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OFFICE OF RESEARCH, DEVELOPMENT, AND TECHNOLOGY

PROVIDING FOR BRIDGES & STRUCTURES RESILIENCY

FHWA-ASTM Webinar on Resilient & Sustainable Transportation

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WHAT WE WANT TO ACHIEVE

- Infrastructure designed to withstand hazard loads or quickly and easily be repairable and operable after an event.

Focus of activities

- **Understanding the hazards, impacts on infrastructure – leading to improvements in design**
- **Avoiding catastrophic failures**
- **Learning from each event**
- **Understanding and managing risk/consequences**

PROVIDING RESILIENCY AGAINST TERRORIST THREATS

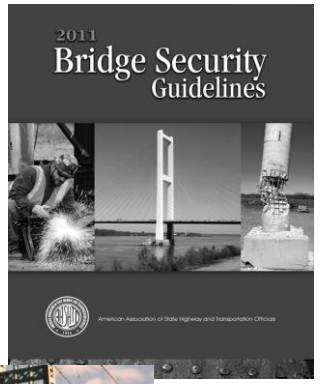
Source: ACE

Mitigation measures

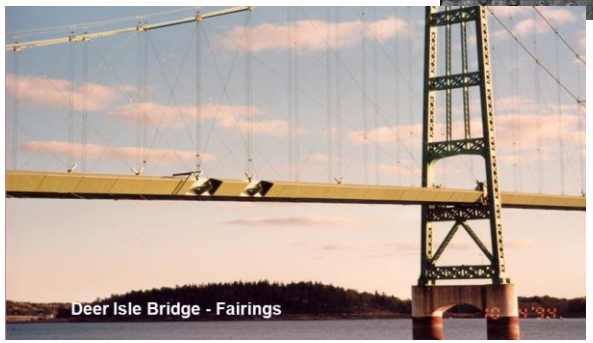
- Steel towers
- Concrete towers
- Cable protection systems
- Analytical programs
- Materials

Resource Materials

- BEL/AT Planner for Bridges
- AASHTO Publication



Source: AASHTO



Source: FHWA.

PROVIDING RESILIENCY AGAINST TERRORIST THREATS

- Advancement of protection technologies against known or newly identified hazards or threats
- Certification/prequalification standards, testing criteria, and specification language for bridge protection technologies
- Vulnerability and protection of bridges susceptible to unmanned aerial system threats
- Load path redundancy as a protection measure
- Updates to Anti-Terrorism Planner (ATP) for Bridges and development of related tools
- Development of webinars, training aids, and short courses


Source: FHWA.

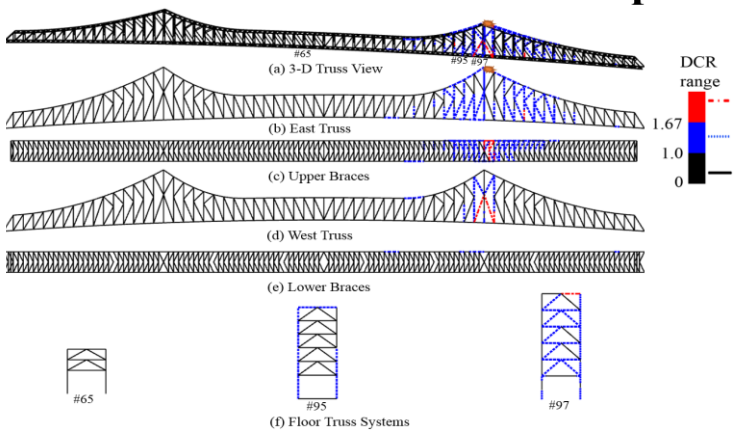
LOAD PATH REDUNDANCY AS PROTECTION MEASURE

Source: FHWA

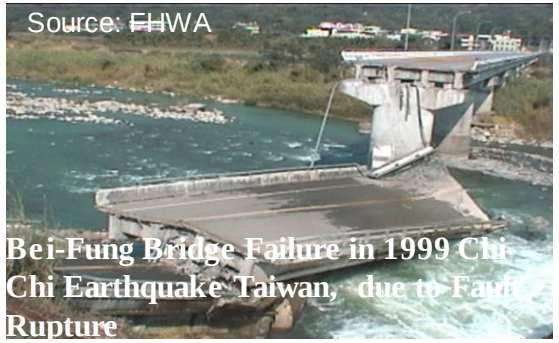
Alternate load path designs – preventing progressive collapse

Source: City College of NY

Ikitsuki Bridge connecting Ikitsuki and Hirado Island in Japan.



FRAMEWORK FOR INFRASTRUCTURE RESILIENCE AND POST HAZARD RESPONSE



Questions to Ask Ourselves

- Are we able to measure resilience improvements?
- Are we learning from extreme events to be able to make improvements?
- Can better assessment of infrastructure performance (engineering performance) improve on the continuous cycle of destruction and rebuilding after every major event?
- What could we have done better or, more importantly, what should we be doing when designing infrastructures to increase their resilience to extreme events?
- Are we gathering appropriate data?

Framework

- Resilience.
  - What constitutes resilience improvements?
  - Methodology to measure resilience improvements.
- Post Hazard Response.
  - Post-event Damage Inspection (PDI).
  - Post-event Engineering Investigation (PEI).
- Feasibility and framework for a disaster resilience database.

TSUNAMI DESIGN GUIDELINES FOR COASTAL BRIDGES

- Pooled fund study TPF-5(307).
- Lead Oregon Department of Transportation.
- Partners – Alaska, California, Hawaii, Maryland, Oregon, Washington, and Federal Highway Administration.

Source: Minister of Land, Infrastructure, Transport and Tourism (MLITT) Japan

Oregon State University - Tsunami Wave Basin
Source: FHWA

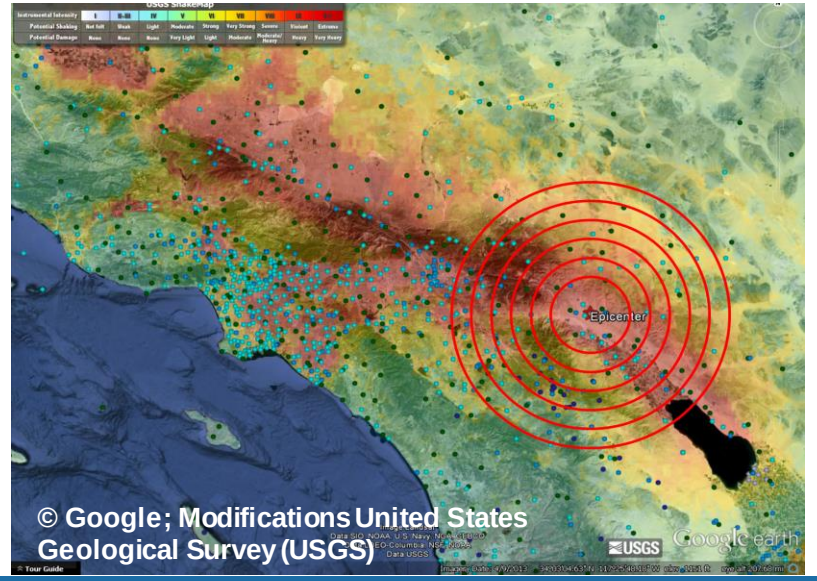
Source: FHWA

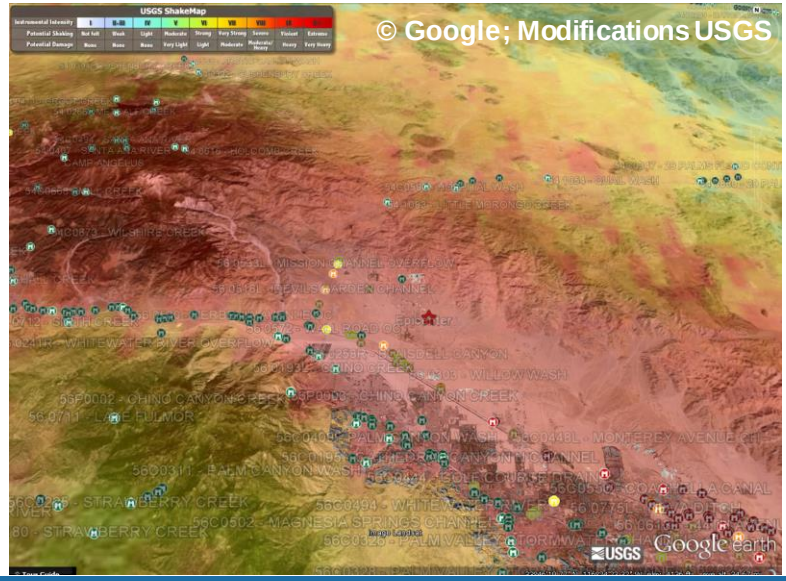
IMPLEMENTING SHAKECAST ACROSS MULTIPLE STATE DOTS FOR RAPID POST-EARTHQUAKE RESPONSE

- Pooled Fund Study – TPF-5(357)
- California – lead
- Partners – California, Idaho, Missouri, Mississippi, Oklahoma, Oregon, South Carolina, Texas, Utah, Washington, and Federal Highway Administration

U.S. Geological Survey's ShakeCast alerts responders to those bridges more likely to be impacted within regions of strong shaking, saving on response time.

ShakeMap – provides best estimate of ground shaking distribution.





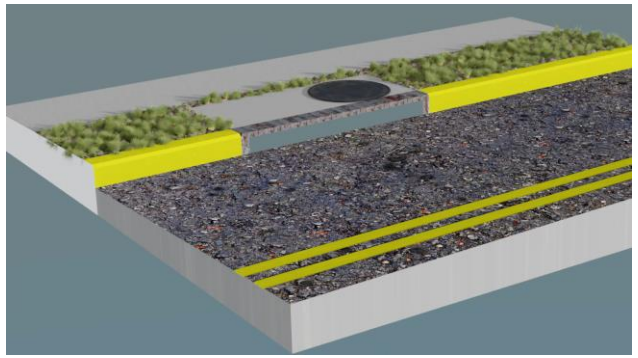
GEOHAZARDS, EXTREME WEATHER EVENTS & RESILIENCE

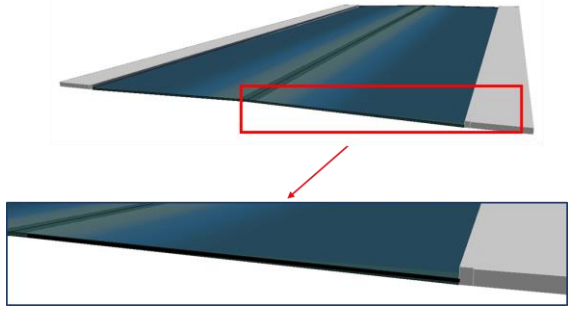
- Geohazards program involves
  - Identification and evaluation of Geohazards
  - The severity, frequency, and intensity
  - Inter-relationship with extreme weather events and changing environmental conditions
  - Mitigation strategies to avoid or reduce negative impacts to highway transportation infrastructure assets (Resilience!)

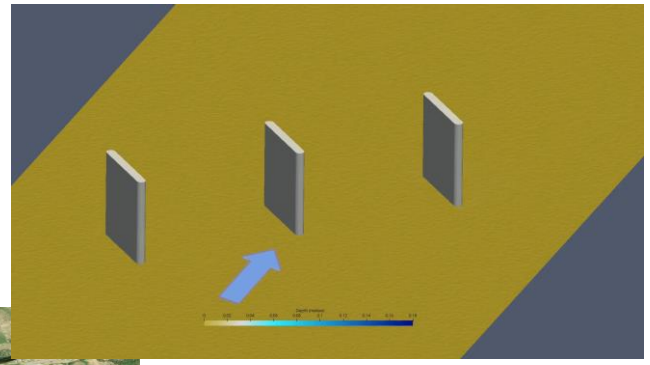
U.S. 89, AZ - 23 mile-long section closed,
45-mile detour ($25 million repair)
Source: AZDOT

HYDRAULIC HAZARDS & RESILIENCE

- Impacts of flooding
- Hydroplaning on roadway
- Curb inlet research
- Bridge scour – CFD scour modeling
- Hydrology – changing flood frequencies
- Tsunami wave experiments/CFD calibration







Source: FHWA

SUMMARY

- FHWA Infrastructure R&D is focusing on developing robust and resilient systems addressing those hazards having an impact on our built infrastructure.

- Focusing on
  - Improving the understanding of hazards on infrastructure/ learning from events – build back better
  - Avoiding catastrophic failures – building redundancy/robustness
  - Measuring resilience, understanding and managing risk/consequences

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