AUSTRALIAN NETWORK OF STRUCTURAL HEALTH MONITORING

Newsletter

Issue 10, Dec 2016

## Contents



# President Message

*Tommy Chan*

*Professor in Civil Engineering, Queensland University of Technology*

Dear All,

I prepare this President message on my way returning to Brisbane after the 8th ANSHM Workshop. I would like to express my sincere gratitude to Monash University to host our 8th Annual Workshop. The effort of the Local Organising Committee led by Colin Caprani and Ye Lu in organising the workshop is much appreciated. For those who have attended this workshop will definitely agree with me that they have done a great job! Without their well planning and hard work, we could not have such a successful event.

Below shows the group photos that we took at the end of the Workshop. It's a pity that some could not be found in the group photos as they need to leave earlier because of other commitments, e.g. Prof Hong Hao and Prof Brian Uy, who have attended every ANSHM Workshops since ANSHM was established in 2009.

Photo 1 Workshop Attendants

Photo 2 ANSHM Advisory Board Members & Executive Committee Members

This president message will mainly focus on the President report that I presented in the Workshop summarising our achievements in 2016.

**ANSHM Achievements in 2016**

*Research Opportunities*

I am so glad that in 2016 many of us has been successful in ARC grants. One thing worth mentioning is that Tuan has been successful in securing two DPs in one round. It is really an excellent outcome. I am also so excited to learn that Bijan and Xinqun have been successful to establish a project with Data61 of SHM installation on existing bridges. The development will not only be beneficial to the asset owners and the data acquired will also be invaluable to us for further development of the SHM technologies.

Having said that, we have come across some difficulties in establishing collaborative projects. It is due to the constraints of the rules and policies of ARC and also the funding scheme of government bodies. Therefore we will continue to use ANSHM as a platform for its members

- to show our strengths to the industry
- to educate the industry to understand the benefits of using SHM to solve their problems
- to collaborate and complement with one another for further development of the SHM technologies

*Publications*

ANSHM has been doing very well in publications, which not only help showcase our developments but also let other researchers overseas be aware of our strengths and there is an effective, important and significant cluster working on SHM in the southern hemisphere.

In 2016, we have two special issues published:

- *Journal of Civil Structural Health Monitoring* Vol. 6, No. 3 in June (special issue for ANSHM) and Volume 6, Issue 4, 2016 to include those papers that could not be included in the special issue
- *Earthquake and Structures* Vol. 11, No. 6 in December 2016 (http://technopress.kaist.ac.kr/?page=container&journal=eas&volume=11&num=6).

*Membership*

As mentioned previously, because of the Ying Wang's departure of Australia, Alex takes up the post of ANSHM Membership Officer. Our membership grows significantly in 2016. We have now members from 37 organisations as compared to 28 organisations last year. Now we have members from 22

Universities (17 in 2015), 7 Government Organisations (5 in 2015), and 8 Private Companies (6 in 2015). In these figures, I have not included the special membership of Ying as he has moved to a university in England (University of Surrey).

*Newsletter*

We have four issues of Newsletter in 2016 (Issues No. 7 – No.10) including this issue. In the last Advisory Board Meeting, we all considered that the Newsletter is an important communication tool of ANSHM. Thank Jun and Andy and their editorial team for their effort. They will continue to work on it to produce a high standard Newsletter to let us know what each of us are working on as well as to let the industry know about our successful stories and how SHM could help them to meet their needs. Also, in the Industry Forum of the 8th ANSHM Worksop, I was so glad to know that many engineers enjoyed reading the Newsletter. Well done, Jun and Andy!

*Organisation of SHMII 2017*

The organising of SHMII 2017 has been progressing well. We have formed 4 sub-committees.

1. Sponsorship and Fund raising: Person-in-charge: Hong Guan
   Committee: Jun Li, Jianchun Li, Lei Hou & Craig Cowled
2. Publicity: Person-in-charge: Alex Ng
   Committee: Jun Li, Lei Hou, Ying Wang
3. Editorial: Person-in-charge: Saeed Mahini
   Committee: Andy Nguyen, Xinqun Zhu
4. Secretarial: Person-in-charge: Claire Vaz
   Committee: QUT Conferences

We will keep on updating the information of the conference in my monthly updates as well as via its web site: http://shmii2017.org/

*Special Sessions*

Organising a special session in a SHM related national or international conference has been one of our strategies to showcase our strengths and exposing us to our peers. In December 2015, we organised a mini-symposium in the PLSE 2015. It was quite a success, being one of the two largest mini-symposiums (each with 20 papers) in the conference. In less than a week time, we will have another mini-symposium in ACMSM 24.

*Webforum*

We strongly believe that Webforum is an effective communicate platform for the SHM researchers to share our views on our developments and let the industry know what the benefits of SHM are. In 2016, we had a trial run of the 1st ANSHM Web Forum on 12 September 2016. However it is not that successful. It seems that not many people are familiar with using social media to have a forum. Some even are not familiar with using those social media like LinkedIn. Lei and his team will continue to explore it and see what we could do to make it a success.

**Industry Forum**

Same as previous years, a highlight of our Annual Workshop is the Industry Forum. Thank Nigel Powers of VicRoads for being the facilitator. A lot of delegates from the Industry shared their views on ANSHM and made suggestions on how it could help SHM to be developed to meet their needs and to practically apply SHM to solve their problems. Xinqun helped us take the notes of our discussion and all these will be considered in the forthcoming Executive Committee meeting to formulate our Task Forces and plan for 2017 and next few years.


Photo 3 – Industry Forum 1

Photo 4 – Industry Forum 2

**New Advisory Board Members**

I would like to express our warmest welcome to Prof Wenhui Duan of Monash University, to join our Advisory Board. Besides Wenhui, in the last Advisory Board meeting we had also proposed a few more prominent people to join the Advisory Board. I will approach them in the coming weeks. I will inform you the outcomes in one of my monthly updates.

**Election of Executive Committee Officers**

I am pleased to inform you that Jianchun Li, Hong Guan, Xinqun Zhu, Tuan Ngo, Saeed Mahini and myself were re-elected to serve in the committee for another 2 years of service (2017-2018). Therefore the Executive Committee in 2016 will consist of the following officers:

- Tommy Chan (President)
- Jianchun Li (Deputy President)
- Alex Ng
- Andy Nguyen

- Hong Guan
- Jun Li
- Lei Hou
- Saeed Mahini
- Tuan Duc Ngo
- Ulrike Dackermann
- Xinqun Zhu

**Subscription Fee**

I am so pleased to inform you that we have decided the annual subscription fee for 2016 will continue to be null.

**ANSHM Future Directions on Research**

In the Workshop, other than the Industry Forum, we had some discussions regarding ANSHM future directions in the Advisory Board Meeting and the Annual General Meeting. In general, we are all pleased with the achievements of ANSHM. We are encouraged to know that we are getting surer about our directions. We aim to develop a new culture in our engineering community of having SHM as part of the asset management of our structures.

To Implement, Promote, Apply and to Develop (IPAD) the SHM technologies are the four keywords for ANSHM. We encourage its members to actively seek industrial or competitive funding either individually or collaboratively to practice and promote SHM. However, members are encouraged to utilise ANSHM platform in their proposal or/and research activities.

I strongly believe because of our joint effort in AHSM, we will be approached more and more from the industry to establish collaborative projects with them solving their problems as well as helping them to have more cost effective asset management schemes. I have already seen that it is happening in the last year when compared to previous years. Besides, some of you may have noticed that the National Review of the R&D Tax Incentive concluded in April 2016 and the report of the Review has just been released for consultation and recommends a collaboration premium of up to 20 % to be introduced for the non-refundable tax offset. I hope this could help us to establish more collaborative would provide additional support for the collaborative research with the industry. Please see the details here https://www.business.gov.au/assistance/research-and-development-tax-incentive/review-of-the-randd-tax-incentive. This will encourage more collaborative research with the industry. Also, I expect that more SHM projects will be established when the revised AS5100 is released.

**Departure of Peter Runcie**

As some of you may have known that NICTA has formally merged with CSIRO to form a new entity called Data61 and Peter Runcie told me that due to the change of his role in Data61 he will no longer be able to contribute to the Advisory Board. It's really a pity for us as Peter had shared the same vision with us and contributed tremendously to the achievements of ANSHM. He had been an invaluable asset of ANSHM. He had tried his best to attend nearly all our annual workshops, giving us ideas including the importance of having the industry forums. He also joined the task force to formulate collaborative research proposals with the other task force members and introduced ANSHM via his connections. Representing the industry, he helped us to steer towards the direction to meet the needs of the industry. As the President of ANSHM, I would like to thank and acknowledge so much his contributions to the association. I am sure that you will all join me in wishing Peter our very best in his new role in Data61. Now Mehri Makki Alamdari will be Data61's Member Representative and I believe Mehri will continue to act as the link between Data61 and ANSHM. We also look forward to having a representative from Data61 sitting on the Advisory Board ANSHM soon. I believe Peter will let us know if his role has changed again and he is more than welcome to return to the Advisory Board.

**Welcome to New Members**

We are also thankful that we are having more and more representatives from the industry joining ANSHM. In the last two EC meetings, the following applicants have been approved for their ANSHM memberships:

- Dr. Torill Pape of AECOM
- Dr. Farhad Aslani of University of Western Australia
- Dr. Seyed Ali Hadigheh of Sydney University
- Dr. Wengui Li of UTS
- Hossein Moravej of QUT (Student Member)

A warm welcome to Torill, Farhad, Seyed, Wengui and Hossein!

We look forward to your participation to ANSHM activities and your contribution to ANSHM.

**9th ANSHM Workshop**

As informed in the last update, the 9th ANSHM Annual Workshop (in 2017) will be incorporated in SHMII 2017 (6-8 December 2017 with 5 December being the Welcome Reception). We decided to organise an ANSHM mini-symposium during the conference as the 9th ANSHM Workshop and have the 2 hour Advisory Board meeting to be held on 5 December 2017 before the Welcome Reception.

Regarding ANSHM Annual General Meeting, we will try to arrange a half an hour AGM during the conference, which may be during a tea break or before or after a lunch.

**SHMII 2017**

Regarding other updates on organising SHMII 2017 please see below a summary in dot points:

1. A face to face meeting with was held at QUT by the conference organisers (Tommy and Saeed) and the Event Manager to discuss the sponsorship document and other issues.
2. ISHMII contract has almost been finalised and hopefully it could be signed between ANSHM and ISHMII very soon.
3. Sponsorship documents have been reviewed and are ready to be released. It is expected that each EC member to start talking to their nominated contacts whom they are associated with, preferably in person. Once the final version of the sponsorship document is ready, I will then send a formal email to the potential sponsors through the conference manager.
4. New LOC members from QUT, Sydney U and industry have been appointed
5. New ISC members have been identified
6. Conference postcard has been re-designed and existing cards have been sent to the 8th ANSHM Workshop, ACMSM24 at Curtin U and the APWSHM in Hobart for distribution and publicity. Thanks should be given to the organisers of ACMSM24 and APWSHM for their support.
7. Conference flyers are under preparation.
8. Keynotes speakers have almost been finalised.
9. A meeting with the ASCE Australia section Vice President was held for the publicly and using the ASCE US mailing list for calling for the SHMII8 sponsors and the abstracts
10. Regarding the publication task, the contract with OpenConf has been finalised and the following online link for SHMII-8 has been set up at OpenConf website https://www.openconf.org/shmii8/openconf.php. Conference themes, abstract template, submission and formatting guidelines, full paper templates and reviewer guidelines are being finalised and the first call for abstract will be made very soon.
11. Website is being up to date and is ready for Call for Abstracts and we even have received one abstract from the Mainland China.

**ANSHM Special Issues**

*Journal of Civil Structural Health Monitoring*

As announced in the 8th Workshop, we will have a special issue in the Journal of Civil Structural Health Monitoring related to the presentations made at the 8th ANSHM Workshop. It will be edited by Colin, Jun and myself and the title for this special issue is "Structural Identification and Evaluation for SHM Applications". The 1st Call for Papers is scheduled on 15 December 2016.

**ANSHM mini-symposium at ACMSM24**

As mentioned earlier, ACMSM 24 will be held in less than a week. It will have a full three-day programme with 272 presentations and more than 260 delegates from 16 countries. ANSHM Special Sessions will have 9 papers in total and the conference program is available at: http://scieng.curtin.edu.au/acmsm24/program/

In the next sections of this Newsletter, the article of Wickramasinghe et al proposes a reliable and effective approach to detect and locate damage in cables/hangers of suspension bridges using mode shape component specific damage indices based on modal flexibility with respect to vibration in different directions. Ernst Niederleithinger from BAM (German Federal Institute for Materials Research and Testing, Division 8.2 - Non-Destructive Damage Assessment and Environmental Measurement Methods) reports the state-of-the-art of ultrasonic monitoring of concrete. The described techniques will lead to early warning systems for slowly developing damage mechanisms as ASR, freeze-thaw, rebar corrosion or fatigue as well as sudden failure due to excessive shear or loss of prestress. Thank Ernst so much for providing such an interesting report and also comes all the way from Germany to give a presentation at the 8th Workshop. Apart from some pictures I embedded in this President Message, you will find more photos of the workshop in the 8th ANSHM Workshop Photo Gallery in this Newsletter.

With kind regards,

Tommy Chan

President, ANSHM

www.ANSHM.org.au

AUSTRALIAN NETWORK OF STRUCTURAL HEALTH MONITORING

Newsletter

# Damage Detection in Suspension Bridges Using Vibration Characteristics

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Suspension bridges are increasingly used in today's infrastructure system to span large distances and are rich in architectural features and aesthetical aspects. However, their main cables and hangers are prone to corrosion (Qiu et al. 2014; Sloane et al. 2012) and fatigue damage. There is thus a need for a simple and reliable procedure to detect and locate such damage in these important structural members so that appropriate retrofitting can be carried out to prevent bridge failure. Structural Health Monitoring (SHM) has emerged as a technique that can address this need.

Current SHM systems are integrated with a variety of damage detection methods, which are global and local in nature. Limitations in local methods necessitate the non-destructive and global techniques for damage diagnosis. This has led to continuous development in vibration based damage detection (VBDD) methods in SHM systems. Due to the difficulties of extracting many vibration modes in large civil structures like suspension bridges, applicability of existing VBDD methods has been limited. Moreover, those bridges vibrate with lateral, vertical, torsional and coupled modes and their vibration patterns are complex making it very difficult to identify the damage sensitive modes. These reasons motivated a comprehensive research project to be undertaken with the aim of developing and applying a simple and efficient VBDD technique to detect and locate damage in the main cables and hangers of a suspension bridge. Towards this end, mode shape component specific damage indices (DIs) based on modal flexibility (MF) were developed and applied in four case studies under a range of damage scenarios. Further, proposed method incorporates only a few lower order modes to detect and locate damage in the main cables and hangers of suspension bridges.

Four case studies were undertaken to verify the performance of these DIs and they cover simple to complex cases. These studies were carried out using finite element (FE) models which were validated with results from self-performed experiments and vibration data from the literature. In this research article, some damage detection results associated with the case study involving a 4m long laboratory model of a suspension bridge model are presented. The proposed method (derivation of DIs) is comprehensively illustrated in a previous publication by the authors (Wickramasinghe et al. 2016). Equations 1 and 2 define the DIs that were developed for the study. In these equations, $i$ ($i=1, 2, 3 \ldots m$) is the mode number and $\phi_{xi}$ is the value of the $i^{th}$ mode shape at location x. Further, $m$ and $\omega_i$ are the total number of modes considered and the natural frequency of the structure at mode $i$, respectively. Subscripts $D$ and $H$ denote the damaged and undamaged (healthy) states of the structure respectively.

While *V* and *L* denote the vertical and lateral components of mode shapes, respectively.

$$DI_V = \frac{\left[\sum_{t=1}^{m} \frac{1}{\omega_t^2} \phi_{xt} \phi_{xt}^T\right]_{DV} - \left[\sum_{t=1}^{m} \frac{1}{\omega_t^2} \phi_{xt} \phi_{xt}^T\right]_{HV}}{\left[\sum_{t=1}^{m} \frac{1}{\omega_t^2} \phi_{xt} \phi_{xt}^T\right]_{HV}} \quad (1)$$

$$DI_L = \frac{\left[\sum_{t=1}^{m} \frac{1}{\omega_t^2} \phi_{xt} \phi_{xt}^T\right]_{DL} - \left[\sum_{t=1}^{m} \frac{1}{\omega_t^2} \phi_{xt} \phi_{xt}^T\right]_{HL}}{\left[\sum_{t=1}^{m} \frac{1}{\omega_t^2} \phi_{xt} \phi_{xt}^T\right]_{HL}} \quad (2)$$


**Figure 1.** The laboratory suspension bridge model

**Table 1-Damage Cases**

| Damage Case | Location | Severity of Damage |
|---|---|---|
| DC 1 | Damage at middle of TSC 1 (X=2.250m to X=2.475m) | 20% |
| DC 2 | Damage at quarter of TSC 1 (X=1.125m to X=1.350m) | 20% |
| DC 3 | Damage at two locations of TSC1 (X=1.125m to X=1.350m) and (X=3.150m to X=3.375m) | 20%<br>10% |

The laboratory suspension bridge model consists of three sets of cables namely; top supporting cables (TSC), pre-tensioned reverse profiled (bottom) cables (RPC) in the vertical plane and pre-tensioned bi-concave side cables (BCSC) in the horizontal plane as shown in Figure 1. Three damage cases, all pertaining to damage in TCS1 are described in Table 1. Damage detection results for $DI_V$ and $DI_L$ in both TSCs (TSc1 and TSc2) are presented in Figure 2 (a) to (f). These results confirm that $DI_V$ performs well in detecting and locating damage in TSC1 in both single and multiple damage cases.

Further evaluation of $DI_V$ was conducted to test its capability to detect 20% and 10% damage at mid and quarter spans for 2 cases: (i) damage across a small length of 0.09m or 2% of cable length and (ii) limited modal data from 5 sensor locations. In the latter case, five $DI_V$ data points were calculated (directly from 5 mode shape data points) and then $DI_V$ curve was fitted with cubic spline interpolation to produce the complete $DI_V$ curve as shown in Fig. 4 (a) and (b). Results in Figs 3 and 4 once again confirms the robustness of the $DI_V$ index.

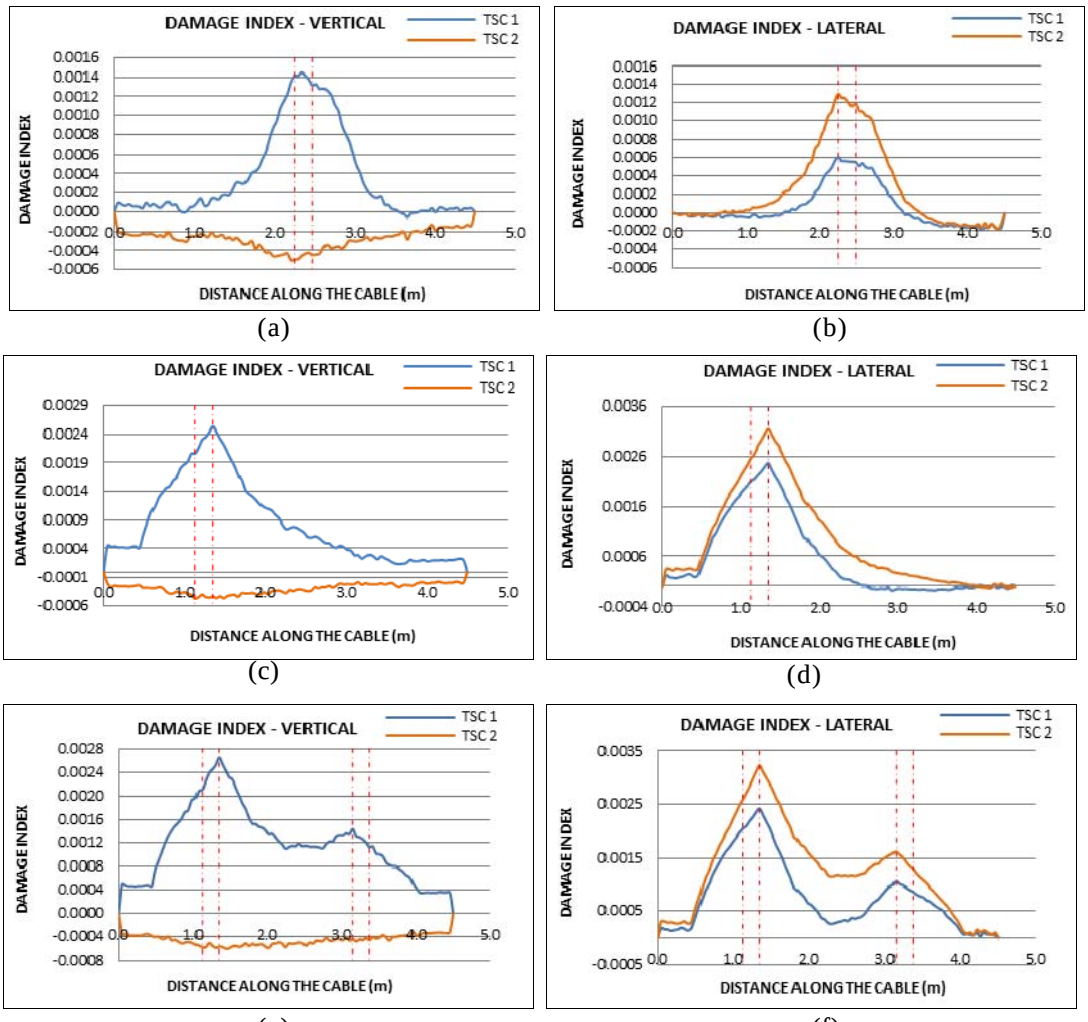
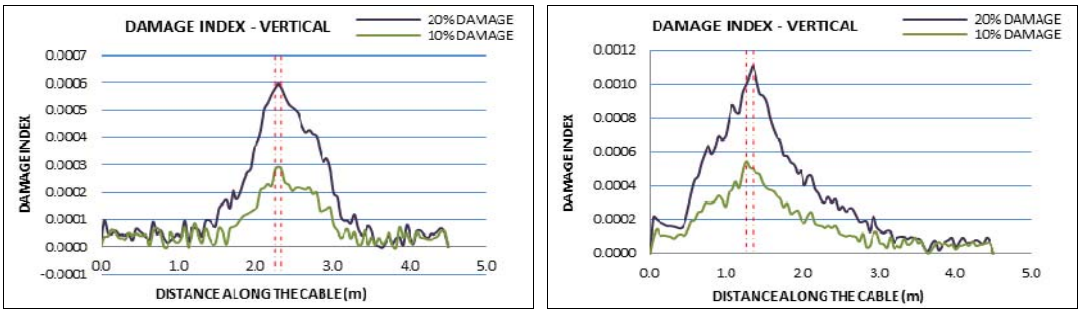
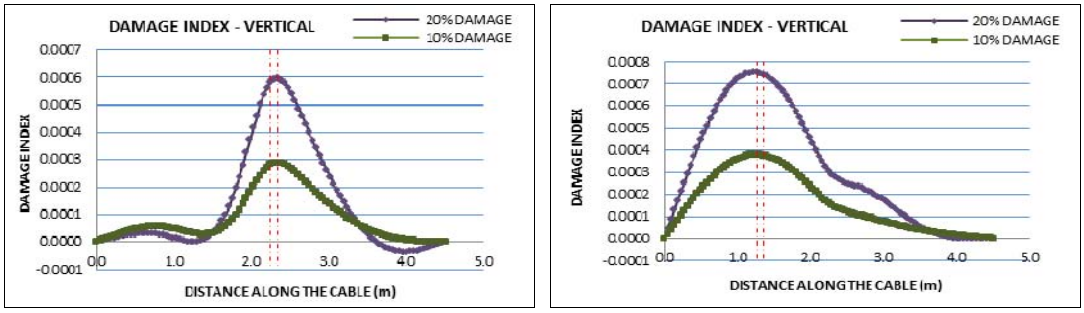



**Figure 2.** DC1-(a)$DI_V$ and (b)$DI_L$ , DC2-(c)$DI_V$ and (d)$DI_L$ , DC3-(e) $DI_V$ and (f) $DI_L$




(a) (b)

**Figure 3.** DC1-(2%) damage length with (a) Damage at mid span (b) Damage at quarter span




(a) (b)

**Figure 4.** DC1-DI calculated with limited sensors and fitted with cubic spline
(a) Damage at mid span (b) Damage at quarter span

This research project treated the development and application of a VBDD method which incorporates only a few lower order modes to detect and locate damage in the main cables and hangers of suspension bridges. Towards this end, mode shape component specific DIs based on MF were derived and applied. Four case studies were carried out to evaluate the competency of the DIs. For brevity, only few results from one case study were briefly presented here. Results from all the case studies demonstrated the competency of $DI_V$ to successfully detect and locate damage in the main cables and hangers of suspension bridges. The findings of this research project will find applications in enhancing the safety and performance of suspension bridges.

## Reference

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AUSTRALIAN NETWORK OF STRUCTURAL HEALTH MONITORING

Newsletter

# State-of-the-art of Ultrasonic Monitoring of Concrete

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## Introduction

Ultrasonic methods are well established in various aspects of concrete testing. They are used for imaging the interior geometry of constructions, estimation of concrete strength or monitoring lab investigations. However, so far the detection of distributed damages, especially in an early stage, has been almost impossible. The arrival of new technologies as deep penetration ultrasonic echo devices, new imaging techniques, embedded transducers for permanent monitoring and sensitive data processing techniques adopted from seismology have opened new fields of work. Recent research has been focused to detect changes in concrete elements induced by stress, temperature, moisture or chemical attacks.

## Advances ultrasonic echo testing

The state of the art in ultrasonic echo testing has already reached a high level. Commercial instruments with point contact shear wave transducers (around 50 kHz) are available in monostatic and multistatic configurations. Even an instrument including fully automated data acquisition and imaging is available. The imaging methods as well have made good progress. Most of the methods applied are based on SAFT (synthetic aperture focusing technique). Most versions are limited to amplitude imaging while recent research has shown, that using phase evaluation it is possible to distinguish low and high impedance reflectors, e.g. to identify voids in tendon ducts. The stat of the art is given e.g. in Krause et al. (2011) and Schulze et al. (2014).

Recently the demand has arisen to image very thick concrete structures, e.g. safety containments of nuclear power plants or massive foundation slabs. Conventional instrumentation is limited to 1.5 m maximum. A new device has been developed at BAM called Large Aperture Ultrasonic System (LAUS). It consists of separate wireless transceiver arrays with 32 point contact transducers each (Figure 1 left). First experiments have shown, that penetration depths up to 5 m can be reached. Recently the system has been deployed to practical application tests. Figure 2 shows measurements and imaging results on a prestressed concrete bridge, where we have been able to image the 1.8 m deep tendon ducts as well as the 2 m deep lower boundary.

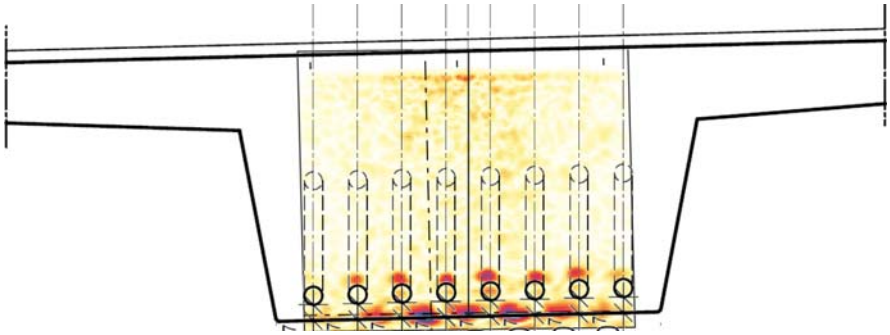

**Figure 1.** Left: The LAUS applied on a prestressed concrete bridge; Right: SAFT imaging result superimposed to the construction drawing showing the position of the tendon ducts and thickness of the construction.

However, the capabilities of imaging are still limited. SAFT is not able to reveal complex structures, e. g. the shape of tendon ducts of vertical boundaries. Recently geophysical imaging techniques have gained interests. We have chosen to evaluate RTM (Reverse Time Migration) which has been developed for seismic oil exploration. We have performed various tests on synthetic data and real measurements. Despite certain limitations (artefacts, computing costs), we have been able to map certain features as vertical steps in boundaries, hidden vertical cracks or the full perimeter of tendon ducts. The current state of our research is given in Müller et al. (2012), Grohmann et al. (2015) and Grohmann et al. (2016).

### Ultrasonic Monitoring

Ultrasonic monitoring is by no way a new method. Transmission measurements as in the well-known Ultrasonic Pulse Velocity (UPV) method are used since decades mainly in the laboratory but also in field applications. However, sensitivity to subtle changes is very limited as well as the volume covered by a specific transmitter-receiver pair. Recent research and development has added new methods to the toolbox of scientists and engineers. Techniques as Coda Wave Interferometry (CWI), originally developed for seismology can resolve changes in ultrasonic velocity in the order of $1*10^{-5}$. Research groups mainly in the U.S., France and Germany are applying this technique in concrete monitoring applications, up to now mainly in the lab (an example is given in Stähler et al., 2009), for a review see Planes et al. 2013). It has been shown that the velocity changes and correlation values determined by CWI can be used to detect changes in stress, temperature, moisture and any degradation mechanism which adds cracks or changes the crack pattern (Figure 2).

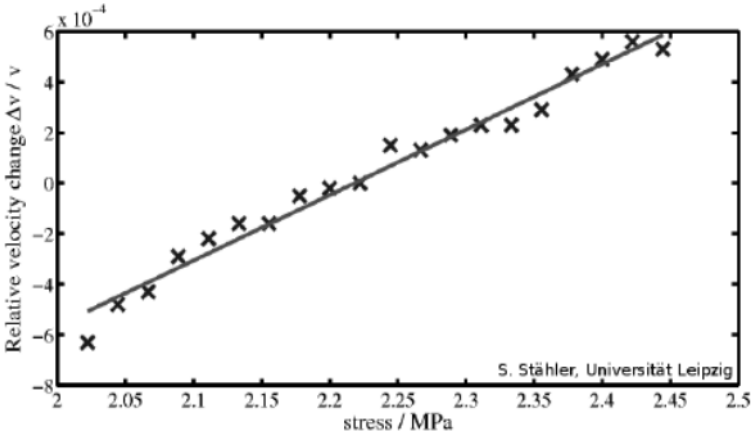


**Figure 2**. Velocity change due to stress change in concrete cube subjected to uniaxial load; Source: Stähler et al. (2009).


**Figure 3.** Ultrasonic transducers for embedment in concrete.

To allow permanent monitoring we have developed robust transducers for embedment in concrete (Figure 4). The have a frequency range between 40 and 90 kHz and emit/receive mainly in/from the radial direction. Due to the inherent scattering in concrete they work almost omnidirectional in practice. They have meanwhile been used in many lab experiments as well as in a few applications in real constructions (bridges, tunnel). Figure 4 shows an example where a network of transducers was implemented in a test block, which was subjected to local compressional load.

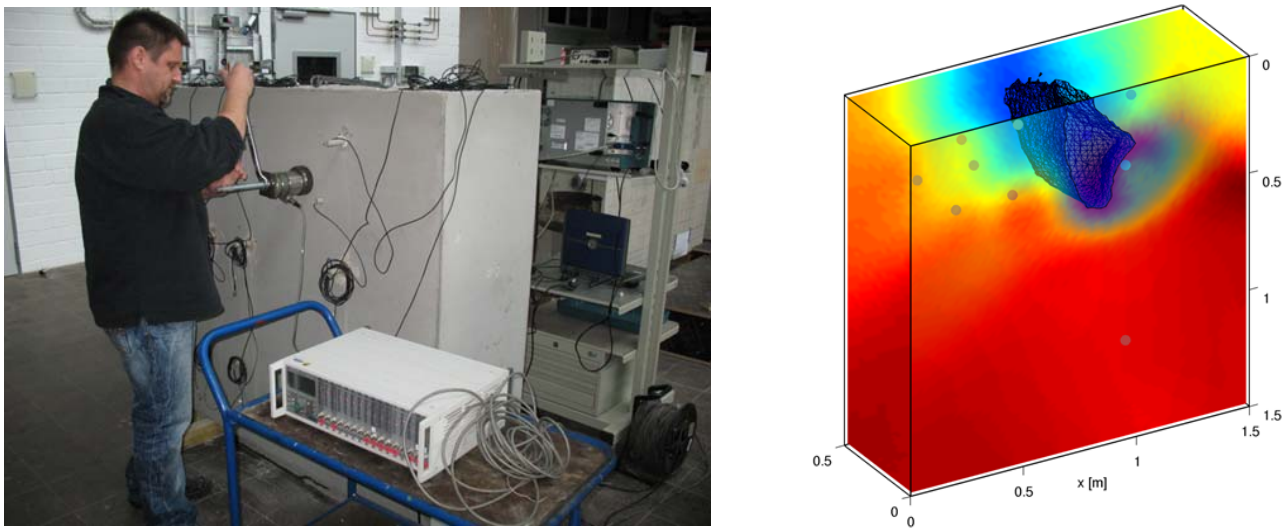


**Figure 4.** Left: Local load applied to a concrete block monitored by a network of ultrasonic transducers. Right: Decorrelation imaging of the changes in the ultrasonic signal, revealing the area of the block affected by the load; Source: Niederleithinger et al. (2014).

The data acquired before and during loading were processed by decorrelation imaging, a technique which can be described da tomographic CWI. It reveals the position of the greatest changes in the signals (blue), thus revealing the volume affected by the load.

It is believed that the techniques described here will lead to early warning systems for slowly developing damage mechanisms as ASR, freeze-thaw, rebar corrosion or fatigue as well as sudden failure due to excessive shear or loss of prestress.

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# 8th ANSHM Workshop-Photo Gallery

*Opening Speech by Prof Ian Smith, Vice-Provost of Research, Monash*


***Oral Presentations I (29 November 2016)***



# 8th ANSHM Workshop-Photo Gallery

*Morning Tea (29 November 2016)*

*Oral Presentations II (29 November 2016)*



*Oral Presentations III (29 November 2016)*




***Industry Presentations (30 November 2016)***

***Industry Forum (30 November 2016)***


## Conference News

- ANSHM mini-symposium in the ***24th Australasian Conference on the Mechanics of Structures and Materials (ACMSM24)***, 6-9 Dec 2016, Perth, Australia. Organized by Prof. Tommy Chan, Prof. Jianchun Li, and Dr. Jun Li. (http://scieng.curtin.edu.au/acmsm24/)
- ***6th Asia-Pacific Workshop on Structural Health Monitoring,*** Hobart, Tasmania, 7-9 December 2016. (http://eng.monash.edu.au/mechanical/shm/)
- ***Structural Health Monitoring of Intelligent Infrastructure Conference 2017,*** 6-8 Dec 2017, Brisbane, Australia. Organized by ANSHM. (http://shmii2017.org/)
- Joint COST TU1402 – COST TU1406 – IABSE WC1 Workshop, ***The Value of Structural Health Monitoring for the reliable Bridge Management***, Zagreb, Croatia, 2-3 Mar 2017. (http://www.grad.unizg.hr/joint-zagreb-workshop)
- ***12th International Conference on Structural Safety & Reliability (ICOSSAR 2017)***, 6-10 August 2017 in Vienna, Austria. (http://www.icossar2017.org/)

## Social Media

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