

Newsletter

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Message from the President

I am so pleased write this monthly update on a different platform – ANSHM Newsletter. The launching of this Newsletter is one of the events to celebrate our 5th Anniversary. We aim to use this new platform to help its readers to be more aware of what is happening in Australia and overseas about ANSHM and the SHM Field and share the successful experience in applying this new technology so that

For the Road Authorities and Industry – to understand better about this new technology and gain confidence in implementing it for safety, effective management and economic reasons and know where and whom to approach when there is a need to use it;

For the Researchers – to understand better the needs of the industry and road authorities

and what other researchers are developing in the Field.

Actually ANSHM was established (as stated in ANSHM Rules) to Implement, Promote, Apply and Develop (IPAD) the technology of Structural Health Monitoring in Australia and specifically –

(a) To coordinate and integrate efforts for better development and application of SHM techniques in Australia;

(b) To showcase achievements, exchange ideas and disseminate knowledge nationally and internationally;

(c) To promote and facilitate national and international collaborative research and development; and

(d) To raise general community awareness on the need for and value of SHM research and application.

We hope this Newsletter could help to achieve this. This is the first issue and I would like to thank Dr Jun Li to take up this difficult task. Please let us know your comments about this Newsletter. We aim to have it as a quarterly issue and whenever there is an issue, my monthly updates will be included in 'the Message from the President' of the Newsletter.

Since the launching of this Newsletter is to celebrate our 5th Anniversary, it is a good time for us to review what we have done in these five years and plan for our future.

Below is a photo taken when we launched the ANSHM in 2009. I am so blessed to have this group of people who have passion for SHM and continuously supported the Association since its establishment.



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Also, we keep on having new members joining us and together with the founding members, they all trying their best to help ANSHM achieve so much. As I always say the achievements of ANSHM are always because of we have a group of people who have passion for the Association and the SHM technology.

From the photo, we can see that at start we have members from only 1 government organisation and 6 universities. Now we have members from 26 organizations, including 3 research institutions, 3 road authorities, 4 private companies and 16 universities. We are proud to claim that we have almost all the experts in Australia who are working in the field of SHM for civil structures. Since 2009, we have successfully organised 5 Annual Workshops respectively in Brisbane, Sydney, Geelong, Adelaide and Melbourne which helped to establish our friendship with one another and showcase our developments in

SHM. We are also keen to let the outside world know that in Australia there is a cluster consisting of experts and users in SHM working together for the advancement of SHM technology, by organising special sessions in international conferences and special issues in high impact journals. In this regard, we have successfully organised respectively a special session in the First International Conference on Performance-based and

in 2012 and a mini-symposium in the 6th International Conference on Structural Health Monitoring of Intelligent Infrastructure (SHMII-6) in 2013. In addition, we were successfully elected by the ISHMII council to host SHMII, the top conference in the field, in 2017 in Australia, the eighth in the series. For publications, so far we have published a book (hard cover in 2011 and reprinted as soft cover in 2014), a special issue in *Advances in Structural Engineering*, *An International Journal* in 2012, *Journal of Civil Structural Health Monitoring* in 2013, *Australian Journal of Structural Engineering* in 2013 and *Structural Health Monitoring, An International Journal (SHMIJ)* in 2014. It is worth mentioning that our special issue was published in July 2014 and in August, I received a piece of good news from Doug Adams, the Chief Editor of the Journal that the Impact Factor for SHMIJ as presented



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by Thomson Reuters is now 3.206, which puts it in the top 5 journals in the category of Engineering, Multidisciplinary (Top 4) and Instruments and Instrumentation (Top 3).

With our effort in the past 5 years, now we are better known nationally and overseas. I am so glad to see that now more and more structures in Australia are being considered to implement a SHM system and some even have implemented SHM at different levels. Another important achievement is that with the effort of Ross of QDTMR, Ari and Parvez of RMS, Yew Chin and Nigel Powers of VicRoads, Brian Uy and many others in ANSHM, now we have included a definition of SHM in AS5100 and few paragraphs on applying SHM for bridge assessment in the latest version of AS5100 Part 7. This is really a breakthrough in the field of SHM and I believe it will induce a chain reaction for more countries to follow, promoting the technology of SHM. I am also glad to see that there are research centres/institutes established in different universities with

SHM as one of their focuses. Also, some universities like QUT has brought SHM in their undergraduate courses so that in future, practising engineers will no longer consider SHM being something that they do not know much about. Besides all these achievements, I always hear leaders in different technical associations, nationally and internationally, commending our successes and trying to learn from us and considering us as a successful example to follow. They also admire that we are so united to work together for ANSHM and we have so many energetic devoted members.

As mentioned in my last monthly updates (30 July 2014), I attended the IABMAS recently. In IABMAS 2014, a total number of 728 participants from 37 countries attended the Conference. About 70% of the submitted abstracts were selected for final publication as technical papers and oral presentation at the conference within mini-symposia, special sessions and general sessions, for a total of 48 parallel sessions scheduled at IABMAS 2014.

Out of these 400 papers, they could be categorised as in the area of SHM or in the area of bridge management, or the use of SHM for bridge management. It is evidenced the implementations of SHM for bridge management is a world trend and I am so glad that many of the Australian delegates in this conference were exposed



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to this important trend. Above is a photo which I received recently from a senior research manager of Daewoo in Korea, who took it during my presentation in the conference.

We are not complacent about all these achievements. Actually to promote SHM in Australia is not easy. It seems that the current financial situation for the road authorities to conduct research is not promising, at least for the current financial year, so we should target our effort on tasks that are more fruitful. Below are some of my suggestions that we ANSHM could work on during this period of time.

- For the researchers in universities, if we have funding it is good to develop further our partnership with the authorities by seeking their support on approving us to carry tests on their assets. We should also try to provide our consultancy service to the industry. Through this we can build up our relationship with them and also help them gain better confidence in us.

- We will continue to help the industry more acquainted of the SHM technology by organising workshops, seminars, short courses and web-forums. We will also try to help researchers in different universities to strengthen their relationship with the industry including local councils, road authorities and private companies by having their universities as the venues of such workshops or an access point of video conferences.

- We will also try to coordinate with different universities to let each other know about our research areas of interest, our expertise and

our successful track records through our Newsletter, ANSHM Homepage and brochures. We will try to ensure that when the industry is looking for someone to help them solve their problems or researchers are looking for collaborating partners, our Newsletter, Homepage and brochures will be able to provide all these information.

As suggested by Yew-Chin, Partnership and Consultancy are what we should work on at the moment and all the above will help us to well prepare for better collaborations via AustRoads, Linkage and Discovery Projects, and my dream is one day we can establish a Centre of Excellence in SHM.

All in all, we will continue to work on organising workshops, special sessions and special papers in journals, these are all important and we have been successful in organising these. However in order to have new achievements, we should think of some new things. That is the reason, to celebrate our 5th Anniversary, we launch our Newsletter, plan to have Webforum and a new journal. All these aim to bring ANSHM to a new chapter. I look forward to having more research collaborations amongst universities and industry in the area of SHM and more SHM systems could be implemented to structures in Australia. I also look forward to that we have some successful SHM implementations in Australia in the year of 2017 when we host the SHMII-8, and at the same time the civil infrastructure owners, managers, asset management teams in Australia could be exposed to this important trend of implementing SHM for



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safety and effective management during SHMII-8.

Below are other updates of the month

6th ANSHM Workshop

The hotel for the 6th Workshop has been booked-- Holiday Inn Parramatta. Xinqun will send the call for abstracts in early September.

Besides, we are pleased to announce that our 6th workshop is approved for EA CPD. Thanks Saeed for his effort. He will advertise this workshop through EA web link, when we are ready to announce this workshop.

SHMII-7 Special Session

As you may be well aware that Hong Hao, Jun and myself are going to organize a special session entitled "Research Advances in Structural Health Monitoring - Australian Experiences" with the 7th International Conference on Structural Health Monitoring of Intelligent Infrastructure (SHMII2015), 1-3 July 2015 in Torino, Italy. (<http://www.shmii2015.org>). So far we have received 4 abstracts. The official deadline has been extended to 30th September, 2014. Please email your abstract to Jun, cc to Hong and myself if you are interested to participate the special session.

SHMII-8

We will soon start our organisation for this big event in 2017 soon. Saeed is working hard on that, which includes forming various committees to draft grant application for paying deposit to secure the venue, seek support from various organisations for financial support, liaise with Brisbane Convention Centre for the revised budget and

working schedule, etc. We are about to call for your involvement. This will be another milestone of ANSHM in our history demonstrating once again how each of us contributes to its success.

Special Issue in the Electronic Journal of Structural Engineering (EJSE)

The deadline of full paper submission has been extended to 31st August. On the date of writing this update, we have received 3 papers. Thank Tuan for all his hard work.

Special Issue in Structural Monitoring and Maintenance (SMM)

Prof Ting-Hua Yi, Associate Editor of SMM and Prof Satish Nagarajaiah, Editor of Chief of SHM welcomed our idea to have a special in the journal. Saeed, Ying and Jun will do coordination work for this special issue. We may have two issues in that journal and its call for abstracts will be started once the paper submission process for the special issue in EJSE has been completed.

New Journal for ANSHM

In the last EC meeting, it was decided to explore the feasibility to launch a new journal for ANSHM. Alex Ng is assigned to form a steering committee composed of Alex, Jianchun Li, Ying and myself to work on that

ANSHM Homepage

Please note that we have revised the membership application form and uploaded it to the site. Please notify those who are interested to be a member to download the form, complete it and send it to Dr Ying Wang. Hong Guan is working with her team to implement an on-line application in the future.



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Research Article

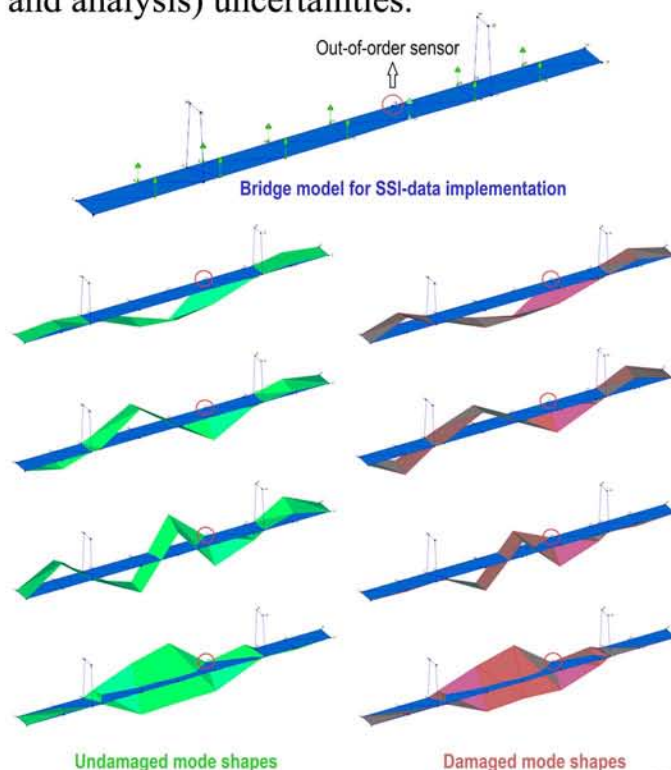
Bridge health check under demanding operational conditions using an enhanced Mahalanobis distance-based method

Theanh Nguyen, Tommy HT Chan, David P Thambiratnam

Civil Engineering and Built Environment School, QUT, Brisbane, Australia

This article summarises a procedure that can be used to address the damage detection problem of the benchmark structure recently developed by the Structural Control and Monitoring (SMC) group (<http://smc.hit.edu.cn>). Based upon data collected from normal and damaged states of a real cable-stayed bridge, this benchmark problem represents a rare case of instrumented civil infrastructure that has been damaged in an actual manner. However, real-world damage detection implementations have generally been seen to be associated with higher degrees of uncertainties and constraints than the applications in laboratory environments. In the study herein, the first challenge is that the quality of data significantly varied from time to time and this could be attributed to the inherent variation of major (ambient) excitation sources such as traffic and wind loads. To overcome this problem and obtain a reliable damage detection outcome, individual data subsets with too poor excitation conditions are first discarded. Next, three worst (out of the total twelve)

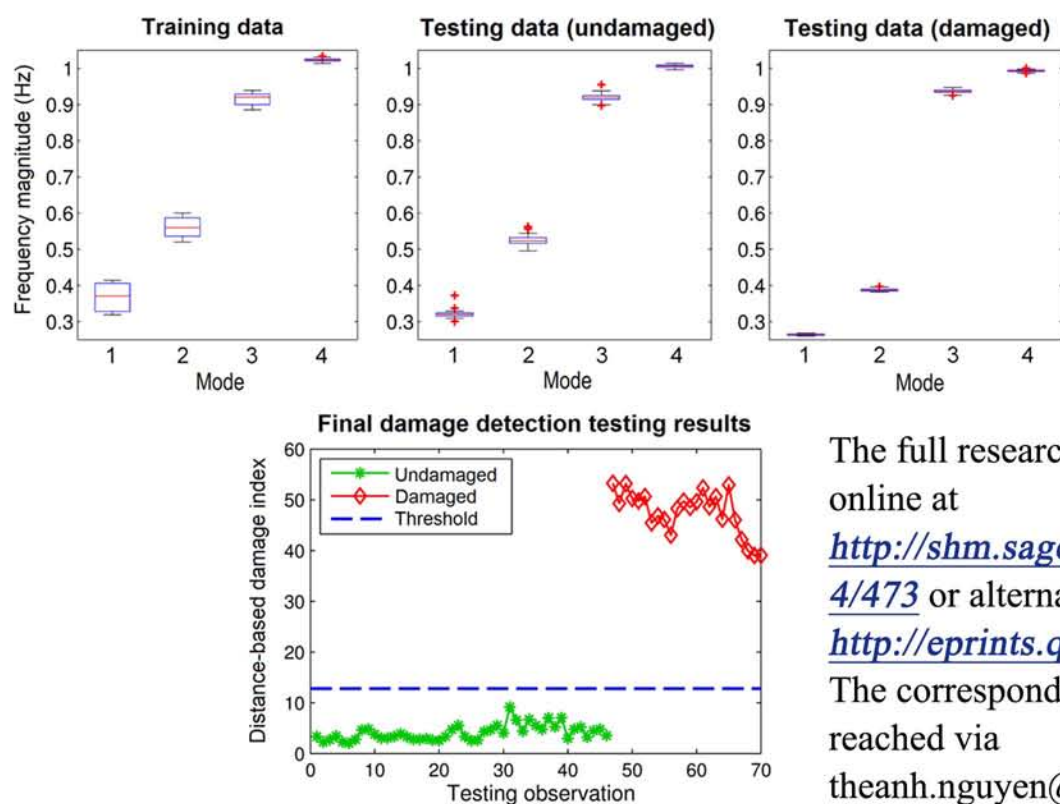
testing days that have too few usable data subsets and/or lack experimental repeatability are also excluded from the subsequent analyses. Finally, the powerful data-driven Stochastic Subspace Identification (SSI-data) technique employing the unweighted principal component estimator is used to cope with large volume of usable data (i.e. with 122 subsets) as well as other (measurement and analysis) uncertainties.



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Due to the limited number of accelerometers, the frequency range of interest is scaled down to be between 0 and around 1 Hz to obtain the most relevant modal information. From this frequency range, four modes that have been frequently excited in both (undamaged and damaged) states are estimated and their typical shapes are shown correspondingly in the figure above. The frequencies of these modes are then used as the (multivariate) damage-sensitive feature. To cope with the challenging influence of environmental and operational factors, an enhanced Mahalanobis (squared) distance-based damage detection method is derived to “learn” possible underlying trends caused by these factors onto the feature data. Here, the enhancement is made onto the distance computation process through the

provision of additional synthetic data (for the training stage) by means of a novel controlled Monte Carlo data generation scheme. Such data provision is to overcome the data shortage problem occurring with the training data herein (but also with any monitoring system at their early monitoring stages). By applying this, inaccurate distance computation can be avoided and reliable detection outcome has been achieved for the SMC data with correct indications for both structural states as reflected in the figure below. The box-plot screenings (at the top of the figure) also reconfirm the distinct difference between the damaged state testing data; and those used for training and undamaged state testing particularly at the first two modes.



The full research report is available online at

<http://shm.sagepub.com/content/13/4/473> or alternatively at

<http://eprints.qut.edu.au/73421/>.

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IBIS-FS DYNAMIC MONITORING GEORADAR

Introduction

Monitoring of structure movements and vibrations (bridges, buildings, monuments, towers etc.) is an increasingly important task for today's construction engineers. IBIS-FS introduces a totally new solution in this field of application, with many advantages over traditional instruments for both static and dynamic monitoring:

- remote sensing at a distance of up to 1 km
- displacement accuracy up to 1/100 mm
- real-time one-dimensional simultaneous mapping of all displacement detected on the structure
- fast installation and operation
- the same instrument can be used for static and dynamic monitoring
- structure vibration sampling up to 100 Hz
- operates day-night, in all weather conditions

Hereinafter the results from an investigation performed on a bridge are given as an example of dynamic structural monitoring. The experimental results consist of:

- visualisation of the displacement of some specific points on the bridge
- identification of the resonance frequencies of the structure
- identification of modal shapes

This experimental campaign has been carried out thanks to the collaboration with the

Department of Structural Engineering at Politecnico di Milano who has compared IBIS-FS results with the accelerometer system results used simultaneously alongside IBIS-FS.



Fig. 1: IBIS-FS

Measure description

One of the advantages of IBIS-FS is that it simultaneously measures the displacements of all the scenario illuminated by the antenna beam providing a continuous mapping of the static and dynamic displacements of the entire structure.

In order to exploit this key feature for bridge monitoring, the best position to install the sensor is under the bridge arch so that IBIS-FS antenna beam can cover the entire structure, as illustrated in the figure below.

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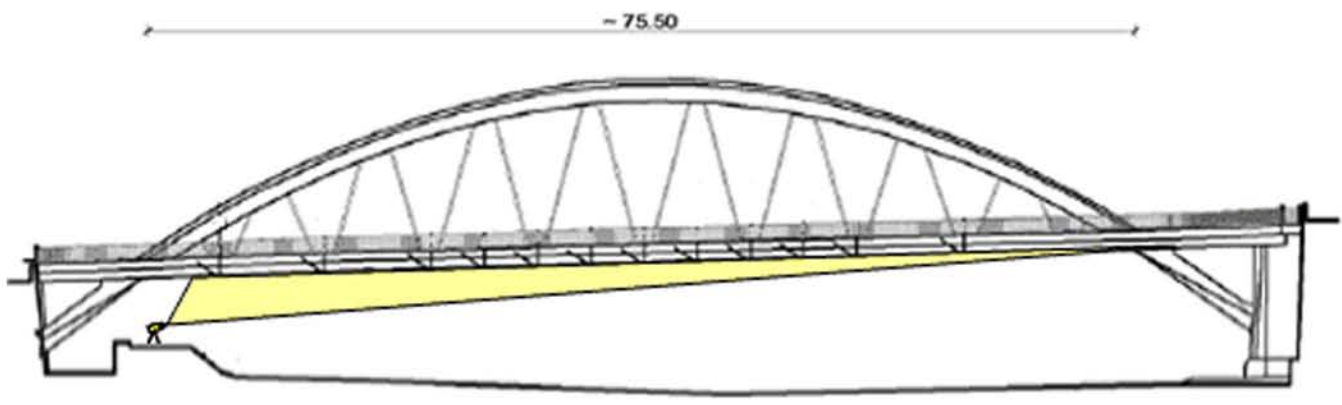


Fig. 2: Installation diagram

In the described measure IBIS-FS was installed under the arch of the bridge at a vertical distance of about 4m.

From this position IBIS-FS illuminated the bridge arch from 7m to 70m far.

The system was configured with the following operational parameters:

- maximum range: 85m
- distance resolution: 50cm
- sampling frequency: 100Hz

In order to perform a direct comparison between the data acquired with IBIS-FS and those acquired by the accelerometers, 12 radar reflectors were installed (corner reflectors) in correspondence with each accelerometer. The use of corners was necessary to accurately identify the points where the accelerometers were installed.



Fig. 3: IBIS-FS Installation

Range Map

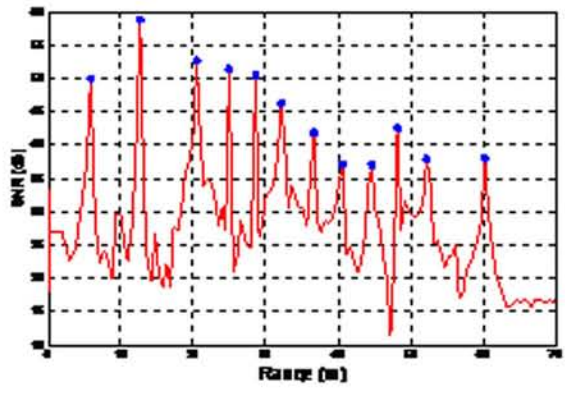


Fig. 4: Distance profile (radar image)

The following figure shows the image of the bridge acquired by IBIS-FS: the figure shows the 12 points corresponding to the corner reflectors (CR) on which the analysis will be carried out.



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Results - Displacement data

AS IBIS-FS raw data is the displacement of the targets belonging to the illuminated scenario, the following figures show the displacement data for the entire duration of the measure and for a temporal zoom of 30 seconds of 4 of the 12 installed CR. These CR were positioned at 11.6, 24, 31.4 and 59.5 m far from IBIS-FS along the bridge.

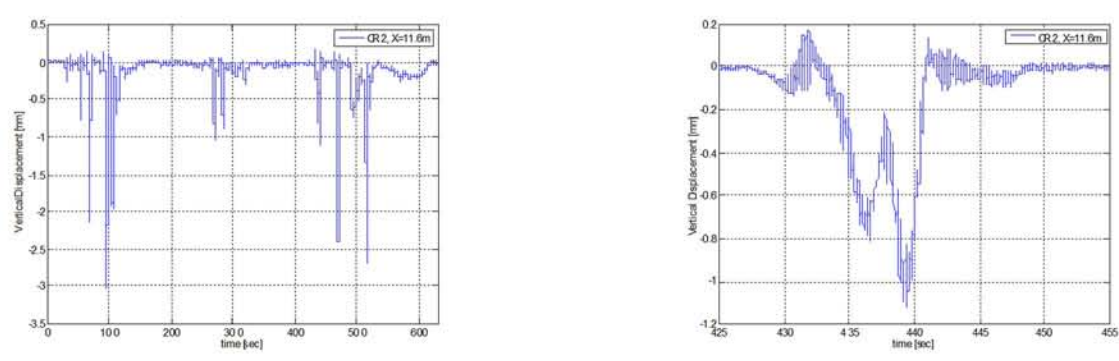


Fig. 5: CR 1 displacement. Entire measure (left), 30sec measure (right)

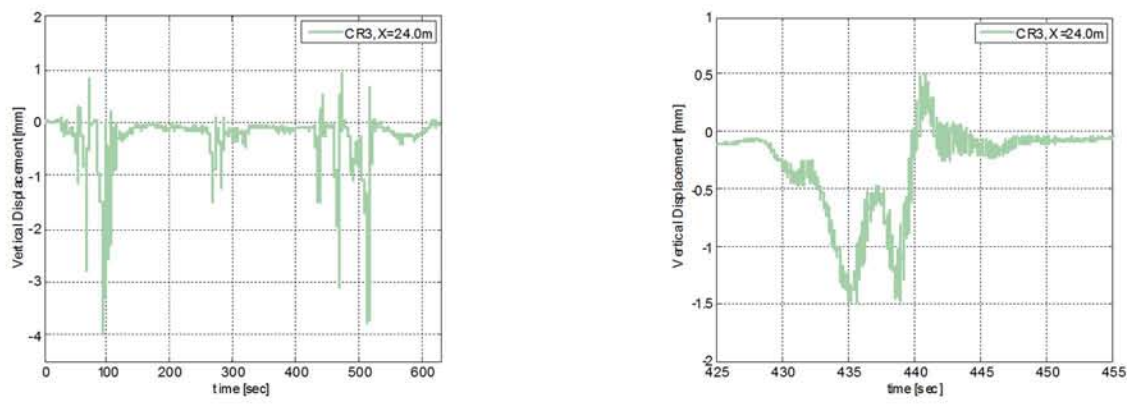


Fig. 6: CR 3 displacement. Entire measure (left), 30sec measure (right)

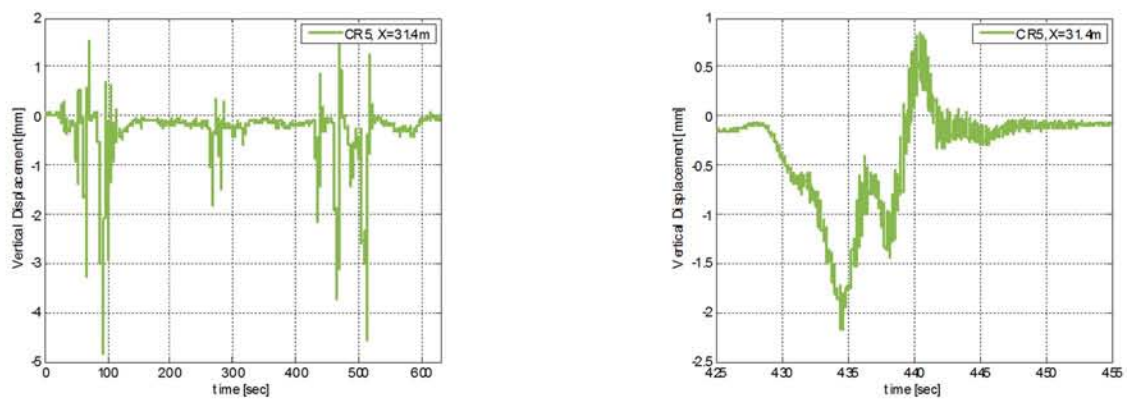


Fig. 7: CR 5 displacement. Entire measure (left), 30sec measure (right)

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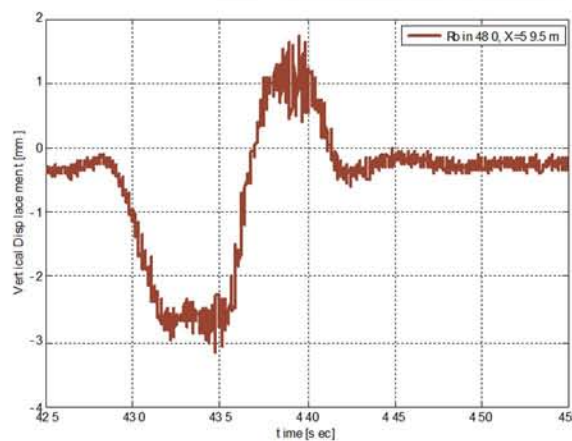
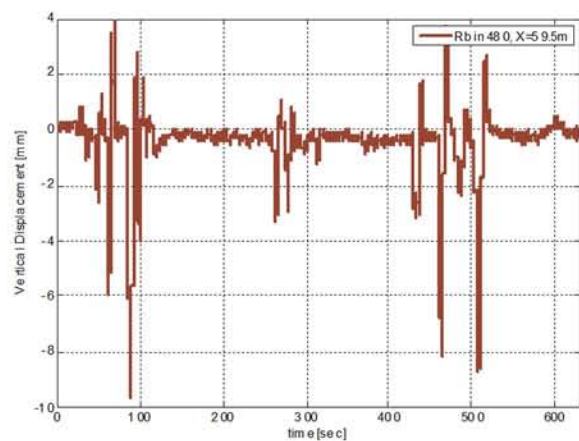


Fig. 8: CR 11 displacement. Entire measure (left), 30sec measure (right)

By the observation of the previous images it is possible to infer the good quality of the displacement signal even at far distances.

In order to validate IBIS-FS collected data, a comparison between IBIS-FS data and accelerometer system data was performed. The following figures show the comparison of the velocity of a point of the bridge 8m far from IBIS-FS measured by the two acquisition systems.

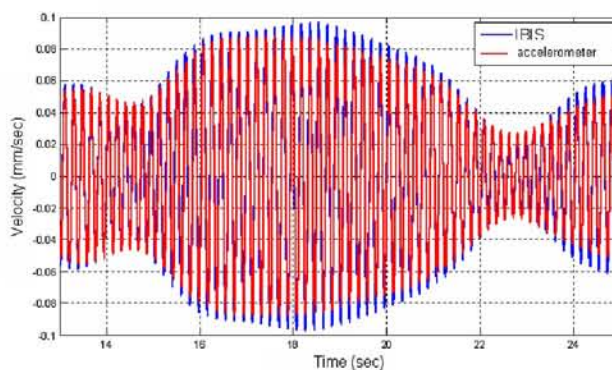
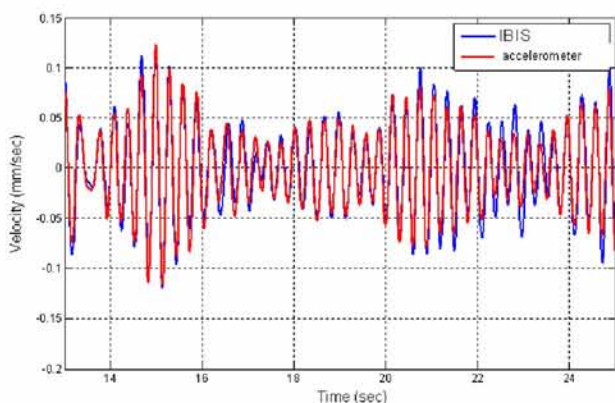


Fig. 9: Comparison of velocity filtered over the first bending mode

Fig.10: Comparison of displacement filtered on the last bending mode

The figures show the excellent correspondence between the two measurements over time.

Results – Frequency and modal analysis

Results of data processing in terms of extracting the resonance frequencies of the bridge are shown in the following figure, including:

- the frequency spectrum of the structure derived from the IBIS data, coloured blue
 - the frequency spectrum of the structure derived from the accelerometers, coloured red.
- An excellent agreement can be seen between the two spectrums.



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An excellent agreement can be seen between the two spectrums.

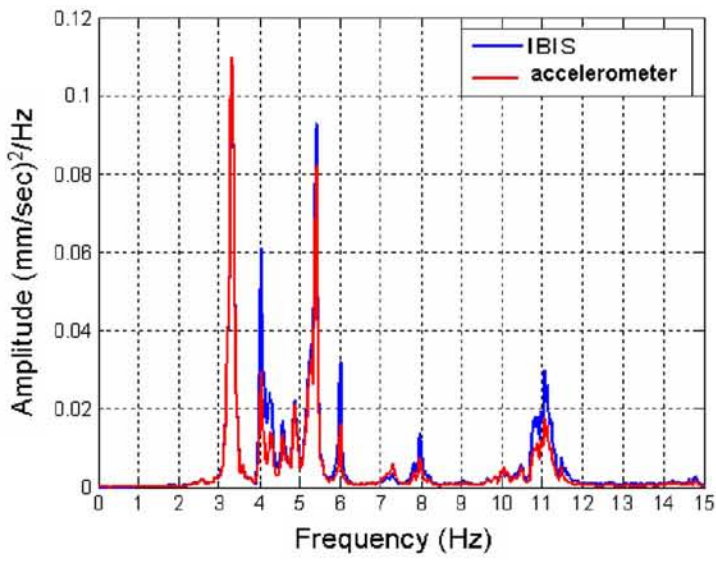


Fig.11: Autospectrum comparison

f1	3.44Hz	f5	5.96Hz
f2	4.02Hz	f6	7.81Hz
f3	4.81Hz	f7	10.64Hz
f4	5.25Hz	f8	10.78Hz

Tab. 1: IBIS-FS derived resonance frequencies

Analysis of the data acquired by IBIS permits all the resonance frequencies of the bridge identified by the accelerometer system to be derived as shown in Tab. 1.

A complete modal analysis of the bridge includes even the determination of the bridge modal shape for the different resonance frequencies. Hereinafter the comparison of the bridge modal shape, derived from IBIS-FS data and accelerometer data, for the frequency $f=3.44\text{Hz}$:

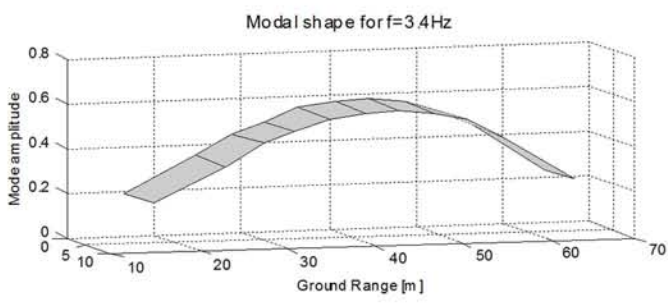


Fig.12: Modal shape for $f=3.4\text{Hz}$ (IBIS-FS data)

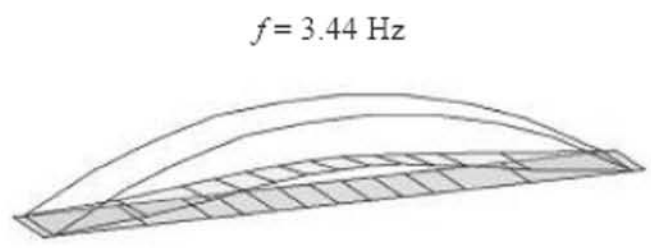


Fig.13: Modal shape for $f=3.4\text{Hz}$ (accelerometer data)

It easy to see that the two modal shapes are similar and comparable.

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Conference Award Information

Best Paper Award at DAMAS 2013

IOP Institute of Physics
Applied Mechanics Group



Best Young Researcher Paper Prize Certificate

Madhuka Jayawardhana, Xinqun Zhu, Ranjith Liyanapathirana,
and Upul Gunawardana

This Best Young Researcher Paper Prize is presented to you for your outstanding paper:

***Compressive Sensing for Structural Damage Detection
of Reinforced Concrete Structures***

presented at the 10th International Conference on Damage Assessment of Structures,
(DAMAS 2013), July 8th-10th 2013, Trinity College Dublin, Ireland



Prof. Biswajit Basu
DAMAS 2013 Conference Chair

Congratulations to Ms. Madhuka Jayawardhana, Dr. Xinqun Zhu, Dr. Ranjith Liyanapathirana and Dr. Upul Gunawardana at University of Western Sydney!

- **Name of award:** "Best Young Researcher Prize"
- **Awarding body:** 10th International Conference on Damage Assessment of Structures (DAMAS 2013), Trinity College Dublin, Ireland, July 2013
- **Award Sponsor:** The Applied Mechanics Group, Institute of Physics
- **Paper Title:** Compressive Sensing for Structural Damage Detection of Reinforced Concrete Structures
- **Presenter:** M Jayawardhana
- **Supervisors:** Dr. Xinqun Zhu, Dr. Ranjith Liyanapathirana and Dr. Upul Gunawardana

Conference Information:

Special Sessions Organized by ANSHM members

- Mini-symposium - "Infrastructure System Identification and Monitoring", organized by Dr. Alex Ng at Uni of Adelaide and Prof. S.K. Au at Uni of Liverpool, Fourth International Symposium on Life-Cycle Civil Engineering, November 2014, Tokyo, Japan.

<http://www.ialcce2014.org>

- Special Session - "Research Advances in Structural Health Monitoring - Australian Experiences", organized by Prof. Hong Hao, Prof. Tommy Chan and Dr. Jun Li, 7th International Conference on Structural Health Monitoring of Intelligent Infrastructure, July 2015, Torino, Italy.

<http://www.ialcce2014.org>

Incoming Conferences

- The 6th ANSHM annual workshop, Holiday Inn Parramatta, Sydney, 8-9 December, 2015. Organized by Dr. Xinqun Zhu at University of Western Sydney.
- 2015 EMI International Conference of ASCE, Hong Kong, January 7-9, 2015.
<http://www.cse.polyu.edu.hk/~ktchau/emi2015-hk/emi2015hk.html>
- The 11th International Conference on Damage Assessment of Structures (DAMAS 2015), Ghent University, Belgium, 24-26 August, 2015. The abstract submission deadline is 30 September 2014.
<http://damas.ugent.be>
- Third Conference on Smart Monitoring, Assessment and Rehabilitation of Civil Structures, SMAR 2015, Antalya TR, 7-9 September 2015. <http://www.smar2015.org>



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ANSHM Special Issues

Special Issues in *Structural Health Monitoring*

Our special issue in Structural Health Monitoring, an International Journal has been published in the July issue (Vol .13 No. 4 <http://shm.sagepub.com/content/13/4.toc>). Thanks are sent to all the authors and the reviewers, who tried their best to respectively revise their papers to address the comments of the reviewers and review the papers to meet various deadlines for the publication.

Special Issues in *Electronic Journal of Structural Engineering*

12 abstracts have been received. The official deadline of full paper submission is extended to 31 August 2014. More details about EJSE can be found at <http://www.ejse.org/>.

Special Issue in *Structural Monitoring and Maintenance*

Ying Wang, Saeed Mahini and Jun Li are coordinating this special issue with Structural Monitoring and Maintenance, an International Journal

(<http://www.techno-press.org/?journal=sm&subpage=1>). We are preparing the special issue application proposal and will circulate the call for papers in due course. The proposed timeline for this special issue is listed as follows

8 September 2014: Proposal

29 September 2014: Call for paper

13 October 2014: due date for abstract (expression of interest)

1 December 2014: due date for full paper submission

You are welcome to submit your articles!

Members Update

Well Done! ANSHM has more than 40 registered members from 26 universities and industry companies.

Social Media

■ ANSHM Facebook webpage:
<https://www.facebook.com/ANSHMAU>

- a platform for all members to post the SHM information to promote SHM and ANSHM

■ ANSHM Facebook group:
<https://www.facebook.com/groups/ANSHM/>

- a place for all members to exchange the information and hold the webforum for a subgroup

■ ANSHM LinkedIn group:
<http://www.linkedin.com/groups/ANSHM-Australian-Network-Structural-Health-4965305>

- a platform for all members to post the SHM information to promote SHM and ANSHM

