Security – Strategic Research Plan
Bridges & Structures

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Outline

- R&D priorities – results of outreach effort
- Current security activities
- All hazards approach
  - Similarities
  - Differences
Identification of Security R&D Priorities

• Needs Assessment
  – Conducted by FHWA – August, 2002
  – Solicited potential research projects from bridge owners, national labs, academia, consultants and associations
  – Generated a list of research needs statements

• Blue Ribbon Panel
  – Convened by FHWA & AASHTO through TRB
  – Experts representing consultants, academia and state & federal agencies
  – Provided recommendations for reducing vulnerability of bridges & tunnels including R&D recommendations

• R&D Security Workshop
  – Conducted by FHWA – March, 2004
  – Generated a list of needs statements to secure the nation’s highways
Publications – from outreach effort

http://www.fhwa.dot.gov/bridge/security/

www.tfhrc.gov/structur/pubs/06072/index.htm
Risk & Vulnerability Assessment

Goal – Develop better decision support tools, and more relevant methodologies for risk and vulnerability assessment

- Synthesis of existing risk and vulnerability assessment methodologies
- Development of consistent risk assessment methodology for all hazard events
- Development of criticality model for bridges and tunnels for incorporation into risk assessment models
- Lessons learned – bridge demolition
System Analysis and Design

Goal – Improve analytical and design methodologies for predicting and understanding structural behavior

- Advanced physical and numerical modeling and simulation capabilities for predicting and understanding behavior under extreme events
- Assessment of bridge design types and components for structural vulnerability
- Assessment of tunnel designs to resist blast and fire
- Optimized designs for hazard loadings
- Catalog of optimized design solutions for each hazard
- Blast resistant designs – Impact attenuators – Structural cladding
- Development of protection measures for rehabilitating existing structures/built into new structures
- Structural vulnerability guide
- Blast effects and retrofit techniques for tunnels
Material Performance

Goal – Better understanding of material performance and improvements under extreme loadings.

- Response modification devices
- Material performance under extreme event loadings including fire
- Resistant materials and coatings for improved performance
- Shape-memory alloys for bridge structural applications
- Application of nanomaterials
**Prevention, Detection and Surveillance**

**Goal** – Adaptation of existing technologies and development of new technologies for detection, surveillance and prevention of incidents

- Damage mitigation measures
- Sensing and monitoring technologies for extreme events
- Use of MEMS sensors
- Smart bridges and automatic notification systems
Response, Recovery and Restoration

Goal – Development of easier response and safety assessment capabilities, and better recovery and restoration techniques to minimize impact of the hazard event

- Better decision support and operational tools
- Improved crisis communication
- Improved means to study traffic movement in crisis situation
- Emergency repair procedures
- Improved repair and restoration techniques
- Forensic analysis capabilities and protocols for rapid assessment
- Inspection techniques for rapid safety assessment of damaged structures
- Damage assessment guide
Evaluation and Training

Goal – Test and evaluate new technologies and develop training aids to assist transportation owners.

- Vulnerability assessment workshops
- Testing and evaluation program for new technologies
- Engineering assessment teams to gather perishable data after an event
NCIP R&D Plan

• National Plan for R&D in Support of Critical Infrastructure Protection
  – Homeland Security Presidential Directive 7 (HSPD-7)
  – 1st annual report released by DHS – April 2005
  – Strategic goals
    • A national common operating picture for critical infrastructure
    • A next generation computing and communications network with security ‘designed in’ and inherent in all elements rather than added after the fact
    • Resilient, self-diagnosing, self-healing physical and cyber infrastructure systems
NCIP R&D Plan

• Nine themes addressing the three strategic goals
  – Detection and sensor systems
  – Protection and prevention
  – Entry and access portals
  – Insider threats
  – Analysis and decision support systems
  – Response, recovery and reconstitution
  – New and emerging threats and vulnerabilities
  – Advanced infrastructure architectures and systems design
  – Human and social issues
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Current Activities

- Synthesis of bridge and tunnel sensor technologies (FHWA – pooled fund study)
- Bridge & tunnel security sensor technology website (FHWA)
- Validation of numerical modeling & analysis of steel bridge towers subjected to blast loadings (FHWA – pooled fund study)
- Blast resistant highway bridges (NCHRP)
- Standardized blast response curves for bridges (FHWA)
- Development of bridge specific blast loading program (FHWA)
- Blast testing of full-scale precast, prestressed concrete girder bridges (States-pooled fund study)
- Making transportation tunnels safe and secure (TCRP/NCHRP)
- A guide to highway vulnerability assessment (NCHRP)
- Guide to risk management of multi-modal transportation infrastructure (NCHRP)
- Bridge & tunnel vulnerability assessment workshops (FHWA)
- Engineering assessments (FHWA)
Strategic Focus Areas

Risk & Vulnerability Assessment
- A guide to highway vulnerability assessment
- Guide to risk management of Multi-modal transportation infrastructure
- Making transportation tunnels safe and secure

System Analysis & Design
- Steel bridge towers subjected to blast loadings
- Blast resistant highway bridges
- Standardized blast response curves for bridges
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- Blast testing for full-scale precast, prestressed concrete girder bridges

Material Performance

Response, Recovery & Restoration

Evaluation & Training
- Bridge & tunnel vulnerability assessment workshops
- Engineering assessments

Prevention, Detection, & Surveillance
- Synthesis & website on bridge and tunnel sensor technologies
All Hazards Approach

- Similarities
- Differences
All hazards approach - differences

- Identifying critical/vulnerable highway infrastructure
- Identifying high risk areas

Easier for natural hazards
All hazards approach - similarities

- Defining critical routes/corridors
- Identifying alternate routes – real time
All hazards approach - differences

- Design
  - Developing designs & mitigation measures for each event is different
  - Still lack understanding on performance of current designs
  - Blast, intentional impact and fire not included in current designs – little knowledge exists
All hazards approach – similarities & differences

- Material performance
  - Bridge materials are affected by fire, but bridges are not designed for fire
  - Need better understanding of the behavior of new materials under high intensity loading
All hazards approach - similarities

• **Post event assessment**
  
  – **Determining safety of structures for emergency operations** – lack guidelines for safety assessment of damaged structures
  
  – **Determining residual capacity of heavily damaged structures** – lack NDE methods for assessment or monitoring of heavily damaged structures
  
  – **Forensic training**
All hazards approach – similarities

• Response and recovery
  – Crisis communication
  – Emergency repair procedures/processes
  – Restoration of a damaged structure to its original condition
  – Technologies for rapid repair and replacement
All hazards approach - differences

• Sharing sensitive information
Summary

- Research needs and focus areas have been identified
- Few studies have been underway to fill these gaps
- All hazards approach
  - To have a resilient infrastructure for a particular event an all-hazards approach may not be appropriate in all cases
  - There are similarities in planning for, responding to and recovering from all hazards but developing design mitigation measures to build resiliency into structures is hazard specific.