



**SPECIAL PROVISIONS  
FOR  
STRUCTURAL HEALTH MONITORING**

**Hardin County  
BRFN-065-6(42)--39-42**

**Effective Date  
July 20, 2010**

**THE STANDARD SPECIFICATIONS, SERIES 2009, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.**

**090085.01 DESCRIPTION.**

Structural Health Monitoring (SHM) is described as the implementation of a multi-sensor continuous monitoring system for the Iowa Falls steel arch bridge. The pilot monitoring system will be developed for general performance evaluation (structural, environmental, security, etc.) so that it can be easily adapted to other bridge types and other monitoring needs. The system will allow easy access to real time data and will provide data in a format for immediate implementation by the Department.

The Bridge Engineering Center at Iowa State University is under contract with the Department for design, acquisition, installation, and start-up of the SHM system. Coordination with the Bridge Engineering Center and the Engineer will be needed during the installation and operation of the SHM System. Assistance in gaining access on and under the bridge or access to bridge components during staging, prior to erection, for the instrumentation and placement of the SHM System will be required. Cooperation of the Contractor during construction will be critical. To verify the operation of at least some of the SHM System components, a load test will be performed after completion of the bridge and the SHM System, prior to opening the bridge to traffic.

The SHM system will include, but may not be limited to the following components:

Environmental

- a) Wind speed and direction (anemometer)
- b) Bridge deck potential icing conditions (temperature puck-CWIM, thermocouples)
- c) Temperature and humidity

Structural

- a) Corrosion potential on one micro pile foundation (corrosion sensor elements)
- b) Corrosion potential in substructure element at one bridge end expansion joint (corrosion sensor element)
- c) Corrosion of bridge deck reinforcement (corrosion sensor elements)
- d) Monitor moisture in arch rib (camera in arch and/or moisture sensor)
- e) Relative movement between S. Abutment and N. Abutment (laser/GPS/string potentiometer)

- f) Rock anchors for rock cut support wall (strain/deflection)
- g) Arch Forces (strain gages)
  - a. At crown
  - b. At north and south of crown
- h) Hanger forces and floor beam connection (cable type strain gage and/or accelerometers)
- i) Collect data to use in updating bridge superstructure rating (i.e. live load demand) (additional strain sensors than noted above for superstructure)
- j) Detection of heavy loads (additional strain sensors than noted above for superstructure)

Vehicle Classification System

- a) Vehicle geometry/volume, alert for delays, etc. (strain)

Construction Monitoring

- a) Monitor critical construction stages

Other Considerations

- a) Security (infrared camera) to monitor movement underneath bridge

Additional details on the SHM components and the approximate locations of sensors are contained in Appendix A.

**090085.02 EQUIPMENT AND MATERIALS.**

The Bridge Engineering Center will provide all SHM components. The Contractor shall provide periodic use of onsite equipment for access to bridge elements for installing SHM components.

**090085.03 CONSTRUCTION.**

The Bridge Engineering Center will install all SHM components. The Contractor shall use care to avoid damage to and maintain the integrity of the SHM system components after installation. The Contractor shall provide the Bridge Engineering Center parking access for two vehicles within the project site.

**090085.04 METHOD OF MEASUREMENT.**

None.

**090085.05 BASIS OF PAYMENT.**

- A.** Payment for Structural Health Monitoring will be the lump sum contract price.
- B.** Payment is full compensation for all work associated with providing access to all bridge components during staging, prior to and after erection for the instrumentation and placement of the SHM System.

**Appendix A**  
**MONITORING PLAN DETAILS**  
**IOWA FALLS ARCH BRIDGE**

<u>Item*</u>	<u>Measurement</u>	<u>Sensor Type/Quantity</u>	<u>Location</u>	<u>Accommodation Needed</u>	<u>Timing</u>
A	Wind speed	Anemometer - 1	West side, floorbeam 8	DOT snooper	After deck curing
B	Deck internal temperature	Thermocouple - 4	Midspan, between Beam Lines B/C and E/F	DOT snooper	After deck curing
			Southern Quarterspan, between Beam Lines B/C and E/F	DOT snooper	After deck curing
C	Deck surface temperature	Temperature puck - 1	TBD	DOT snooper	After deck curing
D	Corrosion potential	Corrosion sensor - 1	Micropile SW Skewback	Access to embedded rod 48 hours in advance	At installation
E		Corrosion sensor - 1	South Abutment micropile	Access to embedded rod 48 hours in advance	At installation
F		Corrosion sensor - 2	West side of deck, near gutterline south end	48 hours notification of reinforcement placement	At installation
G		Corrosion sensor - 1	Southwest abutment to drilled shaft tieback	Access to embedded rod 48 hours in advance	At installation
H		Corrosion sensor - 2	South abutment	48 hours notification of reinforcement placement	At installation
I	Arch rib moisture	TBD	Southwest arch rib location	none	flexible
J	Relative movement	TBD	Sensor at south abutment	none	flexible
K	Rock cut support wall tieback strain	TBD	TBD southwest quadrant	Access to embedded rod 14 days in advance	At installation
L	Arch rib strain	Weldable strain gauges - 8	West Arch rib section RS41 to 0	On-site access 96 hours before erection	Prior to erection
M		Weldable strain gauges - 8	West Arch rib section RS1 to RS2	On-site access 96 hours before erection	Prior to erection
N		Weldable strain gauges - 8	East Arch rib section RS41 to 0	On-site access 96 hours before erection	Prior to erection
O		Weldable strain gauges - 8	East Arch rib section RS1 to RS2	On-site access 96 hours before erection	Prior to erection
P	Outer bearing support plate strain	Weldable strain gauges - TBD	Southwest bearing support plate	none	flexible
Q	Bearing support rotation	Tiltmeters - 2	Southwest and Southeast bearing	none	flexible
R	Hanger forces	Accelerometers - 4	West cables at panel point 3	none	flexible
S		Accelerometers - 4	West cables at panel point 6	none	flexible
T	Stiffening girder strain	Weldable strain gauges - 4	West stiffening girder near panel point 2	On-site access 96 hours before erection	Prior to erection
U		Weldable strain gauges - 4	West stiffening girder between panel points 5 and 6	On-site access 96 hours before erection	Prior to erection
V	Type B floorbeam strain	Weldable strain gauges - 8	South Floorbeam B - midlength and near end	On-site access 96 hours before erection	Prior to erection
W	Stringer strain	Weldable strain gauges - 4	Stringer (Beam Line C) between Panel points 3 and 4	On-site access 96 hours before erection	Prior to erection

X	Deck strain	Adhesive strain gauges - 8	TBD (south end)	DOT snooper	After deck curing
Y	Security	IR camera	South end	none	flexible

\*See figures 1 – 4 of this specification for approximate locations of sensors

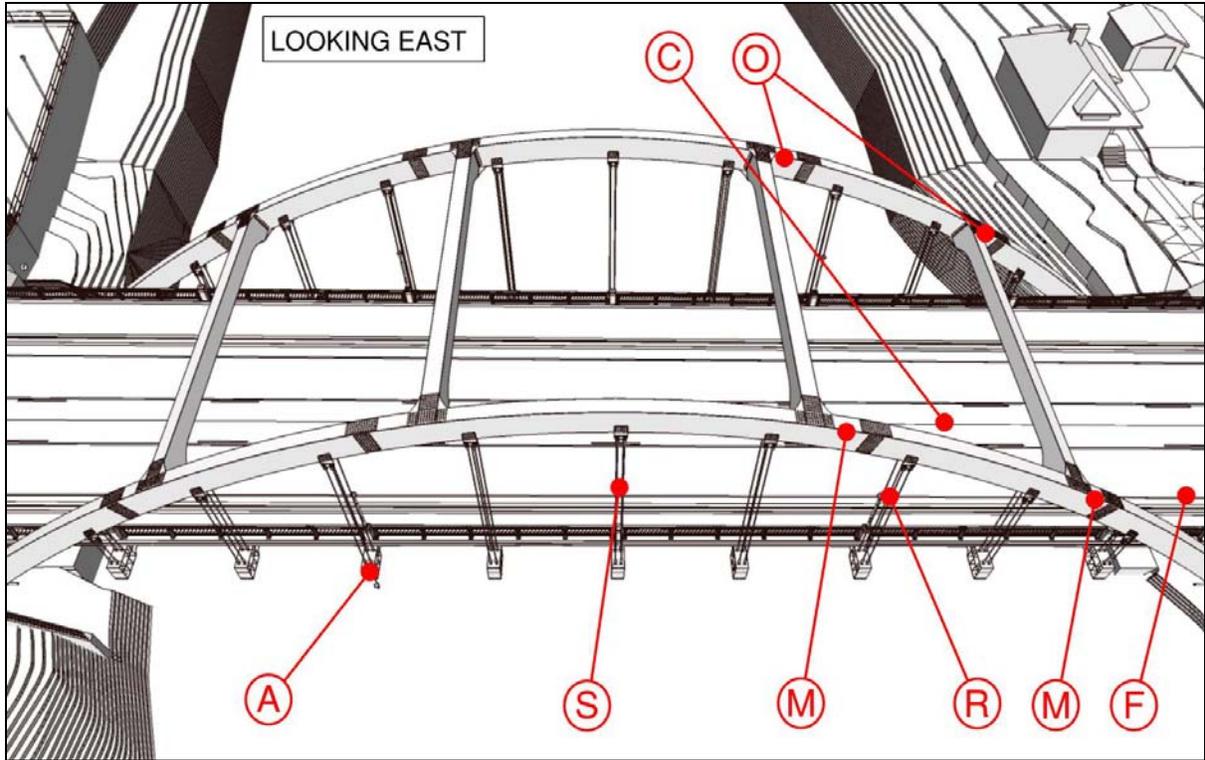


Figure 1

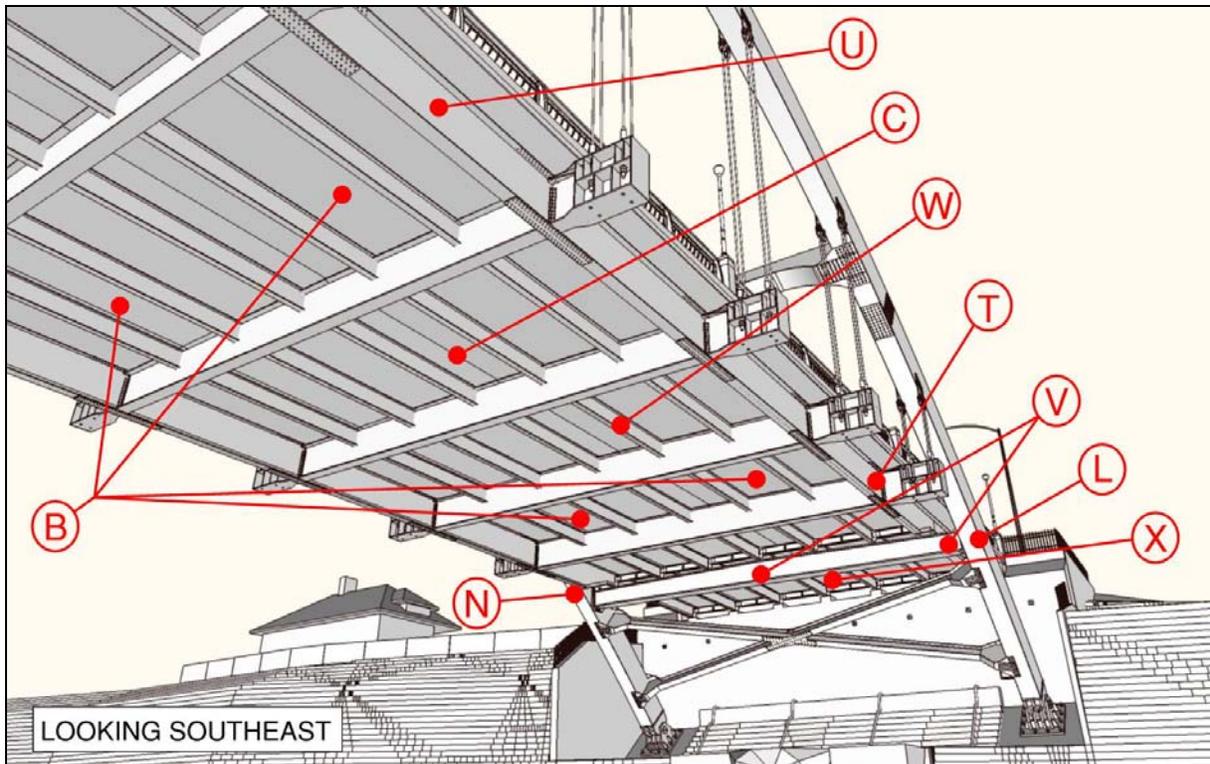


Figure 2

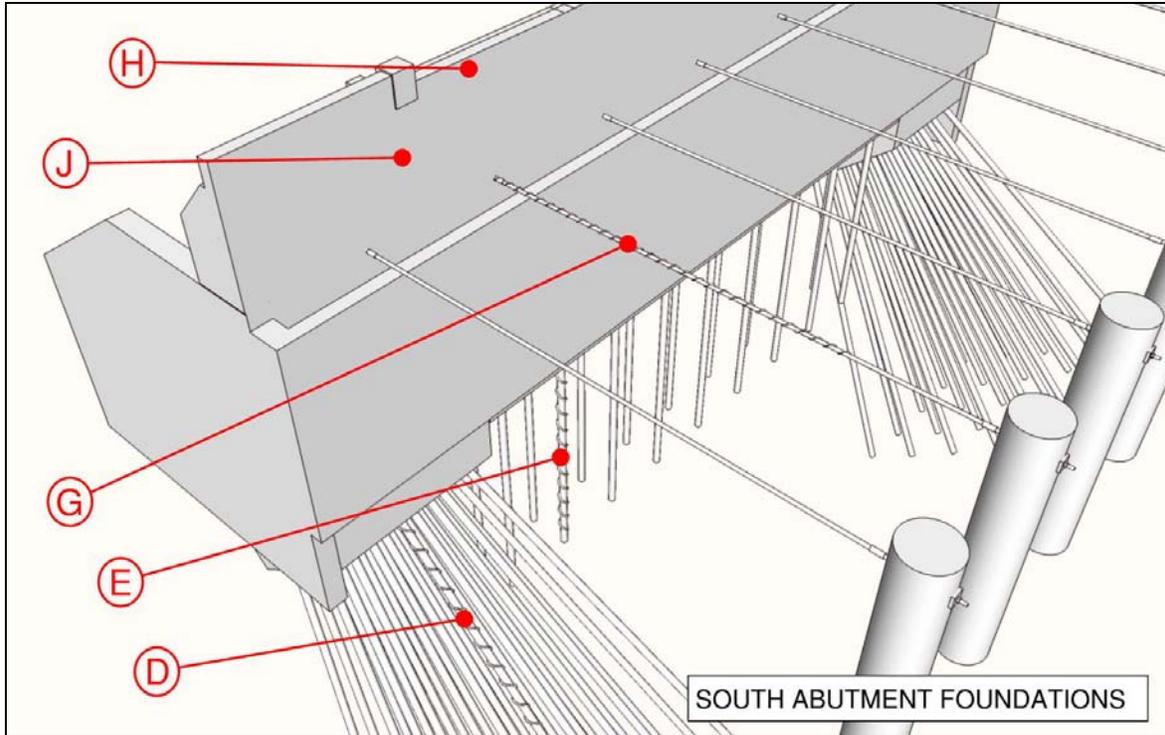


Figure 3

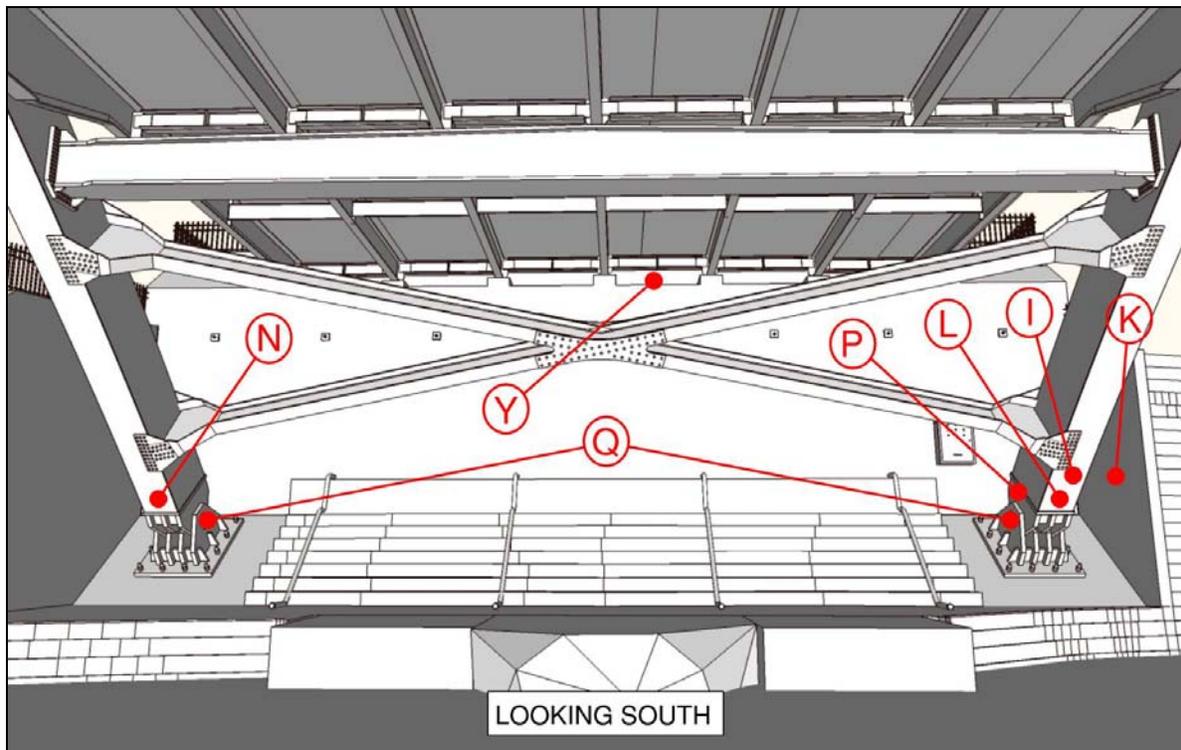


Figure 4