

# **Overturning Forces at Bridge Abutments and the Interaction of Horizontal Forces from Adjacent Roadways**

## **ANNUAL REPORT FOR FY 2011**

ODOT SPR ITEM NUMBER 2228

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## **1.0 General**

ODOT is experiencing a number of problems related to the interactions between bridge abutments and adjacent roadways. These problems include expansion joints closing, roller support bearings tilting, and beams pushing against abutment backwalls. Through field observations, instrumentation of selected bridges, and computer simulations, this project will develop design, construction, and repair guidelines to alleviate adverse effects of interactions between ODOT bridge abutments (non-integral), bridge decks, and adjacent roadways.

For several bridge sites where ODOT has noticed distress due to possible interactions with adjacent roadways background information was first collected. Site reconnaissance visits and visual inspection of all the distressed bridge sites were then conducted. Based on the background information collected and the field visits, two bridges were selected for instrumentation and instrumentation plans were developed. The planned instruments include instruments to measure widths of expansion joints, incremental forces transmitted to bridges from adjacent roadways, incremental rotation of abutments, and temperature changes at various points on the bridge and adjacent roadways. All the instruments have been ordered and received.

## **2.0 Overview of Work Done**

The following tasks were performed in the Fiscal Year 2011:

- (i) collecting background information on distresses
- (ii) field reconnaissance
- (iii) selection of bridges for instrumentation
- (iv) developing instrumentation plans and ordering instruments.

### ***2.1 Collecting Background Information on Distresses***

Discussions with ODOT Bridge and Planning & Research Division personnel about distresses observed in Oklahoma bridges were held on October 28, 2010, December 16, 2010, May 13, 2011, May 31, 2011 and August 26, 2011. Previous bridge inspection reports, photos taken over the years, and other information related to two bridges that will be instrumented (see Section 2.3) provided by ODOT are currently being studied in detail.

### ***2.2 Field Reconnaissance***

The following 8 bridges were visited to study the distresses:

- US 64 Westbound Over Shell Creek – Tulsa County (NBI No. 18141)
- I-244 Westbound – Detroit Ave. Under (NBI No. 18028)
- I-244 Westbound – Cincinnati Ave. Under (NBI No. 18024)
- I-244 Eastbound – Detroit Ave. Under (NBI No. 18029)
- I-244 Eastbound – Cincinnati Ave. Under (NBI No. 18027)
- 19<sup>th</sup> St. Moore – I-35 Under (NBI No. 25440)
- SH 48 Over Long George Creek – Hughes County (NBI No. 13500)
- SH 76 Over Rush Creek – Garvin County (NBI No. 12643)

Field inspections of all of the bridges listed above, except US 64 Westbound over Shell Creek and SH 76 over Rush Creek, were carried out by ODOT and OU research personnel on January 28, 2011. SH 76 bridge over Rush Creek and US 64 bridge over Shell Creek were inspected by OU personnel on March 28, 2011 and May 26, 2011, respectively. Additional field

inspections of 19<sup>th</sup> Street Bridge (I-35 under) in Moore were carried out on June 24, 2011 and on August 25, 2011, mainly for purposes of instrumentation logistics.

### ***2.3 Selection of Bridges for Instrumentation***

Based on the field reconnaissance visits and discussions with the ODOT Bridge and Planning & Research Division personnel, bridges NBI No. 18141 (US 64 Westbound over Shell Creek) and NBI No. 25440 (19<sup>th</sup> St. Moore - I-35 Under) were selected for detailed instrumentation. In addition, widths of expansion joints in several I-244 bridges and the bridge NBI No. 12643 (SH 76 Over Rush Creek - Garvin County) will be monitored on a periodic basis. Some of the distresses observed on the 19<sup>th</sup> Street Bridge in Moore are shown in Figure 1. The northern most rocker bearing and the girder on the west abutment of US 64 Westbound over Shell Creek as seen on May 6, 2011 and May 26, 2011 are shown in Figure 2. The May 6, 2011 photo was provided to the OU research team by Mr. Walt Peters of the ODOT Bridge Division. Sometime after May 6, the rocker bearing shown on Figure 2 was straightened by ODOT personnel. The girder shown in Figure 2 is touching the abutment backwall.



(a)



(b)

Figure 1. 19th Street Bridge (I-35 under) in Moore, OK. (a) Distresses on bridge abutment  
(b) Shearing of elastomeric bearings



(a) On May 6, 2011



(b) On May 26, 2011

Figure 2. Northern most rocker bearing and girder on the west abutment of the US 64 Westbound bridge over Shell Creek before and after repairs

## 2.4 Instrumentation

The instrumentation manufactured by Geokon, Inc. will be utilized in this project. For the 19th St. Moore Bridge, both the east and west abutments will be instrumented. For the US 64 Westbound bridge over Shell Creek, only the west abutment will be instrumented. As shown in Figure 2, distress was more severe on the west abutment of this bridge. A meeting with the ODOT personal was held on August 26, 2011 to finalize the instrumentation plan. The following instruments have been ordered and received from Geokon.

- PVC Thermistor Probes- to measure temperatures at various points on the bridges (Quantity 41)
- Tiltmeters - to measure changes in tilts of bridge abutments (Quantity 6)
- Arc Weldable Strain Gauges- to measure changes in strains in approach slabs and pavements (Quantity 26)
- Crackmeters - to measure changes in widths of expansion joints (Quantity 6)



These Instruments are currently being calibrated. The planned instrumentation layouts for the bridges are shown in Figures 3 and 4.

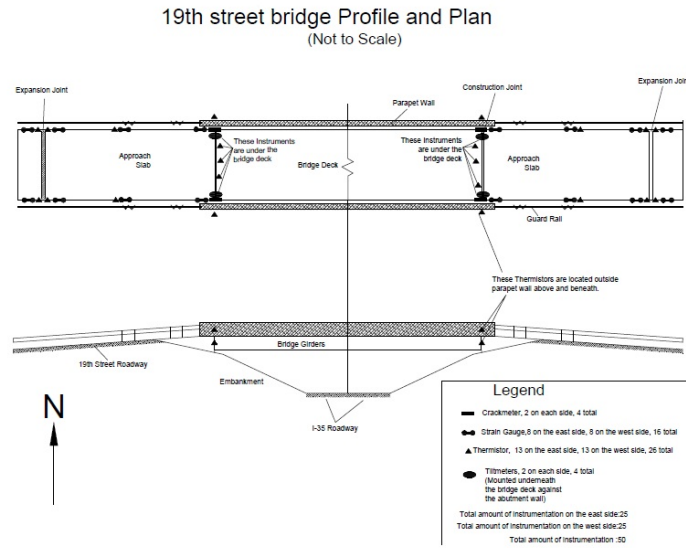


Figure 3. Instrumentation plan for NBI No. 25440 (19<sup>th</sup> St. Moore - I-35 Under)

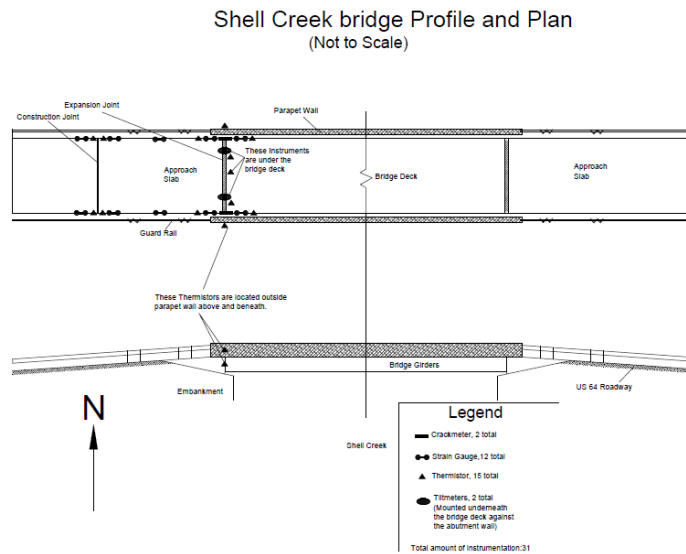


Figure 4. Instrumentation plan for NBI No. 18141 (US 64 Westbound Over Shell Creek)

### **3.0 Plan for Fiscal Year (FY) 2012**

Overall the project is on track. FY 2012 activities for this project will include the following:

- (i) instrumenting the two selected bridges
- (ii) data collection and analyses
- (iii) preliminary computer simulations and simplified analyses of the selected bridges.