Session 4

Max Sheppard
Ocean Engineering Associates, Inc.

Coastal Roadway Vulnerability to Hurricane Storm Surge, Currents & Waves & Potential Solutions

Topic Description

This presentation discusses the mechanisms of coastal roadway failure due to storm surge and wind waves and outlines some of the erosion protection methods that are being used to minimize damage. The coastal states bordering the Gulf of Mexico and Southern Atlantic have experienced significant roadway damage during the past two hurricane seasons. Several of these failures are discussed in this presentation.

Speaker Biography

Max Sheppard is President of Ocean Engineering Associates, Inc. (OEA, Inc.) and Professor Emeritus in the Civil and Coastal Engineering Department at the University of Florida. His areas of expertise include: bridge scour, coastal hydraulics, sediment transport, coastal structures, and wave loading on coastal and offshore structures.

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Mark Gosselin

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Speaker Biography

Mark Gosselin is the Vice President of Ocean Engineering Associates Inc. He is an accomplished Coastal Engineer, Hydraulic Modeler, and Wave Modeler. Mark graduated from Dartmouth College with a Bachelors degree, earned his Masters degree from University of California at Berkeley in Naval Architecture, and earned a Ph.D. from the University of Florida, Department of Coastal Engineering. Mark is a registered Professional Engineer in Florida and Louisiana.

Coastal Roadway Vulnerability to Hurricane Storm Surge, Currents, and Waves and Potential Solutions

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OEA, Inc., University of Florida

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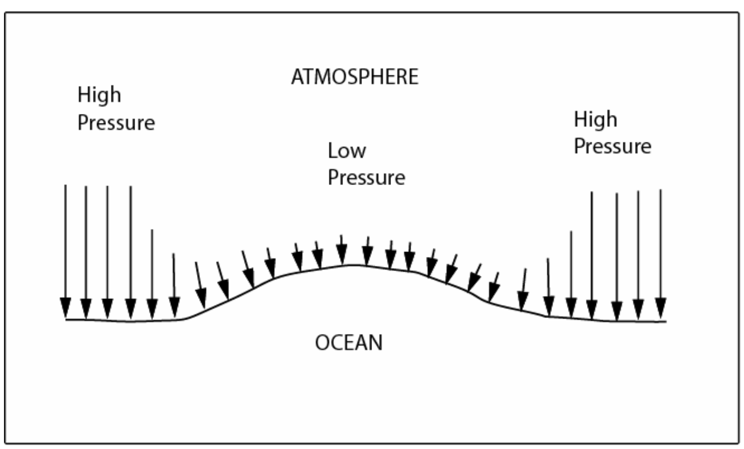
Outline

- Background
  - Hurricane Storm Surge and Waves
  - Erosion Mechanisms/ Hurricane Produced Roadway Problems
    - Shoreline Recession
    - Overwash
- Example Damage
- Possible solutions
- Summary
- Questions

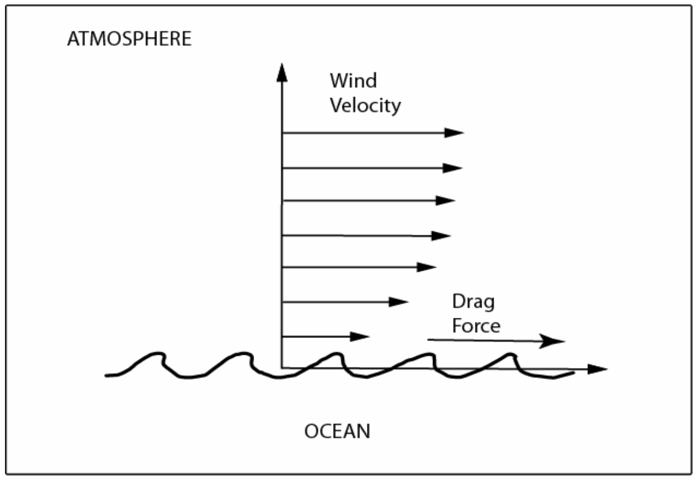
Background

- Storm surge and hurricane generated waves
  - Storm surge mechanisms
  - Hurricane generated waves

Storm Surge Mechanisms
Low Pressure



Storm Surge Mechanisms
Wind Stress



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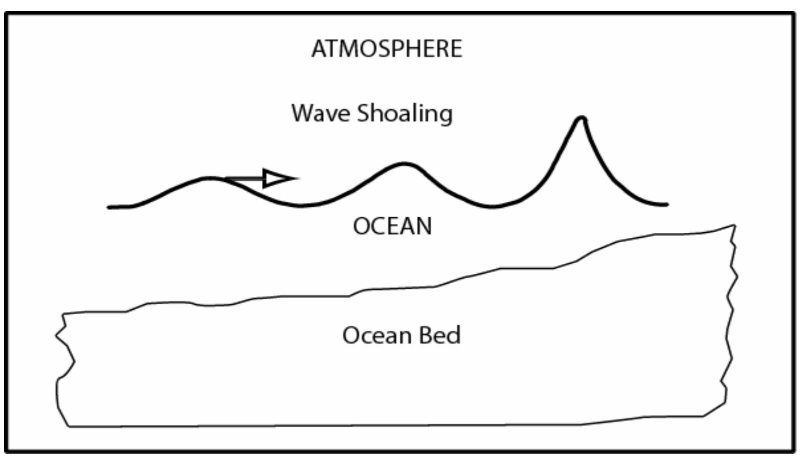
Storm Surge Mechanisms
Wave Shoaling



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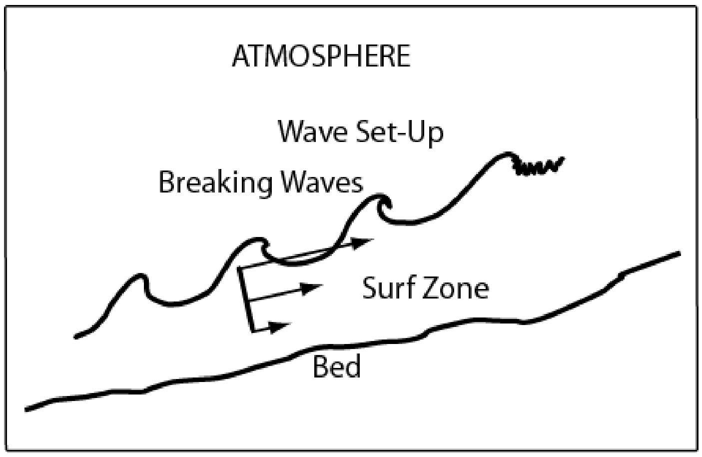
Storm Surge Mechanisms
Wave Setup



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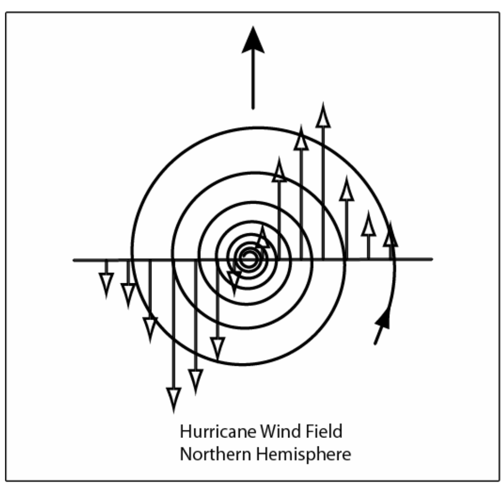
Storm Surge Mechanisms
Wind Field



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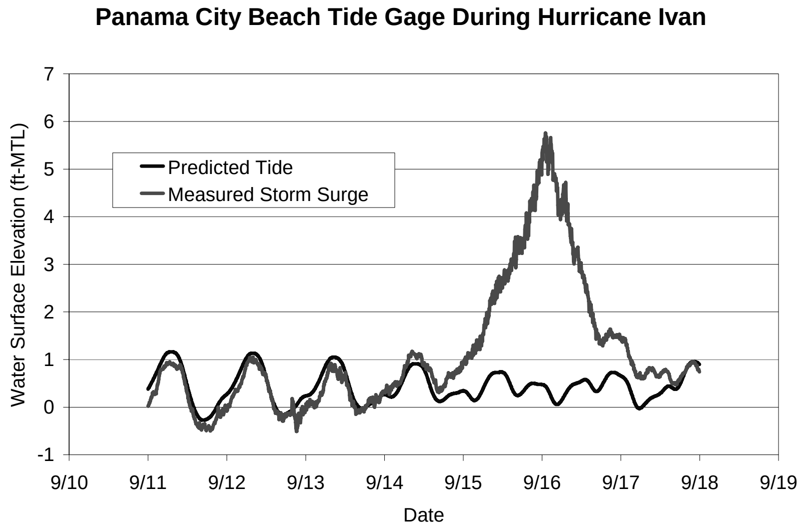
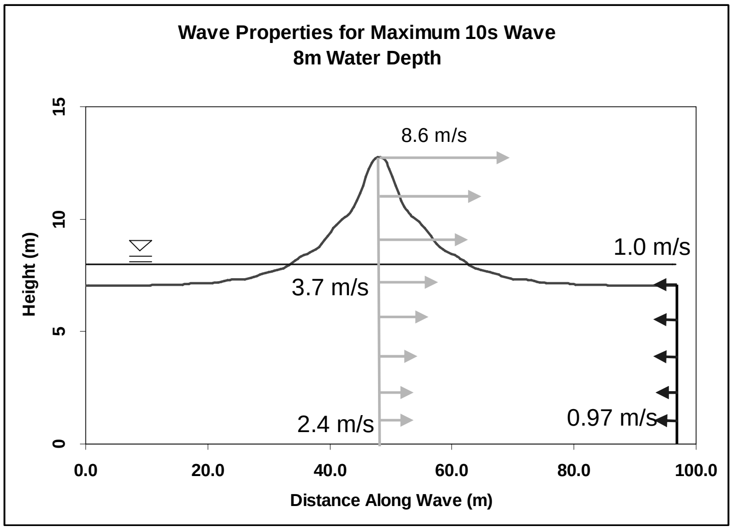
Hurricane Storm Surge



Hurricane Generated Waves

- Random
- Significant Wave Height, Hs
  - Average Height of 1/3 Highest Waves
- Maximum Wave Height
  - Depends on Duration of Storm ~ 1.7(Hs)

Non-linear Wave Properties



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Erosion Mechanisms

- Shoreline Recession
  - Erodes Seaward Side of Roadway
  - Waves
- Roadway Overwash
  - Erodes Landward Side of Roadway
  - Waves/Current

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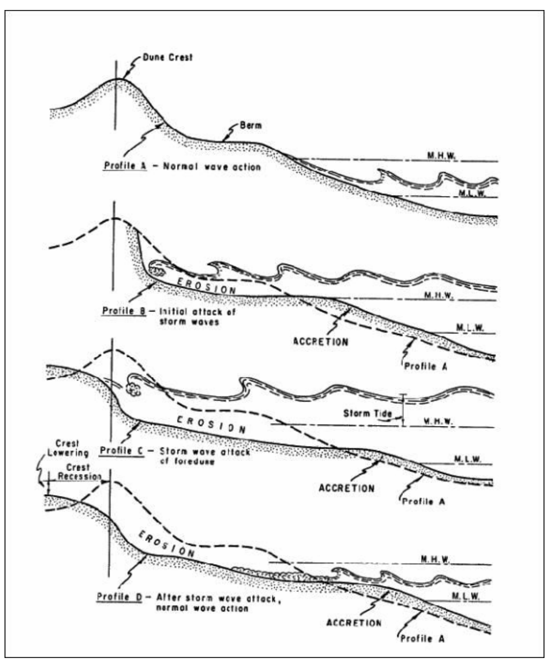
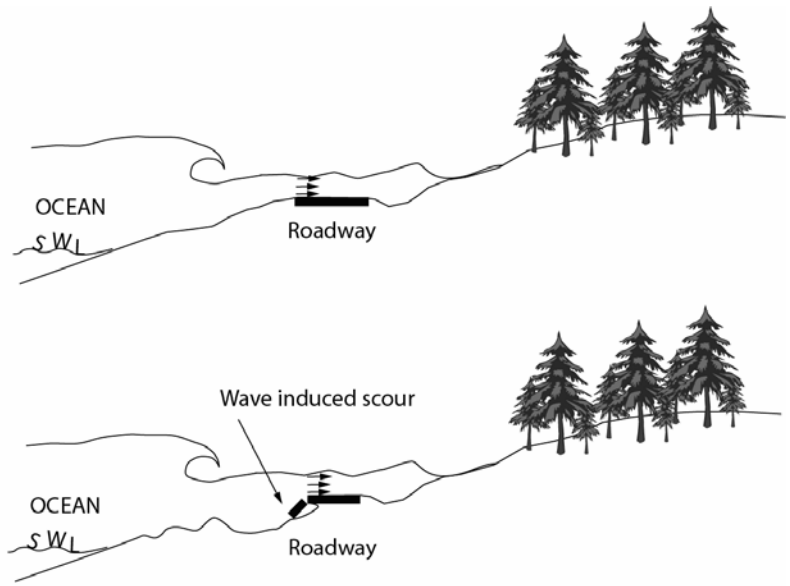
Shoreline Recession

- Shoreline Location Time Dependent
  - Open Coast
    - Accreting Profiles
    - Eroding Profiles
  - Inland — Generally Stable
- Hurricanes
  - Strong Winds Generate Large Waves
  - Large Waves
    - Erode Profile
    - Transport Sediment Offshore
    - Shoreline Recession





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Roadway Overwash

- Storm Surge, Wave Setup, & Wave Runup
  - Pump Water over Roadway
- Roadway Acts like Weir
- High Velocities on Downstream (Landward) Side
  - Possible Supercritical Flow
  - Erode Sand Shoulders
  - Undermine Pavement

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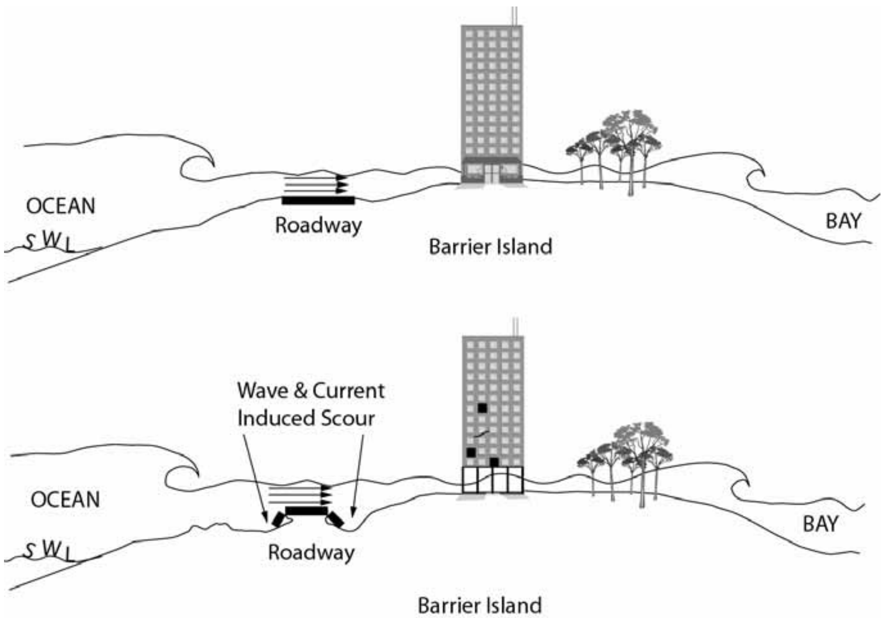

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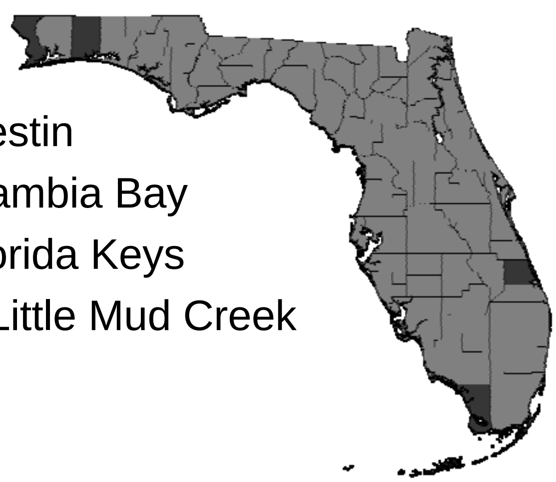
Example Damage



- US-98 near Destin
- US-90 on Escambia Bay
- US-1 in the Florida Keys
- SR-A1A near Little Mud Creek

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US-98 near Destin

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Choctawhatchee Bay
Gulf of Mexico
US 98
Okaloosa County
Looking East
After Hurricane Dennis
7/11/05

US-90 near Escambia Bay

US 90 North End of Escambia Bay After Hurricane Ivan

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I10 – Escambia Bay Bridge East Abutment, WB Lane

After Hurricane IVAN

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US-1 near Duck Key

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SR-A1A near Little Mud Creek

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What Can Be Done To Reduce Damage?

- Move roadway
- Elevate and protect
- Allow to flood and protect
- Do nothing and repair

Scour/Erosion Protection

- Rip-rap
  - Well established designs
  - Requires availability of dense stone
- Man-made materials
  - Performance under wave action not as well understood
  - Can be cost effective particularly in locations where stone is not available

Rip-Rap Revetment

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Recommended Armor Stone Size

Peak Wave Period = 10 s
Revetment Slope 1(vertical) to 3 (horizontal)

Significant Wave Height m (ft)	**Median Stone Diameter D50 m (ft)**	**Median Stone Weight W50 kg (lb)**
1 (3.3)	0.5 (1.6)	253 (558)
1.5 (4.9)	0.7 (2.3)	964 (2,125)
2 (6.6)	1.0 (3.3)	2,344 (5,168)
2.5 (8.2)	1.1 (3.6)	3,873 (8,539)
3 (9.8)	1.3 (4.3	5,837 (12,867)

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Gabion Mattress

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Gabion Mattress

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Articulated Block

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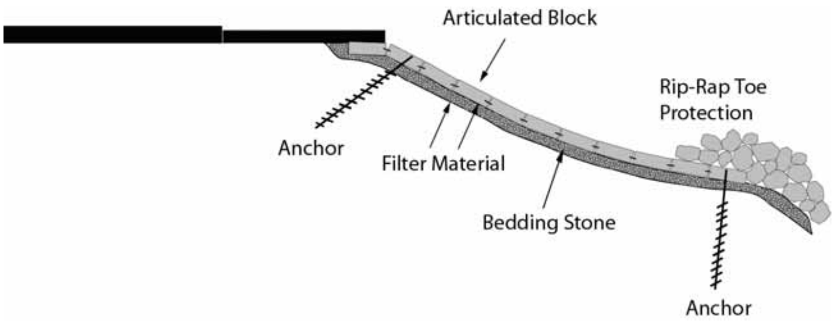
Articulated Block Scour Protection



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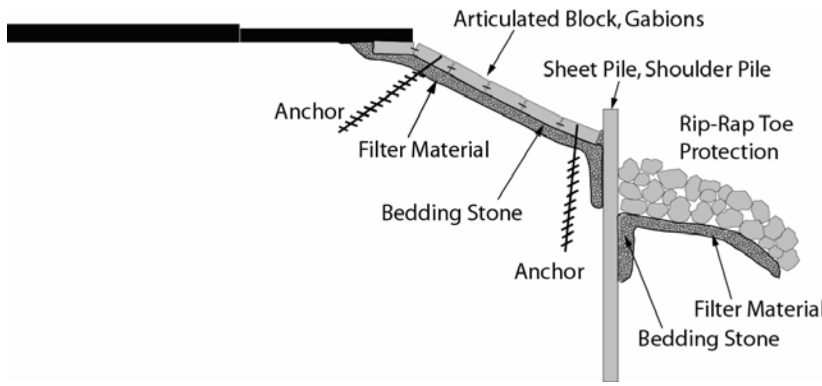
Articulated Block Scour Protection



Fabriform

Seawalls

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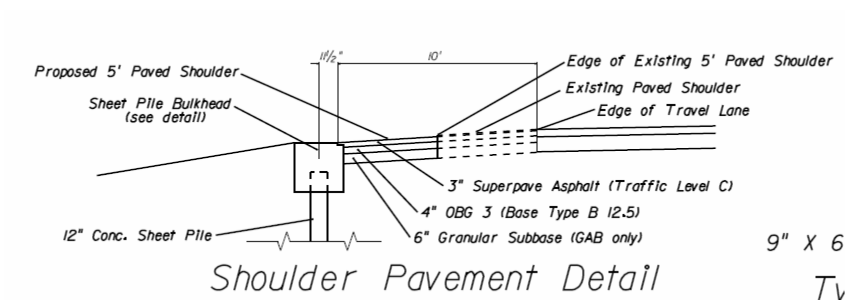

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    FDOT District 6

Questions, Comments

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