AUSTRALIAN NETWORK OF STRUCTURAL HEALTH MONITORING

Newsletter

Issue 14, December 2017

Contents

President Message

Tommy Chan

Professor in Civil Engineering, Queensland University of Technology

Dear All,

First of all, may I extend our warmest welcome to Kenneth Jacobs, Deputy Chief Engineers (Structures) of QDTMR who has accepted our invitation to join ANSHM Advisory Board replacing Ross.

I am so glad for that, as QDTMR position in ANSHM Advisory Board has been vacated for more than a year. It is really important to have more representatives from the Road Authorities in the Advisory Board to ensure we are heading towards a right direction to meet the needs of the industry.

Kenneth, welcome on board!

I would like to congratulate Mark (DP180102334), Brian (DP180100418), Priyan (DP180100643) on winning ARC Discovery grants and David, Brian, Hong Hao, Bijan, Hong Guan and myself winning an ARC LIEF grant in the latest round of ARC grant funding announcement. I am especially encouraged for the success of the LIEF grant demonstrating our capacity of formulating a grant proposal linking different universities of ANSHM together. The success of this LIEF grant well indicates how we have been brought together under the platform established by ANSHM making us so easy to put the trust on others to formulate a collaborative proposal.

I am so excited that when I am writing this update, SHMII is less than one week away. For the past few weeks, the rate I received the email messages was much higher than replying the emails. Sometimes, I just left my office for attending a meeting or a teaching class for a few hours, and when I returned, my outlook was flooded with incoming messages. I have different queries about the conference such as small one like requesting child care support during the conference or some serious issues like evaluating the budget and make suggestions to ensure a breakeven. I have organised many international conferences before, especially when I was in Hong Kong working at the HK PolyU. At that time, together with other colleagues there, we organised an international conference nearly every one to two years. I am well aware that organising a conference is really a hard job. However I consider that for the benefit of ANSHM, although I expect that it is not an easy job, yet I am still very pleased to be the chair of this significant event in the SHM community, nationally and internationally. As mentioned in the last update that the conference could help us demonstrate how ANSHM can work together effectively for a task. Also it helps us showcase our developments in various SHM technologies, give us more exposure to the local industry, and gain more experience in securing funding from the industry, etc. We will maintain the momentum for our preparation of the proposal for an ARC ITRP/ITTC. Actually this conference has demonstrated how well we can gain support, financial as well as in-kind from the industry, especially the local road authorities like Brisbane City Council (BCC) and Queensland Department of Transport and Main Roads (QDTMR). The 8th Australian Small Bridges Conference was held about few days before SHMII-8 from 27-28 Nov 2017 in Gold Coast, Queensland and the 12th RMS Annual Bridge Conference is to be held from 6-7 December 2017. It can be seen how BCC and QDTMR manage their resources so well to provide their support to the SHMII-8 and 9th ANSHM Workshop and give us a lot of support and assistance, at the same time providing their supports to other bridge conferences almost at the same time. It is much appreciated.

Below are some of the updates of the month.

Research Collaboration

Most of you are well aware of that we intend to submit an ARC ITTC proposal next year. Jianchun is working at the last stage to formulate a schedule and some documents to be discussed in the forthcoming Advisory Broad meeting based on the tasks for the preparation together with the corresponding timeline we identified earlier. As mentioned in the last updates that we need to identify the potential industry partners and devise effective strategies to approach them and obtain their support. Actually because of SHMII-8, it creates a lot of opportunity for us to know which industry partners that we could approach for collaboration and also there are a lot of industrial partners looking for collaboration to help them find solutions to their problems as well as finding ways to meet their needs. I look forward to having a good discussion on all these in the forthcoming ABM.

SHMII-8 (https://shmii2017.org/)

We are approaching the countdown of this great event. The three-day Conference program will include keynote lectures, invited lectures, regular sessions, special sessions, mini-symposiums, technical visit and touring activities. Over 200 delegates are invited to present and share their experience with experts, engineers, researchers and scientists from different countries and disciplines and interact with experts from the industry. We have presenters coming from 26 countries, which include Australia, Austria, Canada, China, France, Germany, Hong Kong, India, Iran, Ireland, Italy, Japan, Mexico, Pakistan, Poland, Portugal, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, United Kingdom, United States, and Vietnam, covering the researchers from six of the seven continents of the world.

The presentations cover a wide range of SHM topics including, smart sensors, wireless networks, data acquisition, damage assessment, reliability forecast, damage repair, performance monitoring, life cycle management of infrastructure, smart materials and rehabilitation, GPS, remote monitoring, integrated SHM, design guidelines, standardization of SHM systems, critical issues for SHM and resilience of infrastructure and other related subjects.

As the first time SHMII is being held in the southern hemisphere, the objectives of this SHMII-8 are to share the advancement of the SHM in Australia with other parts of the world, specifically to showcase achievements, exchange ideas and disseminate knowledge nationally and internationally, and to raise general community awareness on the need for, and value of, SHM research and application. It is also the first time in the history of SHMII that most of the delegates are from Australia, about one quarter of the delegates.

The program of the conference could be downloaded via https://shmii2017.org/program/ .

Pre-Conference Training Workshop

As mentioned earlier, we will have this training workshop jointly organised by ASCE-Australia Section (as ASCE Forum), QUT, ANSHM and SHMII-8 as a Pre-Conference Training Workshop, from

14:30 to 17:00 on 4 December 2017 with refreshments. The admission is free. Even if you have not registered for the Pre-Conference Training Workshop, you are still welcome to come, but RSVP is required. There will be two topics in this workshop:

i. Bridge Inspection Techniques: Current Practices in QLD by Mr Bob Barrett, Principal Engineer at the Queensland Department of Transport and Main Roads, Australia.

ii. SHM and Civionics Enhances Evaluation of Ageing Bridges in Canada by Prof. Mufti Aftab, a founder of ISHMII and also the former Scientific Director and President of the Innovative Structures with Intelligent Sensing Canada Research Network.

It will be a very interesting workshop with the traditional way of bridge assessment crossing over with the latest SHM technologies. Details could be obtained via https://shmii2017.org/asce-workshop/ .

9th ANSHM Workshop (ANSHM mini-symposium in SHMII-8)

We always like to try new things to make our workshops better and better. For the first time we have our annual workshop incorporated in an international conference. There are a lot of hurdles to get past in order to make this successful. For example, traditionally our annual workshop is free of charge and the attendants only need to pay for their travel and accommodation expenses. Incorporating our annual workshop in a conference may imply that the attendants need to pay for the registration fee for that international conference. It seems that if we can find a conference that have the theme fit well with ANSHM, like the SHMII series, then it is feasible. However organising the 9th ANSHM Workshop as ANSHM mini-symposium/MS1 in SHMII-8 gives us a lot of good experience to consider when we could incorporate our annual workshop in an international conference. For the members of ANSHM, you don't have to be concerned about that ANSHM workshops will no longer be free as we will try to keep this good tradition.

Regarding this workshop, the programme is included in the SHMII-8 program. As mentioned last month, we will have the followings included in the workshop covering the first two days of the conference:

a. 18 presentations;

b. Industry Forum;

c. Benchmark Structure Collaboration Discussion Forum; and

d. AGM

The Industry Forum will be facilitated by Max Willison of BCC and Torill Pape of ACEOM, and many from the industry including road authorities have agreed to join and participate in the discussion. I think this Industry Forum and the Pre-Conference Workshop will be something first time in the SHMII series, but to those who are in ANSHM are well aware that we have this kind of industry forums as one of the highlights of our annual workshop.

I expect the Benchmark Structure Collaboration Discussion Forum will be another highlight as it will help us make our research studies more practical as well as encourage us to collaborate with one another using different benchmark structures.

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 in SHMII-8, Alex will record your presence and ask directly whether you want to renew your (ordinary) Membership. Alex will also ask if you want to be a core member for the coming year. According to Cl 5.5 of the Rules, "A Core Member is a Member, of which there is at least one individual who is prepared to attend most of the meetings of the Association, e.g. Annual General Meetings, Advisory Board Meetings, Executive Committee Meetings". 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.

For those who could not attend the 9th ANSHM Workshop, Alex will send you emails to inquire. The ordinary membership will be renewed upon your request. However for your request on being a core member, it will be discussed and decided in an EC meeting, based on your participations in ANSHM meetings for the last two years.

10th ANSHM Annual Workshop

I am pleased to announce our 10th ANSHM Annual Workshop will be hosted by the University of Wollongong as coordinated by Dr. Tao Yu. Thank Tao so much for taking the initiative to host this important event of ANSHM. Tao will give us some introduction on this Workshop during the Closing Session of 9th ANSHM Workshop on 7 December 2017.

ANSHM Advisory Board Meeting and Annual General Meeting

Please be kindly reminded that we will have our ABM and AGM during the 9th ANSHM Workshop in SHMII, from 5 to 7 December 2017 (Please note that 9th ANSHM Workshop finishes one day earlier than SHMII-8). The details for the two meetings are as follows:

ABM (Only for the ANSHM Advisory Board Members and Executive Committee Members):

Date: 5 December 2017

Time: 14:15 to 16:45 (AEST)

Venue: S-Block, Level 8, Room S-851, Gardens Point Campus, QUT, 2 George Street, Brisbane, QLD 4001.

AGM (For any ANSHM Members):

Date: 6 December 2017

Time: 16:20 to 16:50 (AEST)

Venue: P-Block, Level 5, Room P-512, Gardens Point Campus, QUT, 2 George Street, Brisbane, QLD 4001.

Election of Executive Committee Members

You may have received my message dated 16 November 2017 on *the Call for Nominations for Election of Executive Committee Members* According to the Rules of ANSHM, the Nominations shall be called at least 14 days prior to the election during the forthcoming Annual General Meeting on 6 December 2017. For this time, the two year term of office of the following EC members will be completed:

1. Alex Ng
2. Andy Nguyen
3. Jun Li
4. Lei Hou
5. Ulrike Dackermann

All these five Executive Committee members are happy to continue their services in the Executive Committee and are willing to be re-elected. In addition, so far, I have received two more nominations. In the upcoming Advisory Board Meeting, we will also review the Executive Committee including the number of members required.

ANSHM 3rd Special Issue in JCSHM

As mentioned in the last update, Journal of Civil Structural Health Monitoring (JCSHM) has adopted a new policy for publishing the accepted papers quickly. Therefore all the papers of our special issue will be published in different issues when they are ready to be published. Therefore although it is called a special issue but it will be spread into different issues with the Forward in the last issue describing all the papers published. In the last monthly update, I mentioned that 3 papers of our Special Issue in JCSHM have been published in Vol. 7 No. 4 issue, and 1 paper in Vol. 7 No.5 issue. 4 papers are currently online first, and the other 3 papers are under the second round review.

ANSHM Special Sessions

1. Prof Hong Hao, Dr. Kaiming Bi and Dr. Jun Li are organising a special session **SS01: Recent Research Advances on Structural Control and Health Monitoring in Australia** at the 7th World Conference on Structural Control and Monitoring (7WCSCM, http://smc.hit.edu.cn/wcscm2018/), which will be held in Qingdao, China in July 2018. 12 abstracts have been accepted. The full paper submission is no later than **15 Feb 2018**. Please kindly note to select our session **SS01** when you submit at: http://smc.hit.edu.cn/wcscm2018/8169/list.htm.
2. For the special session organised by Jun in the 9th International Conference on Bridge Maintenance, Safety and Management (IABMAS 2018) Melbourne, 9-13 July 2018 (http://iabmas2018.org/), 18 abstracts from 5 countries have been received. The full paper deadline is due 1 Dec 2017.

In the next sections of this Newsletter, the article of Sfahani et al. proposes seismic fragility assessment along with structural health monitoring facilitates using Cloud Analysis, of which the limitations were resolved by extending the analysis to a single scaled intensity measure level of utilised ground motion record. In the second article, Zhu et al. presented a long-term monitoring system of a cable-stayed bridge on Western Sydney University campus, and the controllable field test-bed could provide a potential benchmark model for bridge health monitoring.

With kind regards,

Tommy Chan

President, ANSHM

www.ANSHM.org.au

Analytical Seismic Fragility Assessment of Bridge Structures based on Extended Cloud Analysis

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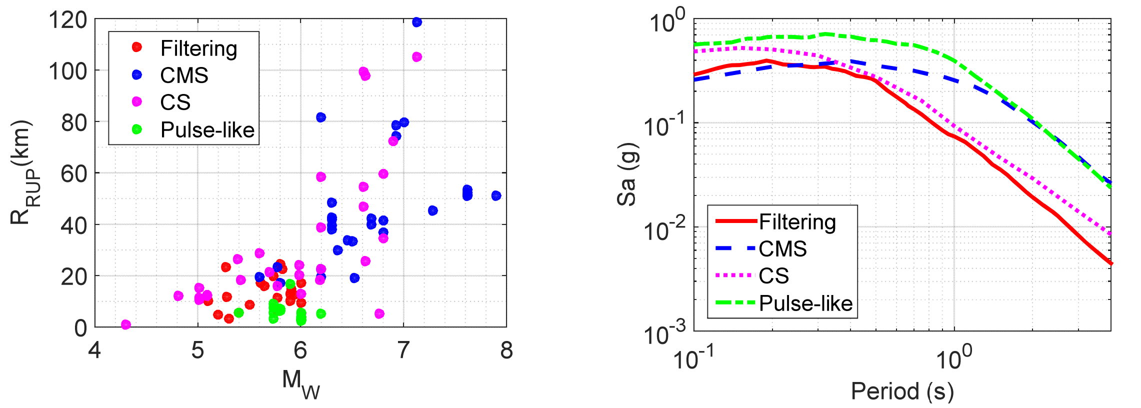
The gross randomness of earthquakes with respect to their return periods, shaking intensities and distances to constructed facilities necessitates adopting a probabilistic attitude for evaluating and expressing the performance of civil structures. Seismic fragility assessment is a practical tool for this purpose. This is to evaluate the cumulative density functions (CDF) of the probability of engineering demand parameters (EDP) exceeding various limit-states (LS), for different structural performance levels, given increasing shaking intensity measures (IM). The closed-form solution of this CDF is known as the analytical seismic fragility curve. Generating such curves for highway bridge infrastructure enables reliable seismic risk estimation, identification of vulnerable bridge components, recognition of the most susceptible bridges, adopting a retrofit prioritisation strategy, and ensuring the functionality of a road network in post-earthquake operations (e.g. emergency and rescue). Furthermore, performing seismic fragility assessment along with structural health monitoring (SHM) facilitates development of a precise deterioration model for long-term performance prediction of highway bridge infrastructure.

A rigorous approach for analytical seismic fragility assessment is the fully-parametric incremental dynamic analysis (IDA) method, which requires successive time-history analyses (THA) of the finite element model (FEM) of a bridge structure subjected to various scaled derivatives of a single ground motion record (GMR). Note that the probabilistic concept of seismic fragility assessment necessitates addressing the sources of randomness and uncertainty for robust fragility curves, through repetition of this process by many different GMRs and FEMs. As such, the use of the IDA method for highway overpasses with complex configuration comprising large FEMs implicates high computational costs. An efficient alternative for analytical fragility assessment is the Cloud analysis method which eliminates the THAs by the scaled derivatives of GMRs and works only by original (unscaled) GMRs. However, this method has some inherent limitations which adversely impact the fragility assessment of bridge structures for accurate evaluation of the collapse probability and/or precise estimation of the probability of non-collapse performance levels with high nonlinearity.

A study was carried out to develop a reliable and efficient method for seismic fragility assessment. To this end, the limitations of the Cloud analysis method were resolved by extending the analysis to a single scaled IM level of utilised GMRs. Subsequently, in addition to the original Cloud analysis (OCA), the scaled Cloud analysis (SCA) needs to be carried out by these GMRs. The scaling factor for the SCA is evaluated as the magnitude of the vector which transmits the median of the original IM-EDP dataset to the median IM level of a LS corresponding to the targeted performance level, called the transition scaling approach. The OCA and SCA datasets are then paired for all the utilised GMRs and categorised for fragility assessment. This process is named extended Cloud Analysis (ECA) method.

Seismic Fragility of Highway Overpasses in Southeast Queensland

A step-by-step procedure was carried out to analytically evaluate the seismic fragility of highway overpasses ubiquitous in southeast Queensland (SEQ) by the ECA method. **Step 1** was selection of GMRs for performing THA. To select a suite of GMRs applicable to the entire road network in this region, a total of one hundred GMRs were selected based on four different methods, considering various selection criteria, site conditions and earthquake scenarios. These included GMR selection based on the (1) filtering, (2) conditional mean spectrum (CMS) method, (3) conditional spectrum (CS) method, and (4) selection of pulse-like GMRs. The distribution of rupture distances (R_{RUP}) to magnitudes (M_W) of the selected earthquake GMRs is shown in Figure 1a, and the mean acceleration response spectra of the selected records are illustrated in Figure 1b.



(a) Distribution of M_W to R_{RUP} (b) Acceleration response spectra

Figure 1. Characteristics of GMRs

Step 2 involved creating the structural model of a highway overpass was created in the OpenSees analysis software. This overpass were comprised of multi-span (separated by expansion joints) prestressed concrete decks which were simply supported by rubber pads and steel dowels bearings over reinforced concrete (RC) pier walls, footings, piles and abutments. The FEM developed for the overpass consisted of a linear semi-rigid model for the decks, a multilayered shell model for the pier walls and analytical models for the rest of bridge components which simulate the dynamic behaviour. These models are schematically demonstrated in Figure 2. To enhance the reliability of fragility assessment for the SEQ highway overpasses eight uncertain bridge parameters were considered in the FEM, including the concrete compressive strength, steel yielding strength, deck mass, damping ratio, number of spans, span length height of under-clearance and the number of piles. This was done by sampling from these uncertain parameters, through the Latin Hypercube sampling (LHS) technique, to create forty highway overpass FEMs for the analysis.

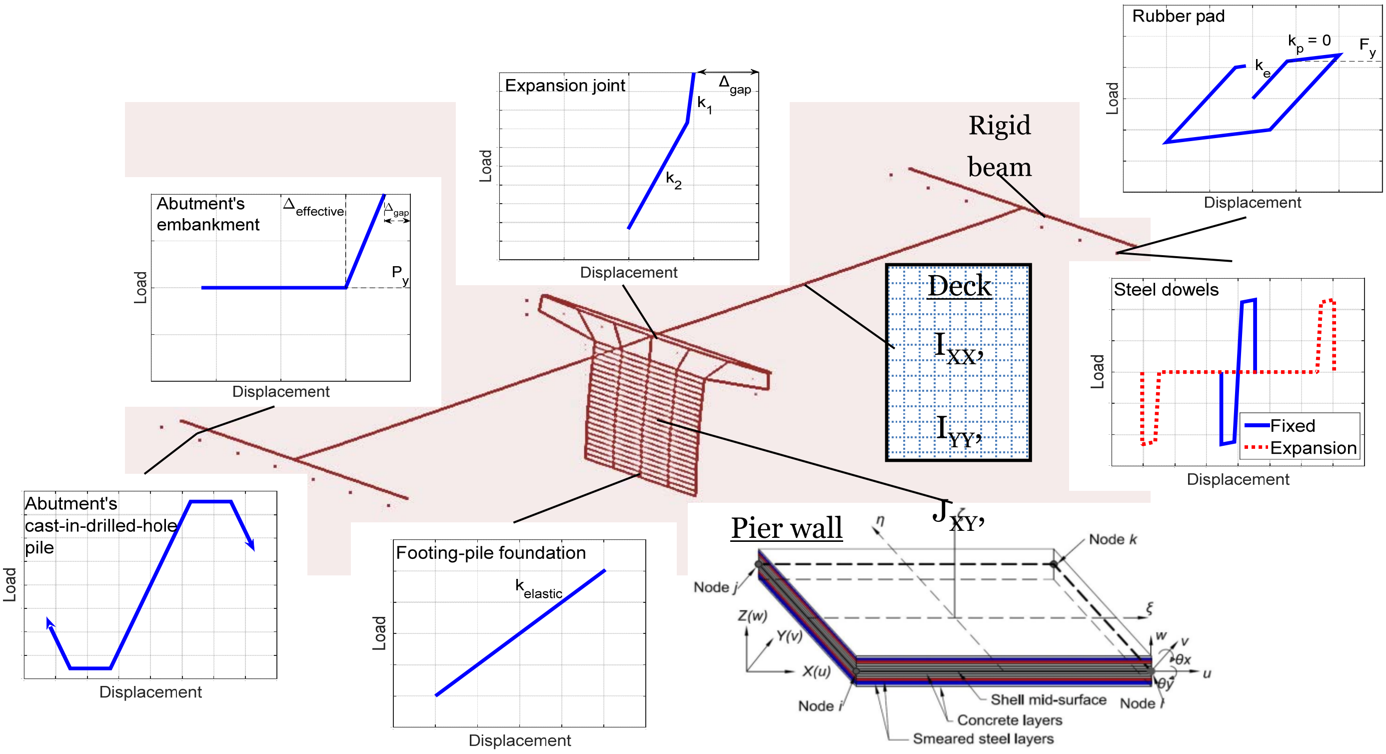


Figure 2. FEM of highway overpasses in OpenSees

One necessary task for seismic fragility assessment is characterising the targeted performance levels for the structure under investigation and nominating representative LSs for each performance level. For this purpose, three descriptive bridge performance levels were developed, based on the available recommendations for seismic performance assessment of bridge structures in the literature, namely the operational (OPL), damaged (DPL) and unstable (UPL) performance levels. These bridge performance levels are recommended in relation to the 50% (frequent seismic event), 10% (occasional seismic event) and 2% (rare seismic event) probability of occurrence in a 50-year return period seismic hazard levels, correspondingly. The relationship between the bridge performance levels and seismic hazard levels and the targeted performance objectives are depicted in Figure 3. At each of these performance levels a number of component EDPs was nominated to represent the thresholds of the recommended bridge performance in analytical fragility functions, including the longitudinal responses of the bridge pier walls, bearings, and abutments, as well as the transverse responses of these bridge components. The quantitative LS values of these EDPs were allocated based on the numerical results of the static-pushover (SPO), moment-curvature or pseudo-dynamic analyses on the individual bridge components. The uncertainty of the assigned LS values was accounted for through a subjective manner, by assigning a prescriptive coefficient of variation and standard deviation to these LS values at each performance level. The performance of highway overpasses at the system-level was investigated through the application of "*cut-set*" concept, which is defined as the maximum of the critical EDPs normalised by the corresponding LS values.

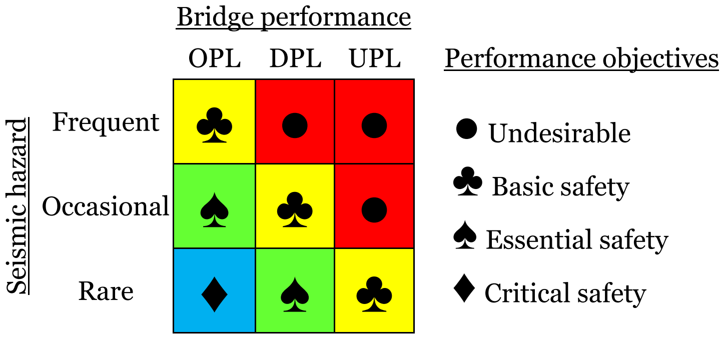
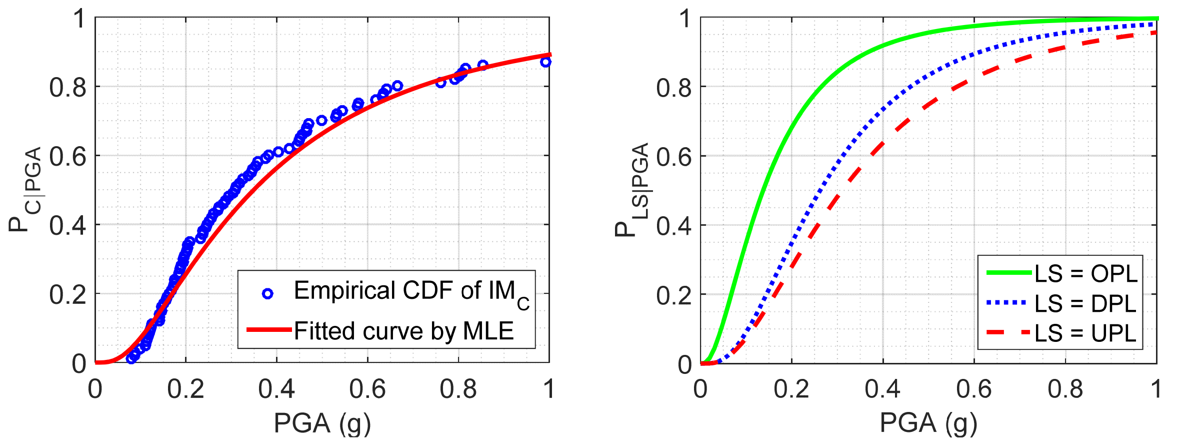


Figure 3. Bridge performance levels and desired objectives in relation to the seismic hazard levels

Subsequently, a code was developed in MATLAB and used to implement steps three to seven. **Step 3** was performing OCA on the sampled FEMs of highway overpasses subjected to the selected GMRs. This consisted of completing 4000 nonlinear THAs in OpenSees and performing probabilistic seismic demand analysis (PSDA) on the OCA data. **Step 4** was accomplished by evaluating the scaling factors for the utilised GMRs based on the transition approach followed by performing SCA. This was fulfilled by carrying out a further 4000 nonlinear THAs in OpenSees. In **Step 5**, the ECA dataset was developed by pairing the OCA data obtained for each GMR with its corresponding SCA data. This dataset was then divided into three categories: Category I containing non-collapse data paired $(IM\text{-}EDP)_{NC}$ with the collapse data $(IM\text{-}EDP)_{C}$; Category II containing pairs of $(IM\text{-}EDP)_{NC}$; and Category III containing pairs of $(IM\text{-}EDP)_{C}$. In **Step 6**, the collapse IM levels, IM_C, of the used GMRs were identified by IM_C for Category I, approximate IM_C for Category II, or lower IM_C for Category III GMRs. The approximate IM_C of GMRs in Category II was approximated through the linear extrapolation at the thresholds of the critical seismic responses at which structures collapse. Then, for each GMR in use the median value of forty IM_C levels, identified for the created FEMs, was sampled from the ECA dataset and sorted ascendingly to evaluate an empirical CDF for these values. This CDF is shown by blue circle marks in Figure 4a, and uses the peak ground acceleration (PGA) as the IM.

The closed-form solution for the collapse probability, $P_{C|IM}$, was evaluated by fitting a curve (red solid line) to this CDF through the maximum likelihood (MLE) method. Finally, in **Step 7**, the probability of exceeding the non-collapse performance levels, $P_{EDP \geq LS|IM}$, was evaluated by identifying the IM levels corresponding to the LS values, IM_{LS}, for each FEM and GMR. Then, the median of forty IM_{LS} values, identified for each GMR, were sampled from the ECA dataset. As such, an empirical CDF of IM_{LS} levels was developed for curve fitting by the MLE method. The total probability of meeting or exceeding different performance levels, $P_{LS|IM}$, of the system-level of SEQ highway overpasses is evaluated as the sum of $P_{C|IM}$ and $P_{EDP \geq LS|IM}$ multiplied by probability of no collapses, $P_{NC|IM}$ (i.e. $1\text{-}P_{C|IM}$). This is shown as the OPL (green solid line), DPL (blue dotted line) and UPL (red dashed line) in Figure 5b, using PGA. Based on the curves generated in this figure, the median collapse seismic fragility (i.e. 50% probability of exceedance) of SEQ highway overpasses is PGA = 0.35g. This means that in case of occurrence of an earthquake at this PGA, the likelihood of survival of a random highway overpass is 50%. In other words, this can be interpreted as the collapse of 50% of the SEQ highway overpasses during such an earthquake, however, it depends on the realisation of this PGA level by all the overpasses in this region. Also, the PGA at the $P_{LS|IM}$ = 0.5 is 0.14g, 0.26g and 0.32g in the OPL, DPL and UPL, respectively.



(a) Collapse (b) Non-collapse performance levels

Figure 4. Seismic fragility curves for SEQ highway overpasses

Structural Safety Research Group in Griffith University

The structural safety research group in Griffith University is led by Prof. Hong Guan in cooperation with Dr. Benoit Gilbert, Emeritus Prof. Yew Chaye Loo and Adjunct Prof. Xinzheng Lu from Tsinghua University, China. Currently, the areas under investigation by this group include the seismic fragility of bridge structures (one PhD student), seismic performance of steel frames with buckling restrained braces (one PhD student), and progressive collapse of RC flat plates (three PhD students).

A Long-term Monitoring System of the Cable-stayed Bridge: a controllable Field Test-bed in Australia

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Abstract: A long-term monitoring system has been installed on a cable-stayed bridge on Western Sydney University campus since June 2016. The system includes 31 acceleration measurement channels, 32 strain measurement channels and one optical switch. This report briefly introduces the monitoring system and this controllable field test-bed could provide a potential benchmark model for bridge structural health monitoring.

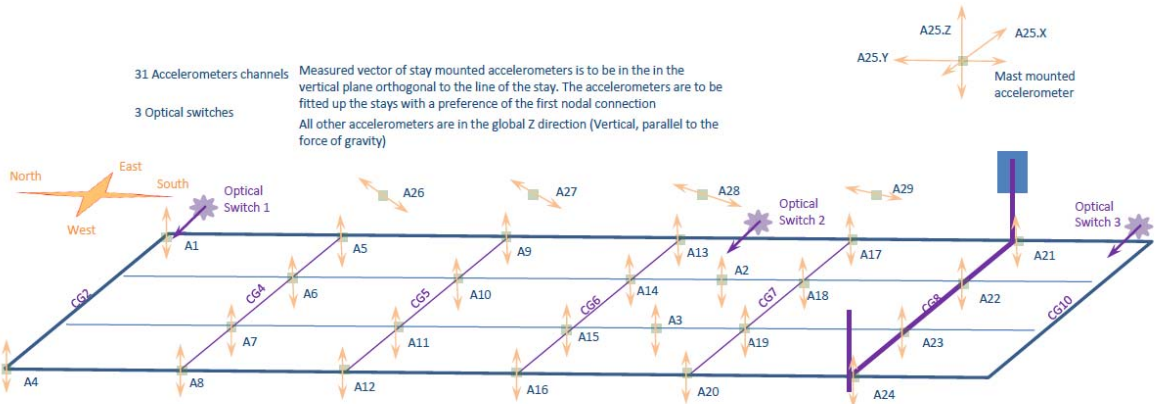
1. Introduction

The civil infrastructure are subjected to degradation due to aging, operational environment and excess loading. Structural health monitoring provides potential solutions to predict the structural performance under operational environment and a cost-effective condition-based maintenance strategy. Li and Hao (2016) presented a literature review of research developments on structural health monitoring in Western Australia. In past decades, numerous vibration-based methods have been developed for structural damage detection and most of them are verified using laboratory testing under controlled operational environments. However, successful applications in practice are limited. The operational environments have significant effects on field measurements and some damage detection methods are very sensitive to these operational environments. How to consider structural modelling errors and the varying operational environments is still a big challenge for practical application of structural health monitoring. Some structural health monitoring systems have been developed and installed on long-span bridges and high buildings to target the benchmark problems using monitored data (Ni et al., 2009; Xu et al., 2012; Li et al., 2014; Sun and Büyüköztürk, 2017). Recently some field testbeds have also been developed in Australia (Nguyen et al., 2015; Sun et al., 2017). This report briefly introduce an instrumented cable-stayed bridge and it has the potential field testbed for bridge health monitoring

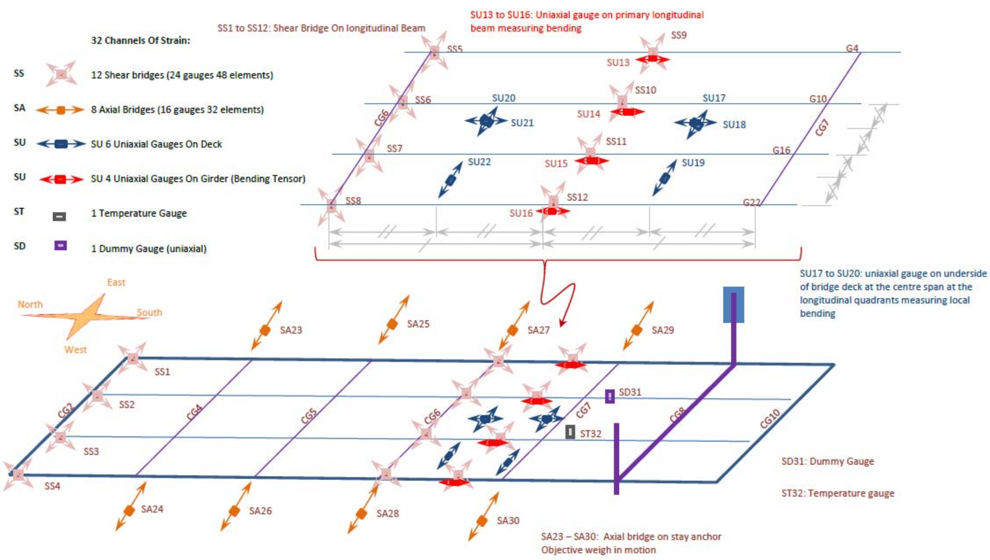
2. Long-term Monitoring System

The instrumented cable-stayed bridge, as shown in Figure 1, is located in Werrington, NSW, Australia. The bridge links the Werrington North and South campuses, Western Sydney University. The bridge is a single lane highway bridge with 46.22m long and 6.3m wide. The height of pylon is 33m and there are 16 cables with the steel-concrete composite bridge deck.

Figure 1. The cable-stayed bridge



(a) Locations of accelerometers



(b) Location of strain gauges

Figure 2. Sensor locations

The bridge was fully instrumented in June 2016 and there are over one year long-term continuing monitoring data available. There are total 64 channels for the monitoring system, that includes 31 channels' acceleration measurements, 31 channels' strain measurements, one channel for temperature and one channel for optical switch. The detail sensor locations are listed in Figure 2. As shown in Figure 2(a), 24 accelerometers are installed on the bridge deck, four accelerometers on fore cables and one tri-axial accelerometer on the top of the tower. The 31 strain channels include 12 shear strains, eight lateral bending strains, six longitudinal bending strains on the bridge deck and four longitudinal bending strains on the four girders. The monitoring data are continuously recorded with the sampling rate 600Hz and saved in the local computer every ten minutes. The data are then transmitted to the long-term storage through the optical fiber cable as shown in Figure 3. The data storage could be accessed through the internet.

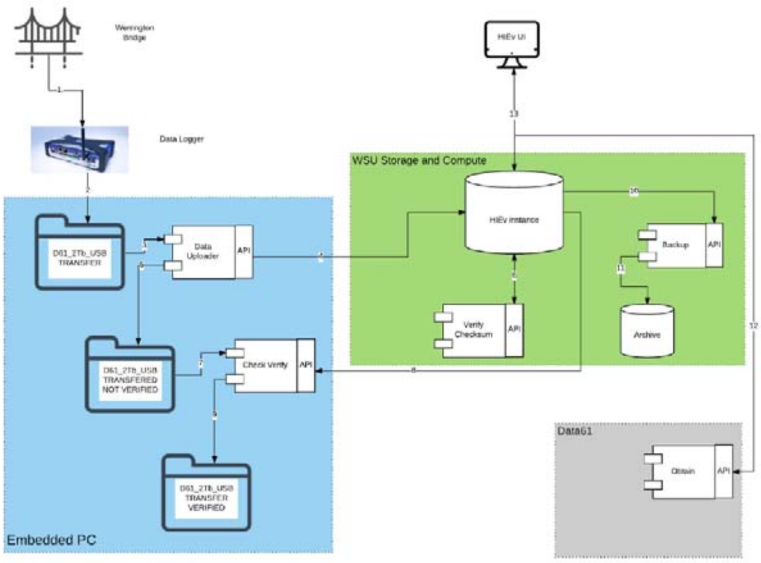


Figure 3. Data acquisition and storage

Figure 4. Proof testing using a heavy truck

3. Potential controllable field testbed for bridge health monitoring

Compared with structural health monitoring systems for long-span bridges and high buildings, this instrumented cable-stayed bridge could be used for the field testing under the controlled operational environments. Figure 4 show one of examples for the bridge testing using a heavy truck. The gross weight of the truck is 25tonnes with one single axle in the front, one tandem-axle in the middle and one tridem-axle at rear. Figure 5 shows typical acceleration and strain measurements and Figure 6 shows the typical acceleration response and its Fourier spectrum when the vehicle is passing over the bridge. Figure 5(b) shows the strain time history when the vehicle is passing this two span bridge. The first frequency of the vehicle-bridge system is 2.034Hz.

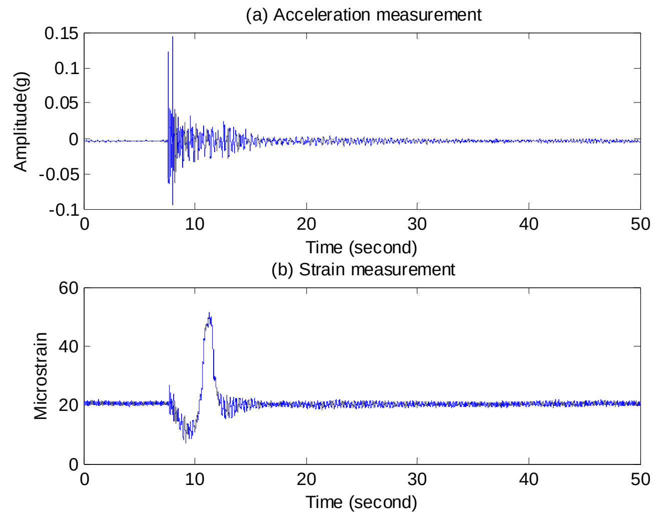


Figure 5 Typical acceleration response and strain measurements

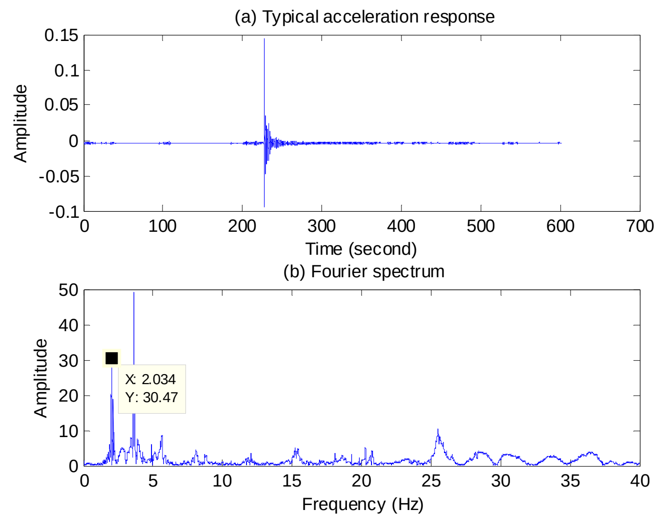


Figure 6 The acceleration response and its spectrum

4. Conclusions

This report briefly introduces the long-term monitoring system for a cable-stayed bridge. Over one year continuing monitoring data have been obtained and the data could be used for the research on the effect of operational environments. Also the instrumented cable-stayed bridge could be a controllable field testbed to carry out the study for bridge health monitoring.

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ARC Funding Received by ANSHM members in 2017

Discovery Projects:

- Mark Stewart, Mark Masia, 2018-2020, 'Stochastic Hazard Assessment of Unreinforced Masonry Wall Systems', ARC Discovery Project Projects. Funds Approved: $473,315.
- Brian Uy, 2018-2020, 'Behaviour & Design of Large Fabricated Stainless Steel Composite Structures', ARC Discovery Projects. Funds Approved: $463,488.
- Vanissorn Vimonsatit, Priyan Mendis, Surendra Shah, 2018-2020, 'Developing Innovative Concrete Composites by Upscaling Material Properties', ARC Discovery Projects. Funds Approved: $392,834.
- Guowei Ma, Farhad Aslani, 2018-2020, 'Development of three-dimensional printing conductive concrete for electromagnetic pulse shielding', ARC Discovery Projects. Funds Approved: $382,834.

Linkage Infrastructure, Equipment and Facilities (LIEF) Projects:

- David Thambiratnam, Tommy Chan, Manicka Dhanasekar, Brian Uy, Xiao-Ling Zhao, Hong Hao, Bijan Samali, Alex Remennikov, Mark Masia, Sabrina Fawzia, Xuemei Liu, Dong Ruan, Hong Guan, Ali Akbarnezhad, Nangallage Fernando, 2018, 'New Generation Facility for Impact Testing', ARC LIEF Projects. Funds Approved: $744,697.

Industrial Transformation Training Centre (ITTC) Projects:

- Buddhima Indraratna, Kiet Tieu, David Airey, David Thambiratnam, Arul Arulrajah, John Wilson, Zheng Jiang, Jian Zhao, Michael Meylan, David Williams, Hamid Nikraz, Manicka Dhanasekar, Rian Dippenaar, Cholachat Rujikiatkamjorn, Pascal Perez, David Wexler, Hongtao Zhu, Olivia Mirza, Jun Li, Tao Yu, Katsumi Maeda, Timothy Neville, Richard Kelly, Liam Palmer-Cannon, Richard Austin, Jingtao Han, Li Yao, Melvyn Leong, Maroun Rahme, James Grant, John Buckley, Todd Clarke, Ryan Jansz, 2017-2021, ARC Training Centre for Advanced Technologies in Rail Track Infrastructure, ARC ITTC Projects. Funds Approved: $3,937,625.

Conference News

- ***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 "Recent SHM advances in Australia" 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. (http://smc.hit.edu.cn/wcscm2018/)
- ***"SS11 - Structural Health Monitoring for Infrastructure Asset Management"*** in the **9th International Conference on Bridge Maintenance, Safety and Management**, Melbourne, 9-13 July 2018. (http://iabmas2018.org)
- ***Smart Cities: Present & Future,*** 26-28 May 2018, Beijing, China. (http://www.jsc-presentfuture.com/)

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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