

## I40-Bridge, New Mexico, USA

### Project Description:

The I40-Bridge over the Rio Grande was part of the Highway "Interstate 40" in New Mexico. In the 1960's and 1970's over 2500 bridges were built in the U.S. with a design similar to this on Interstate 40. These bridges were built without structural redundancy and typically had only two plate girders carrying the loads. Failure of either girder was assumed to produce catastrophic failure of the bridge; hence these bridges were referred to as fracture-critical bridges. The US-Federal Highway Administration (FHWA) and the National Science Foundation (NSF) have provided funds for evaluation and testing of the existing fracture critical bridges over the Rio Grande. The investigation was conducted by the structural dynamics group around Dr. C.R. Farrar of the Los Alamos National Laboratories.

After a modal analysis of the undamaged bridge, it has been damaged artificially in different states where all scenarios have been chosen to reproduce observed damage in the field. The test data has been made available for the scientific community and so the bridge tests could be used as benchmark for testing structural damage assessment methods at a full scale structure.



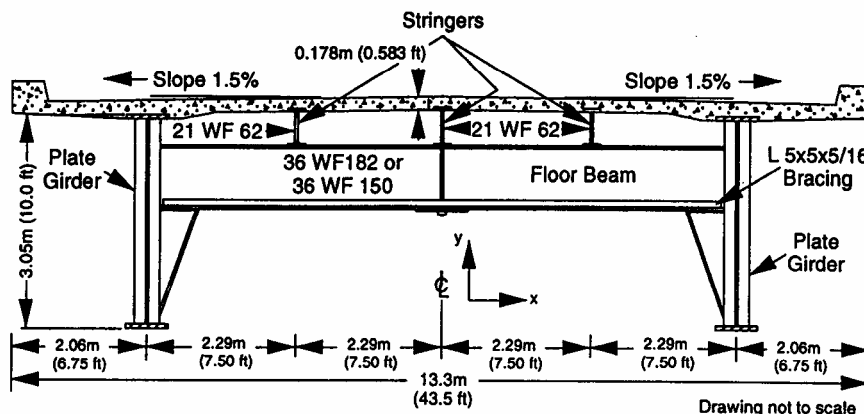
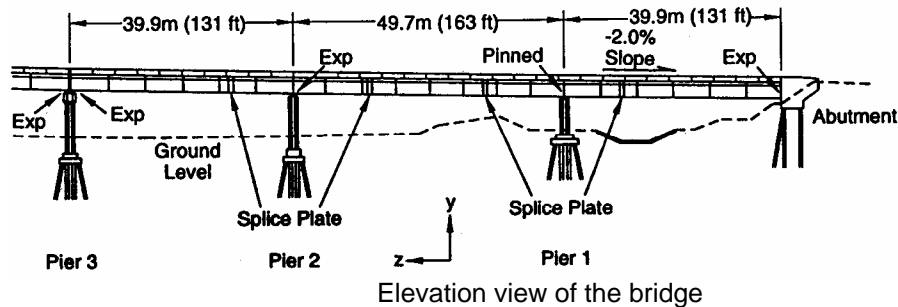
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**Quick Facts:**

- **Name and Location:** I40-Bridge, Rio Grande, New Mexico, USA
- **Owner:** State of New Mexico
- **Structure category:** large span bridge
- **Spans:** 9 spans: 39.9/ 49.7/ 39.9/ 39.9/ 49.7/ 39.9/ 39.9/ 49.7/ 39.9 m
- **Structural system:** Steel box girder with concrete deck and concrete columns
- **Start of SHM:** September, 2001
- **Number of sensors installed:** 26
- **Instrumentation design by:** Los Alamos National Institute, USA

**Description of Structure:**

The I40-bridge consisted of two separate spans for each traffic direction divided in three identical, structural nearly independent sections, respectively. Each section was made up of three spans, see Fig. “Elevation view” which shows one section. The bridge was made up of a concrete deck supported by two plate girders and three steel stringers. The loads from the stringers were transmitted to the plate girders by floor beams, see Fig. “Cross section of the bridge”.

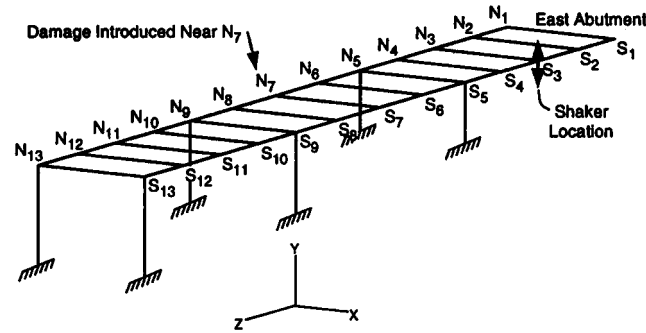


**Purpose of Inspection:**

The purpose of the measurement was to detect the applied damage based on measured modal data and model based damage detection algorithms.

**Sensor Details:**

Type of sensors	Number	Location
Acceleration	26	N1-S13, see Figure below
Force	1	Shaker, see Fig. below

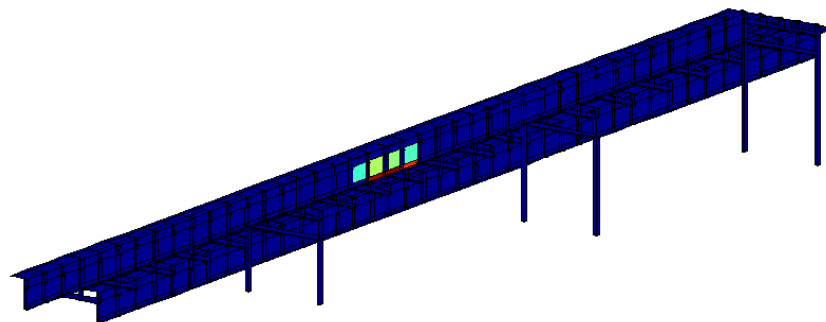


**Data Analysis Procedures:**

Type of analysis	Software	Additional features
Modal Analysis by means of FRFs, Excitation by shaker		

**Examples of Outcomes:**

The damage could be detected, localized and quantified by means of an inverse eigensensitivity approach and Frequency Response Function (FRF) approach (alternatively) combined with parameter selection and regularization techniques.



**Benefits of using SHM Technologies in the Project:**

The occurrence of damage can be detected immediately. A lot of lessons learned lead to optimized model updating and damage detection algorithms.

**References:**

- Fritzen, C.-P., Bohle, K., "Model-Based Health Monitoring of Structures – Application to the I40-Highway-Bridge", Proc. Identification in Engineering Systems IES99, Swansea, UK, 1999, pp. 492-505.
- Fritzen, C.-P.; Bohle, K.: "Identification of Damage in Large Scale Structures by Means of Measured FRFs - Procedure and Application to the I40-Highway-Bridge", Key Engineering Materials Vols. 167-168, 1999. pp. 310-319.
- Farrar, C.R. et al., "Dynamic Characterization and Damage Detection in the I40-Bridge Over the Rio Grande", Los Alamos National Laboratory, Report No. LA-12767-MS, 1994.

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