INTERNATIONAL SOCIETY FOR STRUCTURAL HEALTH MONITORING OF INTELLIGENT INFRASTRUCTURE

October 2012
ISHMII Membership Notes

Vice President's Letter

Dear Members and Colleagues,

I am pleased to introduce myself to you as the ISHMII Vice President for Member Education and to share my views on life-cycle performance monitoring, evaluation and design of civil infrastructure. I am a professor of civil engineering and engineering mechanics at Dalian University of Technology and Harbin Institute of Technology, China.

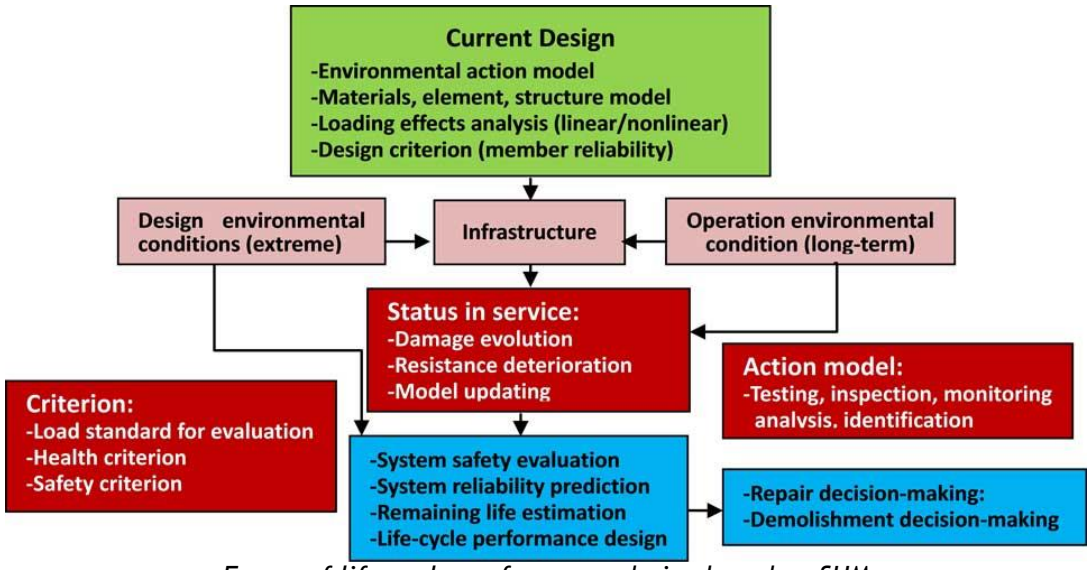
Over the last two decades, China has built infrastructure on the largest scale. This includes transportation infrastructure, buildings, hydraulic projects, offshore engineering, nuclear power plants, and electric power transmission systems.

Three Gorges Project (left) and Jiaozhou Bay Bridge (right)

Guangzhou TV Tower(left) and Jinping Hydroelectric Power Project (right)

The life of civil infrastructure may be 50 years, 100 years or even longer. Unfortunately, civil infrastructure may be subjected to natural disaster actions, harsh environmental actions and sustaining loads alone or in combinations during their life-cycle service period. The long-term harsh environmental actions or cyclic loads result in a decrease in the resistance capability of the structure due to steel corrosion, aging materials and accumulative fatigue damage; the structure may be severely damaged, even collapse under natural disaster actions. We need to understand the life-cycle performance and behavior of infrastructure for ensuring their safety, serviceability, durability, and sustainability under various actions and loads.

There are many questions to answer about the life-cycle performance of a structure, e.g. how well we can predict it and how we will sustain it. We have much less knowledge and practice than would let us accurately answer these questions at the current stage.



Frame of life-cycle performance design based on SHM

SHM provides a powerful tool to through which we investigate the real behavior and life-cycle performance of a structure under various loads and actions. A SHM system on a full-scale structure plays the role of an in-situ test system. Using SHM data, exact models and the parameters of loads and environmental actions can be obtained and the loads in the remaining

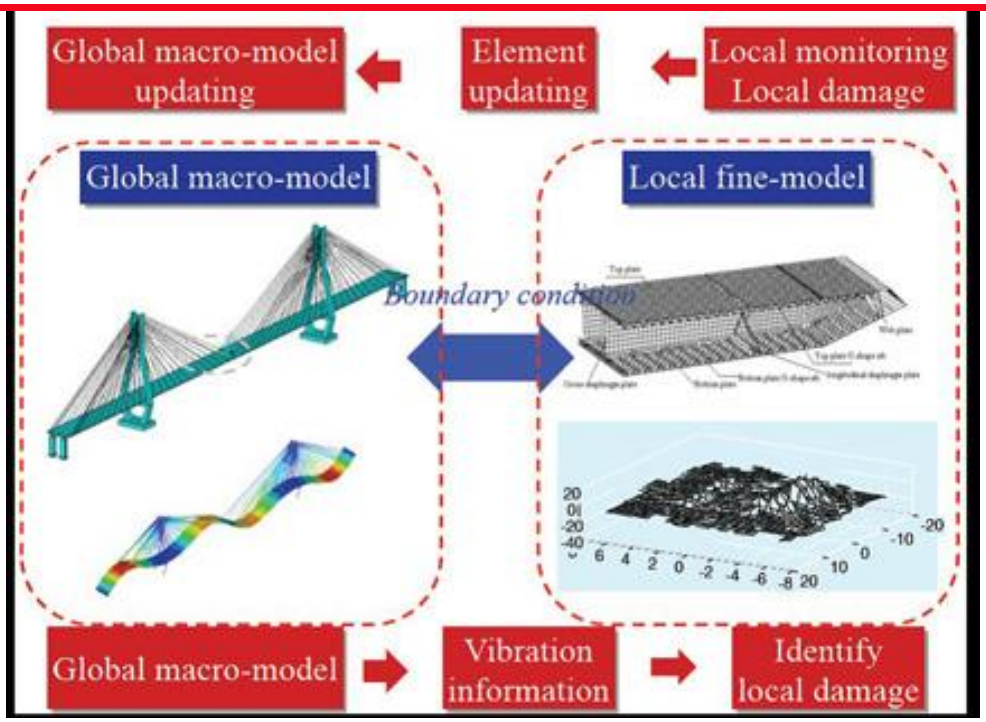
service period can be predicted; a structural analysis model can be updated, and the deterioration in resistance can be calculated. In this way, time-variant reliability can be predicted based on SHM technique. Once the reliability of the structure decreases to a certain threshold, a decision on maintenance can be made that will increase structural safety to an expected level. The failure modes can be found easily because the load patterns and deterioration in resistance of elements can be exactly obtained through SHM data.

A SHM system should include, but not be limited to, three sub-systems: sensors and sensing networks; data acquisition, transmission and management; and safety evaluation. The variables relevant with health conditions of a structure can be categorized into two groups: loads and their responses; and environmental actions and their-induced durability performance of the structure.

A lot of the advanced sensing technologies and sensors have been developed in the past 20 years, including optical fiber sensing technology, wave propagation-based sensing technology (acoustic emission technique, ultrasonic sensing technique, guided wave sensing technique, etc.), cement-based sensors and corrosion sensors. Despite the advances in sensing technology, there are still some challenges to be solved, such as sensing technology for durability and interface stress distribution. So, the accurate life-cycle performance evaluation is still difficult for us. Potential tools to solve these challenges can be found in wireless sensing technology, distributed sensing networks and robotic mobile sensor networks and the nanomaterials-based and bio-inspired sensing technologies that are now emerging.

As Prof. Ansari has mentioned in *Membership Notes*, a number of sophisticated SHM systems have been implemented in structures in China. The sensors in these SHM systems are not only installed on the upper-structure, but also in pile foundations and piers for monitoring of corrosion and scour. These SHM systems can be automatically operated and managed through the Internet.

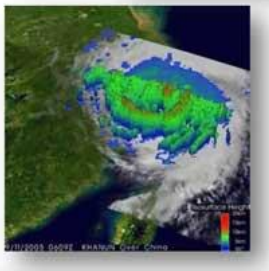
In China, we are concerned about the utility of the data obtained from the SHM operating systems. The measured data may be incorrect or contaminated by strong noise, e.g. data packet loss has been observed in wireless sensors network, and the monitored wind speed may be impacted by rainfall during hurricane events. With monitored data, we can establish models of loads and environmental actions, and develop an extreme value model of structural response, structural fatigue accumulated damage model and the corrosion extent of the rebar and steel elements. Model updating is conducted to produce a more exact structural analysis model based on monitored data, and while the vibration-based updated model cannot be used for safety evaluation, a multi-scale model of a structure is needed for a safety evaluation. Then, the response at locations without sensors can be predicted using the updated model. Finally, the life-cycle performance and safety level of the civil infrastructure can be evaluated and predicted based on established models of load and environmental action, response models, and updated structural model.



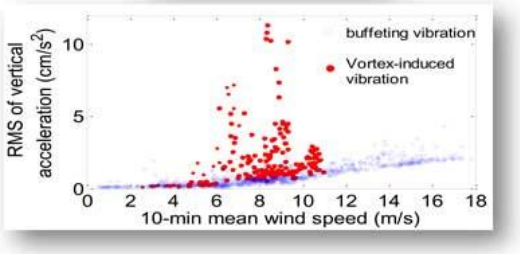
Multiple-scale finite element model of a structure for safety evaluation

As mentioned before, infrastructure may be subjected to earthquake attacks and wind loads. Ground motion and earthquake-induced vibration and wind and wind effect on structures should be included in the SHM system. In earthquake engineering, for example, sensors can be installed on faults to monitor the occurrence of earthquake events. As a result, the model and parameters of the fault can be identified, which will aid us to understand the mechanisms of earthquake occurrences. Early warning of an earthquake event can be made based on monitored P-wave and S-wave. The structural seismic damage and residual seismic performance can be assessed based on the monitored earthquake ground motion and structural response. The Chinese government has invested 6.1 billion RMB to set up seismic ground motion observatories that will cover all of the strong earthquake zones in China.

Typhoon Monitoring
---flow path, decaying model & its parameters, simulation & prediction of urban typhoon-induced disaster



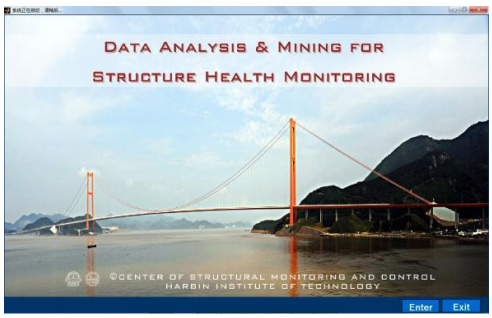
Wind, Wind Load & Effect Monitoring
--Anemoscope: wind speed & direction
--Pressure sensors: distribution pressure & load
--Accelerometer: vibration
--Analysis & modeling of extreme wind load, fatigue wind spectrum
--Warning criteria for comfort
--Warning & evaluation of safety & reliability

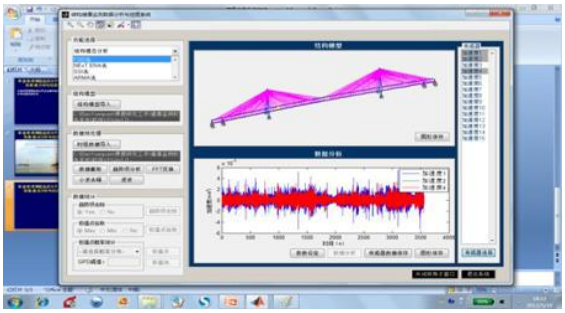


Wind, wind loads and wind effects monitoring

Strong winds induce large deformation and dramatic vibration in flexible structures. The SHM system can monitor a hurricane over a region or a city, which will be useful to the investigation of the behavior of hurricanes over land. In addition, monitoring the wind speed, load and their effects on a structure will aid in the investigation of the real behavior of a structure under wind. The data can be used to validate exiting methodology and develop new structural analysis approaches in wind engineering.

Software for data mining of SHM for life-cycle performance evaluation of a structure has been developed in China.





Software for life-cycle performance evaluation of a structure

In recent years, the Chinese government has supported an R & D program on National Smart Structures Grids. This integrates monitoring, data transmission, decision-making and feedback control for all critical infrastructures in the whole country.

Finally, a point on SHM education. Since 2005, we have set courses on SHM for undergraduate students and graduate students at HIT, DUT, Tongji University, Southeastern University, and Xiamen University. Several associations have successfully offer short courses on SHM in summer. I hope that ISHMII may set up a course on SHM for students and engineers - I will talk about this concept in the future.

I encourage you to communicate with me.

With best wishes to all,

Jinping Ou

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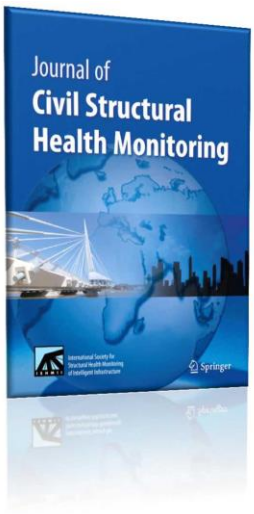
Dr. Ou's letter with additional graphics may be accessed at ISHMII.org. Some of the proposed data process approaches to improve data quality that are mentioned in this extended version of Dr. Ou's letter, undertaken by his research team at HIT and DUT, will be featured in the upcoming issue of *The Monitor*.

We encourage authors to submit brief research reports to *The Monitor* through one of the Associate Editors and research papers to the *Journal of Civil Structural Health Monitoring* (JCSHM).



Follow-up on these ideas with yours.

Submit your research papers to the *Journal of Civil Structural Health Monitoring*, a peer-reviewed Journal, through the *JCSHM* Editorial Manager

Volume 2, Number 2, September 2012

is available to ISHMII members who have

logged in to their account at ISHMII.org.

WORKSHOPS AND CONFERENCES

Join us at CSHM-4 November 6-8, 2012

SHM Systems Supporting Extension of the Structure's Service Life

REGISTER ***Program Information***

CSHM-4 is an Official ISHMII Workshop

2012	2013
The 3rd International Symposium on Advances in Urban Safety	MODERN Monitoring Developments for Safe Repository Operation and Staged Closure

SAUS2012
Nanjing, China
November 23-25, 2012

3rd International Symposium on Advances in Urban Safety

Call for Papers

Prospective authors are invited to submit abstracts (250 words maximum) no later than October 20, 2012. Details are available at www.saus2012.com. All inquiries relating to the Symposium should be addressed to the Professor Jian ZHANG, Southeast University, Nanjing, China.

PLSE 2012 Hong Kong
December 5-7, 2012

First International Conference on Performance-based and Life-cycle Structural Engineering (PLSE 2012).

ANNOUNCEMENT

AFTAB MUFTI MEDAL AWARD

MoDeRn International Conference and Workshop, Luxembourg
March 19-21, 2013

International Conference and Workshop - Monitoring in Geological Disposal of Radioactive Waste.

Abstracts for Papers now being considered

SMAR 2013
Istanbul, Turkey
September 9-11, 2013

2nd Conference on Smart Monitoring, Assessment and Rehabilitation of Civil Structures.

7NSC 2013
Oakland, California
May 20-22, 2013

7th National Seismic Conference on Bridges & Highways

Additional information is also available from Jerome O'Connor, P.E., Conference Coordinator at conf7NSC@buffalo.edu.

ISHMII is Proud to be an Outreach Partner of 7NSC.

Jou rna l of Civ il Str uct

ural Health Monitoring Best Paper competition. The papers considered will include those published through the end of 2012.

Each author of the Best Paper will receive the Aftab Mufti Medal during the 6th International Conference on Structural Health Monitoring of Intelligent Infrastructure (SHMII-6), in December 2013 in Hong Kong.

Nominated authors must be members of ISHMII.

Faculty Opening

SHMII-6 Hong Kong December 2013

ISHMII invites you to attend the 6th International Conference on Structural Health Monitoring of Intelligent Infrastructure, SHMII-6.

SHMII-6 2013 is organized by the Department of Civil and Structural Engineering at The Hong Kong Polytechnic University.
Details are available at shmii6.2013@polyu.edu.hk.

CREDITS AND APPRECIATION

ISHMII extends its thanks to those who make photos and graphics available. Our thanks to Dr. Jinping Ou for contributing those that accompany his letter with the exception of the following:

Three Gorges Project: http://www.news.com.au/travel/news/fast-and-furious-worlds-most-powerful-dam-in-full-operation/story-e6frfq80-1226435772794

Jiaozhou Bay Bridge: http://newsfeed.time.com/2011/06/30/china-opens-worlds-longest-sea-bridge-%E2%80%94-and-three-other-record-breakers/

Guangzhou TV Tower: http://www.trekearth.com/gallery/Asia/China/South/Guangdong/Guangzhou/photo1316336.htm

Jinping Hydroelectric Project: http://www.highestbridges.com/wiki/index.php?title=Lancanjiang_River_Pipeline_Bridge

Submit Your Photos for ISHMII.org Home Page

Your photo of your team at work installing sensors or conducting other activities related to ISHMII may be published on the ISHMII.org Home

Missouri University of Science and Technology

(formerly University of Missouri - Rolla)

announces a tenure track faculty opening in structural engineering for the Fall term, 2013.

Applications are now being accepted.

Inquiries and applications from ISHMII members are welcome.

Members have access to the full description through Careers at www.ISHMII.org.

Swiss National Science Foundation Postdoctoral Openings

Applied Computing and Mechanics Laboratory, EPFL,
Lausanne, Switzerland

Research topics include active and biomimetic structures as well as system identification through measurement data interpretation.

page or in our electronic communications.

Learn How: Instructions on how to submit your photo

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Build ISHMII by Sharing *Membership Notes*

Membership Notes and *The Monitor* are delivered to members and colleagues. Your colleagues can receive both for free.

Refer them to or send contact information to NancyC@ishmii.org. Your comments on

Membership Notes are welcome.