Meeting Minutes of the Benchmark Study in Structural Health Monitoring of Bridges

Venue: *SPIE Conference – San Diego, California.*
Date: *March 6, 2005 (3:00 p.m. – 5:00 p.m.)*

Meeting Chairs: *Shirley J. Dyke and Necati Catbas*
Recorder: *Juan M. Caicedo*
Attendees:

Bob Bolton	Texas A&M
Frank Moon	Drexel University
Kirk Grimmelsman	Drexel University
Walter Saltzberg	University of Manitoba/ISIS Canada
Daniele Inaudi	Smartec, Switzerland
Emin Aktan	Drexel University
Necati Catbas	University of Central Florida
Shirley Dyke	Washington University in St. Louis
Juan Caicedo	University of South Carolina

I. Welcome Remarks and Background Information

The meeting was called to order by Shirley Dyke at 3:10 p.m. followed by an introduction of the attendees.

An overview of the *International Association of Bridge for Bridge Maintenance and Safety* (IABMAS, www.iabmas.org) was presented by Emin Aktan. The association has two technical committees: Bridge Health Monitoring and Bridge Management. The Bridge Health Monitoring Committee identified three focal areas during the 2004 IABMAS conference in Kyoto [meeting minutes under www.iabmas.org Bridge Health Monitoring Committee]: i) Overview of current bridge health monitoring applications, ii) Synergies between bridge management and health monitoring and iii) Development of a bridge health monitoring benchmark problem. This meeting is to gather information from the research community and practitioner engineers regarding the development of the benchmark problem.

Shirley Dyke added that despite the latest developments in sensors and the application of these sensors in real life structures there is a gap between research and application of these methodologies. For this reason we should identify the needs from practitioners and encourage the participation of the community in a single problem focusing on the most significant need. The timeline for this committee will be to have a draft problem statement for input from the research community by May 1, 2005. The revised problem statement will be available for researchers in June 1, 2005 and a special session presenting the first results from this problem will be held at the IABMAS06 conference in Portugal (July of 2006).

A short summary of the experiences obtained from the ASCE building benchmark problem was given by Shirley Dyke. The focus of this study was a scaled 4 story steel structure. The problem has two analytical and two experimental phases in increasing difficulty. This approach of increasing difficulty facilitated the study of particular effects to existing methodologies and encouraged the development of new methodologies. The outcomes of this benchmark problem include several special sessions at conferences and a special issue in the Journal of Engineering Mechanics.

More information about the ASCE benchmark problem can be found at (http://wusceel.cive.wustl.edu/asce.shm)

Emin Aktan asked if there has been an effort to define a common terminology for practitioners and researchers for SHM within these benchmark problems. Shirley Dyke responded that this has not been done in the ASCE benchmark problems.

Necati Catbas described some of the possible directions of this benchmark problem. These included studies on decision making, the effectiveness of methods under non-stationary excitation, model development and updating, the impact of uncertainties in this type of structures and implementation issues. Then, he described the two experimental structures proposed for this study. The first experimental specimen is the University of Central Florida Grid which is composed of two 18 feet girders and 6 feet cross members. The second experimental specimen is the Grid at Drexel University. Different boundary conditions can be simulated in these structures by changing their supports and structural members can be easily manipulated to create a wide variety of damage scenarios. Several sensors including accelerometers, strain gauges and tiltmeters are installed on the structures to perform dynamic and static tests. Also, numerical models of the structures are available for this benchmark problem.

III. Discussion

After the description of the candidate structures the meeting was open for discussion for the attendees.

Shirley Dyke asked the attendees if highway bridges would be the appropriate type of structural system to be studied or if there were suggestions for other type of bridges such as cable-stayed or suspension bridges.

Daniele Inaudi commented that highway bridges are the typical bridges constructed but they are not the typical monitoring case. Large bridges are more likely to be instrumented than highway bridges.

Emin Aktan mentioned that the proposed experimental models could be treated as a small part of a larger structure such as a cable-stayed bridge.

Walter Saltzberg commented that large structures receive a lot of attention but other smaller bridges do not receive as much attention as they should. Given the large number of small bridges, damage detection in highway bridges might be more important that damage identification of large structures. He also said that cost is a big part of the decision making process. He suggested focusing in identifying if something has changed in the structure or not. This is the information that bridge owners want to know. This will also drive the costs of structural health monitoring systems down.

It was noted that one of the main problems with current health monitoring systems is false positives because structure owners loose confidence in the monitoring system. Concerns that a laboratory experiment might not be effective to study the reliability of SHM methodologies were expressed.

Emin Aktan suggested having a meeting or a workshop with bridge owners to identify their needs and to define some realistic scenarios from bridge owners.

Walter Saltzberg commented that currently bridge owners only want to know if something has changed on the bridge or not. He noted that the implementation of BHM system should be incremental. A reliable systems indicating if something has changed on the structure will be appropriate for the current needs of bridge owners. This information can be used to decide when to send inspectors to the bridge. Once bridge owners feel comfortable with this technology other type of methods providing higher level of diagnosis and prognosis could be implemented.

Daniele Inaudi agreed with Walter Saltzberg and note that the best information that a monitoring system can provide for bridge owners is that nothing has changed on the structure.

Discussion about what type of damage would be the most appropriated for the benchmark problem followed. Some of the damage mentioned are corrosion, overload and impact to girders from oversized vehicles passing under the bridge.

Robert Bolton commented that practitioner engineers and bridge owners are interested in knowing the capacity of the bridge and how long they have before they have to repair the structure. Current system sensors and data analysis implementations confuse owners because they do not provide processed information but raw data that can not be used for decision making.

Shirley Dyke proposed to start with a simple problem using a numerical study using the finite element models of the specimens. Once this simple problem was solved it could be expanded to include something more realistic. Attendees agree with this approach.

Juan Caicedo suggested the use of a high number of simulations in the numerical example for each damage case. False positives should be included in these simulations. The rate of success of the methodologies identifying damage and false positives could be used to study their reliability.

Daniele Inaudi noted that several researchers are studying static methods for damage detection. He suggested providing static data for the damage cases considered as well as dynamic data.

Juan Caicedo suggested using the National Bridge Inventory to identify the most common damage scenarios for the simulation damages.

Necati Catbas suggested contacting DOTs to determine the most common damage scenarios. This will also spread the word of this benchmark problem and would encourage participation from bridge owners.

The meeting was adjourned at 5:00 p.m by Necati Catbas.

IV Action Items

The coordinators of this benchmark problem are going to contact DOTs that they have had interactions with to develop a list of the most common, and yet analytically tractable, damage (or change) cases to consider. Next, they will develop a problem statement using a FEM of one of the two bridges presented that can best display these damage cases. The problem will be of increasing complexity.