FHWA/AASHTO Wave Task Force
Plan of Action

A Briefing by

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14 February 2007
Caveats

- Discussions of
  - Laws (lawyers)
  - Regulations (more lawyers)
  - Policy (even more lawyers)

... can be dangerous for the Hydraulic Engineer ...
Background

FHWA Organization

- Headquarters
- Division Offices
  - 50 States, District of Columbia, Puerto Rico
  - 3 Federal Lands Divisions
- Turner Fairbanks Highway Research Center
- Resource Centers
An Alternative View

FHWA Organization

Poobahs

Legal

Infrastructure

Bridge Office

Environment & Planning

Safety & Operations

TFHRC & RCs

Divisions
Background

Highway “Players”

- **State DOTs**
  - Standards, Guidance, and Procedures
    - Allowable Loads on bridges
    - Design frequency of bridges
  - Adopts AASHTO when appropriate
  - Funds Research

- **AASHTO**
  - Represents State DOTs (funded by States)
    - Subcommittee on Bridges and Structures
    - Special Committee on Hydrology and Hydraulics
  - Standards, Guidance, and Procedures
  - Funds Research (NCHRP)

- **FHWA**
  - Policy, Standards, Guidance, and Procedures
  - Tied to Federal-aid monies
    - 80% - 20% cost sharing
    - 90% - 10% on Interstates
    - 100% emergency relief
  - Can adopt AASHTO into regulations
  - Funds Research

Congress
What’s the Status Quo?

Bridge Design Frequency

- Typical Design
  - Use 25 to 50-year return period
  - Consider freeboard
  - Peak flow
  - Does not consider
    - unsteady flow
    - waves

- Why?
  - National Bridge Inventory
    - 600,000 bridges
    - 475,000 over waterways
    - Approximately 95% of those riverine
Coastal Storms
Is ‘Status Quo’ Good Policy?

- Perception/Reality
  - Not ‘losing’ coastal bridges
  - Scarce resources
    - Staff
    - $$$
  - Insufficient coastal bridge research, methods, and tools
  - Informal assessment of risk
Status Quo

Consequences
Consequences

Ivan: I-10 Escambia Bay

- **Storm Surge**
  - Design stillwater level = 11.7 ft

- **Waves**
  - Significant wave height = 6.5 ft
  - Maximum wave height = 13.0 ft
  - Maximum wave elevation = 21.2 ft
  - Peak period = 3.2 seconds

- **Probabilistic characterization**
  - About the 200-year event

- **Replacement bridge**
  - Built to maximum surge + wave
  - $200 million
Consequences

Katrina: US-90 Biloxi Bay

- **Storm Surge**
  - Design stillwater level = 20 ft

- **Waves**
  - Significant wave height = 6.2 ft
  - Maximum wave height = 10.6 ft
  - Maximum wave elevation = 27.2 ft
  - Peak period = 5.1 seconds

- **Probabilistic characterization**
  - Slightly greater than 100-year event

- **Replacement bridge**
  - Built to maximum surge + wave
  - $250 million
Consequences

Katrina: US-90 Bay Saint Louis

- **Storm Surge**
  - Design stillwater level = 25 ft

- **Waves**
  - Significant wave height = 9.1 ft
  - Maximum wave height = 15.3 ft
  - Maximum wave elevation = 37.2 ft
  - Peak period = 6.1 seconds

- **Probabilistic characterization**
  - Much greater than 100-year event

- **Replacement bridge**
  - Built to maximum surge + wave
  - $300 million
Consequences

Katrina: I-10 Lake Pontchartrain

- **Storm Surge**
  - Design stillwater level = 12 ft

- **Waves**
  - Significant wave height = 6.0 ft
  - Maximum wave height = 12.6 ft
  - Maximum wave elevation = 22.8 ft
  - Peak period = unknown

- **Probabilistic characterization**
  - Katrina about a 130-year event
  - Used extreme event

- **Replacement bridge**
  - Built to extreme event surge + wave
  - $600 million
Consequences

What to Do?

Given: *Legislative & Regulatory Authority*

- **Policy**
  Intent of a specific Section
  “Prevent coastal bridge failure …”

- **Technical Advisory & Guidance**
  Provide Guidance on how to achieve Policy

- **Research, Documents, & Specs**
  Procedures on how to achieve Guidance

Plan of Action
How FHWA will proceed with Policy, Guidance, and Procedures
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GOAL

A proposed set of studies, technology transfer activities, and policies to fully achieve a rational approach that addresses wave force, storm surge, and scour vulnerabilities in existing and new structures.
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Incentives

- Storm Events may be Increasing

- Public Safety
  - Loss of Life
  - Loss of access
  - >1000 structures?

- Economics
  - Several $billion ER
  - Lost capacity

- Political
  - Congress will act
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Initial Efforts

- **FHWA**
  - Wave Force Workshop
  - University of South Alabama
    - HEC-25 “Highways in Coastal Environment”
    - Numerical & Physical Modeling
  - TFHRC research
  - Vulnerability & hazards assessment

- **DOT**
  - Vulnerability screening
  - Probabilistic wave force assessment
  - Time dependent / wave synergistic scour
  - Use of coastal models

- **AASHTO**
  - LFRD specifications
  - Coastal H&H specifications
  - NCHRP

- **Others**
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Focused Direction!

Joint FHWA-AASHTO Task Force

- Work together to address
  - technical issues
  - design specifications
  - implementation measures

- Multidisciplinary
  - structural
  - coastal
  - hydraulic
  - geotechnical

- Composition
  - FHWA
  - State DOT
  - Academia
  - Consulting

Task Force Approach

Worked well in other bridges related issues:
- Seismic
- Vessel collision
- Extreme events
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Task Force Membership

**Greg Perfetti – NCDOT – Chair**
Tom Everett – FHWA – vice-Chair

**State DOT Partners**

*Bridge Engineers*
- Mitch Carr – MS DOT
- vacant

*Hydraulic Engineers*
- Rick Renna – FDOT
- Dave Henderson – NCDOT
- Kevin Flora – CALTRANS

**Academic Partners**
- Robert Dalrymple – JHU
- David Kriebel – USNA
- Spencer Rogers – NCS

**FHWA Partners**
- Kornel Kerenyi – TFHRC
- Shoukry Elnahal – RC
- Joe Krolak – HIBT
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Approach

- **Pooled Fund Project (on-going)**
  - Coastal State DOTs & FHWA
  - Bridges Vulnerable to Coastal Storms
    - Development of Guide Specifications
    - Handbook of Retrofit Options
  - Modjeski & Masters
    - John Kulicki, PI
    - Other Team members
      - Moffatt & Nicols (Jeffrey Sheldon/John Headland)
      - OEA (Max Sheppard)
      - D’Appolonia (James Withiam)
      - Dennis Mertz
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Scope & Focus

**National & Coastal Orientation**

- **Present**
  - Fixed Bridges
  - Constituents
    - storm surge
    - hydrodynamic forces*
    - scour
- **Future**
  - Movable Bridges
  - Roadway embankments
  - Ancillary structures (signs, signals, lights)

*wave impact, uplift, and buoyancy

Douglass, 2005
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Pieces of the Puzzle

- State of Practice
- Damaging Waves
  - Size, Period, Frequency, Cycles, Probability of occurrence
  - Where and how do they cause damage?
- Wave and water loads and forces
  - What are they?
  - Where and how do they act on structure and substructure?
- Vulnerable Bridges
  - Which are they?
  - How do you determine (screen) these?
  - What is the risk?
- Potential mitigation and retrofit measures
  - Older bridges v. New bridges
- Gordian Knot
  - "policy-guidance-technical document--who-does-what-and when--show-me-the-money“
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State of Practice

Headland, Allsopp, 2005
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Design Frequency

- **Interim Guidance**
- **Help out Gulf States directly affected by Katrina**
  - Allowing them to rebuild structures
  - State DOT standards would have required them to rebuild to same elevation as Katrina destroyed
  - FHWA showed a way to use our regulations to avoid this
  - Codified same approach used after Ivan at I-10 Escambia Bay, Florida
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Wave Forensics

- Conceptualization

Douglass, 2006
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Wave Forensics

- Numerical Modeling

Simulation Time = 120.000 hrs

Sheppard/Chen, 2005-2006
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Wave Forensics

- Wave Tank Modeling
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Wave Forensics

- Wave Tank Modeling
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Wave Forensics

- Wave Tank Modeling

Sheppard, 2007
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Wave Forensics

Field Work

Douglass, et. al., 2006

this girder moved this way off the pile cap and pulled 4 bolts out
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Wave Forensics

- Field Work

Kulicki, et. al., 2006
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Wave Forces

WAVE FORCES ON BRIDGE DECKS

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April 2006
DRAFT REPORT

Prepared for
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
Office of Bridge Technology
Washington, DC

http://www.southalabama.edu/usacterrec/waveforces.html
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Vulnerability

- Hazard Characterization
  - Storm Surge
  - Waves
  - Joint Probability

- Risk Analyses
  - Seismic & Other approaches

- Bridge Screening
  - Multi-level screening
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Retrofit Options

- Compile & Catalog Options
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Retrofit Options

- Compile & Catalog Options
  - Concept Drawings
    - Shear blocks
    - Fuses
    - Break-ways barriers
    - I-girder replacement
  - Analytical Studies of Options
    - Apply to set of actual bridges

Unsure of effectiveness of these concepts!
**Plan of Action**

**Desired Results**

- **Guide Specification**
  - Incorporate into LFRD specs
  - Risk and Vulnerability
  - Balloted by AASHTO

- **Retrofit Handbook**
  - Programmatic component
  - Screening methods
  - Standard sheets and drawings
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Timeline

- Research - ongoing
- Retrofit Options – March 2007
- Analytical Study of Retrofits – April 2007
- Retrofit Handbook – October 2007
- Final Reports – November 2007

All dates subject to change
Questions?
Acknowledgments & Credits

- University of South Alabama
  - Dr. Scott Douglass
  - Dr. Jim Chen

- Texas A&M
  - Dr. Billy Edge

- OEA
  - Dr. Max Sheppard
  - Dr. Mark Gosling

- Moffatt & Nichol
  - John Headland
  - Jeff Sheldon

- HR Wallingford
  - William Allsopp

- Florida DOT
  - Rick Renna
  - William Nickas

- North Carolina DOT
  - Dave Henderson

- Delaware DOT
  - Dennis Shea

- USACE

- NOAA

- FEMA

- FHWA
  - Fred Skaer
  - Tom Everett
  - Jorge Pagan
  - Kornel Kerenyi
  - Jeffrey Ger
  - Phil Thompson (ret)