \text{ m/s}$
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 in place.
  4. Fill until design elevation achieved.
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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.
**Marine Mattress Installation**

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Lessons Learned

- Scour protection b/w 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 Areas
- Increase in Revenue
  - Marina Capacity
  - Eco-tourism
- Serves as “pilot study” for future projects
Thank You

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