Case Study – Bridges
Arsenal Bridge
Rock Island, IL, 2009-2010
Arsenal Bridge - General Characteristics

- Constructed 1896, Steel Through Pratt Truss, 8 Spans
- Combined Two Lane Highway-Railway Structure
- Length: Rail (Spans 1-8) 1,848 ft, Vehicle (Spans 2-6) 1,556 ft
- 360° Swing Span 2: 336 ft, 2,000 Tons
- Swing Span Average Turn Time: 12 Min
- Traffic: Rail 1,881/yr, Vehicle 10,297/day, Barges/Boats 18,568/2,884/yr
# Arsenal Bridge – Structural Monitoring System Overview

<table>
<thead>
<tr>
<th>Aim</th>
<th>To monitor the integrity and behavior of the bridge structure, and effects due to high traffic and heavy truck loads that could cause possible damage &amp; fatigue.</th>
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</thead>
<tbody>
<tr>
<td>Location</td>
<td>Rock Island, IL</td>
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<tr>
<td>System Integrator</td>
<td>Chandler Monitoring Systems, Inc. <a href="http://www.chandlermonitoring.net">http://www.chandlermonitoring.net</a></td>
</tr>
<tr>
<td>Customer</td>
<td>Concurrent Technologies Corporations</td>
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<tr>
<td>Date</td>
<td>November 2009</td>
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</tbody>
</table>
| Instrumentation | (1) Micron Optics sm130-500 Optical Sensing Interrogator  
(1) Micron Optics sm041-416 Optical Channel Switch Extension |
| Sensors | (36) Micron Optics os3100 Strain Sensors  
(21) Micron Optics os4300 Temperature Sensors  
(10) Micron Optics os7100 3D Accelerometers  
(1) Fiber Optic Tilt Meter  
Conventional AE, weather and corrosion sensors |
| Project Scope | Employ system on the bridge to greatly reduce risk of catastrophic failure by providing advance warning of growing structural problems caused by corrosion/materials degradation.  
Demonstrate and validate state-of-the-art and emerging innovative technology approaches for remote structural health and corrosion degradation monitoring of steel bridges. |
• Sensors were installed along the length of the entire structure, including the rail deck above and the road deck below.

• The bridge is broken up into four different zones.
• A total of 15 sensors cover the upper and lower deck.
• Sensors consist of:
  (6) Strain
  (5) Temperature
  (4) 3D Accel
Arsenal Bridge - Swing Span And Sensor Locations

Zone 2 - Arsenal side of the swing span.
- (13) Strain Sensors
- (6) Temperature Sensors
- (1) 3D Accelerometer
- (1) Tilt Meter

Zone 3 - Davenport side of the swing span.
- (11) Strain Sensors
- (4) Temperature Sensors
- (1) 3D Accelerometer
A total of 15 sensors cover the upper and lower deck.

- Sensors consist of:
  - 6 Strain
  - 5 Temperature
  - 4 3D Accel
Arsenal Bridge - Sensor Network Configuration

Splice Tray Cable Color Guide
The monitoring system instrumentation is composed of:

- Single optical interrogator (model sm130-500), 1Khz, 4 channels
- 4x16 channel sensor multiplexer (model sm041-416)
- sp130 controller and data acquisition module
FBG sensor arrays were pre-assembled to length for each bridge segment.
Arsenal Bridge – Installation

Once on-site, sensors are unpacked and prepared for installation.

Access via man-lift and scaffolding
3D Accelerometer being installed on the swing span
Arsenal Bridge – Installation (Splicing to Trunk FO Cable)

Main cable feed tapping point and industrial grade IP69 splice tray. *(below)*

Tapping into the main cable feed at various locations along the bridge. *(above)*
The optical system is housed inside a NEMA rated box with controlled temperature and humidity.

Acer 15.6” monitor
sm130 Interrogator
FC/APC Patch cords (4)
Sm041-416 multiplexer (switch)
Vented shelf
Linksys switch (5 port)
15 amp 8 outlet power strip
Keyboard
HP Desktop PC
Enclosure
Enclosure floor stands

Control House with optical panel in attic.
AE System Installation Layout By Zone

- 16 AE sensors on underside of road deck (8 per side)
- 20 AE sensors on vertical trusses (10 per side)

- Zone 1
- Zone 2
- Zone 3
- Zone 4

- Davenport Side
- Arsenal Side

● Sensor on front side
○ Sensor on back side
← Side view of sensor
Acoustic Emissions System Installation Layout For Swing Span

- **Davenport Side**
  - Zone3

- **Arsenal Side**
  - Zone 2

- 4 AE sensors staggered around turntable structure

- Sensor on front side
- Sensor on back side
- Side view of sensor
Acoustical Emission Sensors are installed and tied into the IntelOptics Software Program.
IntelOptics Software

- Chandler Monitoring Systems’ customized GUI software
  - Monitors, gathers data and provides alerts and analysis when various sensing systems approach or exceed established limits.
  - Communicates with numerous sensing systems to display status and provide information in one centralized user program which can be accessed remotely.
  - Electrical Resistance Corrosion Sensors, Weight in Motion Sensors, Weather Stations, Security sensors, and Water depth sensors are some sensors that may be fully integrated into the IntelOptics™ software.

- Micron Optics ENLIGHT application software is used for FBG sensor setup and to stream sensor data to IntelOptics™.
IntelOptics Software

Button linked to AE System Page

Button linked to Optical Systems Page

Button linked to AE System
Computer located at the bridge

Button linked to Optical Systems Page

Button to zoom in on the sensor map

Button linked to Corrosion Systems Page
IntelOptics Software

- Zone 1 Zone 2 Zone 3 Zone 4 Button Button Button Button
- Accelerometer Sensor Graph
- Optical System Zone 1 Sensor Map
- Temperature Sensor Graph
- Strain Sensor Graph
- Minimum Sensor Limit (when exceeded status will turn red)
- Maximum Sensor Limit (when passed status will turn red)
Data saving options. Choose to save on peak events or continuously.

- **Data saving interval (in seconds)**
- **Start connection to server**
- **Server IP address indication**
- **Stop connection to server**

- **Data saving on peak events**
  - **Yellow/Red Status - Save Data Time Interval (Seconds)**
    - 1 second

- **Data saving continuously**
  - **Green Status - Save Data Time Interval (Seconds)**
    - 1 second

- **ENLIGHT connection status**
- **Database server connection status**
- **Optical graph connection status**

- **Exit system**
- **Connect ENLIGHT at location on bridge**

- **IP Address**: 10.1.1.26
- **Start**
- **Stop**
- **Exit**
- **Open SM130 Controls**

- **Enlight Communication Status**: Working Normal
- **SQL Server Data Save Operation**: Working Normal

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- Mr. Christian Hawkinson and Rock Island DPW

Keith Chandler of Chandler Monitoring Systems, Inc., system integrator and on-site installer.