AUSTRALIAN NETWORK OF STRUCTURAL HEALTH MONITORING

Newsletter

Issue 22, December 2019

Contents

President Message

Tommy Chan

Professor in Civil Engineering, Queensland University of Technology

Dear All,

There was a catchphrase from a popular TV drama in Hong Kong, "There are not many '10 years' in one's life." It is also true to an organisation. ANSHM is celebrating its 10th anniversary in 2019. In the last meeting of the ANSHM Executive Committee, it was decided to include some descriptions of the first 10 years of ANSHM in my President message in this issue of the ANSHM Newsletter. Although it is a hard job to me as I have no historian training, yet I think I might be the only person that could talk about the first 10 Years of ANSHM. Since it needs to be included in this issue, I could not make it too details and thus do not expect too much from this message.

Its Birth - ANSHM started in 2009

On April 2009, when I had moved to Australia for almost two years, I noticed that the technologies in the field of Structural Health Monitoring (SHM) were not being known by many engineers in Australia, even the road authorities. However I had been involved in the SHM of some of the big bridges in Hong Kong since their constructions. After I moved to Australia, I would like to make use of the experience and connections that I gained on SHM in HK and extend them to Australia and promote and enhance SHM in Australia. The first step would be to gather the SHM experts in Australia to form a national network so that our research could be complementary one another in order to promote the SHM applications in Australia. Coincidentally the Infrastructure Research Theme Leader at QUT, Prof Ashantha Goonetilleke, shared a similar view requesting me to organise a workshop at QUT to promote the field of the research that I had been working on. He was also willing to provide all the expenses for a

formal workshop inviting the SHM experts from other states of Australia to attend the Workshop in Brisbane. That opportunity was great as I considered I could make use of the SHM workshop to be a step towards forming this national network. With the help of Prof David Thambiratnam, I was able to invite Prof Brian Uy, Prof Hong Hao, Prof Bijan Samali and Prof Mark Stewart to come to Brisbane to give presentations on their work on SHM. Locally, we have Ross Prichard of Queensland Department Main Roads, David and myself presenting the views of Road Authorities and our research work related to SHM. Before the workshop, we had a pre-meeting on the establishment of this Australia National Network on SHM (ANSHM). We then officially announced the launch of the ANSHM at the closing of the Workshop. The Workshop was held on 30th June 2009, so we termed it the 1st Workshop of ANSHM and also officially considered that ANSHM was established in 2009.

Photo 1 Launching of ANSHM on 30th June 2009

The above photo was taken at the Launching Ceremony of ANSHM. See how many faces that you can recognised. In the social media, what it called the "10 Year Challenge" is very popular. You could also see how we have changed in these 10 years.

In the pre-Workshop meeting, we discussed and finalised the objectives of ANSHM as follows:

- To coordinate and integrate our efforts for better development and application of SHM techniques in Australia and initially to be confined to Civil Engineering infrastructures
- As a platform to showcase our achievements, exchange of ideas and dissemination of knowledge
- To engage in collaborative research

These were the base for us to formulate the official 4 objectives stated in our Rules of the Association (Cl 3.1) as follows:

(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 also proposed a lot of long-term and immediate tasks/activities in order to achieve these objectives. In the meeting, it was decided that as a network was still in a cocooning stage it would be best to form a steering group presently before forming a formal committee at a later stage. Hong Guan, Jianchun Li, Xinqun Zhu and myself volunteered to be serving in the steering group. Many thanks for them as they serve ANSHM since its beginning. Besides, when I prepared this summary on the birth of ANSHM, I am so pleased to note that we have been working well in these ten years heading towards these objectives. Below I try to summarise some of our achievements.

Its Publications

ANSHM aims to promote the knowledge, skills and technologies of SHM to the community. One of the tasks that could be done to achieve this is through publications. Actually in the pre-workshop meeting of our 1st Workshop, we had already decided the first activity for the ANNSHM would be a research monograph (to be peer reviewed) coming out of the workshop. We have been working well in reporting our latest development. Below showing our publications in these 10 years, which include our first monograph and special issues in high impact journals with the papers generated from the presentations of our Workshops and Special Sessions in various international conferences.

1. 2011 - Structural Health Monitoring in Australia, Nova Publishers.
2. 2012 - Special Issue on Australian Network of Structural Health Monitoring, Advances in Structural Engineering, Vol. 15, No. 5.
3. 2013a - Special Issue on Australian Network of Structural Health Monitoring, Australian Journal of Structural Engineering, Vol. 14. No. 1.
4. 2013b - Special Issue on Australian Network of Structural Health Monitoring, Journal of Civil Structural Health Monitoring, Vol. 3, No. 2.
5. 2014a - Special Issue on Structural Health Monitoring of Civil Structures, Structural Health Monitoring – An International Journal, Vol. 13 No. 4.

6. 2014b - Special Issue on Structural Health Monitoring, Electronic Journal of Structural Engineering, Vol. 14, No. 1.
7. 2015 - Special Issue on Structural Health Monitoring: From Data to Decision Making, Structural Monitoring and Maintenance, Vol. 2, No. 3.
8. 2016a - Special Issue on Structural health monitoring and vibration control of seismically excited structures, Earthquake and Structures, Vol. 11, No. 6.
9. 2016b - Special Issue on Australian Experiences in Civil Structural Health Monitoring, Journal of Civil Structural Health Monitoring Vol. 6, Issue 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.
10. 2018 - Special Issue on Structural identification and evaluation for SHM applications, Journal of Civil Structural Health Monitoring Vol. 8, Issue 5.
11. 2019 - Special Issue on Real Word application of SHM in Australia, Structural Health Monitoring – An International Journal, Vol. 18 No. 1.

Its Workshops/Conferences/Seminars

For that ten years, ANSHM has held 10 Annual Workshops. Together with the forthcoming one at Gold Coast, we have 11 Workshops. Below shows a list of this 11 Workshops.

- 1st ANSHM Workshop (2009) - hosted by Queensland University of Technology, at QUT Gardens Point Campus, Brisbane
- 2nd ANSHM Workshop (2010) - hosted by University of Technology Sydney, at City Campus & Mercure Sydney Hotel, Sydney
- 3rd ANSHM Workshop (2011) - hosted by Deakin University, at Four Points by Sheraton, Geelong
- 4th ANSHM Workshop (2012) - hosted by the University of Adelaide, at North Terrace Campus, Adelaide
- 5th ANSHM Workshop (2013) - hosted by the University of Melbourne at Parkville Campus, Melbourne
- 6th ANSHM Workshop (2014) - hosted by University of Western Sydney at Holiday Inn, Parramatta
- 7th ANSHM Workshop (2015) - hosted by Curtin University, at Curtin Graduate School of Business, Perth
- 8th ANSHM Workshop (2016) - hosted by Monash University, at Monash Conference Centre, Melbourne
- 9th ANSHM Workshop (2017) at SHMII8, Brisbane
- 10th ANSHM Workshop (2018) jointly with IAPS-AUS- hosted by University of Wollongong at their campus, Wollongong
- 11th ANSHM Workshop (2019) - hosted by Griffith University, at Griffith University, Gold Coast Campus, Gold Coast

As we consider that it is important to promote SHM to the community as well as to showcase our developments, it has been our tradition that there would be no registration fee required for attending these workshops. The organiser of each workshop is able to find supports from their universities and/or from the industry.

Below are some photos from some of these workshops, which will be another “10 Year Challenge”

Photo 2 – 2nd ANSHM Workshop 2010

Photo 3 – Advisory Board Meeting at 7th ANSHM Workshop

Photo 4 – 9th ANSHM Workshop (SHMII-8 Group Photo)

Photo 5 – 10th ANSHM Workshop (jointly with IAPS-AUS)

Other Achievements

Besides, publications and workshops, we also have other achievements like

- Successfully introduce units on SHM into the undergraduate engineering courses in some of the Australian universities, e.g. QUT. Hence in few year time, SHM will not be considered as a stranger to graduate engineers;
- More and more structures in Australia considered the importance of SHM and implemented or considering to implement SHM systems on their assets, e.g. QUT P-block, Sydney Harbour Bridge
- Inclusion of a section on SHM in the AS5100, and the section was drafted by me.

To sum up, I strongly believe that we are doing the right things and will continue to expand the impacts of ANSHM working on our objectives. I should thank the Executive Committee members and the Advisory Board Members for their continuous supports since its establishment. All the achievements are due to their unreserved contributions for that many years. I am really blessed to have the opportunity to serve in ANSHM.

Below are the updates of the month.

ATCSI

As mentioned in the last monthly updates, we decided to submit again a new proposal for establishing an ARC Industry Transform Training Centre (ITTC). However, we need to submit the proposal by 11 December 2019. Also we need to do it strategically by restricting the number of universities to no more than 7 universities as Eligible Organisations (EOs), the maximum number of EOs of the ITTCs that have been awarded previously. Therefore, we will have some getting involved in the preparation of the proposals and some other helping to promote the training centre as they are not named investigators in the proposal. This time the title of the training centre is "ARC Training Centre for Smart Data Driven Next Generation Infrastructure" (ATCSI). The main aim of this ARC Training Centre is to transform and improve the current practices on the design, construction, maintenances and management of infrastructure through smart data collection and data analytics in Structural Health Monitoring (SHM) technologies. We have been working effectively for the past weeks including approaching our previous industry partners, contacting those we had approached last year but could not make decision last year, identifying who will be participating the project as chief investigators, finalising the amount of cash contributions and in-kind contributions, seeking support for relevant universities, preparing the proposal, formulating the budgets, writing their justifications, etc. I am so pleased to let you know that we are progressing well and we should not have any problems for its submission by the deadline.

Executive Committee Meeting

We had a very fruitful Executive Committee meeting on 26th November 2019. We spent a lot of time on the discussion for the ITTC proposal submission. We also discussed on the preparation of the 10th ANSHM Workshop including the preparation for the Advisory Board Meeting and the Annual General Meeting and other matters. We also discussed the nominations of the Executive Committee for the 2020-2021 term.

Election of Executive Committee Members (2020-2021)

You should have received my message on the call for the nominations of election of Executive Committee Members and as stated in the message the call has been closed on 25th Nov 2019. As mentioned in my message, the two-year term of office of the following EC Members will be completed this year

Richard Yang
Alex Ng
Andy Nguyen
Jun Li
Lei Hou

Mehrisadat Makki Alamdari
Ulrike Dackermann

Six of these Executive Committee members except Ulrike Dackermann, are happy to continue their service in the Executive Committee and are willing to be re-elected. Ulrike is on a special medical leave until end of her term of service. We also received other nominations by the deadline. All these candidates will be discussed in the forthcoming Advisory Board Meeting. In the meeting, we will also review the existing Executive Committee to determine the number of officers to be elected. The election will be conducted in the Annual General Meeting on 3rd Dec 2019.

ANSHM 11th Annual Workshop

You received the tentative Program sent by Dr. Dominic Ong to circulate you the updated Information Pack of our annual important event, the 11th ANSHM Workshop. Thank Hong Guan and Dominic Ong for hosting and organising this ANSHM Workshop. There will be 18 presentations together with an Industry Forum, entitled as "Structural Health Monitoring: Bridges and Buildings". As our tradition, the Industry Forum will be a highlight of the Workshop, which will be facilitated by Peter Burnton (Arup) and Govinda Pandey (Rockfield Technologies Australia). Many thanks to them for taking up this role.

We will also have the Celebration of our ANSHM 10th Anniversary at the Workshop.

Look forward to meeting you all in the workshop

Annual Membership Renewal

We need to renew our membership around the time of AGM, which could be done similarly as previous years. If you are going to attend the coming ANSHM workshop, Alex will record your presence and ask directly whether you want to renew your (ordinary) Membership. However, for the Core Membership, as such membership needs to be approved by demonstrating commitments to ANSHM, so Alex will send emails to you asking whether you wish to be core members. Your ordinary Membership will be renewed upon your request while your Core Membership request will be reviewed and approved by the Executive Committee based on your attendance of ANSHM Workshops in the previous two years.

ANSHM Journal Special Issue

The special issue in the International Journal of Structural Dynamics and Stability (IJSSD) is for the presentations at the 10th ANSHM Workshop as well as the ANSHM Special Session in ACMSM25, to celebrate our 10th Anniversary.

We are conducting our first round of review. We expected it could be completed end of November. Please complete your review by the deadline stated in the invitation message.

ANSHM Newsletter

Thank Andy for looking after this issue of the Newsletter. You may have noticed that this issue a special issue devoted to the celebration of our 10th Anniversary. Therefore, instead of including research articles, we presented the submitted summaries of the most notable SHM-related research and/or consultancy activities during the past 10 year (2009-2019) from our member organisations. For this issue, we received the submissions from Queensland University of Technology, Griffith University, Monash University and Rockfield Technologies Australia. Other member organisations are welcome to send their summaries for publishing in the next newsletter.

With kind regards,
Tommy Chan
President, ANSHM
www.ANSHM.org.au

AUSTRALIAN NETWORK OF STRUCTURAL HEALTH MONITORING
Newsletter

Structural Health Monitoring Research at QUT: From Theory to Application and Implementation

Tommy Chan, David P. Thambiratnam, Andy Nguyen, Zhen Chen, Craig J. L. Cowled, Liang Wang, Buddhi L. Wahalathantri, Rupika P. Bandara, Man H. Yau, Kuo Li, Mehran Aflatooni, Wasanthi R. Wickramasinghe, Khac-Duy Nguyen, Tharindu Kodikara, Parviz Moradi Pour, Zhi Xin Tan, Thisara S. Pathirage, Manal Hussin, Ziru Xiang, Yi Wang, Shojaeddin Jamali, Ngoc Thach Le, Benjamin Monavari, Nirmani Jayasundara, Hans Moravej, Jomon Joseph and Chathurangi Randiligama

Queensland University of Technology

Led by Prof Tommy Chan and Prof David Thambiratnam, research on Structural Health Monitoring (SHM) at Queensland University of Technology (QUT) has been growing steadily over the past ten years. Ever since, various achievements have been accomplished, mainly in three categories: (i) system development, (ii) sensors/measurement and (iii) applications, as shown in Fig. 1.

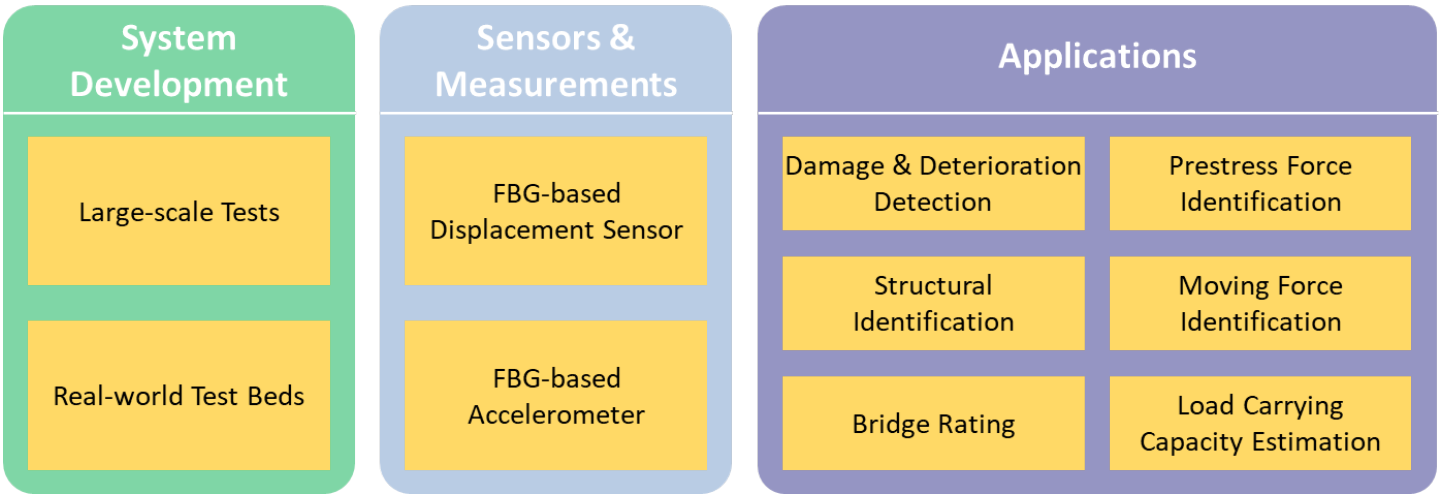

Figure 1. Research themes at QUT

System Development: Under the first category, number of test-beds have been selected covering a range of civil structural systems from laboratory models (two large-scale bridge models) and three real structures (i.e., one 5-star-green rated medium-rise building, and two footbridges at QUT). Remarkably, a cost-effective Ethernet-based peripheral DAQ system with a software-based synchronisation strategy were designed and successfully implemented to the aforementioned medium-rise building, as shown in Fig 2. Data obtained from this real-world test bed has been used for various SHM applications such as finite element model updating and deterioration detection.

Sensors and Measurements: In the sensors/measurement category, much of the recent work has been done to enhance the Fibre Bragg Grating (FBG) sensing technology. One of the recent developments refers to a new FBG strain modulation method based on nonlinear string transverse-force amplifier, which was found more effective than a traditional strain modulation method based on change in distance between two fixed ends of the FBG sensor. Besides, other developments in FBG sensing technology include and a biaxial FBG accelerometer based axial and transverse forces and a high-sensitivity FBG accelerometer based on transversely rotating stick. Another research has been conducted in developing indirect displacement measurement technique using FBG tilt sensors.

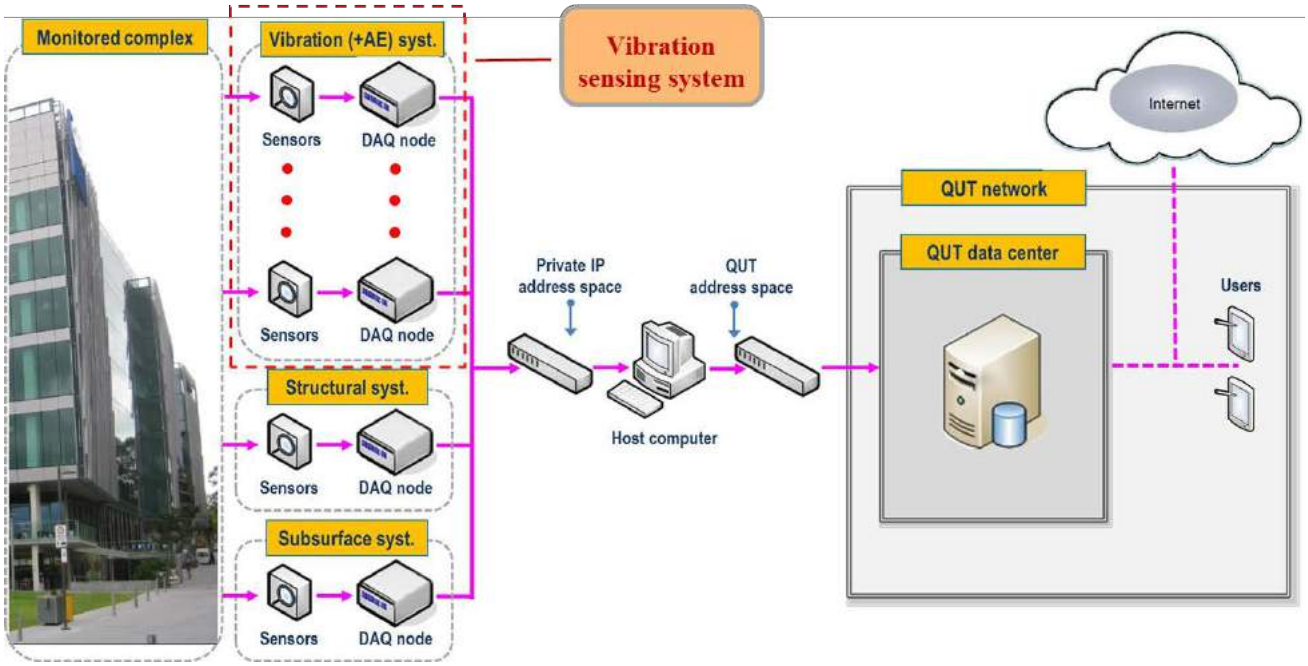

Figure 2. SHM system of a 5-star-green rated medium-rise building in QUT

Applications: The application category includes number of ongoing and recently completed projects on developing various Damage Detection (DD) methods. Namely, (i) Method which includes combination of three parameters, natural frequencies, Modal Flexibilities (MF) and Modal Strain Energy (MSE) to detect, locate and estimate severity of damage on slab-on-girder bridges; (ii) Vibration-based multi-criteria approach to assess damage of asymmetric tall buildings; (iii) Multi-layer genetic algorithm for damage detection; (iv) Correlation-based method using ratio of MSE to eigenvalue (MSEE); (v) direct and indirect deflection-based approach to assess damage in both determinate and indeterminate beam-like structures; (vi) Damage detection for arch bridges using MSE, MF and artificial neural networks; (vii) Damage identification of civil structures with mass variation using modal kinetic energy (MKE) change; (viii) Damage detection in Hyperbolic Cooling Towers using vibration characteristics. In addition, a recent research has been conducted in developing a deterioration identification approach based on time-series analysis.

Apart from the DD topics, studies in system identification (St-Id) and finite element (FE) model updating have drawn some significant outcomes, including successful St-Id of the aforementioned building with ambient vibration data employing Bayesian approach and St-Id of one of the laboratory-scale bridge models (steel through truss cantilevered bridge with suspended span). Furthermore, a method for probabilistic FE model updating of civil structures has been developed by integrating Bayesian approach and Gaussian process.

Besides, researchers at QUT has successfully developed a synthetic rating procedure for railway bridges based on structural conditions at network level as well as the integration of various tools such as structural analysis, SHM and analytic hierarchy process. The developed procedure was found to enhance the reliability of condition assessment for rating a network of bridges.

Moreover, a group has developed methods to identify effective prestress force (PF) in prestressed concrete box girder bridges. One of the developed methods refers a synergic identification method, which can determine PF and moving load simultaneously in prestressed concrete beam-like bridges. Another study proposed a simplified modelling approach to predict PF from vibration responses by idealising the top slab of box girder bridges using boundary characteristics orthogonal polynomials. The third study develops a non-destructive testing technique to predict PF from relative change in Electromagnetic Ultrasonic waves travelling along the concrete surface.

Moving force identification (MFI) has also been intensively studied by the researchers at QUT. Recent developments include the truncated generalised singular value decomposition (TGSVD) method and the modified preconditioned conjugate gradient (M-PCG) method, both of which can significantly overcome ill-posed problems associated with measurement noise in MFI.

Another research has been conducted in developing methods to assess the load-carrying capacity of bridges using SHM techniques. A practical method was proposed to estimate flexural stiffness and load-carrying capacity of beam-like bridges using a substructural technique and response optimisation. In addition, a multi-tier framework for load-carrying capacity assessment of bridges was developed using advanced nonlinear analysis and reliability analysis.

On-going Projects: QUT's SHM group is currently focusing on the following topics:

- Long-term performance monitoring for real structures
- Data-driven damage and deterioration detection
- Soft computing for damage detection
- Condition assessment for hyperbolic cooling towers and arch bridges
- Structural settlement and condition assessment using GNSS technology

For more details of research activities at QUT and collaborations, please contact Prof. Tommy Chan at tommy.chan@qut.edu.au

AUSTRALIAN NETWORK OF STRUCTURAL HEALTH MONITORING
Newsletter

Structural Deterioration, Damage Detection and Sensor Monitoring Research Activities at Griffith University

Hong Guan, Dominic E.L. Ong, Fuwen Yang, Dzung Dao & Huaizhong Li
Griffith University

In the School of Engineering and Built Environment of Griffith University, various projects related to structural deterioration, damage detection and sensor monitoring have been accomplished over the last decade or are currently being undertaken. Collective efforts of Civil, Electrical and Mechanical Engineering and IT academics have contributed to these multi-disciplinary projects, supported by Griffith's Cities Research Institute (CRI), Queensland Micro- and Nanotechnology Centre (QMNC), and Institute for Integrated and Intelligent Systems (IIIS).

Funded by the ARC Linkage Project (LP0883807) and in partnership with the QLD Department of Transport and Main Roads and Gold Coast City Council, a robust Artificial Intelligence (AI)-based bridge deterioration model (Fig. 1) was developed to generate unavailable historical condition ratings, thereby minimising uncertainties in predicting the long-term performance of bridge structural elements. The model has helped to enhance reliability of the prevailing maintenance, repair and rehabilitation (MR&R) practices leading to great savings in prolonging the life cycles of bridge networks. The project outcome also helps bridge authorities to effectively plan maintenance strategies for obtaining the maximum benefit with limited funds.

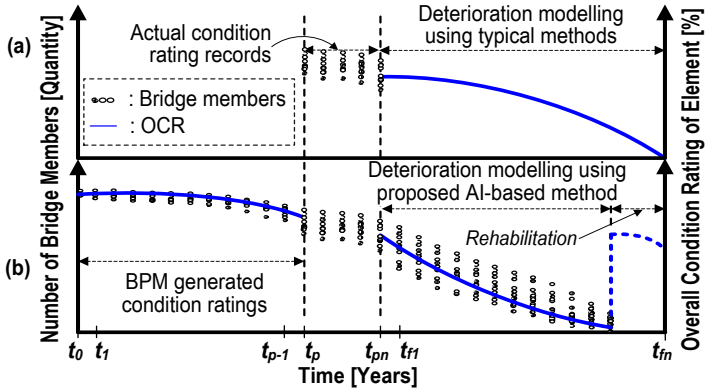

Figure 1. Conceptual diagram of the AI-based bridge deterioration model: (a) Typical deterioration curve; (b) AI-based deterioration curve

To overcome the limitations of costly and subjective visual-based level-2 condition assessments for critical infrastructure assets, a hybrid method for crack detection was proposed (Fig. 2), in which cracks are modelled as linear foreground structures on textured background, which can be extracted by combining salient structure extraction with global pattern distribution. A real-time monitoring framework was also established for a landslide susceptibility area based on wireless sensor network using multiple unmanned aerial vehicles (UAVs).

Original image | Proposed foreground-background separation technique | Structure extraction method | Saliency method

Figure 2. Results of three methods for a shadowed crack image

A 'Living Lab' is being built in a new 6-storey academic building at Griffith's Nathan Campus. Electronic sensors are being placed on and within the structural elements (i.e. footings, beams, slabs, and columns) to capture how the building will respond to environmental effects (rainfall, temperature and ground water fluctuations) and short-/long-term loading effects (construction, wind, earthquake, shrinkage, creep, laboratory machineries induced vibrations) during its service life (Fig. 3). Based on the acquired data, machine learning and AI systems will be deployed to efficiently assess the health status of the building for early interventions, thereby minimising maintenance costs.

Figure 3. Installation of vibrating wire earth pressure cells underneath building footings

Other ongoing projects include the development of (1) a low-cost, low power consumption, high-performance sensor network technology for a wide range of applications including preventing accidents and catastrophic failures in the energy, extractive, chemical and aeronautical industries. (2) an automated structural health monitoring (SHM) system for damage detection based on unsupervised deep learning approach, making the SHM process more computerised with minimum human intervention; (3) a structural identification method for accurate model response predictions of cable-stayed bridges utilizing on-structure sensor data for model validation and updating, ultimately achieving efficient maintenance monitoring.

Monash University Smart Structures Team

Colin Caprani, Ye Lu, Mayer Melhem, Shaohua Zhang, Jun Wei Ngan, Shihab Khan

Monash University

Monash University Smart Structures Team is at the cutting edge of research and innovation in applied structural health monitoring (SHM). The team, led by Dr Colin Caprani, has been involved in the monitoring of mainly highway bridges and low-rise buildings. The team applies cutting-edge research from the fields of structural dynamics, structural reliability theory, value-of-information in synergy with SHM information to provide significant benefits in infrastructure management.

In collaboration with the Victorian Department of Transport, Monash University Smart Structures Team have worked together in adopting SHM on critical existing highway bridge assets. The team is now responsible for what we believe to be Australia's largest bridge SHM network. This SHM network provides the bridge structural performance to normal traffic loads and assists in the traversing of "superloads" (Figure 1a) – extreme vehicle loads with gross mass of up to 600 tonnes. The SHM network comprises of both wired and wireless systems, with data accessed remotely and/or on-site. Devices includes steel and concrete strain transducers (Figure 1b), tiltmeters (Figure 1c), strain gauges, and crack gauges.

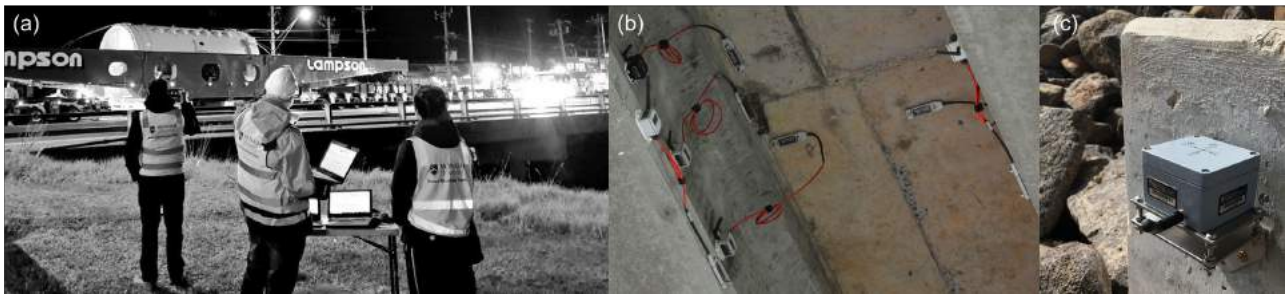

Figure 1. (a) Smart Structure Team monitors bridge subject to "superload" (b) Wireless concrete strain transducers on bridge girders and slab (c) Wireless tiltmeter on concrete bridge pile cap

Our team has used SHM measurements to update bridge safety assessments. We believe the Monash University Smart Structures Team to be the first to implement probability-based bridge assessments (structural reliability theory) for "superloads" in Australia. SHM reduces the parameter uncertainties, providing a more certain result in probability-based assessment using a Bayesian statistics approach. Moreover, data from the SHM can help tune bridge structural analysis models, providing a truer prediction of the bridge structural response, and thus more accurate bridge safety measures.

Most recently, Monash University Smart Structures Team has implemented our SHM expertise on the Woodside Building for Technology and Design (also known as Technology Education or TEd Building)

at Monash University Clayton Campus (Figure 2a). The team has designed a complex SHM scheme to capture and monitor the behaviour of the 5-story building during its life-cycle since construction. Hundreds of advanced sensors including strain gauges, accelerometers, transducers, and vibrating wire gauges have been installed at critical locations of the structural members across all levels of the building. Locations and elements were chosen to supplement teaching activities in several units, such as concrete design, steel design, and composite construction, forming a cognitive platform for students to interact with and understand the built environment. Furthermore, the global structural behaviour is also carefully monitored. Examples include the composite reinforced concrete slabs (Figure 2b) and steel bracing (Figure 2c).

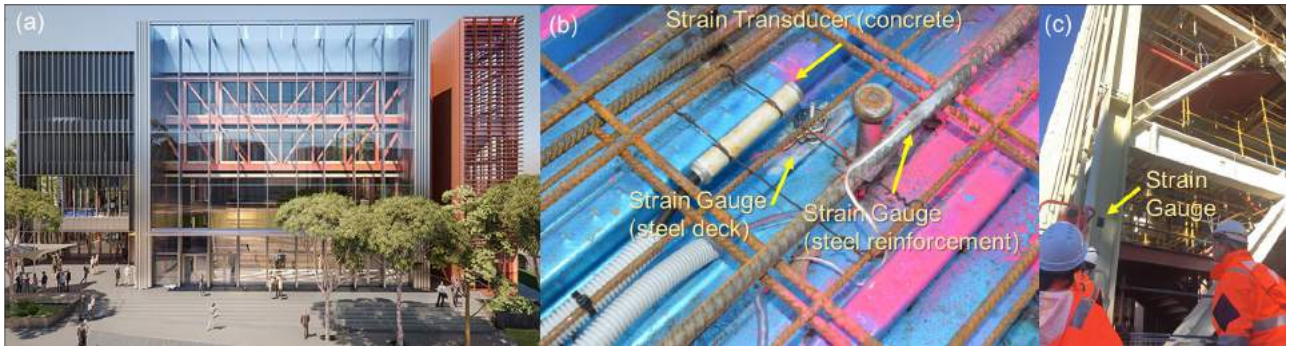

Figure 2. (a) Woodside Building for Technology and Design, Monash University Clayton Campus (b) Sensors installed in building's composite reinforced concrete deck (c) Sensors installed in building's steel bracing

The Monash University Smart Structures Team are working towards a state-of-the-art acquisition system to collect all multi-stream data at high speed and developing a user-friendly program to manage and analyse the multi-modal data streams for both research and teaching purposes. Upon completion in early 2020, the TEd Building will be Australia's Smartest Building, providing real-time data of its structural response, as well as a wide range of other sensing solutions, such as geotechnical, mechanical, and environmental conditions, both inside and outside.

Other on-going research by team includes exploring vibro-acoustic-ultrasonic based damage detection and engineering applications of artificial intelligence. These includes linear and nonlinear guided wave-based methods for fatigue damage, corrosion of rebar, and debonding of FRP laminate. Moreover, electrical conductivity of carbon black and steel fibres have been deployed in engineered cementitious composites for crack detection.

Whether it is bridges or buildings, the Monash University Smart Structures Team has adopted its diverse research skills to be at the forefront of applied SHM. Our structural analysis models integrated with SHM information provided advanced decision-support tools for asset-owners for data-driven infrastructure management.

For more information, contact Team Leader Dr. Colin Caprani: colin.caprani@monash.edu

Pioneering Industry 4.0 to Transform Asset Integrity Management

Govinda Pandey

Rockfield Technologies Australia

Rockfield Technologies Australia (Rockfield) is a specialist high technology company with offices in Townsville, Melbourne and Perth. Our core skills are in advanced computational modelling, sensor technologies, data analytics and engineering design solutions. Since our establishment in 2000, Rockfield has been assisting clients from across many industrial sectors in better understanding and managing the risk profile of critical assets in terms of capacity utilisation, structural integrity, remnant life and Standard's compliance.

It is our experience that Asset Owners often find themselves in a quandary when trying to balance risk appetite against growth/ROI and management of compliance. Multidisciplinary engineering science tempered through a holistic perspective is required to maximize utilization whilst minimizing intervention. With aging infrastructure assets in our built environment and the availability of Industry 4.0 technologies, industry demands state of the art Asset Integrity Management.

Rockfield has been working on instrumentation of mining and process structures for more than 15 years. A number of years ago Rockfield realized the urgent need for practical SHM techniques for bridges given their age, criticality and risk profile. As a result, Rockfield started deep and meaningful collaborations with several universities, asset owners and government bodies in Australia (Figure 1).

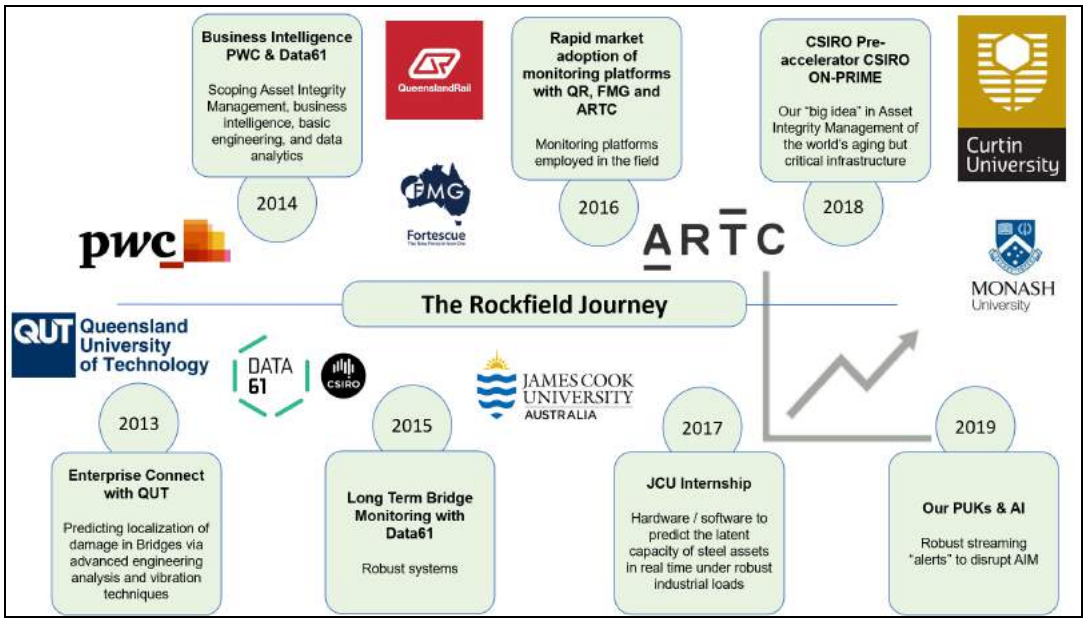

Figure 1. Rockfield's SHM research and development journey

Rockfield is also a core member of the Australian Network of Structural Health Monitoring (ANSHM). The Rockfield CEO Dr Govinda Pandey sits on ANSHM Advisory Board and facilitates industry forums at ANSHM's annual conferences.

In 2013 Rockfield collaborated with QUT Professor Tommy Chan's team to investigate a practical method of damage detection using SHM techniques through AusIndustry Enterprise Connect grant. Rockfield then collaborated with CSIRO Data61 to develop a robust long term SHM system including its implementation on a bridge in Sydney. Rockfield are fully aware of Data61's SHM system with 2400 sensors that is currently in place on Sydney Harbour Bridge.

Since then Rockfield has instrumented more than 30 bridges and culverts across Australia in both road and rail applications with approximately half of those having mid to long term remote real time monitoring systems in place (Figure 2). Rockfield has also worked on bridge assessments where data is sourced from a third-party instrumentation system.

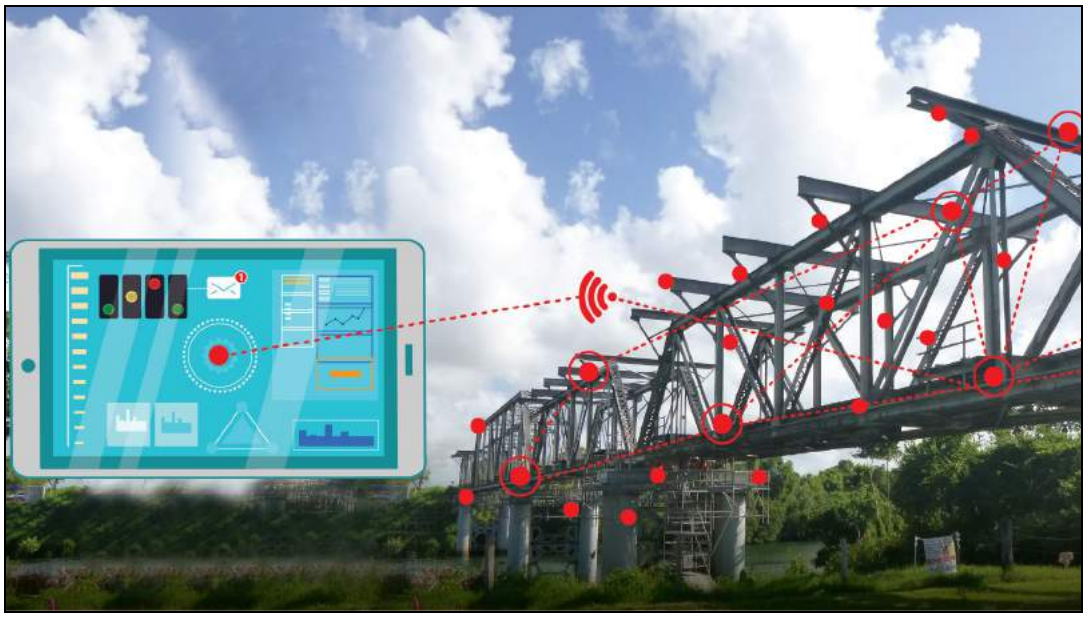

Figure 2. Rockfield's Real-Time Structural Health Monitoring System

More recently Rockfield has been pioneering the utilisation of low cost IoT sensors for the application of SHM and is currently running a field trial on utility poles and street light poles. Rockfield has received several grants (including AusIndustry Innovation Connections) in collaboration with James Cook University to develop a bespoke IoT system, with sensor devices, data aggregation gateways, data analytics (AI/machine learning and physics) and a visualisation platform.

For constant updates of Rockfield activities, please visit our dedicated LinkedIn page below:
https://www.linkedin.com/company/rockfield-technologies-australia-pty-ltd/

Conference News

- **ANSHM special session "Recent Research Advances on Innovative Techniques for Structural Health Monitoring" in the 16th East Asia-Pacific Conference on Structural Engineering & Construction (EASEC-16), 3-6 Dec 2019, Brisbane, Australia. Organized by Dr Jun Li and Dr Qingzhao Kong. https://easec16.com.au/**

- **10th European Workshop on Structural Health Monitoring , 6-9 July 2020, Palermo, Italy. http://www.ewshm2020.com/**

- **8th Civil Structural Health Monitoring (CSHM-8) Workshop, 16-18 September 2020, Naples, Italy. http://cshm8.unimol.it/**

Social Media

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

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

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