Hurricane Engineering and Multidisciplinary Research and Education Challenges

National Science Board
Hurricane Science and Engineering Meeting
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American Association for Wind Engineering
American Society of Civil Engineers
Wind Hazard Reduction Coalition
Why are we having this meeting?

• Charley, Francis, Ivan, Jeanne, KATRINA, Rita, Wilma
Why are we having this meeting?

- **In Just 15 months** (Aug 2004-Oct 2005)
  - Over 2000* lives lost
  - Hundreds of Billions of $ Damage
  - Much of Gulf of Mexico Coast from East Texas to Florida damaged or destroyed
  - Hundreds of thousands of homes damaged or destroyed
  - Cities wiped off the map
Why are we having this meeting?

- Loss of Life
  - Occurred primarily in buildings
- Massive Destruction of the Built Environment
  - Significant national impacts
    - Response and reconstruction costs
    - Construction materials shortages
    - Insurance and reinsurance markets
    - etc
The Problem is
Hurricane Interactions with
the
Built Environment
The destruction of our built environment is first and foremost an Engineering Problem.

Solution requires strong collaborations with physical, environmental, and social sciences.
National Program for Wind Hazard Impact Reduction

- National Windstorm Impact Reduction Act of 2004

- This program lays out part of the solution –
  - includes responsibilities by NSF, NOAA, FEMA, and NIST
Primary Hurricane Threats

Storm surge flooding and waves
Extreme winds and tornadoes
Extreme Rainfall and freshwater flooding
Windborne/floodborne debris
Raid-induced landslides
Erosion/scour/washover
Secondary Hazards

• Fire
• Contaminated floodwaters/debris
• Combined environmental & technological hazards
  – e.g. hazardous materials releases caused by storm damage to pipelines, storage tanks, etc.
• Floodborne diseases
Surge, Wind, Waves
Flood and Wind

Hurricane Ivan
Hurricane and Tornado Winds

Hurricane Ivan
Paradigm Shift Required

- Hurricanes have and will continue to strike inhabited coastal areas of the world
- Building, infrastructure, and community design professionals should explicitly consider this fact
- New engineering methods, tools, materials, and technologies required
- Education of designers of built infrastructure crucial
What is Hurricane Engineering?
What is Hurricane Engineering?

Engineering of the built environment with due consideration of the complete array of hurricane hazards
State of Practice

Earthquake vs Hurricane

Hurricanes cause more casualties and property damage than earthquakes, but are somehow not explicitly considered in the normal engineering design process.
Earthquake

- Seismic safety is a fundamental design consideration
- Consumers ‘relatively aware’ of risk
- Design professionals have a minimum level of understanding and competence
- Specialty seismic portions of professional registration exams
- Earthquake engineering part of Civil Engineering curricula
- Textbooks and curricular materials readily available
- Faculty members active in research and practice
- NEHRP - $100M+ annual research budget for earthquake engineering
Hurricane

- Hurricanes are not fundamental design consideration
- Consumers “relatively unaware” of risk
- Design professionals do not have a minimum level of understanding and competence
- No specialty sections on professional registration exams
- Hurricane engineering not part of Civil Engineering curricula (with a very few exceptions)
- Textbooks and curricular materials not readily available
- Few faculty members active in research and practice
- Wind - $5 Million annual research budget
**Structural Engineering**

- Wind Engineering
  - Wind, Debris

- Design for Lateral and Uplift Loads

- Design of Building Envelope

- Flood Protective Design
Geotechnical Engineering

- Foundation Design
  - Lateral loads
  - Uplift loads
- Rain-Induced Landslides
- Earth Structures
  - Levees
  - Dams
- Erosion/deposition/scour
Transportation Engineering

- Evacuation and Reentry
  - Planning, Operations, Monitoring, Communications
  - Design for Contraflow

- Design of Storm Resistant Transport Infrastructure

- Rapid Assessment and Repair
Water Resources Engineering

- Storm surge flooding and waves
- Inland Rainfall Flooding
- Structural flood controls
- Nonstructural flood controls
Environmental Engineering

- Water and Wastewater Treatment Facilities
  - Design, response, recovery

- Contamination
  - Surface water, groundwater, soils, flooded structures

- Solid Waste (Debris) Disposal
  - Transportation, Landfills, burning
Beyond Engineering

• Architecture
• Land Use Planning
• Coastal Sciences
• Information Technology (GIS)
• Emergency Management
**Project Highlights**

- Developed a brand new engineering curriculum
- Created web site for distribution of curricular materials
- Created & taught 5 new courses at LSU
- Writing the first book on hurricane engineering
- Coastal and Hurricane Engineering Minor in approval process
Web Site

- Hurricane Engineering Resources
  - Instructor reference materials
    - syllabi
    - sample problems and exams
  - Powerpoint lecture files
  - Much material posted now – will continue to add to it

www.HurricaneEngineering.lsu.edu
Project Team

• Lead units -
  – LSU Civil and Environmental Engineering
  – LSU Hurricane Center

• Other LSU Departments
  – Mechanical Engineering
  – Chemical Engineering,
  – Landscape Architecture
  – Environmental Studies

• Collaboration with
  – University of Missouri-Rolla
  – Southern University
Assessment and Remediation of Public Health Impacts from Hurricanes

Over 20 investigators
• Engineering
• Environmental Sciences
• Social Sciences
• Medical/Health Scientists

Lt. Chris Bodet, LSP, discusses evacuation updates for New Orleans, LSU CSPHIH Advisory Board Meeting, April 2004
Flowchart of Research Activities
New Orleans Pilot Study – Applied during Katrina

- Experimental Storm Surge Modeling (ADCIRC)
- Evacuation Studies
- Flood Casualty Modeling
- New Orleans Population Survey
- Wind Damage to Petrochemical Structures
- Water and air contaminant modeling
- Public health aspects
- Animal evacuation
- other study areas

Experimental storm surge modeling, Hurricane Katrina
Support for Katrina Response - Prelandfall
LSU Hurricane Center activated Saturday morning Aug 27

• Satellite storm tracking
• Meteorological support
• Storm surge modeling
• Damage estimates
• Consultation on evacuation and sheltering decisions
• Briefings every 2-3 hours
Support for Katrina Response – Post Landfall
Staffed the ‘LSU’ workstation at the Louisiana Emergency Operations Center 24/7 for next 3 weeks

• Post-Landfall Activities
  • Stood up GIS/Remote Sensing/Mapping capability in less than 24 hours
  • Meteorological support
  • Upgrading surge model to account for levee damage state
  • Water quality sampling – results shared with EPA
  • FEMA Data Clearinghouse – LSU allocated 20 Terrabytes of space
Questions/Opportunities Raised

- Role of Higher Education in Emergency Preparedness and Mitigation
  - Unique expertise and capabilities
  - Technology transfer
  - Coordination with state and local EM agencies before disaster wrt capabilities
Questions/Opportunities Raised

- Role of Higher Education in Operational Disaster Support
  - Unique expertise and capabilities
  - Surge capacity
  - Invaluable learning experience for students, faculty and research staff
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