

## Issue 4, June 2015

### Contents

President Message.....	1
Structural Health Monitoring Group at the University of Adelaide .....	6
Sustainable Infrastructure Research Theme in Deakin.....	9
ASCE Brisbane August Lecture.....	11
Conference Information and Social Media.....	12
Acknowledgment.....	12

### President Message

*Tommy Chan*

*Professor in Civil Engineering, Queensland University of Technology*

Dear All,

Time flies and here we have our 4<sup>th</sup> issue. I should thank Dr Jun Li and his editorial team to take up this difficult task and make it a success to use it as an important platform for communication among us.

Each year in May, we all look forward to seeing if there is any good news from the Federal Budget. Some may be happy and some may be disappointed. For this year, it can be seen that the National Collaborative Research Infrastructure Strategy (NCRIS) will be funded for a further year, using funds from the Sustainable Research Excellence in Universities (SRE). The SRE was budgeted to grow, but will fall by around \$100 million in 2016-17 before returning to 2015 levels in later years: in total some \$263 million will be cut from SRE. It seems that the NCRIS also comes at the expense of \$212.5 million cuts to university research and \$26.8 million in cuts to the Cooperative Research Centres program over four years. The research environment will continue to be not easy in the coming years, except the medical research. The Federal Budget will allocate \$10 million to the Medical Research Future Fund in the coming financial year, with the government fund bumped up to \$400 million for medical researchers by mid-2019. The researchers conducting medical research are very pleased with this budget. Prof Doug Hilton, president of the Association of Australian

# Newsletter

Medical Research Institutes (AAMRI) considered this as “a wonderful outcome”. “We also know that there is a lot of research that needs to be done into the health system itself – the way it operates and ways to make it more efficient,” he said. “With an ageing population you want to be able to provide a world-class health system within a limited budget.” To me, I consider this statement is equally true when applied to SHM, with a minor modification of his statement as

“We also know that there is a lot of research that needs to be done into *the structural health monitoring system* itself – the way it operates and ways to make it more efficient. With an ageing *infrastructure* you want to be able to provide a world-class *structural health monitoring system* within a limited budget.”

I strongly believe that under this not so promising research environment for SHM, ANSHM has a very important role to play. We should continue to apply research funding through various means, like ARC Discovery, Linkage, etc. Research collaboration amongst different universities and incorporating the expertise from different universities as required in the proposed project will always strengthen the proposal. ANSHM will aim to establish more of this kind of projects through our different established platforms like our Homepage, newsletters, conferences, workshops, special sessions, special issues, various social networks (ANSHM Facebook and ANSHM LinkedIn), etc. In the past few years, we have also been trying our best to play a more proactive role to establish an ANSHM based project. However we also need to admit that it is not an easy task due to different constraints, e.g. ARC policies, difficulties for road authorities in allocating funding for research. Therefore we will still work on it and be well prepared when opportunities come, e.g. ARC Industrial Transformation Research Program. Actually my dream is that we could establish a Centre of Excellence for SHM. Meanwhile we will continue to use our established platforms to promote the SHM technology, exchange ideas on various topics related to SHM and share the successful experience in applying this new technology and understand better the needs of the asset owners. I am so pleased to see that numerous real-life SHM applications were made visible through these established platforms. We will also try our best to work with various road authorities and asset owners to apply SHM technologies to meet their needs and help them manage their assets in a more cost-effective and efficient manner for the safety of their assets and the public.

In this issue of Newsletter, we have two reports on the SHM research in the University of Adelaide and the Deakin University respectively. Alex writes a very interesting article about how his SHM Group at U of Adelaide uses Lamb waves to achieve quantitative imaging of the local damage in plate-like structures. Ying also gives a very interesting article introducing the Sustainable Infrastructure Research Theme in Deakin U.

# Newsletter

## ANSHM Special Issues

We have published a number of special issues in various high impact international journals. However it is also because we have published so many special issues in these years, e.g. currently we are working on two special issues, I received requests asking me to clarify each of these special issues in terms of how they are generated. Below I give a summary of all the special issues and other publication that we published or are working on for the clarification.

- i. A book entitled "*Structural Health Monitoring in Australia*" published in 2011, for publications arisen from the 1<sup>st</sup> ANSHM Workshop, signifying the establishment of ANSHM in QUT, Brisbane, 2009.
  - ii. Special issue in *Advances in Structural Engineering* in 2012, for publications arisen from the 2<sup>nd</sup> ANSHM Workshop, UTS, Sydney, 2010.
  - iii. Special issue in *Australian Journal of Structural Engineering* in 2013, for publications arisen from the 3<sup>rd</sup> ANSHM Workshop, Deakin U, Geelong, 2011.
  - iv. Special issue in *Journal of Civil Structural Health Monitoring* in 2013, for publications arisen from ANSHM Mini-Symposium in PLSE 2012, Hong Kong.
  - v. Special issue in *International Journal of Structural Health Monitoring* in 2014 for publications arisen from the 4<sup>th</sup> ANSHM Workshop, U of Adelaide, Adelaide, 2013.
  - vi. Special issue in *Electronic Journal of Structural Engineering* (to be published in June 2015), for publications arisen from the 5<sup>th</sup> ANSHM Workshop, U of Melbourne, Melbourne, 2014.
  - vii. Special issue in *Structural Monitoring and Maintenance* (to be published in September 2015), publications arisen from the ANSHM Mini-Symposium in SHMII 2013, Hong Kong.
- Regarding Item vi (Special issue in *Electronic Journal of Structural Engineering*), all the corresponding authors of the accepted papers should have received the request of the completion of Copyright Transfer Form. Please complete and return if you have not done so. We aim to publish the issue in June 2015.
  - Regarding Item vii (Special issue in *Structural Monitoring and Maintenance*), the review process is progressing well. The review comments of 5 of the seven submitted papers have been received. We are grateful to the reviewers for their effort and swift response. We aim to receive all the revised versions by 16 June 2015.
  - Regarding the special issue arisen from the 6<sup>th</sup> ANSHM Workshop, UWS, Sydney, 2014, we have not received the confirmation of the special issue proposal from the two journals that were proposed in the last Advisory Broad Meeting in the 6<sup>th</sup> ANSHM Workshop. Xinqun will contact the editor of another high impact international journal for the possibility of having the special issue in the journal.

## **Mini-Symposium in PLSE 2015**

As stated in one of my messages sent in early May that Saeed and I will organize a mini-symposium jointly with Prof Y.Q. Ni of the Hong Kong Polytechnic University at PLSE 2015, which will be held in Brisbane from 9-11 December 2015 (<http://plse2015.org/>). The mini-symposium will be entitled "Structural Health Monitoring for Performance Assessment & Recent Research by Australian Network of Structural Health Monitoring". If you would like to give a presentation at the mini-symposium, no matter you have submitted the abstracts to Prof Ni, Saeed or myself or not, please send your full paper to Saeed (ssmahini@gmail.com) and cc me (tommy.chan@qut.edu.au). The deadline of the full paper submission will be 20 June 2015. The Full Paper submission instructions and the Full-paper sample template could be downloaded through <http://plse2015.org/full-papers/>. Please DO NOT submit it online via the PLSE site, as we have a separate review process and we do not need to follow the official deadlines. We only need to have all the accepted papers in final form to be delivered to the Organizing committee by 1st September 2015.

## **SHMII 2017**

The first SHMII 2017 Local Organizing Committee meeting has been held on the 2nd of June 2015. This meeting was a steering committee meeting consisting mainly of the ANSHM Executive Committee members. There are others who have already agreed to join the LOC and we have not invited them this time to join this meeting because we just need this one mainly for the preparation on the promotion in SHMII 2015, Turin, such as Logo design. We will invite other LOC members to join the LOC meetings in the future. We will also invite more people to join the LOC later.

## **ANSHM Mini-symposium in SHMII 2015, Turin Italy**

The final program for ANSHM mini-symposium at SHMII 2015 has been scheduled and submitted to the conference secretary. This mini-symposium will be one of the best in the history of ANSHM. As mentioned in my last monthly update that our mini-symposium at SHMII 2015 is the second largest in this SHMII. There will be 18 presentations and many of us will be attending, including 7 of our Executive Committee members and 1 Advisory Board Member (not counting those who are also ECM). We have been assigned one full day symposium from 8:30am – 5:40 pm (2<sup>nd</sup> July 2015). I really look forward to it.

## **ANSHM Workshops**

As mentioned in my last updates that the 7<sup>th</sup> ANSHM Workshop will be hosted by the Curtin University from 26-27 November 2015. We are also excited to know that another university is very

# Newsletter

interested to host the 8<sup>th</sup> ANSHM Workshop 2016. We are heartened by their being so keen to express that in a number of occasions to me as well as to Ulrike, our Workshop Coordinator. We will make the decision accordingly and announce that in due course. In order not to confuse the members, we will focus more on the 7<sup>th</sup> ANSHM Workshop in Perth this year. For your information, based on our experiences in organizing various ANSHM Workshops, the EC is working on formulating the Guidelines for Hosting of ANSHM Workshops by Ulrike.

## **ANSHM LinkedIn**

As mentioned above, we consider it is important to use social network as a means of communication. Besides ANSHM Facebook, we have also established the LinkedIn ANSHM group. It is open now. It provides a platform to help us exchange ideas on various topics related to SHM. At the moment, there are 35 members and another 9 people applied to join the group. All ANSHM members are encouraged to use this social media. This platform can run a webforum through 'Discussions', present your case studies through 'Promotions' and recruit PhD students through 'Jobs'. Thank Xinqun so much for his effort in establishing it.

## **Sponsor of MMT 2015**

The 9th International Symposium on Mobile Mapping Technology (MMT 2015) will be hosted by the School of Civil and Environmental Engineering, UNSW Australia in Sydney, 9-11 December 2015. Realizing the Mobile Mapping for Structural Health Monitoring will be one of the key topics at MMT2015, in our last EC meeting, we decided to be a sponsor (not financially) in terms of publicizing that in ANSHM and through our connection. You are welcome to attend or present a paper at this important international symposium ( <http://www.mmt2015.org/> )

With kind regards,

Tommy Chan

President, ANSHM

[www.ANSHM.org.au](http://www.ANSHM.org.au)

# Newsletter

## Structural Health Monitoring Group at the University of Adelaide

### Quantitative Damage Imaging Using Lamb Waves

*Ching-Tai Ng*

*School of Civil, Environmental and Mining Engineering,*

*The University of Adelaide*

#### Problem

Ageing infrastructure is one of the imperative issues worldwide for sustainable development. The need to quickly find creative solutions to address the significant economic implications and the potential risks to public safety is well understood. Hence, the development of robust, cost-efficient and reliable technologies to provide in-situ safety diagnosis of structures is of utmost importance. A local damage at a critical section of a structure can lead to catastrophic failure, which has been demonstrated in a number of structural failures in the past. Apart from the essential requirement that inspection system must be reliable to incipient damages, two highly desirable features are capacity for graphical representation and the ability to evaluate damage quantitatively. Our research group is working on the problem of using Lamb waves to achieve quantitative imaging of the local damage in plate-like structures.

#### Approach

Lamb waves (named after Horace Lamb who first described them in 1917) are also known as guided plate waves. They are a kind of ultrasonic wave that propagates along thin-walled structures with free boundaries, such as plate or shell. They are either symmetric or anti-symmetric in their form. The average displacement of symmetric Lamb waves over the thickness of the structure is in the longitudinal direction, whereas the average displacement of anti-symmetric Lamb waves is in the transverse direction. We are developing a Lamb wave tomographic imaging approach for in-situ safety inspection of structures. Lamb wave tomographic imaging is similar to X-ray computed tomography (CT) but instead of using ionising radiation it employs Lamb waves that can be transmitted across the inspection area from a remote and accessible transducer location. While the interaction of photons with matter can be described by simple ray models in X-ray CT, scattering diffraction and refraction phenomena characterise the encoding of the mechanical property information of Lamb wave signals. Diffraction and refraction add considerable complexity to the problem of retrieving Lamb wave tomographic imaging and managing these phenomena present the main challenge in developing this approach. Therefore at a fundamental level, we are currently

# Newsletter

investigating Lamb wave propagation and scattering characteristics at different types of damages. We have gained a fundamental insight into this physical phenomenon and are currently developing a general approach of Lamb wave diffraction tomography, which can provide a quantitative imaging of the damage.

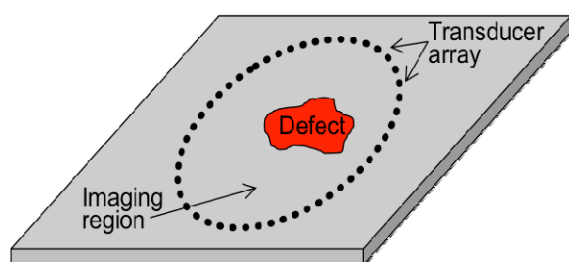


Fig. 1 Schematic diagram of transducer array

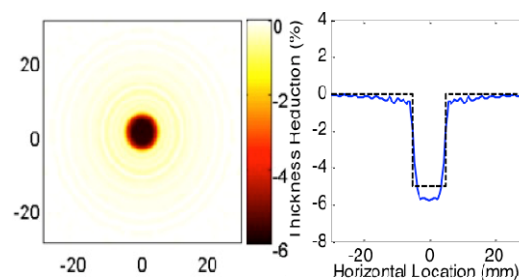


Fig. 2 (a) Reconstructed image of isotropic plate thickness reduction defect using simulated data, (b) profile of the thickness reduction; dashed line shows the actual reduction.

## Recent Findings

The research team has already carried out an extensive investigation. Finite element analysis and laser Doppler vibrometer were used to numerically and experimentally investigate the physical phenomenon of the Lamb wave propagation and scattering phenomena at damages in metallic and carbon fibre reinforced composite laminates. The findings improved the fundamental physical insights of Lamb waves in different types of damage, e.g. corrosion in metallic plate and delamination in composite laminate, which provided a strong theoretical basis in developing a quantitative and cost effective damage imaging technique. A diffraction tomography has been developed and we are currently evaluating its performance using finite element simulation data and experimental verification will be carried out as well.

## Impact

This research could result in an imaging technique for identifying incipient damage in structures. The technique not only quantitatively identifies the location, size and shape of the damage, but also provides a graphical presentation of the damage detection results to assist engineers who are in making judgments about the remedial work.

# Newsletter

## Selected Publications

1. Ng, CT. (2015) “*A Two-stage Approach for Quantitative Imaging of Laminar Damage in Plates Using Lamb Waves*”. *Earthquakes and Structures An International Journal*, 8(4): 821-841.
2. Ng, CT. (2015) “*On the Accuracy of Analytical Modelling of Lamb Wave Scattering at Delaminations in Multilayered Isotropic Plates*”. *International Journal of Structural Stability and Dynamics*, 15(7): 1-12.
3. Ng, CT, Veidt, M. Rose, LRF, Wang, CH. (2012) “*Analytical and Finite Element Prediction of Lamb Wave Scattering at Delaminations in Quasi-isotropic Composite Laminates*”. *Journal of Sound and Vibration*, 33(22): 4870-4883.
4. Ng, CT. (2012) “*Scattering of the Fundamental Anti-symmetric Lamb Wave at Delaminations in Composite Laminates*”. *Journal of the Acoustical Society of America*, 132(1): 115-123.

# Newsletter

## **Sustainable Infrastructure Research Theme in Deakin**

*Ying Wang*

*School of Engineering, Deakin University*

The research theme of Sustainable Infrastructure was established in the School of Engineering, Deakin University, in 2010. Now it incorporates three professors, two associate professors, seven lecturers/senior lecturers, and four postdoctoral research fellows.

The Sustainable Infrastructure Research Theme is dedicated to the establishment of a multi-disciplinary research platform that enables researchers to address current and future challenges in infrastructure engineering. The group works closely with industry using the latest in design, simulation tools, materials, manufacturing processes and monitoring technology. The research team has the expertise to deliver high impact applied and fundamental collaborative research in the areas of structural engineering, corrosion, and water management.

State-of-the-art equipment are available in civil laboratory, concrete laboratory, and light structure laboratory, which enable researchers to undertake various projects. The equipment for structural engineering include general use 100kN load frame, concrete shear and compressive strength load frames, 1000kN Horizontal compression testing load frame, 500kN Load frame with Uniformly distributed load attachment, vibration testing system composing of NI data acquisition system, impact hammer, and accelerometers, NDT guided wave testing system, and ANCO shaker table with 16 input channels.



# Newsletter

Dr Ying Wang now leads the research area of smart structure. To safeguard critical civil infrastructure under extreme loading and enhance their life-cycle performance, his research focuses on the techniques to identify structural damage, to assess structural condition, and to protect structures under extreme loading. His main contributions include the development of innovative structural damage identification algorithms, development and application of spectral element models and guided wave testing methods for civil structures and construction materials, and development of integrated structural health monitoring system and smart structures using local and global methods. Further, he has developed the following new collaborative research programs which distinguish Deakin's structural engineering research.

- Green concrete: the use of waste materials in making concrete, with Ms Eloise Gordon
- Application of machine learning algorithms to structural and geotechnical engineering, together with Dr Suiyang Khoo and Dr An-jui Li
- Corrosion detection and assessment: combining the guided wave based method and electrochemical methods, with Prof Mike Tan
- Carbon fibre reinforced concrete: the development of concrete reinforced by innovative carbon fibre members, with Prof Bronwyn Fox



# Newsletter



AUSTRALIA SECTION

## Brisbane August Lecture

### Recent Advances in Structural Health Monitoring

Hosted by ASCE (American Society of Civil Engineers) Australia Section

**Presented by: Prof Tommy H. T. Chan**

**Date:** Wednesday 12 August 2015

**Time:** 12.30 pm for 1.00 pm

**Venue:** Engineering House 447 Upper Edward Street Brisbane

**RSVP:** [asce.qld@gmail.com](mailto:asce.qld@gmail.com) by 31 July

**Cost:** This is a Free Lecture

Tommy will talk about the recent advances in SHM in three categories, (i) System development; (ii) Sensors/ measurement development; (3) Applications. The concept of a section on SHM in the latest edition of the Australian Bridge Design Codes, AS5100 will be included in the presentation.

## Conference Information

- Mini-symposium “**Structural Health Monitoring for Performance Assessment & Recent Research by Australian Network of Structural Health Monitoring**” with the **Second International Conference on Performance-based and Life-cycle Structural Engineering (PLSE 2015)**, 9-11 Dec 2015, Brisbane, Australia. Organized by Prof. Yi-qing Ni, Prof. Tommy Chan, and Dr. Saeed Mahini.
- **The 7<sup>th</sup> Annual ANSHM workshop**, 26-27 Nov 2015, Perth. Organized by Prof. Hong Hao and Dr. Jun Li
- Mini-symposium “**Research Advances in Structural Health Monitoring – Australian Experiences**” with the **7<sup>th</sup> International Conference on Structural Health Monitoring of Intelligent Infrastructure (SHMII 7)**, 1-3 July 2015, Torino Italy. Organized by Prof. Hong Hao, Prof. Tommy Chan and Dr. Jun Li.

## Social Media

Follow us at the next social media and webpages

- ANSHM Facebook webpage: [www.facebook.com/ANSHMAU](http://www.facebook.com/ANSHMAU)
- ANSHM Facebook group: [www.facebook.com/groups/ANSHM](http://www.facebook.com/groups/ANSHM)
- ANSHM LinkedIn group:  
[www.linkedin.com/groups/ANSHM-Australian-Network-Structural-Health-4965305](http://www.linkedin.com/groups/ANSHM-Australian-Network-Structural-Health-4965305)

## Acknowledgement

Sincere thanks go to Dr. Johnson Shen for his kind assistances to edit and proofread the articles.

Welcome your any comments and suggestions, please contact

Newsletter Editor: Jun Li, Curtin University, Kent Street, Bentley, WA 6102.

Email: [junli@curtin.edu.au](mailto:junli@curtin.edu.au), Tel: +61 8 9266 5140.