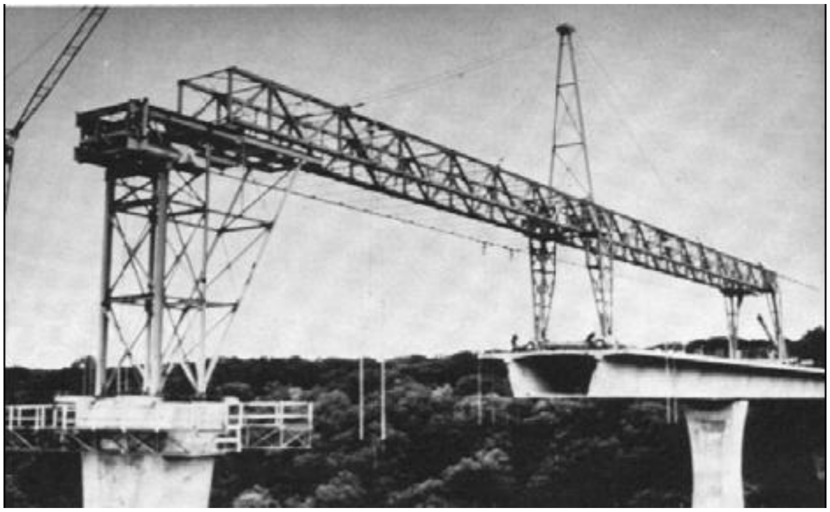
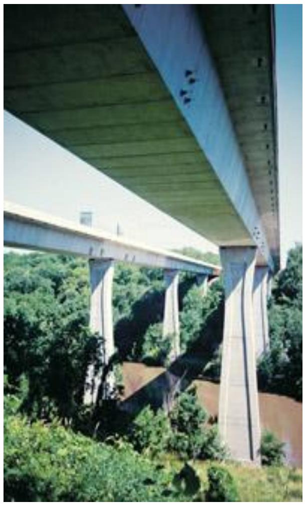
KISHWAUKEE RIVER BRIDGE, ILLINOIS, USA

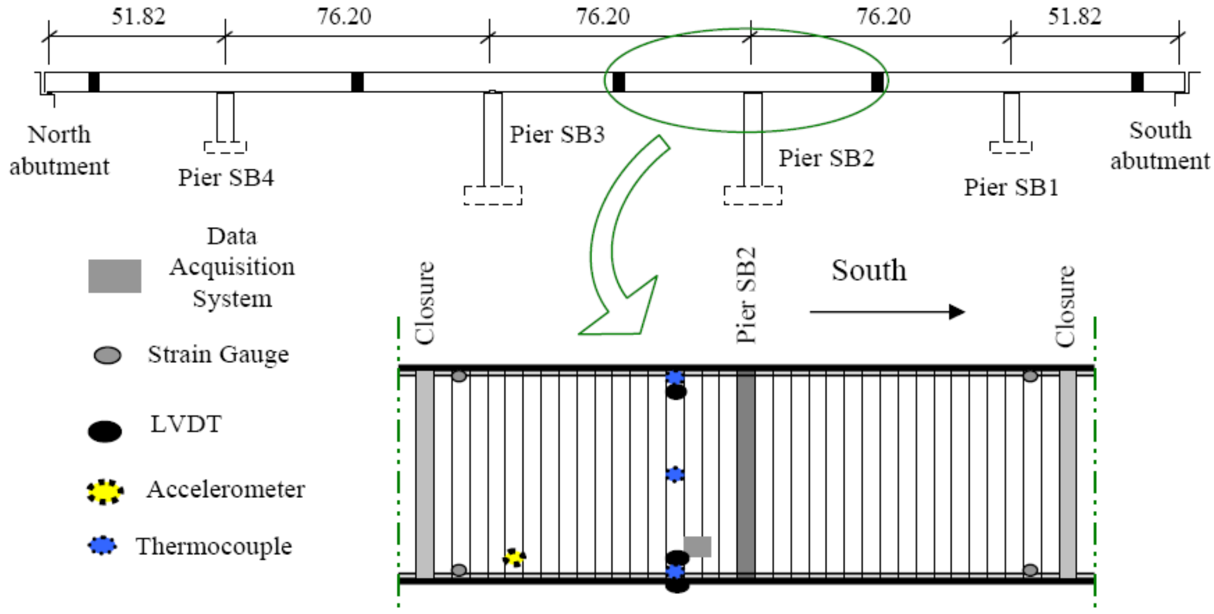
The Kishwaukee River Bridges, located in about 4 miles south of Rockford, Illinois, are twin post-tensioned segmental concrete box girder bridges, constructed using a balanced cantilever technique. The 5 span 1090 foot long bridges with 250-foot interior spans and 170-foot end spans are opened in 1980. Each box girder carries two 12-foot lanes and shoulder of 10 and 6 feet. The out-to-out width of the box girder is 41 feet, and the heights of the box at pier and mid section are 18 and 8 inches respectively.





As the first-generation of segmental structures, the Kishwaukee Bridge engineers chose the design of a single shear-key joint usually located close to the centroid of the cross-section. These joints are quite vulnerable especially during polymerization of the glue since nonpolymerized epoxy acts as a lubricant (Wang et al. 2001). At that time, shear forces in the web concentrates at the shear key which acts as a corbel. After the epoxy hardens, the whole joint will carry shear forces in the form of shear stresses that are uniformly distributed along the length of the joint.

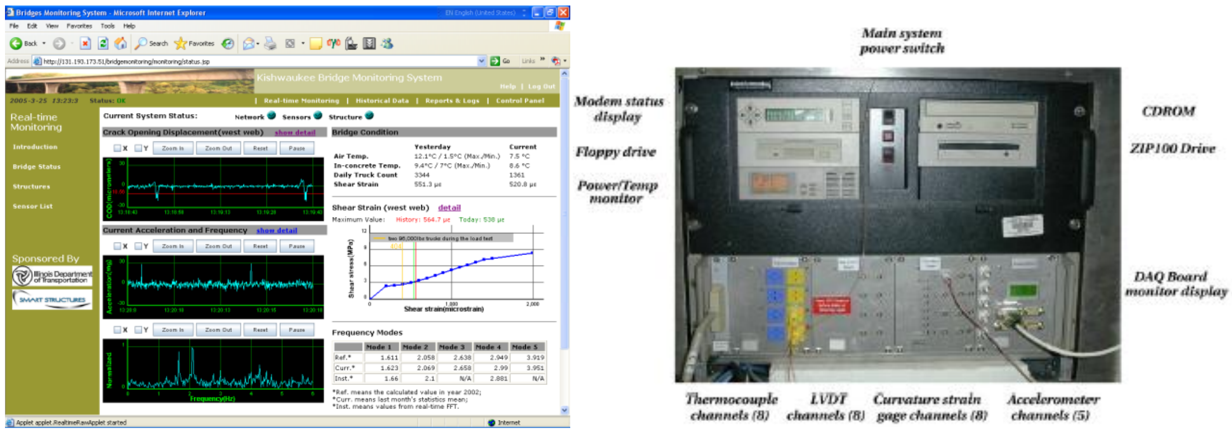
There are numerous inherent challenges in designing a long-term health monitoring system. It is desirable to instrument as many sensors as possible to obtain the most reliable measurement of behavior and performance of the structure. But this is impractical and unfeasible for a large structure. For a long-term health monitoring system, it is seldom possible to include every critical global and location response measurement. Therefore, a number of strategies must be utilized in the design of long term health monitoring systems.



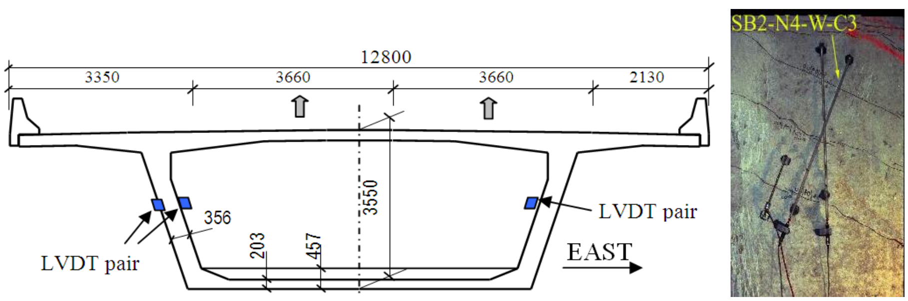
Strain gages, accelerometers, clip gages and LVDT gages were installed on the bridge for global and local monitoring of the bridge.

Local strains and displacements were measured on the inside and outside of the webs, the presence and extent of crack growth and state of shear reinforcement in webs were observed. FEM model updating for global monitoring was performed. Static load test was performed on the bridge in 2000, mid-span deflection, axial strains in web closures; average strains and crack opening in webs were recorded. Shear stress/strain analysis was performed.

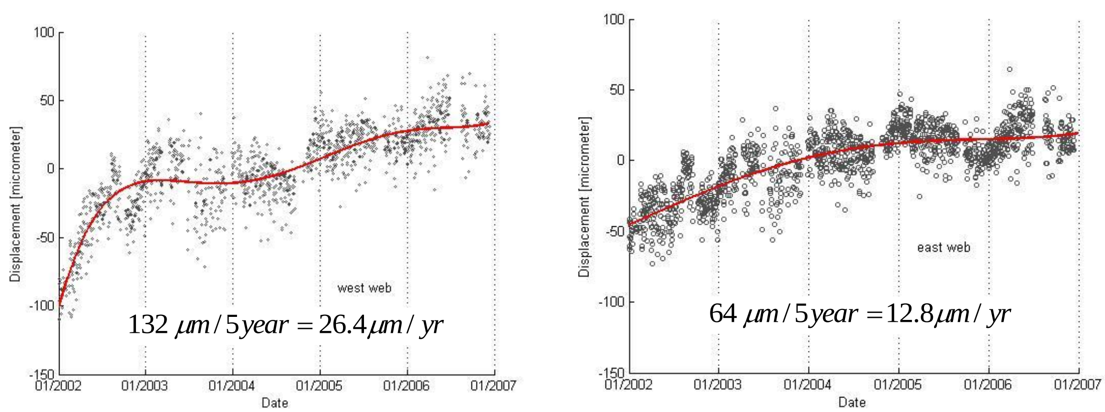
A customized user-friendly remote web-based Bridge Monitoring System (BMS) to access to real time data was developed. The BMS is a combination of sensor integration, warning and alarm system, statistical analysis and expert system. The BMS provides a password-protected access to the known users. An automated monitoring system for the bridge has been deployed since December 2001. The system provides critical information on strains, displacements, accelerations and temperature at the key segments. A multi-year system maintenance and data analysis program was considered for the bridge for identification of an effective retrofit design.



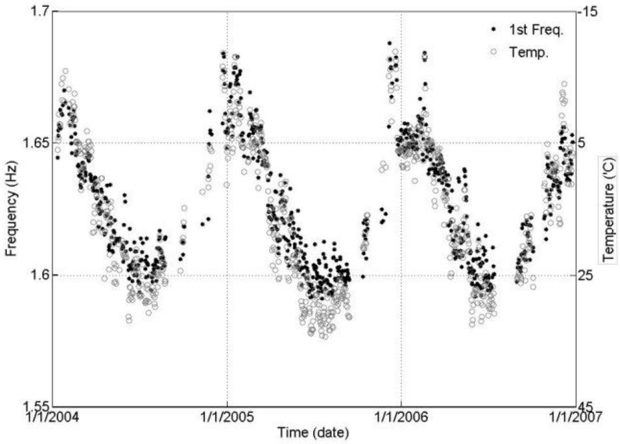
Bridge Monitoring System (BMS)

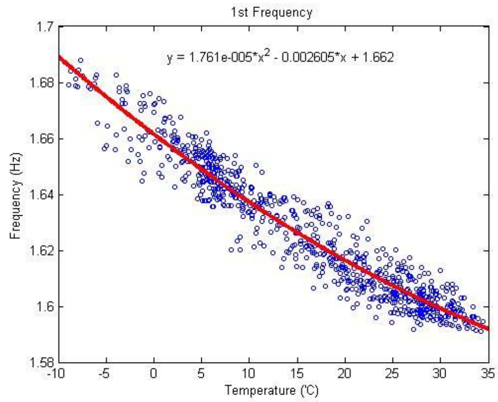


LVDT rosette for monitoring crack opening displacement (COD)



Fatigue crack opening displacement for 5 years after temperature compensation





1st mode Frequency history and its relationship with temperature

Temperature Effects		Traffic Effects	
Daily Temp.	Yearly Temp.	Impact	Hourly Traffic
100 μm	500 μm	26 μm	39 μm
4	20	1	1.5
365 cycle/yr	1 cycle/yr	1.1M cycle/yr	365 cycle/yr

ZHANJIANG BAY BRIDGE, CHINA

Zhanjiang Bay Bridge, located in Guangdong province, China, is composed of an 840 meter long cable-stayed bridge and 3,141 meter long approach viaducts (Fig. 44). The longest bridge in Guangdong province was opened to public on December, 2006. The cable-stayed bridge consists of 480 meter long main span, two 120 meter interior spans, and two 60 meter exterior spans. Two different types of girder are used in the cable-stayed bridge. The 720 meter interior spans are steel box girder, and the 120 meter exterior spans are pre-stressed concrete box girder. The out-to-out box girder is 28.5 meter and the height of the box is 3 meter. It carries two 6-meter lanes on each direction to east and west bound. A-shaped pylons made of reinforced concrete are 155 meter high.

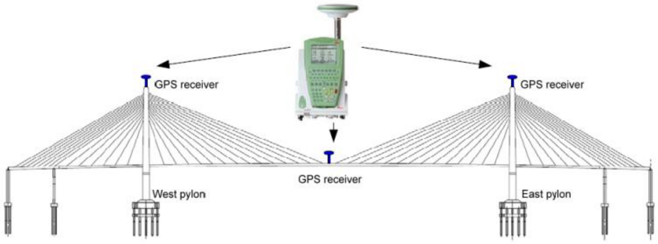
IIS is working in collaboration with the Chinese Railroad Bridge Institute to design a distributed Intelligent Bridge Monitoring System for the Zhanjiang Bay Bridge.

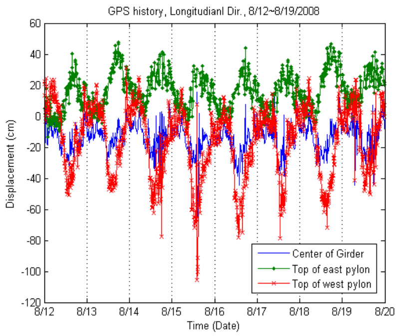
Zhanjiang Bay has a coastal climate, with long days and little change in temperature. The Bay is subjected to rains and thunderstorms throughout the majority of the year.
The monitoring system includes the following measurements: stress and the strain in the structure, temperature of the structure, dynamic mode analysis, the force in stay-cables, structural space deformation, wind loads, structural loading condition, and connection joint monitoring of the steel and concrete beams.

Zhanjiang Bay Bridge, China

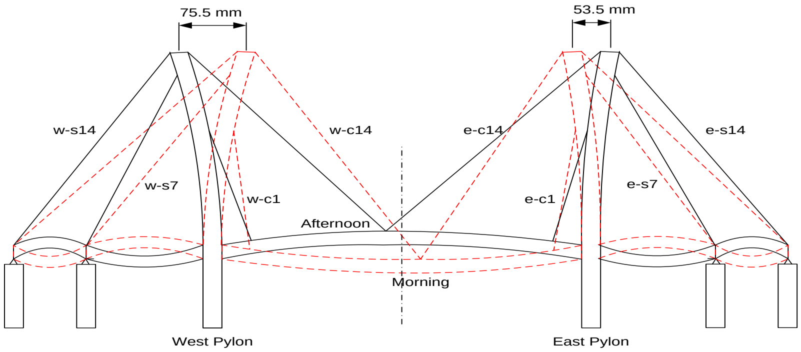
The Bridge Monitoring System would include sensor installation, sensor integration, real-time data acquisition including preprocessing and post processing, a warning/alarm system, data archiving, expert system and data interpretation and reporting.

SHM System





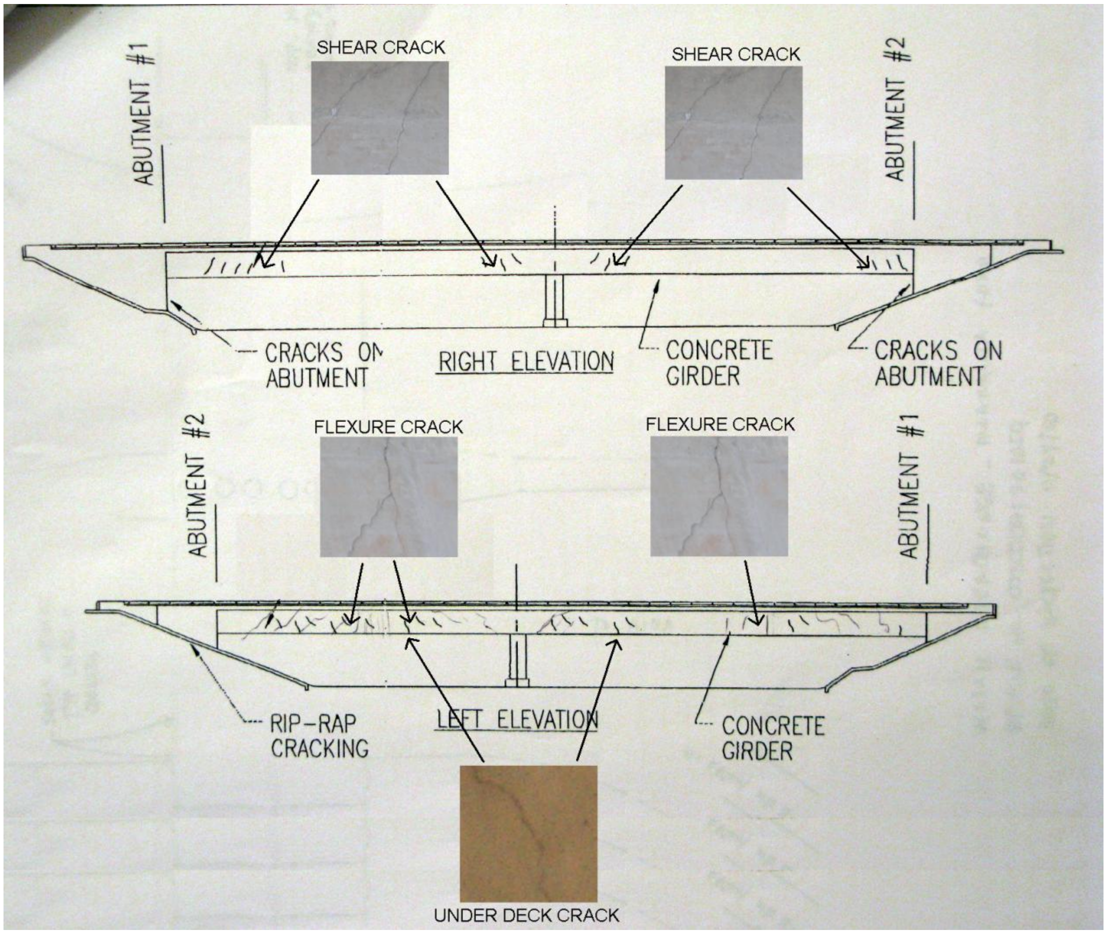
GPS locations and its results



Bridge behavior measured by GPS

WAIAU BRIDGE, HAWAII, USA

The Waiau IC Bridge, built in 1970s, located at Island of Oahu in Hawaii, is a continuous concrete box girder bridges. This H-1 freeway bridge is an overpass of a local road (Moanalua Rd) with two spans. After more than 30 years of service, many cracks have developed. Both shear cracks on the web and flexure cracks in the middle of the span are present and extensive (Fig. 1). Major concern of the bridge is its current health status due to severe cracking. Monitoring of the crack extension and measure of its current resistance capacity are the most valuable for the decision making on the maintenance of the bridge. This proposal is to present a Bridge Monitoring System focusing on monitoring the progress of crack opening, strain values due to traffic loads at strategically selected locations, as well as the temperature values at various locations. Its final goal is to determine the current resistance capacity of the bridge through these measured data and validated analysis, and indeed the cracks are alive and active.

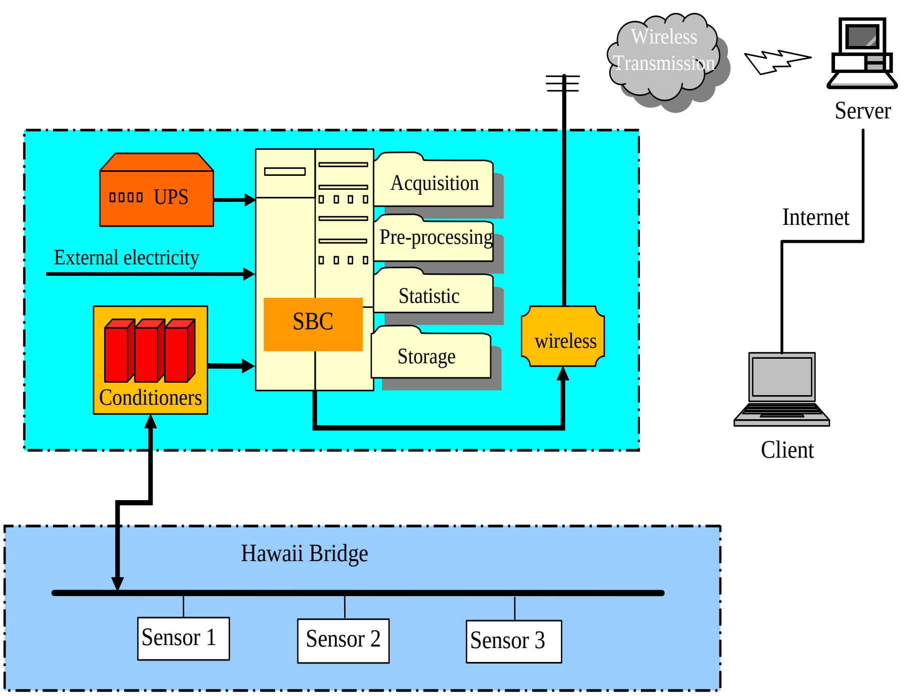


The purpose of the Bridge Monitoring System (BMS) developed for the Waiau Bridge is as follows:

- To determine the approximate load carrying capacities in terms of flexure and shear strength.
- To monitor the propagation existing cracks;
- To automatically send out warnings to the bridge authority in case of exceeding the predetermined threshold values;
- To enable users to perform monitoring in real-time via internet;

BMS is a platform designed to remotely monitor and analyze the health condition of any bridges in real-time and for a long period of time. Its functionalities include:

- Data acquisition and archive;
- Data transmission via internet;
- Data processing and reporting upon user's setup;
- Warnings upon user's setup;
- Data retrieval and display;
- Data analysis upon user's request;
- System management;
- User management;
- Bridge information management



Bridge Monitoring System Configuration