

Newsletter

Issue 11, March 2017 Contents

President Message.....	1
Advanced Asset Health Indicators for Utility Wooden Poles.....	7
Optical Measurement Solutions for SHM in Cable-stayed Bridges.....	11
Conference News.....	13
Social Media.....	13

President Message
Tommy Chan

Professor in Civil Engineering, Queensland University of Technology

Dear All,

Time flies and this is the 11th Issue of the ANSHM Newsletter. I am very pleased to know that some engineers from industry including road authorities enjoy reading our Newsletter. You could have noticed that many of the discussions in the ABM and AGM in the 8th ANSHM Workshop related to strengthen the links between the industry and the academics so that the industry could know more about SHM. It seems that our Newsletter has been serving as an effective way for this purpose. For the past 10 issues, we have published 22 articles and 17 of them are from academic institutions and 5 of them are from private companies or research institutions. For this issue, we have all the two articles from the industry. I am so glad that now even some private companies are also prepared to contribute articles related to SHM. Thank Jun and Andy for their effort for the past few years. In recent discussions with them, their concern is about collecting good articles to publish on each issue. From a rough estimation, ANSHM has members from 36 organisations, 19 of which are universities, 8 are private companies, 6 are road authorities and 3 are research organisations. I understand some of these organisations may have heavier involvement with SHM than others. Under some careful planning, we should be able to keep having articles to be published in the Newsletter about their work related to SHM. Also, it will provide very good opportunities for those who are doing postgraduate research on SHM to report the progress of their work in the Newsletter. I believe Jun and Andy will formulate a good plan and strategy to collect articles for each issue. Please respond to them when they request any support or information from you.



Newsletter

Below are some updates of the month.

SHMII-8 2017 (<http://shmii2017.org/>)

First of all, let me express my gratitude towards your patience. I understand that some information you expect to publish on the Conference webpage has not been released. We are striving to finalise these but some of them are out of our control. Please accept my apology. Having said that the organising of the conference has been progressing well. I should thank all the Executive Committee, especially Saeed, who have been working so hard for organising the conference. Below are updates.

- *Sponsorship*

The responses to our call for Sponsorship are good. So far, we have received two universities each agreed to sponsor \$5000 to the conference. A road authority has agreed to be a Gold Sponsor. Since it is a government organisation, we are preparing a document for them to arrange the funding. A private company has also agreed to be an exhibition sponsor. Besides, many of my connections have expressed their interests to be a sponsor and they are seeking advice from their internal offices in charge. I believe also there are some organisations/companies locally, interstate or overseas, are prepared to become an exhibitor. I am quite optimistic to reach the amount we budgeted for the conference. However, we should also keep on letting our connections know there is an opportunity for them to sponsor this conference, as they may like to use it as a way to showcase their products, services etc., to the delegates from all over the world. Please click (http://shmii2017.org/wp-content/uploads/2016/12/SHMII-Sponsorship_191216.pdf) to download the 2017 SHMII-8 Conference sponsorship prospectus. If you have already sent the prospectus to your connections, please follow up. Hong Guan is doing the coordination of the sponsorship and you may have already received her reminder about that.

- *Responses to Call for Abstracts/Organising of Mini Symposia and Special Sessions*

Upon the close of call for abstracts, we have received more than 200 abstracts and three proposals for organising MS/SS. Besides, ANSHM will also organise a mini-symposium as the 9th ANSHM Workshop (please see below for more details). Also, after the close of abstracts, we are still receiving abstracts each day. Therefore, it is expected that we will have around 300 abstracts. We will dispatch the acceptance of letter very soon and we may have over 250 papers for the conference. We plan to have around 235 presentations in the conference it seems that our estimation is very close to the actual situation. At the moment, the Editorial sub-committee is formulating an effective way to conduct the review of papers later.

Newsletter

- *Keynote speakers*

We need to finalise the six keynote speakers very soon. We select these speakers based on locations (with an aim to have speakers from different continents or countries) and topics. As SHMII is a conference of ISHMII, we need to consider their interests for the keynote as well. We are working on the list of keynote speakers to be invited. Once it is confirmed (which will be very soon), we will then start the invitation accordingly. We will also prepare a list of alternatives to fill up these speaker places in case those identified ones are not available.

- *International Scientific Committee*

We have compiled the list for International Scientific Committee members. We will send the invitation letters to our International Scientific Committee very soon. We expect that they will help us to review the conference papers as well as helping us to publicise the conference. This could help further to attract more delegates outside Australia and more MS/SS organisers.

- *Registration Fee*

Since ISHMII is at a transition of changing its President, there is some delay in the signing of the contract for the Conference. Dr Wolfgang Habel, the former President has been working with us closely regarding SHMII-8 for last few years and Prof Zhishen Wu, the new President is also very supportive and helpful. I expect the contract will be signed very soon and then the registration fee details will be provided on the Conference webpage.

9th ANSHM Workshop

It was confirmed in the last EC meeting that, the 9th ANSHM Workshop will be incorporated into the SHMII-8 and it will be organised by QUT. Normally our annual workshops will have three main components:

- I. Presentations
- II. Industry Forum
- III. Advisory Board Meeting and Annual General Meeting

Andy and I will organise a Mini-Symposium entitled “Recent SHM advances in Australia” in this conference to use it as the Presentation Component of the Workshop. For the second component, Industry Forum, we will conduct a larger scale Forum as compared to previous ones and this Forum will be included in the Conference Programme. For the meeting component, we will try to arrange the

Newsletter

Advisory Board Meeting immediately before the Welcome Reception and the Annual General Meeting in an appropriate time slot.

Regarding the Presentation Component, you may have received our email regarding the Call for abstract and paper for the ANSHM mini-symposium. For your convenience, I re-state below the key dates for submission of abstract and full paper for this mini-symposium

10 Mar 2017

Deadline for abstract

10 Jun 2017

Deadline for full paper manuscript

Abstract and full paper should be sent directly through email to the mini-symposium organisers as below (please include both of the email addresses in your submission email for the purpose of cross-checking).

Professor Tommy Chan

tommy.chan@qut.edu.au

Dr Andy Nguyen

a68.nguyen@qut.edu.au

If you already submitted abstract through SHMII-8's OpenConf platform or its submission email address, you could still submit to this mini-symposium by notifying us of your previous submission detail (e.g. your abstract ID). We will liaise with SHMII-8 editorial team to direct your abstract into ANSHM mini-symposium. Each accepted paper of ANSHM mini-symposium with a confirmed presenter will be included in the conference proceedings. More details of this mini-symposium will be released close to the conference date.

ANSHM Special Issues

In JCSHM

I suppose you have already received the reminder email by Colin dated 23 Feb 2017. Up to now, 1 manuscript has been received. Please note that the submission deadline due on 30 March 2017. Please prepare your paper following "Introductions for Authors" (<http://www.springer.com/engineering/civil+engineering/journal/13349>) and submit online to this issue 'SI: Structural Identification and Evaluation for SHM Applications' through the official journal submission system. It is important to select the correct 'SI', otherwise your paper will be dealt with the Chief Editor and considered as a general submission.

In IJLPE

The review process of the three submitted papers have been completed. These three papers will be published as general articles. Thank you for those who have helped as reviewer.

Newsletter

ANSHM Forum – Physical/WebForums

In our last EC meeting, we have some discussion on how we could strengthen or establish channels to collect the views from the Industry and to educate the industry to know the importance of SHM and how it could be applied. ANSHM Newsletter is an effective way. However, we also need some other platforms that could help to know the needs of the industry so that we could ensure our research aligns well with their needs. A forum is an effective way. We consider the Industry Forum (physical forums) we have each year at our annual workshop is a very successful way. WebForums will also be good. We have been working hard on this for the past few years. For this year, Xinqun, Ulrike and Lei will work together to explore and devise ways to use social media like LinkedIn, Facebook, and our webpage to make it more effective to achieve our targets. We will give you more details in due course.

ANSHM Membership

The annual membership renewal for this year was completed. Based on the email returned as mentioned in the last monthly updates. In total, we have 15 Core members for this year. Since our next ANSHM Workshop will be incorporated in the SHMII-8, there will be quite a number of ANSHM members attending the conference. Therefore, most likely we will not automatically renew the Core membership if the members attend the Workshop as previously. Otherwise, we may have too many Core members and this will induce a problem in meeting the quorum requirement for the AGM in 2018. It was suggested that the Core membership renewal will be based on the email to be sent out after the SHMII-8 for annual membership renewal.

Information on Research Collaboration

We are still collecting information of research projects that involves industrial collaboration. We plan to put some successful stories of completed / on-going / potential industry collaboration projects on the ANSHM website. As mentioned previously, this will provide a platform for sharing information and help our members to have a better picture about how we get involved with the industry and assist industry partners to identify suitable expertise in the SHM field. Please note that this platform can help promote your research capability by showcasing of your successful industry collaboration story, and let others, nationally and internationally about SHM in Australia.

We also discussed in the last EC meetings the need to prepare an ANSHM successful story to show our strengths in our expertise and collaboration. It will be very useful for us include this for our future request for research funding for the ITRP. We have prepared something similar in the past and we could write this story based on our previous materials prepared. Jianchun has been appointed to take the leadership role on this to prepare it with Tuan and Alex.

Newsletter

Regarding this issue, as mentioned at the start of this message, I mentioned that both of the articles from this issue are from the industry. Kia and McLeely from Reliable Lines present a state of the art non-destructive testing (NDT) system for assessing utility poles. Using eight transmit-receive sensors wrapped around the pole's cross section, this system is capable of mapping test data for the purpose of indicating anomalies as well as producing advanced asset health indicators such as Percentage Remaining Strength and Probability of Failure for wooden poles. Huxley and Wang of Warsash Scientific introduce non-contact laser-based vibration analysis techniques including the use of long range laser vibrometers RSV-150 that could be used to determine vibration characteristics and tension forces of stay cables in cable-stayed bridges.

With kind regards,

Tommy Chan

President, ANSHM

www.ANSHM.org.au

Newsletter

Advanced Asset Health Indicators for Utility Wooden Poles

Jalal Kia & Dan McLeely¹

¹ *Reliable Lines Pty. PwC, 2 Riverside Quay, Southbank VIC 3006, Australia.*

Abstract

The problem of assessing condition of in-service wooden structures and identifying their suitability to withstand extreme wind loads can effectively be handled by performing non-destructive testing and a comprehensive engineering load analysis. We present a state of the art non-destructive testing (NDT) device and introduce a method for quantifying the reliability of the poles under extreme wind loads. The suggested solutions provide a way to obtain advanced asset health indicators namely Remaining Strength and Probability of Failure of the poles. These asset health indicators can be used to establish an effective maintenance program.

Overhead utility poles health indicators

Wooden poles used for electricity distribution deteriorate with age. As an example, about 70 per cent of the 8.5 million wooden poles in service as part of the electricity distribution infrastructure in Australia are over 35 years old. These aging wooden poles are at different stages of degradation as demonstrated by various pole testing trials over the last few decades. Utilities that take a more scientific approach to the life cycle management of their wooden poles have realized that use of non-destructive testing methodologies and engineering load analysis are the most efficient and cost effective ways to maintain their assets. The combination of non-destructive pole testing and engineering load analysis produces structural health indicators which can be used to determine when a pole needs to be replaced or maintained. This approach maximises the reliability of the network while minimizing unnecessary pole replacements.

Reliable Lines has been involved in research and development of an automated NDT device and its accompanying mobile software called Pole Tester. The Pole Tester device with its 8 transmit-receive sensors is attached around a cross-section of the pole. Pole Tester complemented with a data capture software application is capable of identifying Percentage Remaining Strength of the pole. This is a very effective health indicator that the asset manager can use to determine whether a pole needs to be replaced immediately or not.

While a very low remaining strength value can trigger immediate pole replacement, the majority of poles would have a range of values from low to high. It is vital that the calculated remaining strength value be used in an engineering load calculation system to find other health indicators that can be used to determine whether the in-service pole is capable of withstanding extreme wind loads.

Newsletter

Reliable Lines has also developed a mobile software application called Pole Designer that is capable of calculating extreme loads on overhead structures. The Pole Designer application captures information such as pole dimensions, conductor spans, bearings, sags and surface areas to winds and builds statistical distribution models of pole strength and historical regional extreme wind loads. The output of the engineering analysis is Probability of Failure and its corresponding Reliability Index. Figure 1 demonstrates a block diagram view of Pole Designer software highlighting the data capture, calculation modules and reported health indicators.

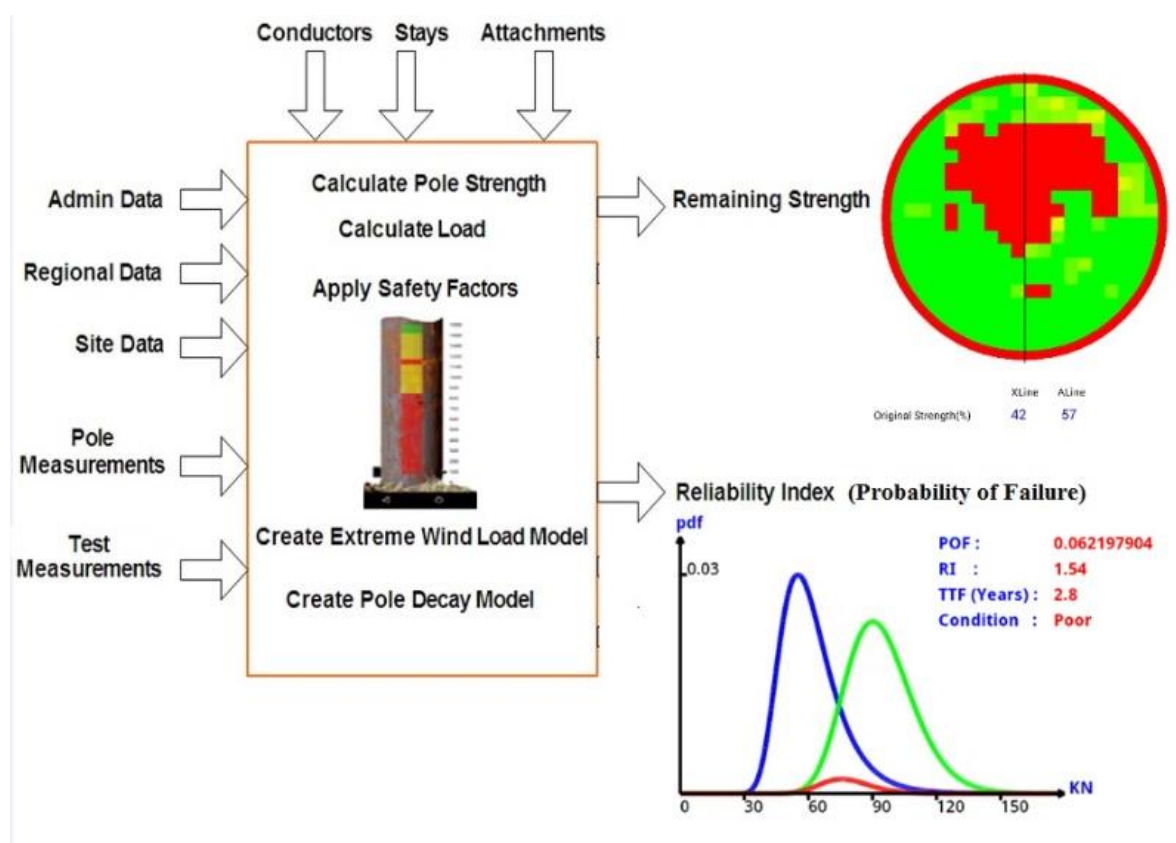


Figure 1: Pole Designer software application: data capture, calculation modules and reported health indicators

Pole Tester

Pole Tester (Figure 2) is a fast and lightweight electro-mechanical device for non-destructive scanning of wooden poles. The device is attached around the pole using 8 transmit-receive sensors in a configuration shown in Figure 3. This sensor configuration allows 56 Time of Flight values to be generated at a cross-section of the pole.

Newsletter

The 8 sensors are hit lightly with a small rubber mallet to produce Time of Flight values which indicate whether anomalies exist within the pole. The values are automatically sent to a tablet computer. The software maps the time of flight values and shows the cross sectional plot (Figure 4). The mapping results plus the information about pole species and its dimensions allow the software application to calculate the percentage of original strength and breaking strength of the pole.



Figure 2: Pole Tester NDT

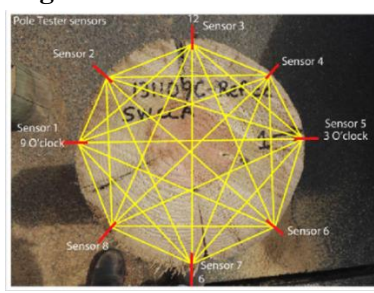


Figure 3: Pole Tester sensor

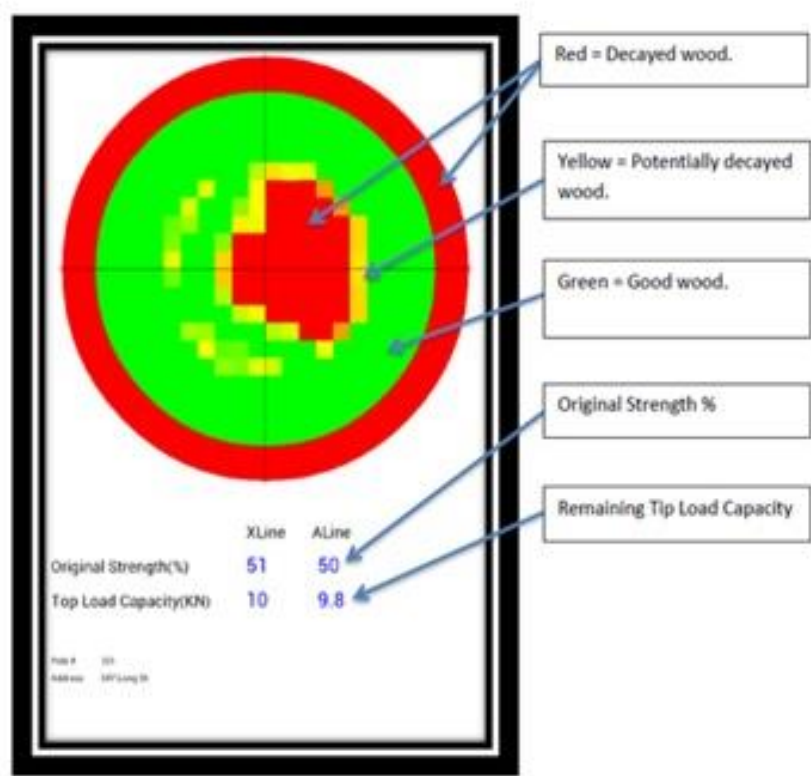


Figure 4: Pole Tester cross-sectional plot

Reliability of in-service poles: Probability of Failure

The Reliability of power poles can be measured using methods that calculate Probability of Failure (POF) of the pole under extreme wind load. There is an established methodology called Reliability Based Design that underpins the calculation of probability of failure. In our Pole Designer system, Lognormal distribution is used to model the uncertainties in measuring pole strength and Gumbel distribution is used to model the uncertainties due to variations in historical regional wind loads.

The overlap region between strength and load distribution curves gives rise to the probability of failure curve shown in red color (Figure 5). The area under the red curve i.e. the probability of



Newsletter

failure in turn can be converted to Reliability Index. Based on the calculated Reliability Index we can establish Condition Categories using policies set by the asset owner.

In addition to Reliability Index (RI), the modelling algorithm in our proposed system also gives a predictive Time to Failure (TTF) which is a prediction of the number of years a pole can reliably stay in service. This is a very useful result which can be used to produce maintenance schedules.

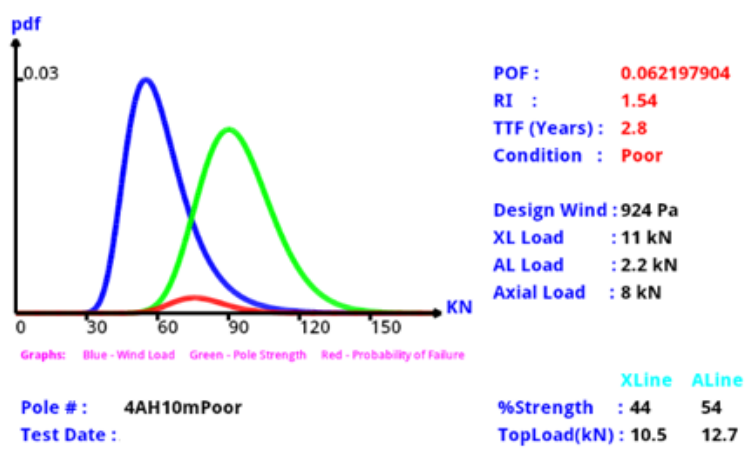


Figure 5: Probability of Failure report

Conclusion

Utility asset managers will benefit from using non-destructive pole testing systems that are capable of producing advanced asset health indicators such as Percentage Remaining Strength and Probability of Failure. The Pole Tester and Pole Designer products introduced in this article have been designed to assist utility asset managers to:

1. Inspect wooden poles using Non-Destructive Technology (NDT).
2. Find the Remaining Strength of the poles.
3. Calculate loads on the pole to produce Reliability Index.
4. Design (on site) the replacement pole.
5. Optimize the maintenance of assets.
6. Build a long term pole replacement strategy based on Reliability Based Design methodology.



Newsletter

Optical Measurement Solutions for SHM in Cable-stayed Bridges

Derek Huxley¹, David Wang¹

¹ *Warsash Scientific. PO Box 1685, Strawberry Hill NSW 2012, Australia.*

There are many obvious advantages that cable-stayed bridges have over other types of bridges. Some of the reasons behind their great popularity are their cost-efficient construction and attractive appearance. However, the main structural elements holding the deck in place are the stay cables, which in most cases are not thoroughly inspected over the years.

Due to corrosion, slippage, or settlement of all or part of the structure, load imbalances may occur which can have a negative effect on the service life of the bridge. Other events such as impacts, fire or seismic movement can significantly disrupt the cable force distribution, influencing the fatigue life cycle of the cables. Polytec, represented by Warsash Scientific in Australia, have successfully used systems to provide non-contact laser-based vibration analysis services to bridge engineering firms and bridge owners – providing information about the tension forces in each cable which in turn could be used for the dynamic analysis of the structure.

A laser vibrometer measures the reflected signal returning from the surface of the sample object and compares it to the internal reference signal. Utilizing an optical interferometer, the instrument is able to measure very small movements at the target location. This non-contact, non-invasive technique also eliminates the requirement for direct access to the object, which allows efficient measurements on areas that are impossible or difficult to reach by traditional means such as accelerometers.

Figure 1 shows the photo of the long range laser vibrometer (RSV-150) located on the deck of the Deh Cho Bridge in Canada during its construction stage. The engineer performed measurements on the third-point of each locked coil cable. Two different excitation methods were used to determine the natural frequencies of the cable and subsequently the tension forces calculated provided vital information to the engineers for the final completion of the bridge. All 24 cables were measured within a period of 4 days on site. The non-contact vibration approach is recognised by the research community and its results generally match those generated by more traditional methods such as the use of accelerometers.

Newsletter



Figure 1: RSV-150 in action during the construction of the Deh Cho Bridge in Canada.

In addition to the advantage of being a non-contact method, no rigging equipment is required to measure any point on a cable. A simple line of sight roughly perpendicular to the measurement point is all that is required to use this technology to make extremely accurate measurements quickly and effortlessly. Traditional methods can involve physical lift-off of the cable or strand at the anchorage; in some cases the use of jacking equipment on the bridge deck is unfeasible due to access restrictions or inability to access the cable strands. In most cases the resources required for hiring the jacking equipment and managing its logistics/operation would outweigh the purchase of a Polytec laser vibrometer.

For more SHM related application articles on Polytec laser vibrometer please see:

[http://www.polytec.com/fileadmin/user_uploads/Applications/Civil_Engineering/documents/OM
AN_VIB-T-02_Structural_Dynamics_2014_06_1000_E.pdf](http://www.polytec.com/fileadmin/user_uploads/Applications/Civil_Engineering/documents/OM_AN_VIB-T-02_Structural_Dynamics_2014_06_1000_E.pdf)

Polytec is the market leader for non-contact, laser based vibration and velocity measurement instrumentation and a global corporation with facilities in Europe, North America and Asia. Polytec is represented exclusively in Australia and New Zealand by Warsash Scientific Pty Ltd for over 35 years. For more information, please contact Warsash Scientific on +61 2 9319 0122 or sales@warsash.com.au

Newsletter

Conference News

- **4th International Conference on Smart Monitoring, Assessment and Rehabilitation of Civil Structures (SMAR 2017)**, 13-15 Sep 2017, Zurich, Switzerland.
(<http://www.smar2017.org/>)
- **8th Structural Health Monitoring of Intelligent Infrastructure Conference (SHMII-8)**, 5-8 Dec 2017, Brisbane, Australia. Organized by ANSHM and QUT.
(<http://shmii2017.org/>)
- ANSHM mini-symposium in the **8th Structural Health Monitoring of Intelligent Infrastructure Conference (SHMII-8)**, 5-8 Dec 2016, Brisbane, Australia. Organized by Prof. Tommy Chan and Dr. Andy Nguyen.
- Mini-symposium “Recent Research Advances on Structural Control and Health Monitoring in Australia” in the **7th World Conference on Structural Control and Monitoring (7WCSCM)**, in Qingdao, China, 22-25 July 2018. Organized by Prof. Hong Hao, Dr. Kaiming Bi, and Dr. Jun Li.

Social Media

Follow us at the next social media and webpages

- ANSHM Facebook webpage: www.facebook.com/ANSHMAU
- ANSHM Facebook group: www.facebook.com/groups/ANSHM
- ANSHM LinkedIn group:

www.linkedin.com/groups/ANSHM-Australian-Network-Structural-Health-4965305

If you have any comments and suggestions, please contact

Newsletter Editor: Jun Li, Curtin University, Perth.

Email: junli@curtin.edu.au, Tel: +61 8 9266 5140.

Co-Editor: Andy Nguyen, Queensland University of Technology, Brisbane.

Email: a68.nguyen@qut.edu.au, Tel: +61 7 3138 0741.