

NSF-NEESR-SG

Seismic Performance of Bridge Systems with Conventional and Innovative Design



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**Co-PIs: G. Fenves (UC-Berkeley), A. Elgamal (UC-San Diego),
A. Mirmiran (Florida Int'l U.), & I. Buckle (UNR)**

**Other Senior Participants: A. Kiremidjian (Stanford), A. Itani,
& G. Pekcan (UNR)**

\$2,000,000 Budget; 4-years; Starting date: Nov. 15, 2004



Objectives

- 1) Conduct a comprehensive investigation of seismic performance of a series of large-scale four-span bridge *systems* including the soil-structure effects at the footings and the abutments.
- 2) Evaluate relative performance of components, bridge piers, and bridge systems and implications relative to current *design* assumptions and philosophies.
- 3) Incorporate *innovative* materials in bridge piers and determine system seismic performance to set the stage for the next generation of earthquake resistant bridges.



Objectives (Cont'd)

- 4) *Use OpenSees for comprehensive evaluation of bridge models with conventional and innovative details. Calibrate analytical models at micro and macroscopic levels and study important system parameters.*
- 5) *Utilize the study and its products as resources to promote understanding of the importance of bridge earthquake engineering at all levels including the kindergarten to graduate school and the earthquake engineering profession.*

NEES tools: UNR Shake Table System; UCSD Shake Table; and NEESgrid



Components of the Project

- **Shake table testing of 4-span bridges (Saiidi)**
- **Abutment testing (Elgamal)**
- **Computer simulations (Fenves)**
- **Innovative materials (Saiidi, Mirmiran)**
- **Data Management (Pekcan)**
- **Education and outreach (Itani)**
- **Wireless sensors (Kiremidjian)**
- **Design implications (Buckle)**
- **International cooperation (Kawashima; Fischinger)**

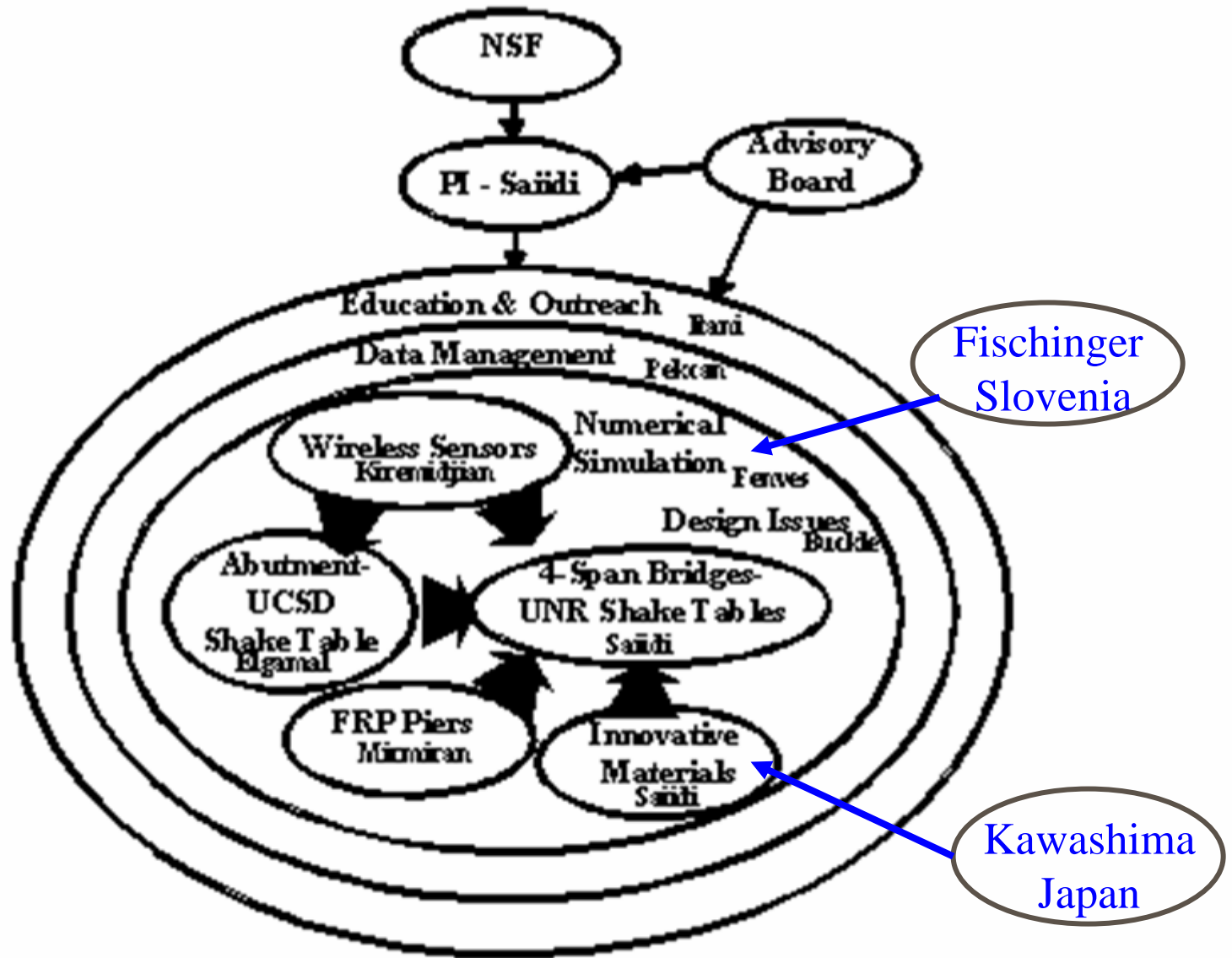
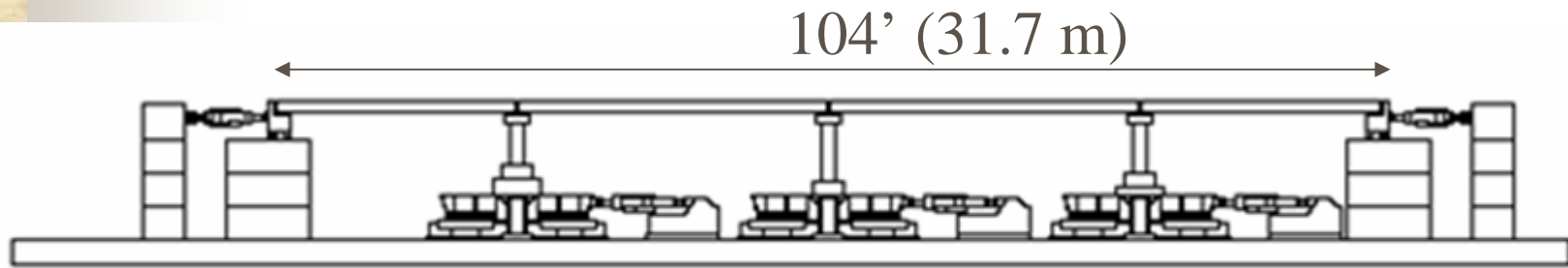
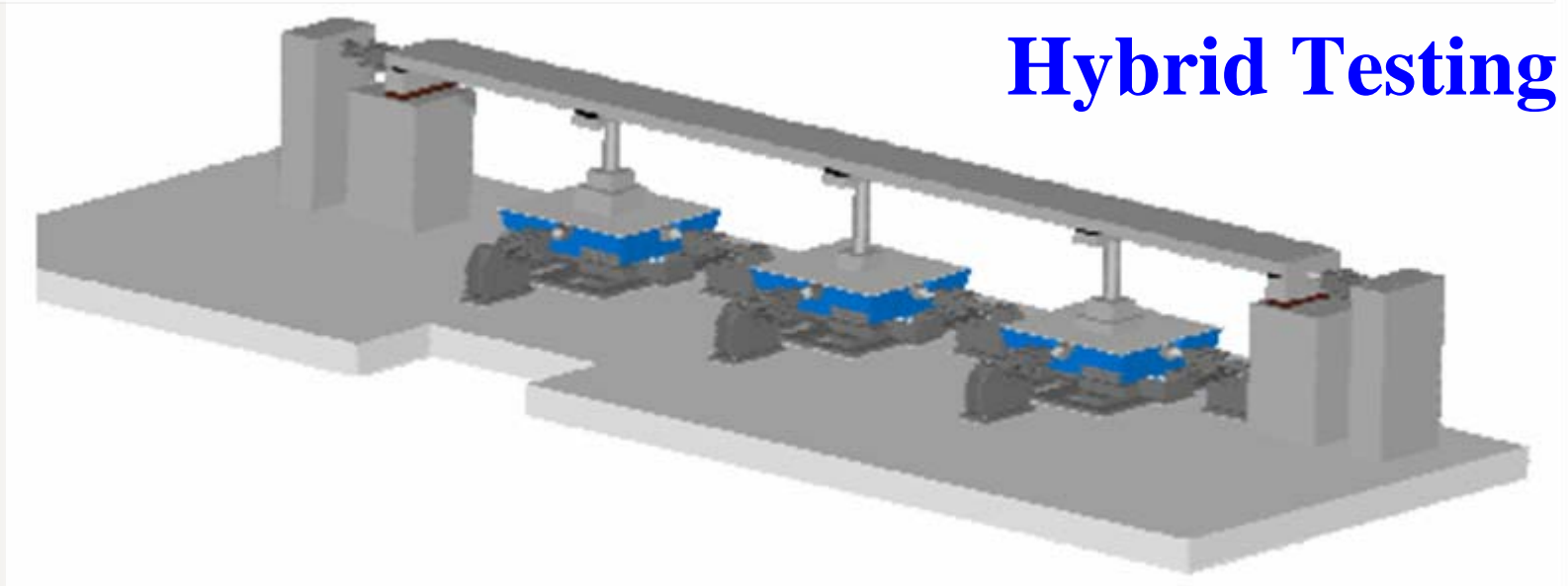


Fig. 4 Project tasks and their relationships

Bridge Tests (UNR)



2D Rendering



NSF NEES Demo

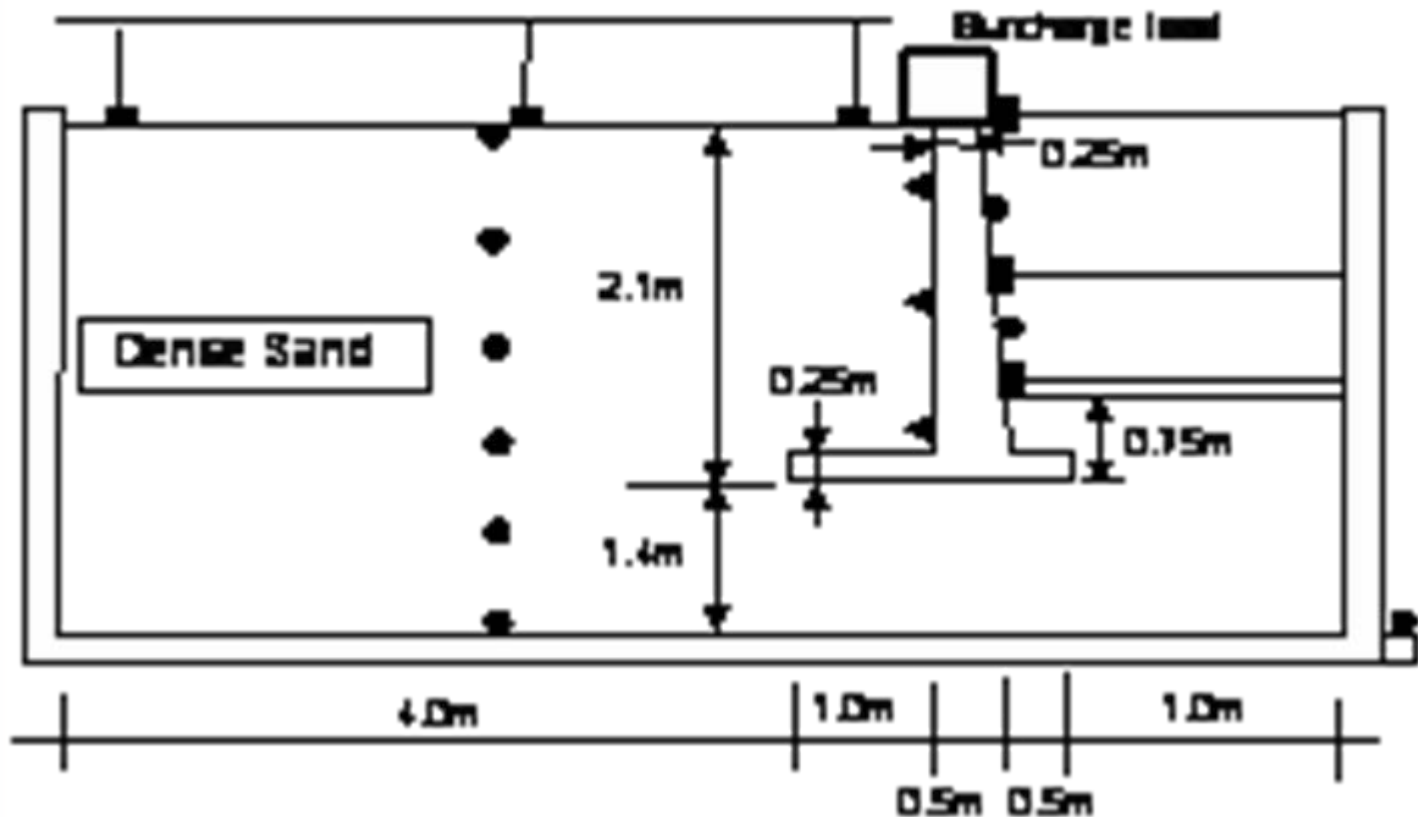
Overall PI: S. Wood; UNR PI: Saiidi

UNR Co-PI: Sanders; PhD Student: Johnson



Abutment Tests (UCSD)

- Accelerometer
- ▲ Earth pressure transducer
- LVDT

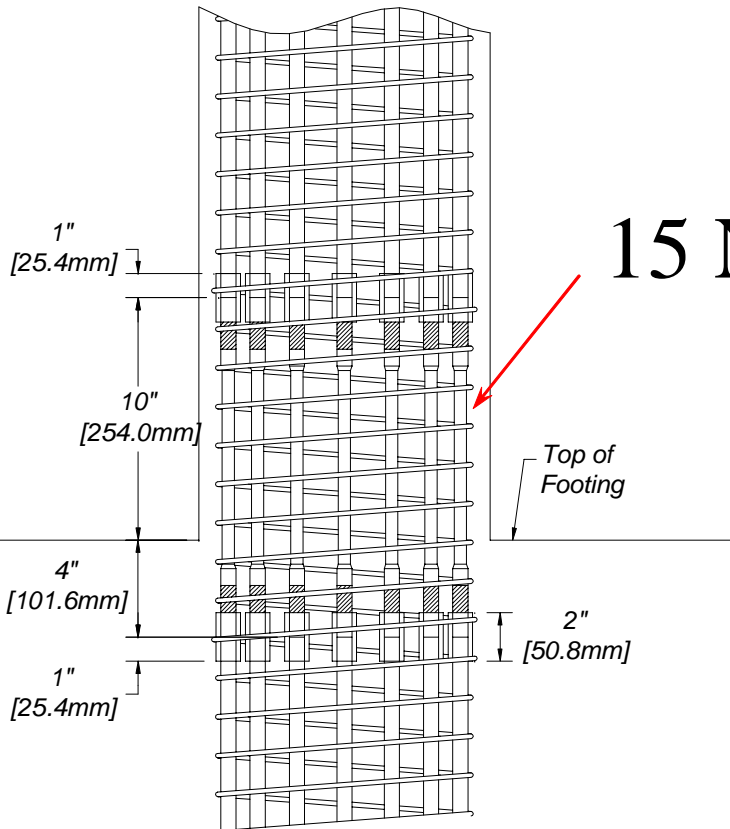


Innovative Components (Florida)

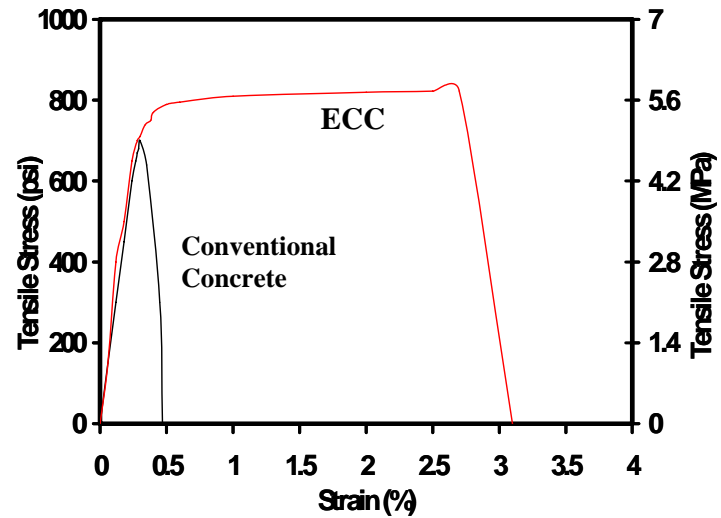
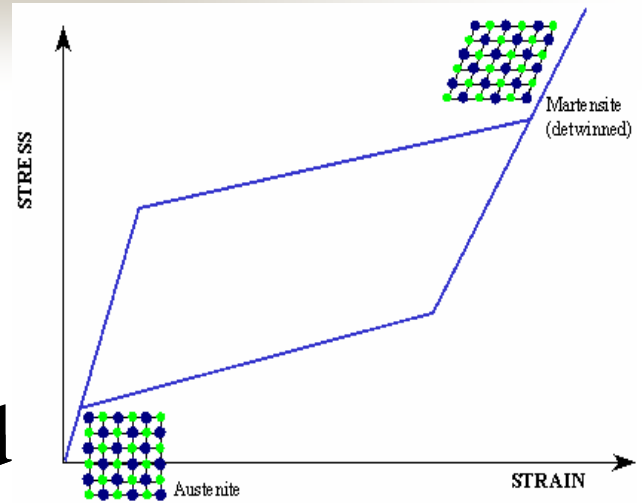
- Fiber composite piers



Innovative Details (UNR)



15 NiTi Rod



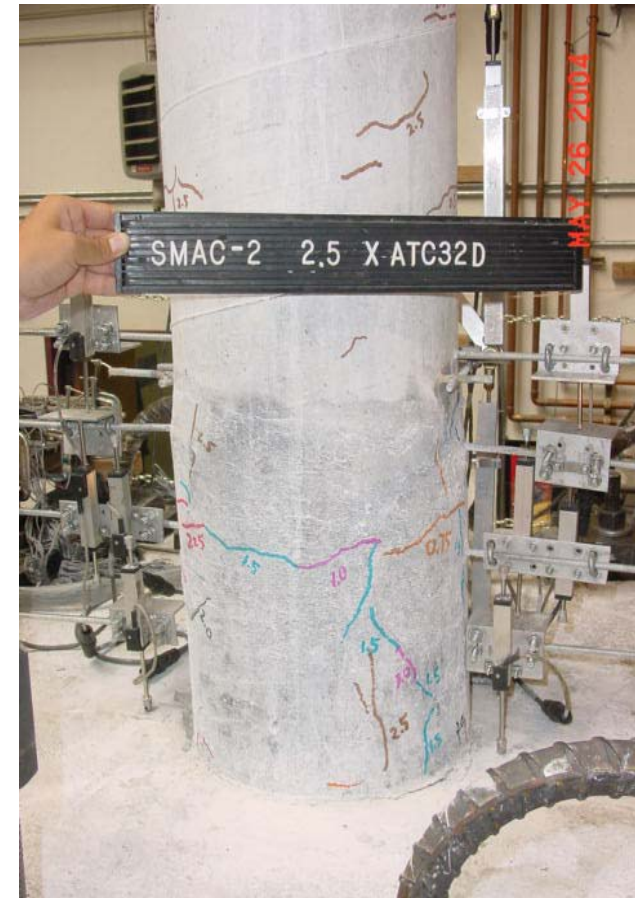


Conventional RC

ECC & SMA



Conc. & SMA





OpenSees Simulations (Berkeley)

- Simulate SFSI effects at pier bases
- Integrate abutment and bridge test data
- New elements for FRP members
- New elements for NiTi reinforced members and others



Wireless Sensors (Stanford)

- **Design and prototyping of multi-sensor monitoring unit**
- **Bridge Testing and Damage data collection**
- **Data pre-processing and damage algorithm testing**
- **Development of embedded algorithms**
- **Design of star-mesh wireless network**



Data Management (UNR)

Acquisition, Curation, and Dissemination

- Includes *all* of the project information: design, construction, observations, acquired test data (from sensors and cameras); computational and generated data, literature in the form of reports, journal papers, drawings, and presentations
- Basic NEESgrid data models.
- Expanded data models for abutment tests and bridge tests.
- Store data in local UCSD-NEES, UNR-NEES, and NEESgrid central repositories



Education and Outreach (UNR)

- **Main objective: Educate; Inform and motivate**
- Education: Post-doc/research associate; PhD; MS; Undergraduate researcher; Multi-media course modules
- Information/Motivation:
Target: kindergarten to professionals
Interactive project website; Publicity of the tests;
Lab tours; K-12 teachers



Design Issues (UNR)

- Abutment tests- Mononobe-Okabe method?
- Design implications of the *system* (vs. component) response.
- Close interaction with designers will maximize potential use



Interaction w/ Industry

- **Commitment from FHWA and Caltrans to closely interact with the project team**
- **State DOT surveys**
- **Caltrans and NDOT bridge files available to the project**



International Cooperation

- Tokyo Inst. of Technology, Dr. Kawashima:

Bridge columns with built-in elastomers

- University of Slovenia, Ljubljana, Dr. Fischinger:

Simple modeling of bridges with large in-plane rotations

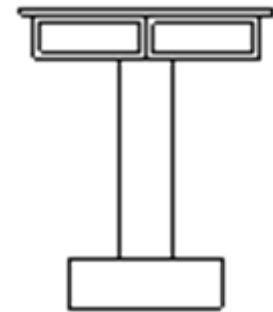
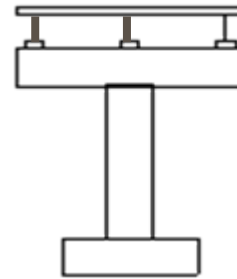
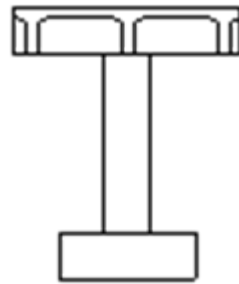
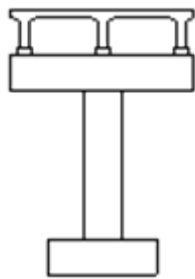


Current Status

- Subcontracts issued
- Project website being prepared
- A research associate and MS student hired
- Two presentations given about the project to Caltrans and Nevada DOT engineers
- State DOTs surveyed
- First bridge model being designed.

Bridge Type for Model Tests

- A survey of DOTs w/ $PGA > 0.1g$ in progress asking for the more common types (current)
- FHWA data:



Most common overall

**Most common
In the west**



Other Items

- **Project advisory board**
- **Intellectual property agreement**
- **Project website**
- **Payload projects**
 - Shape memory alloy restrainers**
 - Fiber optic sensors**
 - Others**

Media Coverage- NEESR-SG- Saiidi



- UNR Press release



- Reno Gazette Journal (12/13/04)

UNR awarded \$2 million to study bridges in earthquakes

Associated Press ASSOCIATED PRESS

12/13/2004 09:53 pm



- Local NBC affiliate interview w/ Saiidi (12/14/2004)
- Local public radio live interview w/ Saiidi (1/11/2005)

