The 15th Australian Network of Structural Health Monitoring Workshop & The Smart Infrastructure Summit 2023

Townsville, 23-24 November 2023

Infrastructure Digitisation for Net Zero Transition

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The Smart Infrastructure Summit 2023 & The 15th Australian Network of Structural Health Monitoring Workshop

Day 1, 23rd November

Time	Program Details
8:00am - 8:30am	**Registration** **Venue: The Banquet Centre, 252 Flinders St, Townsville**
8:30am - 8:40am	Welcome and Smart Infrastructure in the Context of Net Zero **Dr Govinda Pandey, CEO - Rockfield, Chair - Organising Committee**
8:40am - 8:45am	Opening Remarks **Cr Jenny Hill, Mayor of Townsville City Council**
8:45am - 8:55am	Opening Remarks and JCU's Net Zero Research **Prof Jenny Seddon, Deputy Vice Chancellor Research - JCU**
8:55am - 9:05am	ANSHM Vision, Journey and Future Directions **Prof Tommy Chan, QUT, President - ANSHM**
9:05am - 9:25am	The Confluence of Transport, Energy and Technology – Shaping Our Transport Future **Mr Michael Caltabiano, CEO - NTRO (ARRB)**
9:25am - 9:40am	Digitisation and the Energy Transition **Mr Jason Hall, A/Chief Engineer - Energy Queensland**
9:40am - 9:55am	Over the Rainbow of Structural Health Monitoring **Prof Ian Atkinson, eResearch Professor JCU and a Futurist**
9:55am - 10:05am	**Trailblazer Spotlight - The InfraVision Journey**
10:05am - 10:30am	**Morning Tea**
10:30am - 10:45am	Structural Engineering Opportunities to Contribute to Net Zero **Prof Brian Uy, Scientia Professor of Structural Engineering - UNSW**
10:45am - 11.00am	The Role of Sensor Technology in the Sustainable Management of Transport Assets **Dr Torill Pape, A/Deputy Chief Engineer Structures, E&T - Dept of Transport and Main Roads**
11:00am - 11:15am	Building to the Code does not get us Resilient Structures **Dr David Henderson, Chief Engineer - Cyclone Testing Station, JCU**
11:15am - 11:30am	Challenges in Managing Port Assets and PIANC's Initiatives in Leveraging Technology **Dr Sam Mazaheri, Chair Northern Chapter PIANC ANZ and SI Specialist DBCT**
11:30am - 12:10pm	Panel Discussion: Navigating Asset Management Challenges withAgeing Infrastructure: Opportunities and Barriers in Embracing Transformative Digital Technologies **Nigel Powers (ARRB) / Dr Torill Pape (TMR) / Peter Prasad (ARTC) / Kathy Noonan (Energy Queensland)** **Facilitator: Prof Jianchun Li (UTS)**
12:10pm - 1:00pm	**Lunch Break**
1:00pm - 1:15pm	High and low value Structural Health Monitoring **Mr John Vazey - Engineering Manager, EngAnalysis**
1:15pm - 1:30pm	Structural Health Monitoring in the United States and Europe **Dr Arash Behnia - Principal, Robert Bird Group**
1:30pm - 2:15pm	"Collaboration Catalyst: Bridging Gaps and Overcoming Barriers" Pitches on Industry Challenges followed by a Panel Discussion on: Towards a Purposeful Industry-University-Government Collaboration **Prof Hong Guan (Griffith) / Mario Martini (CSIRO) / Dr Denise Hodge (JourneyTech) / Greg Bruce (Townsville City Council)** **Facilitator: Dr Ulrike Dackermann**
2:15pm - 2:30pm	Challenges and Emerging Technologies in Decarbonising the Building Industry towards a Net Zero future **Prof Tuan Ngo - The University of Melbourne**
2:30pm - 2:40pm	Circular Economy - Vote of Thanks **A/Prof Rabin Tuladhar, James Cook University**
2:50pm - 3:30pm	**Networking and Afternoon Tea**

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The Smart Infrastructure Summit 2023 & The 15th Australian Network of Structural Health Monitoring Workshop

Day 2, 24th November

Venue: 025-001, James Cook University, Bebegu Yumba Campus, Douglas

Time	Program Details
9:00am - 9:10am	Welcome Address **Prof Ron White, Dean - College of Science and Engineering, JCU**
9:00am	**Keynote Session**
9:10am - 9:25am	Bridge and Traffic Monitoring Insights **Dr Robert J Heywood, Department of Transport and Main Roads**
9:25am - 9:40am	Practical Monitoring for Superload Transports **A/Prof. Colin Caprani, Monash University**
9:40am - 9:55am	Dynamic assessment of large infrastructure **Dr David Lo Jacono, Jacobs**
9:55am - 10:10am	Monitoring of a 1960s Bridge in Victoria **Dr Desiree Nortje, Transurban**
10:10am - 10:30am	Panel Discussion: Dr Rob Heywood, A/Prof Colin Caprani, Dr David Lo Jacono, Dr Desiree Nortje
10:30am - 11:00am	**Morning Tea**

Morning Parallel sessions (11:00am -12:15 pm)

Time	Program Details
11:00am	**Session 1a Venue: 25-001, James Cook University, Bebegu Yumba Campus, Douglas**
11:00am - 11:10am	A synergic method for updating prestress force and identifying moving force in prestressed concrete bridges **K. Jeyamohan, T. Chan, K. Nguyen and D. Thambiratnam**
11:10am - 11:20am	Mobile Crowdsensing and IoT sensing techniques for drive-by bridge condition monitoring **J. Li, Z. Peng and H. Hao**
11:20am - 11:30am	A dual-sensor technqiue for the calibration of frequency-dependent wave speed and attenuation in water pipes **J. Gong, J. Lee, W. Zeng and M. Lambert**
11:30am - 11:40am	Development of IoT-based SHM system prototype for footbridge vibration monitoring using LoRa technique **H. Qiao, H. Guan, A. Bailey, S. Jamali and Y Zhu**
11:40am - 11:50am	Non-destructive Monitoring and Imaging of Civil Engineering Infrastructure **S.Majhi, A.Mukherjee**
11:50am - 12:00am	Infravision: Next-Gen Dynamic Line Monitoring **M. Ferraris and C. Van Der Berg**
12:00am - 12:10pm	Low-Cost Water Level Gauging for Flood Impact Analysis **S. Igloi**
12:10am - 12:20pm	Question Time
11:00am	**Session 1b Venue: 25-002, James Cook University, Bebegu Yumba Campus, Douglas**
11:00am - 11:10am	Significance of Economic Framework in Maintenance Decision-Making **S. More, R. Tuladhar and D. Grainger**
11:10am - 11:20am	Asset Mangement of Berth Shiploader Rail Girders via Online Monitoring System **S. Mazaheri**
11:20am - 11:30am	UAS-Based Multi Layered Data Collection Methods and Defect Detection Algorithms for Predictive Analytics and Bridge Asset Management **H. Rathod, C. Owen and D. Arscott**
11:30am - 11:40am	Structural Condition Assessment based on Knowledge Transfer **X. Zhang, S. Talaei, X. Zhu and J. Li**
11:40am - 11:50am	A Framework for Structural Damage Detection based on SAP2000-OAPI and Nature Inspired Optimisers **A. Reid, P. Ghannadi and A. Nguyen**

Time	Program Details
11:50am - 12:00am	Proactive Approaches to Asset Management: Lessons from Queensland Rail **A. Miri**
12:00am - 12:10pm	Port of Townsville Berth 1 Structural Health Monitoring **M. Jaditager and D. Whipp**
12:10am - 12:20pm	Question Time
12:25pm - 1:30pm	**Lunch**

Afternoon Parallel sessions (1:00pm -2:30 pm)

Time	Program Details
1:30pm	**Session 2a Venue: 25-001, James Cook University, Bebegu Yumba Campus, Douglas**
1:30pm - 1:40pm	Development of Fiber Bragg Gratings Sensors for Reinforcement Corrosion Detection in Structural Health Monitoring **S. Saha, A. Hadigheh, S. Fleming, I. Rukhlenko and M. Valix**
1:40pm - 1:50pm	Next-generation coupled structure-human sensing for pedestrian-bridge interaction analysis using data fusion and machine learning **U. Dackermann and S. Hassani**
1:50pm - 2:00pm	Tunnel Displacement Monitoring using Battery-Powered Wireless Radar Sensors **B. Paneru, D. Yau and S. Igloi**
2:00pm - 2:10pm	Crack identification in beams by a novel modal-based correlation method **K. D. Nguyen and T. H.T. Chan**
2:10pm - 2:20pm	Bridge and Traffic Monitoring (BTM) of the Gateway Arterial Flyover **R. Newman**
2:30pm - 2:45pm	Question Time
1:30pm	**Session 2b Venue: 25-002, James Cook University, Bebegu Yumba Campus, Douglas**
1:30pm - 1:40pm	Spatial Positioning in the SHM World **B. Dalton**
1:40pm - 1:50pm	Asset Condition Monitoring using operational data from SCADA systems **M. Krishnamenon and R. Tuladhar**
1:50pm - 2:00pm	Nonlinear vibration control of offshore wind turbines under multiple dynamic hazards **H. Zuo, S. Zhu, K. Bi and H. Hao**
2:00pm - 2:10pm	Automated Stromwater infrastructure inspection leveraging deep learning or Convolutional Neural Network **A. N. Yussuf, H. Chen, N. Weerasinghe, L. Hou and K. Zhang**
2:10pm - 2:30pm	Question Time
2:30pm - 2:45pm	**Closing Ceremony**
2:45pm - 3:00pm	**Afternoon Tea Networking**

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Smart Infrastructure in the Context of Net Zero

Dr Govinda Pandey
PhD, MBA, GAICD, FIEAust, CPEng, RPEQ, PE (Vic)
CEO – Rockfield Technologies
Co-Chair – Organising Committee

Synopsis:

Australia's civil infrastructure such as bridges have a rich history, with many surpassing 50 years of service, including iconic structures like the Sydney Harbour Bridge nearing its centenary mark. These ageing bridges were not designed for the contemporary demands of heavier traffic, larger freight vehicles, and stricter design standards. Consequently, when assessed against modern criteria, a significant portion of these bridges may fail to meet compliance standards. Retrofitting them to meet current standards would entail substantial costs and, in some cases, may be impractical due to historical design features.

Moving towards net zero emissions requires addressing two core aspects: enhancing safety margins based on reliable data and making future bridge designs sustainable by reducing construction material requirements and carbon footprints. Effective asset management hinges on understanding asset-specific loading demands, applying data-driven methods rooted in structural reliability principles, and optimising asset use to minimize costly strengthening or replacements.

Achieving breakthroughs in many of these areas necessitates deep and meaningful collaboration and partnerships among industry, universities, and academia.

Bio:

Dr Govinda Pandey is the CEO of Rockfield, Co-Founder of LiXiA and Adjunct Professor at James Cook University. Govinda, a fellow member of Engineers Australia, holds a bachelor's degree in civil engineering, a master's degree in structural engineering, and a Ph.D. in concrete structures. Additionally, he has earned an MBA and is a graduate of the Australian Institute of Company Directors. His leadership has resulted in Rockfield pioneering the adoption of modern sensor technologies to accelerate the world's transition to safe and intelligent infrastructure.

Govinda possesses technical expertise in structural rehabilitation, bridge engineering, and structural health monitoring. As a recognised thought leader in the industry, he imparts knowledge through talks at workshops, seminars, and conferences globally as an invited speaker. His passion for education is evident in his commitment to lecturing at the university, supervising research students, mentoring aspiring engineers, and engaging with schools and broader community, all driven by a desire to contribute to the greater good of society.

Welcome Address

Cr Jenny Hill
Mayor of Townsville City Council

JCU in the Transition to Net Zero

Prof Jenny Seddon
Deputy Vice Chancellor Research, JCU

Bio:

Professor Jenny Seddon is the Deputy Vice Chancellor, Research at James Cook University (JCU). Jenny has responsibility for building research partnerships and enhancing the research performance through developing and implementing strategic initiatives to deliver high quality research. Jenny has previously held the role of Associate Dean Research and Deputy Executive Dean of the Faculty of Science at The University of Queensland. Prior to that, she gained leadership experience as Deputy Head and Acting Head of the School of Veterinary Science at The University of Queensland. Jenny has an international research reputation in conservation genomics of wildlife and has worked with a range of species, most recently koalas and dugongs, with >90 peer reviewed publications. She has held research positions in the UK and Sweden and led a Veterinary Education Twinning Project in Vietnam.

ANSHM Vision, Journey and Future Directions

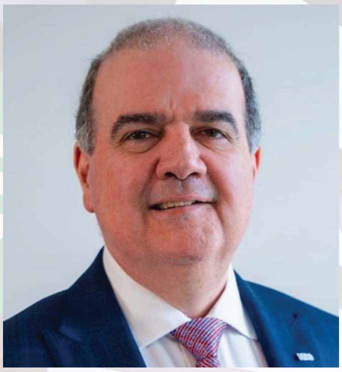
Prof Tommy Chan
BE (Hons I), MDiv, ThM, PhD, FIEAust, CPEng, NER, APEC Eng, IntPE(Aus), FHKIE, RPE, MICE, C Eng, MCSCE
Professor QUT, President ANSHM

Synopsis:

This talk introduces the Australian Network of Structural Health Monitoring by its President, including its establishment, mission and achievements. It will also bring some insights for discussion about the future trends of SHM and how Smart Infrastructure could be achieved using SHM.

Bio:

Prof Tommy Chan is a Full Professor of Civil Engineering in the School of Civil and Environmental Engineering at Queensland University of University (QUT) and members of ARC College of Experts. He is also the Founding Chair and President of the Australian Network of Structural Health Monitoring (ANSHM). Prof Chan has been actively involved in carrying out research on structural health monitoring (SHM). He has almost 30 years of experience in SHM of various significant long span bridges in Hong Kong and the Mainland China and taking an active role in promoting SHM in Australia after he moved to Australia in 2007, leading various significant achievements in SHM with other SHM experts, asset owners, government and industry practitioners under ANSHM. He is also a professional engineer and Fellow of Engineers Australia and HKIE. Besides SHM, his research interests include bridge engineering, structural dynamics, impact studies, Moving Force Identification, Weigh-in-Motion Studies, optical fibre and other sensor developments, and new engineering materials.



The Confluence of Transport, Energy and Technology – Shaping Our Transport Future

Michael Caltabiano
BE(Hon), MPhil, GDBA, FIEAust, FAICD, RPEQ, IAMA
CEO - NTRO (ARRB)

Synopsis:

The Confluence of Transport, Energy and Technology – Shaping Our Transport Future

Bio:

Mr Michael Caltabiano was appointed Chief Executive of ARRB, the Australia Road Research Board, in November 2016 after a very successful three years at the helm of the Australian Asphalt Pavement Association (AAPA). Mr Caltabiano brings to the role of Chief Executive extensive experience in the flexible pavement and bituminous surfacing industry. ARRB is the National Transport Research Organisation for Australia and New Zealand with offices across Australia and is the national reference agency for infrastructure standards and delivery outcomes for State and Federal Governments.

Michael graduated from James Cook University with an Honours degree in Civil Engineering and commenced work with the Department of Main Roads, Queensland. He subsequently completed a Master of Philosophy degree at Nottingham University in the UK and researched the application of treatments to prevent reflective cracking from cement treated bases through asphalt pavements. He has also gained a Graduate Diploma in Business Administration and is a qualified Company Director and Mediator.

He has extensive experience in the public and private sectors and also had an elected representative role and Local and State Government level for 10 years. His career has spanned across a wide range of areas including the delivery of large infrastructure projects, the development and planning of multibillion-dollar City Budgets and public representation, legislative engagement and community representation.

Michael brings more than 35 years of experience, and great enthusiasm for the roads and transport sector with a particular focus on creating knowledge for tomorrows transport challenges and driving innovation to deliver an adaptable connected future.

Digitisation and the Energy Transition

Jason Hall
BEng(Hons), GradCertMgt, RPEQ, MAICD
General Manager Grid Technology - Energy Queensland

Synopsis:

Energy Queensland is playing a significant role in designing and delivering the grid of the future on one of the largest distribution networks in the world.

The energy transition is a pathway toward transformation of the global energy sector from fossil-based energy to zero-carbon renewable energy by the second half of this century. At its heart is the need to reduce energy-related CO2 emissions to limit climate change. Electrification powered by renewables is the way to eliminate most energy-based emissions.

Integrating large quantities of variable solar and wind generation, whose peak output may not match moments of peak demand, requires more sophisticated management of electrical grids. Digital technologies and data hold tremendous potential to forecast and match electrical supply and demand, thereby cutting costs, improving efficiency and resilience, and reducing emissions.

Energy Queensland's #electriclife2032 strategy includes a number of no regrets digital initiatives required to achieve net zero by 2050.

Bio:

Jason Hall is the General Manager Grid Technology at Energy Queensland, a government owned corporation responsible for the distribution of electricity across Queensland via their two electricity distributors - Energex and Ergon Energy. He is accountable for ensuring safe and reliable protection, telecommunications and control systems exist for the Energy Queensland electricity network including the introduction of new technologies to transition to an intelligent grid.

Jason has a Bachelor of Engineering (Electrical and Computer) Honours Degree from Queensland University of Technology and a Graduate Certificate in Management from Deakin University. He is also a trade qualified electrical fitter mechanic and has over 30 years experience in the Queensland Electricity Supply Industry comprising of positions in generation, transmission and distribution. Jason is a Registered Professional Engineer of Queensland, Energy Queensland's member representative of CIGRE Australia, a member of the Energy Networks Australia Asset Management Committee and also a Board Director of the Australian Power Institute.

Over the Rainbow of Structural Health Monitoring

Prof Ian Atkinson
eResearch Professor JCU and a Futurist

Synopsis:

We are all aware of the urgency to introduce new approaches to SHM and Asset Management as the world's infrastructure stock ages, demand climbs and the capacity to fund replacements becomes more complex. Changing standards and growing regulation, societal expectations and changing demographics—along with the necessity to respond to climate change and quickly transition to a net-zero economy—are just some of the forces that make innovation in SHM not only desirable, but essential.

Technologies that have become accessible in the last decade—such as IoT, reliable remote high-speed networks, ML and AI, along with the adoption of digital twins—hold potential to provide insights for asset managers and permit significant lifetime extensions, as well as improving safety profiles.

However, with any new technology there is a complex adoption curve—there are no 'free lunches'. Emerging ethical issues and/or concerns about social licence are now being asked, and governance and security concerns are not well understood. If a better future awaits us, we need to expeditiously focus on data security, workforce training and regulatory compliance issues.

Bio:

Ian Atkinson is a Professor of eResearch at JCU and co-founder of LiXiA. He started his career as a chemist, moved into supercomputing computing. His expertise in eResearch (using advanced IT to develop new research methodologies), big data management, and IoT. His work in using widely deployed, low-cost sensors for environmental monitoring has helped develop a new approach to understanding the world in real-time. He has been using AI and image recognition in health and agriculture for a decade and is anxious we use AI safely to thrive as this once in a millennia invention is unleased.

Trailblazer Spotlight

Michael Ferraris
Technology Lead

Infravison builds new technologies that unlock efficient and scalable methods of power line construction and maintenance. Infravision has quickly become a household name in the Australian and United States transmission industry that works closely with its customers to solve legacy challenges and reshape the grids of the future.

Structural Engineering Opportunities to Contribute to Net Zero

Prof Brian Uy
Scientia Professor of Structural Engineering
University of New South Wales

Synopsis:

Net Zero is a significant challenge that our society is faced with. Much of the current discussion has focused on the reduction of operational energy. This challenge often does not provide much opportunity for structural engineers to contribute to. However, the role of structural engineers in reducing and minimising embodied carbon is one which has received less attention. This presentation will present some opportunities particularly in the context of the Structural Health Monitoring community.

Bio:

Brian Uy is Scientia Professor of Structural Engineering at The University of New South Wales. He is the Chairman of the Standards Australia Committees BD32 on Composite Structures for Buildings and BD-90-Part 6 on Steel and Composite Structures for Bridges. He is Chief Editor (Asia-Pacific) for the journal Steel and Composite Structures and he is the current Vice President (Australasia and South-East Asia) of The Institution of Structural Engineers (2022-2024) and Vice President of the International Association of Bridge and Structural Engineering, (2023-2026).

The Role of Sensor Technology in the Sustainable Management of Transport Assets

Dr Torill Pape
FIEAust CPEng RPEQ BEng(Hons) PhD
A/Deputy Chief Engineer | Structures
Engineering & Technology
Department of Transport and Main Roads

Synopsis:

This presentation will discuss the challenges and opportunities faced by TMR in relation to being truly sustainable in the management of its transport infrastructure. Torill will talk through TMR's sustainability approaches, particularly in relation to how TMR is considering the carbon impact across the infrastructure lifecycle, with a focus on operations and maintenance of existing assets. Focussing on high-value structural assets, examples will be provided on how sensor technology is currently supporting TMR in making informed and sustainable decisions towards a NetZero infrastructure approach.

Bio:

Dr Pape is a Director in Engineering and Technology's Structures team in TMR.

Torill has over 20 years' experience as a civil/structural/bridge engineer across a broad number of sectors, including consulting, construction, public service and academia.

She has a keen interest in the whole-of-life management and performance of assets. Torill's experience is supported by her academic research on the performance of in-service older concrete structures.

Building to the Code does not get us Resilient Structures

Dr David Henderson
Chief Engineer, Cyclone Testing Station, JCU

Synopsis:

Building regulations coupled with insurance for assets provide resilience to the homeowner, business and government. Major changes were made to regulations, and designer and builder training for house construction due the devastation to the city of Darwin following Tropical Cyclone Tracy (1974). Damage investigations following cyclones over the subsequent decades have shown that there is positive step change in performance for life safety robustness of housing built after the code changes. However, investigations of claims data shows that contemporary construction is driving the losses in terms of cost of rebuilding or repair and loss of property's functionality. This raises questions as to appropriateness of our building construction, codes and design practices, in terms of today's need for community resilience. There is a disconnect between designing for the "acceptable" point risk level as prescribed in the building code for that one building, but the whole community is also impacted by the cyclone with the consequences of damage greatly amplified (as everything is built to that same minimum design level).

Bio:

David Henderson is an engineer at the Cyclone Testing Station (CTS) at James Cook University. David joined the CTS in 1991. He has broken everything from roofing screws to complete houses. David has conducted post-disaster damage investigations in Australia and overseas. He has developed vulnerability models for residential and commercial buildings. David is involved in Australian Standards committee for Wind loads on housing as well as Standards for Design, Testing and Installation of various building materials and elements.

Challenges in Managing Port Assets and PIANC's Initiatives in Leveraging Technology

Dr Sam Mazaheri
Chair Northern Chapter PIANC ANZ and Structural Integrity Specialist DBCT

Synopsis:

This presentation explores the multifaceted challenges faced by modern port authorities and operators, who serve as vital conduits for global trade. Effective port management presents unique hurdles necessitating innovative solutions. Central to this discussion is the pivotal role played by the World Association for Waterborne Infrastructure (PIANC), with a specific focus on their 2023 publication, "Health Monitoring of Ports and Waterway Infrastructure." This publication introduces ground-breaking solutions for preserving the condition and health of these essential assets. A primary challenge under scrutiny is the inspection and maintenance of waterborne transport infrastructure, often located in remote and inaccessible areas. The intricate logistics involved necessitate advanced techniques, such as the creation of supplementary infrastructure for access and the deployment of divers for in-situ inspections underwater sections. These methods require careful coordination to minimize economic impact due to temporary infrastructure shutdowns. Additionally, the presentation underscores the irregularity of these inspections, driven by substantial initial costs and potential economic consequences. This emphasizes the pressing need for a more efficient, cost-effective, and technologically advanced approach to these critical tasks. The audience will be introduced to how smart technology is reshaping these procedures. Innovations like remote sensing, autonomous inspection vehicles, data analytics, and predictive maintenance are at the forefront of transforming inspections into more streamlined, efficient, and sustainable processes.

Bio:

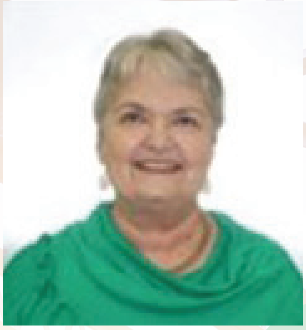
With over 30 years of experience in a variety of industrial sectors, Dr. Sam is a recognized leader and chartered professional engineer in Structural Engineering, Civil Engineering, and Asset Management. He has extensive experience in industries such as mining, ports and offshore terminals, rail and transportation, and water management, and has been involved in the design, construction, and management of complex and critical infrastructure projects. As a skilled strategic thinker and problem solver, Dr. Sam has provided effective solutions to numerous complex challenges faced by asset owners and operators in a range of industries. He is also a highly accomplished academic and researcher, having taught and supervised students in the fields of Structural and Maritime Engineering, and having published over 100 peer-reviewed articles. In addition, he holds important positions in various national and international organizations, including Engineers Australia, PIANC ANZ, Ports Australia, and Standards Australia.

Panel Discussion: Navigating Asset Management Challenges with Ageing Infrastructure: Opportunities and Barriers in Embracing Transformative Digital Technologies.

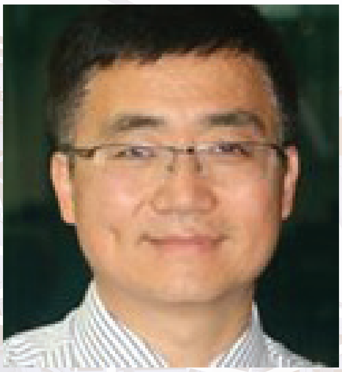
Nigel Powers
NTRO

Dr Torill Pape
Dept of Transport and Main Roads

Peter Prasad
ARTC



Kathy Noonan
Energy Queensland



Facilitator:
Prof Jianchun Li

UTS
Vice President - ANSHM

Bios:

Nigel Powers

Nigel commenced with NTRO in 2019 and is currently the National Leader - Structures and Certification. He has over 23 years experience in the industry with 18 years experience in the Victorian public service including VicRoads/DoT and Major Road Projects Victoria (MRPV). During this time Nigel reached Director level and he has worked across numerous aspects of road assets including the planning, design, construction, maintenance and management of bridges, structures, pavements and related road assets. Nigel has practical experience in program delivery, project management and asset management of road assets. His technical focus is bridges and other road structures with experience throughout the lifecycle of a structure and is acknowledged nationally and internationally for this work. His experience includes design, inspection, assessment, asset management, network management, construction, maintenance and operation. He was responsible for the maintenance, management and operation of the West Gate Bridge for 5 years, bridge asset network development and delivery across Victoria and has developed and delivered numerous technical documents, training and standards including AS5100 – Bridge Design Code. Nigel is a leader within the bridge and structures industry. He led securing the hosting rights, and then chaired, the Austroads Bridge Conference 2017 and the 9th International Conference on Bridge Maintenance, Safety and Management (IABMAS 2018). He has been a nominated representative with Austroads and Standards Australia and is currently the President of IABMAS Australia. Nigel is also an Advisory Board Member of ANSHM.

Dr Torill Pape

Dr Pape is a Director in Engineering and Technology's Structures team in TMR. Torill has over 20 years' experience as a civil/structural/bridge engineer across a broad number of sectors, including consulting, construction, public service and academia. She has a keen interest in the whole-of-life management and performance of assets. Torill's experience is supported by her academic research on the performance of in-service older concrete structures.

Peter Prasad

Peter Prasad joined the Australian Rail Track Corporation in April 2005 as their National Bridges & Structures Engineer. Prior to this, he was with the New South Wales Railways for 13 years and spent over 17 years with the New Zealand Railways. He has over 45 years of experience with design, maintenance and construction of the bridges. Peter's primary focus currently is on the development and monitoring of short to long term (up to 25yrs) strategic asset management plans with respect to over 22,000 bridges and structures on the ARTC rail network, stretched over 8,500 route kilometers of standard gauge interstate track from Kalgoorlie in Western Australia to Brisbane in Queensland, ensuring they are consistent with life cycle trending predictions.

Kathy Noonan

Kathy Noonan is a Principal Engineer in the Asset Maintenance team at Energy Queensland. Kathy has 45 years of experience working as an electrical engineer within the power industry in Queensland. Kathy is responsible for the development and improvement of maintenance standards, activity frequency and acceptance criteria for poles, towers and pole-top structures within the Ergon Energy and Energex distribution networks. This includes providing engineering advice on condition monitoring, maintenance, and replacement decisions on the existing electricity network assets to support a safe and continuous electricity supply for Queensland. Kathy is the Energy Queensland representative on both the Energy Networks Australia research project on non-destructive testing of wood poles, and a research co-operative with the Australian Utility Pole Research Cooperative.

Prof Jianchun Li

Professor Jianchun Li received his PhD degree from Trinity College, University of Dublin, Dublin, Ireland. He is currently professor and chair of Structural Dynamics. He is also the co-Director of the Centre for Built Infrastructure Resilience (CBIR) in Faculty of Engineering and IT, University of Technology Sydney in Australia. Professor Li's current research interests are in the areas of smart materials and smart structures, structural control for civil engineering, structural health monitoring and non-destructive testing, machine learning and digital twin as well as structure rehabilitation. Prof Li has published over 200 journal and conference articles including over 100 SCI journal articles. He has successfully conducted many projects with the funding over AU$6M, including several Discovery and Linkage Grants from Australian Research Council. He is the Vice-President of Australasia Panel of International Association for Structural Control and Monitoring (IASCM). He is also Deputy President of Australia Network of Structural Health Monitoring

High and Low Value Structural Health Monitoring

John Vazey
BEng Mech, MAppSci, MIEA, CPEng, REPQ
Managing Director, EngAnalysis

Synopsis:

His talk overviews a series of monitoring projects to identify the common attributes of high value SHM from the perspective of asset managers, utilities and service providers.

The talk concludes with a series of supported recommendations on how to:

- specify a SHM project
- collaborate with industry
- get value out of university collaborations &
- deliver meaningful outcomes.

Bio:

John has 25 years of experience in carrying out measurement and monitoring projects for industry.

With a background in applied science, engineering research, consulting and more recently business operations, John is about to give us a talk focused on the value proposition for SHM.

John is generally not shy with his opinions so, hold onto your seats and prepare to be challenged and informed.

Structural Health Monitoring in the United States and Europe

Dr Arash Behnia
Principal, Robert Bird Group

With contributions from
Dr Ozan Celik
structural monitoring group lead at Geocomp

Synopsis:

Arash will deliver a collective presentation on the projects, covering various topics across the US and Europe. This presentation will encompass challenges, lessons learned, and added value, with a focus on increasing asset owner awareness and improving our market understanding of what to expect and why proactive monitoring is necessary. The presentation will cover a wide range of topics:

- BridgeStrike solutions and the importance of bridge strike detection on asset life
- Dynamic Bridge Evaluation and Monitoring
- Geotechnical: Rail sinkhole monitoring, bridge foundation evaluation, site characterization
- TBM: Geotechnical Monitoring and Geophysical Hazard Characterization
- Complex Bridge Monitoring

The objective is to highlight the value that can be added to the asset owner and improve the market understanding of proactive SHM and monitoring projects.

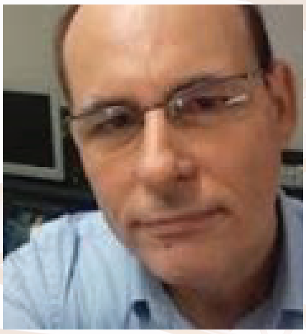
Bio:

Dr. Arash holds a Ph.D. in structural materials engineering with expertise in structural health monitoring. He is a Principal at Robert Bird Group. With two decades of industry experience, he's a seasoned engineering leader who has worked across diverse regions in Asia-Pacific and Europe. His broad expertise includes infrastructure design, structural engineering, bridges, tunnels, and asset management. Arash's international project portfolio includes the DASH Highway Bridge in Malaysia, Hieu Bridge in Vietnam, Rama 3 Bridge in Thailand, MRT2 & LRT 2 (Malaysia), Sydney Metro, Melbourne Metro Tunnel, North-East Link, West Gate Tunnel Bridges, Level Cross Removal, and Airport Viaduct Package. He is also known for his work in structural health monitoring, both in industry and research. Arash spent three successful years as an adjunct research fellow at Monash University, contributing to pioneering research, authoring technical papers, and speaking at various conferences in the fields of bridge engineering and the application of AI in SHM and asset management.

Dr. Ozan Celik is a professional engineer leading the structural monitoring group at Geocomp. He specializes in long and short-term instrumentation, testing, and monitoring applications for civil infrastructure. He oversees the application of artificial intelligence methods into infrastructure projects. He has managed projects for stakeholders such as New York State Thruway Authority (NYSTA), Federal Highway Administration (FHWA), State DOTs, various design and construction firms, national laboratories, airports, and universities. He has shared his experience via speeches, webinars, articles provided at conferences, professional engineering meetings and in journal publications. He has served as a reviewer for Journal of Structural Engineering of American Society of Civil Engineers (ASCE), Transportation Research Board (TRB), Experimental Techniques (Springer) and Journal of Civil Structural Health Monitoring (JCSHM).

"Collaboration Catalyst: Bridging Gaps and Overcoming Barriers"
Pitches on Industry Challenges followed by a Panel Discussion on:
Towards a Purposeful Industry-University-Government Collaboration

Prof Hong Guan
Griffith University



Mario Martini
CSIRO

Dr Denise Hodge
Co-CEO
JourneyTech

Greg Bruce
Townsville City Council

Facilitator:
Dr Ulrike Dackermann

University of New South Wales

Bios:

Prof Hong Guan

Dr Hong Guan is a Professor of Civil Engineering in the School of Engineering and Built Environment at Griffith University Gold Coast campus. She is research leader of Griffith's Cities Research Institute "Building Science and Construction Innovation" group. Hong is an expert in structural engineering and computational mechanics research. She is also an Executive Committee Member of Australian Network of Structural Health Monitoring.

Mario Martini

Mario is an SME Innovation Connections Facilitator for Northern Australia, based in Townsville at the Australian Tropical Science and Innovation Precinct - CSIRO. His role is to connect local companies with the technical expertise and state-of-the-art equipment available from research organisations (i.e. CSIRO and Australian universities). These connections can then lead to collaborative R&D projects to help companies develop their commercial innovations with the support of the research organisation. Facilitated projects over the last 4 years have resulted in world firsts and new Patents, Discovery research, and ARC-Linkage funding. Mario also assists companies connect to the relevant government funding and assistance programs, as well as Innovation Connections, which provides eligible companies matching funding to support their R&D projects with these research organisations. Mario's diverse 30-year frontline industry career in R&D and senior manufacturing leadership, began in formulation chemistry and process development of household and industrial products with Kiwi Brands. Moving to Biotechnology (human diagnostics) manufacturing, then human pharmaceuticals and veterinary pharmaceuticals as the TGA and APVMA manufacturing licensee. Many of these products and brands are still in supply domestically and globally, some being made elsewhere and imported.

Dr Denise Hodge

Denise started her formal training as a biologist in the UK, graduating with a PhD from the University of York, in the field of molecular biology. Moving to Australia in 2004, Denise undertook a post-doctoral position at the Institute for Molecular Bioscience at the University of Queensland. With a strong foundation in the biological sciences, Denise then trained as a patent attorney, becoming registered in Australia and New Zealand in 2010. With six years' experience working in private patent and trade mark attorney firms, Denise has critical expertise in IP strategy and management across all areas of IP, including patents, trade marks, plant breeder's rights and designs. In 2010, Denise joined QUTbluebox Pty Ltd as a Commercialisation Manager, responsible for 'cradle to grave' commercialisation of technologies across the University in all areas of research. In 2014, Denise became Director, Commercial Operations at QUTbluebox, responsible for commercialisation at QUT from licensing to startup creation, industry partnerships, IP strategy, protection and management, and early seed funding, managing a team of Commercialisation Managers. In 2017, Denise extended her experience in commercialisation to the United Kingdom, where she joined The University of Edinburgh. Denise led the Business Development team (across biology, chemistry and physics), establishing multiple industry partnerships, negotiating benefit sharing arrangements between parties and driving research translation efforts. With a key understanding of international models, Denise moved to Melbourne and joined Agriculture Victoria Services Pty Ltd (AVS) as their Chief Operating Officer, leading and delivering on all commercial, research translation activities for Agriculture Victoria and managing the commercial team. After three and a half years at AVS, Denise joined James Cook University in Townsville to become their Director, JCU Connect, leading the University's Research Office, Commercialisation and Innovation capabilities across all areas of the University. Since founding JourneyTech, Denise has continued to collaborate with JCU across IP management, research translation and commercialisation. Greg Bruce

Greg Bruce

Greg Bruce has worked in local government on environmental management and sustainability as a practitioner and an executive manager for 20 years. Greg has evolved and delivered innovative, adaptive and a community relevant "system designed for change" in the way sustainability and environmental outcomes are achieved for the city and community. He sees Ecotourism as a major opportunity to assist the planet with sustainability in practice. Greg led Townsville City Council to achieve Advanced Ecotourism Certification in 2006 for their Eco-education catchment tours. The Council has retained this certification. In addition, they have worked closely with Professor Sam Ham for the past 10 years building strategic and on-ground thematic communication practices across and within the community. He has also pioneered with his team and experts, collective learning and advanced technology (STEM) based approaches to NRM and Sustainability, including the cities Rowes Bay Sustainability Centre and NRM Hub.

Dr Ulrike Dackermann

Dr Ulrike Dackermann is a lecturer in the School of Civil and Environmental Engineering and a member of the Centre for Infrastructure, Engineering and Safety at UNSW. Dr Dackermann's expertise lies in non-destructive testing, timber engineering, structural health monitoring, wave propagation analysis, damage detection, structural dynamics and artificial intelligence. She believes that integrating artificial intelligence (AI) in smart structural health monitoring systems can help generate more sophisticated and reliable inspection procedures, ensuring the sustainability of civil infrastructure. On a project involving the Sydney Harbour Bridge, she developed new damage assessment methods to safeguard its longevity, using AI to analyse vibration measurements gathered from the bridge's sensor system. Dr Dackermann's knowledge in AI also has practical applications for the energy sector. In an ARC Linkage grant, partnering with AusGrid, she used her expertise in AI and timber engineering to develop a screening tool that enables AusGrid pole inspectors to distinguish healthy poles from unhealthy poles using wave-based detection and AI to locate invisible damage. As a true engineer, when she sees and identifies a problem, she must help to solve it. This vision has extended to her work abroad with Engineers Without Borders where seemingly simple innovations have resulted in practical real life solutions for communities to conserve energy, improve health outcomes and diminish environmental degradation. This 'giving back' is Dr Dackermann's down to earth, hands-on approach to creating balance in her life as a researching academic and a global engineer.

Key Challenges and Opportunities in the transition to Net Zero for the Building Industry

Prof Tuan Ngo
The University of Melbourne

Synopsis:

The building industry has faced severe challenges over the past two decades. Labour and skill shortage, spiralling costs of materials and construction have led to cost overrun, project delay, building defects, and safety issues. In addition to that, the frequency and intensity of disasters have been steadily increasing in the last decades due to climate change. Many critical infrastructure and buildings are particularly vulnerable, evidenced in the prevalence of floods, cyclones, and fires in recent years, exacerbated by populations heavily concentrated in cities and regional centres. Innovative designs, low carbon emission and high-performance materials, and new construction techniques are urgently needed for producing sustainable, resilient, smart and cost-effective structures. Prof. Tuan Ngo's presentation will highlight the key challenges, benefits and opportunities in using the Industry 4.0 technologies such as new materials, digital technologies and advanced manufacturing techniques for net Zero buildings. His talk will also cover new innovations in low carbon materials, utilisation of construction wastes for manufacturing building products, new innovative structural systems, artificial intelligence in design and construction automation for resilient and sustainable buildings towards a circular economy.

Bio:

Prof Tuan Ngo is the Research Program Leader of the Building 4.0 CRC, a new $130m initiative to transform the building industry in Australia. Prof Tuan Ngo leads the Advanced Protective Technologies of Engineering Structures (APTES) Group at the University of Melbourne, which has been recognised as one of the leading centres in advanced materials & structural systems, and physical infrastructure protection in Australia and the Asia Pacific region. He is a board director of PrefabAUS, the peak industry body in prefabrication and offsite construction in Australia. Prof Ngo is one of the pioneers in Australia carrying out research in the area of modular prefab technologies for buildings and infrastructure. Prof Ngo is the winner of the 2013 Eureka Prize for Outstanding Science in Safeguarding Australia. He also received the Award for Excellence in Concrete by the Concrete Institute of Australia-Vic Branch in 2017 and 2023. Professor Tuan Ngo is named the world's top Composite Materials researcher in 2022.

Building Materials and Circular Economy and Day 1 Closing Remarks

A/Prof Rabin Tuladhar
James Cook University
Co-Chair – Organising Committee

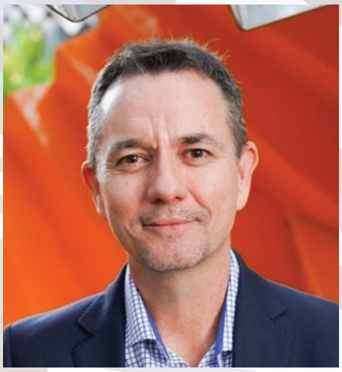
Synopsis:

With global annual carbon dioxide emissions nearing 37 billion tonnes, urgent actions are imperative on all fronts to meet the net zero 2050 target. This challenge necessitates not only innovative clean energy technologies but also transformative developments in the construction industry. As a significant contributor to carbon emissions, construction sector must prioritize efficient material usage, innovations in sustainable materials, and alternative fuel adoption.

At JCU, our research embraces a holistic approach to sustainable construction materials, aligning with the net zero objective. Over the last decade, we have developed and pioneered the use of 100% recycled plastic fibers in concrete, the integration of recycled materials like crushed glass and recycled aggregates into concrete, and the application of energy-efficient curing technologies. These translational research efforts have led to numerous practical applications in the industry, showcasing scalable solutions for sustainable construction.

Bio:

Dr Rabin Tuladhar is as an Associate Professor in Civil Engineering at James Cook University, with a specialization in Concrete and Structural Engineering. He has made notable contributions to the field through translational research, focusing on sustainable and low carbon construction materials. Rabin led a research team that was awarded the Australian Innovation Challenge 2015 for their pioneering work in developing 100% recycled plastic fibers for reinforcing concrete.



Welcome Address (Day 2)

Prof Ron White
Dean – College of Science and Engineering JCU

Bridge and Traffic Monitoring (BTM) Insights

Dr Rob Heywood
FIEAust CPEng RPEQ NER BE(Civil) Hons MEngSc PhD
Specialist Technical Engineer, Engineering & Technology
Department of Transport and Main Roads

Synopsis:

Bridge and Traffic Monitoring (BTM) systems monitor both the bridge's response to heavy vehicles and the traffic to provide a richer data set supporting better risk-informed decisions for asset management, access management, investment, and safety. Bridge and Traffic Monitoring provides key insights into the safe operation of bridges and the interactions with the vehicles that cross them. The information provided is central to the risk-informed sustainable management of these bridges. Practical insights will be shared regarding the collection, analysis and the interpretation of data to better inform to help ensure the data is of high quality, accessible, and readily analysed to support better risk-informed asset management, access management, and sustainable decisions and a productive transport system. Case studies provide the basis of these insights and highlight challenges and opportunities for development.

Bio:

Dr Rob Heywood has over 45 years' experience as a structural engineer in private, academic, and public organisations. Rob is assisting the Queensland Department of Transport and Main Roads safely manage their bridge assets. Fundamental engineering principles, risk assessment, bridge monitoring, weigh-in-motion, OBM and advanced analysis are underpinning risk-informed decisions that support the safe, productive, and sustainable operation of existing bridge networks.

Rob is a recipient of the XXVII World Road Congress (Prague 2023) prize for road design, construction, maintenance, and operation, which was awarded for a paper titled "Bridge monitoring and data-driven structural asset management." This paper also received an Austroads award for the best Australasian paper for that conference. He was a member of the OECD DIVINE international research project investigating the dynamic interaction between heavy vehicles and infrastructure, is a past Chairman of the Structural College Board of Engineers Australia. Rob was awarded an Australian Centenary Scholarship and the Warren Medal for his research into live loads applied to bridges. The Austroads Bridge Conference series was initiated by Rob in 1991.

In a range of forums, Rob frequently shares his knowledge on topics such as bridge assessment, forensic engineering, earthquake damage, detailing concrete structures, bridge-vehicle interaction, bridge monitoring, live loads on bridges, cyclone damage and risk-informed decision making. In 2012, he was invited to be an expert witness to the Canterbury Earthquakes Royal Commission because of his involvement as a volunteer engineer in Queensland's Urban Search & Rescue team dispatched to Christchurch immediately following the catastrophic earthquake of February 2011. The evidence related to Rob's related to the search and rescue operations and forensic investigations following the catastrophic collapse of the CTV building where, sadly, many lost their lives.

Rob along with Dr Peter Shaw are the founding directors of FMA Engineering Services P/L and are currently developing an Austroads' *Guideline to Bridge Assessment.*

Practical Monitoring for Superload Transports

A/Prof Colin Caprani
FIStructE, FIEAust, FIABSE, FIEI, MASCE
Associate Professor
Head of Structural Engineering, Dept of Civil Engineering
Monash University

Synopsis:

The Smart Structures Team at Monash University has been supporting the movement of superload transports throughout the Victorian road network and beyond for many years using Structural Health Monitoring (SHM) in combination with other techniques. The success of these projects relies on the translation of cutting-edge laboratory techniques into the field, in such a way as to efficiently address client needs. Such work involves multi-criteria decision-making so as

to arrive at an optimal outcome. Often, the global optimal outcomes are non-optimal when viewed from just one dimension of the problem. Balancing competing demands is a key challenge of translational research in SHM. This presentation will review the projects that the Monash team has been involved in, and will convey some over-arching lessons learnt. In particular, practical

instrumentation, coordination with the haulers, and clear communication with the client, will all be discussed.

Bio:

Dr Colin Caprani is a Registered Professional Engineer of Victoria (RPEV), a Chartered Structural and Professional Engineer. He is a Fellow of Engineers Australia, the Institution of Structural Engineers, Engineers Ireland, and the International Association of Bridge and Structural Engineering. His work specializes on the safety assessment and performance monitoring of bridges involving highway bridge traffic loading for short- and long-span bridges; vibration serviceability of footbridges; structural reliability and statistics of extremes; and heavy vehicle access to the road and rail network. He is a Director and Chair of the non-profit Confidential Reporting on Structural Safety – Australasia (CROSS-AUS) and Chair of the Institution of Structural Engineers, Australia Regional Group. Dr Caprani is Head of Structural Engineering in the Dept. of Civil Engineering at Monash University. He has supervised many PhD and MSc students and published in a variety of topics related to structural safety and bridge engineering. He has received numerous awards and attracted significant research funding. He is a prominent media contributor on structural safety issues.

Dynamic assessment of Large Infrastructure

Dr David Lo Jacono
Senior Principal and Technical Director for Data Science
Jacobs

Synopsis:

A full-scale ambient, random, and forced dynamic testing of the Matagarup footbridge (Perth, WA) was performed to evaluate the bridge's performance. The bridge is 370m long, with 3 decks supported by 72m high lattice steel arches. Main Roads commissioned Jacobs to develop a complete 3D numerical finite element dynamic model of the bridge with the tuned mass damper (TMD), calibrated via site measurements, leading to a bridge digital twin solution.

Previous dynamic testing consisted of deck-by-deck measurements, whereas Jacobs deployed a full-scale monitoring system across the bridge, synchronising all measurements between decks, arches, TMD, and bearings movements. Pedestrian motion and density captured via CCTVs enhance data accuracy while minimising holistic assumptions. The solution consisted of 90 tri-axial accelerometers, displacement sensors placed within the decks and arches, a weather station, and laser survey. Jacobs solved numerous challenges ranging from covid impacted global chain supply (Jacobs designed and built wired accelerometers from scratch) to synchronisation of complex instrumentation combining wireless and wired sensors involving multiple gateways and data acquisition equipment.

Nearly a year's remote monitoring captured ambient conditions and large crowds from the nearby Stadium. A controlled crowd test involving 300 participants walking in a synchronised way completed this dataset. This innovative large-scale structural health monitoring for pedestrian footbridges has never been undertaken nationwide and worldwide and will further our understanding through a unique database. Innovation includes computer vision and data assimilation through AI/ML, enhancing the digital bridge twin solution's robustness and providing the necessary insights related to its dynamic behaviour.

Bio:

David is a Senior Principal and Technical Director for Data Science at Jacobs. David is an international expert on topics ranging from data science, AI/ML, data-driven decision-making, modelling & simulation of dynamic systems to emerging technologies and science. David champions solutions from the sensors to actionable insights leveraging both data and advanced modelling through data assimilation. A firm advocate for synergising physical modelling and observable quantities.

David spent 20 years in academic research as an interdisciplinary complex dynamical system scientist. He has extensive experience in large scientific databases and information systems, including expertise in scientific data mining. David focuses on applied AI/ML coupling sensors and engineering modelling. At Jacobs he leads the Advanced Data & Analytics team and acts as subject matter expert for Data Science.

Monitoring of a 1960s Bridge in Victoria

Dr Desiree Nortje
Principal Asset Manager – Civil Structures
Transurban

Synopsis:

Transurban build and operate toll roads in Melbourne, Sydney and Brisbane as well as in Greater Washington, USA, and Montreal Canada. As one of the worlds largest toll-road operators, everything we do works to get people where they want to go, as quickly and safely as possible – from designing and building new roads to researching new vehicles and road safety technology.

We acquired a bridge that was designed to standards and accepted engineering best practice of the 1960s. As little information about this bridge is available, it has been assumed the designers made use of the NAASRA Highway Bridge Design Specifications published between 1965 to 1975. These design standards were based on the MS18 design vehicle, which is equivalent to a 33 tonne truck. The bridge is a prestressed precast segmental box girder with a precast link slab connecting the northbound and southbound carriageways. The overall length is approximately 61.38m consisting of a short span of 14.43m and a long span of 46.95m. The bridge is continuous over the supporting pier between the two spans. Since its construction in the early 1970s there have been no significant structural changes or modifications to the bridge.

Transurban engaged Rockfield in June 2023 to assist with instrumenting the bridge and to build a finite element model that, as close as possible, reflects the behaviour of the bridge to applied loads. We have attached 4 strain gauges and crack gauges to both the bottom and top flanges of each carriageway. The output of the instruments has been presented in a dashboard which records the events and also provides a short video snippet of heavy vehicles travelling over the bridge. This presentation will give a short introduction to the bridge, its structural design and the information we have been able to extract from the instruments attached to the bridge

Bio:

BSc (Engineering)-Civil, University of the Witwatersrand, South Africa
PhD, University of Western Australia, Perth.
Masters in Construction Law, Melbourne Law School, The University of Melbourne.
CAAM, Certified Associate in Asset Management, Asset Management Council.

Desiree has 30+ years experience working in mining, building, water services and transportation industries. She has been responsible for designing and managing multi-million dollar projects as engineer and asset owner, as well as making client side decisions for production stoppages for safety reasons. Desiree has designed cable car structures, large-span warehouse, sky scrapers, silos, support structures for mining equipment as well as assessing bridges for the road and rail industry.

Mentoring graduate engineers to provide knowledge transfer and experience has always been a top priority for Desiree. Similarly Desiree takes every opportunity to learn and update her own knowledge to understand the changes in thinking with time.

Session 1a

Chair:
Dr Ali Hadigheh

A synergic method for updating prestress force and identifying moving force in prestressed concrete bridges

Speakers:
Kunaratnam Jeyamohan, Tommy H.T. Chan, Khac-Duy Nguyen and David P. Thambiratnam

Synopsis:
Structural health monitoring holds immense significance for prestressed concrete bridges (PCBs), given that their overall performance is significantly influenced by both initial and long-term prestress losses. A long-term monitoring of prestress loss is essential for the timely maintenance of these PCBs. Equally critical is the evaluation of moving forces (MFs), essential for conducting load carrying capacity comparisons that ultimately safeguard and ensure the remaining life span of the PCBs. Considering these imperatives, this study introduces a methodology that synergistically updates the state of prestress forces (PFs) and identifies MFs for PCBs. Leveraging displacement and rotational responses, this approach incorporates the virtual distortion method and the Duhamel integral to derive near-by accuracy results from a limited number of sensors. The ill-posed nature of the prestressed bridge-vehicle system is assessed by a condition number which is defined as the ratio between the maximum and minimum singular values of the prestressed bridge-vehicle system matrix. The ill-posed nature of the prestressed bridge-vehicle system is mitigated by using a truncated generalized singular value decomposition. To evaluate the updated PF and MF in a medium-span PCB, a model of a simply supported PCB was used. The findings of this investigation underscore the efficacy of the proposed approach in accurately and efficiently identifying updated PFs and MFs. It is crucial to emphasize that this synergistic identification process plays a pivotal role in advancing the forensic engineering applications pertinent to PCBs.

Mobile Crowdsensing and IoT sensing techniques for drive-by bridge condition monitoring

Speakers:
Jun Li, Zhen Peng and Hong Hao

Synopsis:
This presentation talks about the development and validation of mobile crowdsensing techniques for bridge mode shape identification using drive-by measurements, and IoT sensing technique for drive-by bridge condition monitoring. Experimental tests are performed to validate the accuracy of measurement responses and feasibility of using the developed IoT sensing system for drive-by structural health monitoring applications. Experimental studies are conducted on a footbridge to demonstrate the identification accuracy of bridge mode shapes using crowdsensing drive-by measurements.

A dual-sensor technqiue for the calibration of frequency-dependent wave speed and attenuation in water pipes

Speakers:

James Gong, Ji-Sung Lee, Wei Zeng and Martin Lambert

Synopsis:

The propagation of pressure waves in water pipes is frequency dependent which leads to these waves experiencing a frequency-dependent wave speed and attenuation, resulting in wave dissipation and dispersion. The effect is much more significant and complex in plastic pipes than in metal pipes, which makes most wave-based pipe condition assessment techniques ineffective for plastic pipes. In this paper, a new technique is developed to calibrate the frequency-dependent wave speed and attenuation for pressurized water pipes. Persistent hydraulic waves induced by a side-discharge valve are used as excitation. Pressure responses are measured by two pressure sensors, and a "paired-impulse response function" (paired-IRF) is determined through a deconvolution process. The transfer function between the two sensors is determined using the main spike in the paired-IRF trace, which contains the information on the wave propagation characteristics. The frequency-dependent wave speed and attenuation are then derived from the transfer function. The proposed new technique is validated by both numerical simulations and laboratory experiments. The developed new technique can be potentially applied to other civil structures for the calibration of wave speed and attenuation, which is then useful for condition assessment.

Development of IoT-based SHM system prototype for footbridge vibration monitoring using LoRa technique

Speakers:

Huiyue Qiao, Hong Guan, Andrei Bailey, Shoja Jamali and Yong Zhu

Synopsis:

In comparison to the SHM systems for vehicle bridges, customised ones for footbridges are still lacking, likely due to the cost and benefit concerns. However, IoT techniques can facilitate the development of convenient and cost-effective SHM systems for footbridges, and LoRa (long range) is found to be a promising protocol for outdoor SHM with a long transmission range and less power consumption. However, the low transmission rate of the LoRa technique restrains its application in bridges since conventional bridge SHM strategies might require a large amount of synchronised raw data from multiple sensors. To solve this problem, an IoT-based vibration monitoring system prototype was developed, where LoRa wireless communication technology is implemented between two sensor nodes to produce synchronised data on chip for modal parameter identification. This will provide a foundation for multiple synchronised sensor nodes to be integrated to the concerned footbridge. Data produced on chip including the maximum acceleration, peak frequency, and phases can then be transmitted to a gateway wirelessly using LoRa technique and uploaded to the cloud platform for footbridge mode shape identification and serviceability evaluation. The functionality of two synchronised sensor nodes was tested using a small-scale cantilever beam in the laboratory. The beam was purposely devised to produce a similar level of frequency as the footbridge, to minimise adjustment of local software design on the sensor nodes when applied to the footbridge. The first vertical bending mode of the beam was determined by the two sensor nodes' peak frequencies both around 2.53 Hz and almost zero phase difference. Subsequently, the workability of the prototype was validated on the footbridge to identify its fundamental mode shape in operation, where the two LoRa sensor nodes were placed near the largest displacement point of the deck on either side. An average peak frequency of 2.3 Hz, comparable to 2.2 Hz from the design document, was obtained with a nearly zero phase difference from the cloud platform. This suggests that the mode shape that contributes the most to the operational deflection shape of the footbridge is a vertical bending mode of around 2.3 Hz. In long-term SHM, local LoRa synchronisation on chip can achieve automatic clock drift correction for LoRa sensor nodes. Moreover, upon modification of the FFT algorithm in software design, LoRa sensor nodes will be able to identify further mode shapes (e.g., torsion mode and transverse mode).

Non-destructive Monitoring and Imaging of Civil Engineering Infrastructure

Speakers:

Subhra Majhi and Abhijit Mukherjee

Synopsis:

According to the National State of the Asset Report in 2021, $51bn worth of Australian infrastructure assets are in poor capacity. 5% of concrete bridges are in poor shape with a replacement cost of $1.2bn. Only 45% of timber bridges are in good condition and $310m is the replacement cost of timber bridges in poor condition. Four in five Australians live within 50 km of the coast. A significant portion of Australian-built infrastructure is at risk of corrosion due to its proximity to the coast. The steel rebars in concrete corrode due to the ingress of salts. The prevalent electrochemical method of corrosion inspection can speculate their presence but not their extent. Timber assets often deteriorate in the core without any sign on the surface, called piping of the timber. These assessments are undertaken traditionally visually as Level 1 inspections. In Level 2 inspections, a hole is drilled in the timber to detect piping. The resistance to drilling is noted. Any drop in this resistance to drilling in the presence of a pipe in the timber is noted and reported. The reporting of resistance in drilling depends on the inspectors and the reported pipe can be subjective. Moreover, asset owners find it difficult to allocate resources for their maintenance. A lack of reliability in inspections due to the paucity of qualified inspectors has created a need for reliable and accurate sensing systems.

Travelling ultrasonic waves are like ripples in a pond of water when a stone is dropped in it. As these waves travel through the bulk of the material, they interact with any defects in the material. These interactions change the character of the incident waves based on the veracity of these defects. As the body waves attenuate rapidly, they can only monitor a limited portion of the structure. Guided waves travel through a waveguide. As the volume of the waveguide can be much smaller than the entire specimen, these waves can travel through them to much longer distances. The guided waves can be excited either by Piezo or Laser transducers. The Piezo excitation is an energy range of μ-Joules and generates narrow narrow-banded frequency response. The Laser excitation is of the order of ~1Joules and the response is broad-banded containing multiple frequencies. To decipher the condition of

the structure, advanced signal processing is warranted. Some guided wave modes are sensitive to defects on the periphery of the waveguide while others are in the sub-surface. Based on the application, required guided-wave modes are excited. These modes have been used to monitor concrete corrosion and piping in timber. An image of the inside of the structure can be generated by ultrasonic scanning that combines multiple ultrasonic measurements. Scanning has revealed details about the presence of rebars and corrosion including cracks in concrete. Ultrasonics can thus identify and classify the veracity of deterioration in concrete and timber infrastructure. The ultrasonic sensors can be coupled with the Internet of Things (IoT) and cloud computing for a paradigm shift in infrastructure monitoring.

Infravision: Next-Gen Dynamic Line Monitoring

Speakers:

Michael Ferraris and Cameron Van Der Berg

Synopsis:

This project aimed to develop grid-scale technology that enables transmission network operators to transition from the industry standard of a static line rating to a dynamic line rating. The main objectives were to enhance asset utilisation and facilitate effective integration of renewable energy sources, at the same time, allowing the line to be operated safely and reliably especially during periods of extreme weather conditions.

The project involved deploying hardware and software technology solutions along transmission line assets with the use of drones to enable a scalable solution. These solutions would enable the safe and reliable uprating of the amount of electricity transmitted through the line. This uprating would be achieved by continuously measuring key environmental parameters and line characteristics in real time.

Current solutions are, slow, and dangerous. The project aimed to address this by using drones for sensor installation, eliminating line outages and hazardous work, while also providing real-time data validation for more reliable DLR calculations.

By adopting dynamic line rating technology, operators can optimise power transmission based on actual micro-climate weather conditions and other relevant factors, rather than

relying on conservative assumptions. This, in turn, would lead to better utilisation of transmission network assets and improved integration of renewable energy resources into the grid.

Low-Cost Water Level Gauging for Flood Impact Analysis

Speakers:

Simon Igloi

Synopsis:

Understanding the impact of flooding, especially flash flooding, on critical infrastructure like bridges is essential for both safety and asset longevity. This abstract introduces a cost-effective approach to water level gauging designed to improve our comprehension of flooding's effects on structures. By comparing stress data from flood events with stresses from typical vehicle loads, we aim to gain comprehensive insights into structural behaviour during flood events. This deeper understanding could potentially lead to strategies for increasing the lifespan of infrastructure. This abstract outlines the methodology and objectives of our low-cost water level gauging system and its potential benefits in enhancing infrastructure resilience in the face of flood events.

Session 1b

Chair:
Dr Lei Hou

Significance of Economic Framework in Maintenance Decision-Making

Speakers:
Sagar More, Rabin Tuladhar and Daniel Grainger

Synopsis:

Engineering asset management (EAM) has received a lot of attention in the last few decades. Despite this, the dilemma of identifying the best maintenance strategies for assets remains unresolved. Maintenance decision-making has evolved from a subjective assessment, chiefly dependent on expert opinions, to utilizing live-data-sensor technology. Generally, organizations focus only on either overt risks or basic performance of assets, thus creating uncertainties in the organisational decision-making process. Moreover, organisations are typically constrained by maintenance budgets not necessarily aligned with economic value maximisation. To enable an effective decision-making process, it is imperative that uncertainties are minimised for the maximisation of economic value. Predictive maintenance strategies are a means to this end. While deriving decision making strategies, the focus should be on the economic factors along with risk and performance. Implementing the hybrid model of maintenance can allow organisations to invest strategically with respect to organisation's maintenance budget and help it gain a marked competitive edge. Every organisation is bound by a specific annual maintenance budget, which is a constraint while applying affordable maintenance strategies, thus making the allocation of budget unstructured and arbitrary. Success is measured by financial performance not only for asset management but also for any other segment in organisations. Therefore, decision-making in asset management cannot be divested from financial considerations. Decision-making should be done through the prism of budgeting, while the degree of influence that the budget exercises over decision-making may vary according to the scale and scope of the industry. An economic framework is proposed to identify predictive maintenance strategies for economic value maximisation. The framework incorporates Availability, Downtime, Cost-Benefit analysis, Maintenance Implementation cost, Sensitivity Analysis and Probability of Failure information to determine whether or not predictive maintenance of a particular component is aligned with organisation level economic value maximisation. Thus, the maintenance budget for predictive maintenance is efficiently utilised by determining the subset of components eligible for predictive maintenance conditioned on whether they contribute to organisation level economic value maximisation. Although the remaining components can be maintained by the corrective and preventive maintenance strategies, predictive maintenance can eventually be used to regulate the entire system. The policy implication is that predictive maintenance strategies are likely best implemented by solving the component level predictive maintenance selection problem which aids the organisation level economic value maximisation.

Asset Mangement of Berth Shiploader Rail Girders via Online Monitoring System

Speakers:

Sam Mazaheri

Synopsis:

One of the berth structures at Dalrymple Bay Terminal comprises two 900WB175 rail girders, each extending approximately 600 meters along both the seaside and landward sections. These rail girders facilitate the longitudinal movement of the ship loader, ensuring efficient bulk cargo loading operations. The introduction of AS4324.1 in 2017 brought about changes in the consideration and management of load cases for these structures.

In response, we conducted a comprehensive analysis of the load cases, developed an FEA model to assess their impact on the structural integrity of the asset, and visualized stress distributions using a normalized, color-coded pattern representing section utilization. Furthermore, leveraging five years of SCADA data, we meticulously gathered and analysed loading data, including material types and frequencies.

This data-driven approach led to the selection of three consecutive spans, subjected to more frequent loading, for closer monitoring. Subsequently, we installed 12 wireless strain gauges on the top and bottom flanges of each designated span to monitor structural behaviour under extreme loads. After collecting and analysing sensor data over several months, we planned and executed a manual block chute event in line with AS4324.1 guidelines.

The integration of sensor data and a comprehensive understanding of extreme operational load cases, based on actual data, empowered our asset management team to devise a robust strategy for the effective management and maintenance of these critical offshore assets.

UAS-Based Multi Layered Data Collection Methods and Defect Detection Algorithms for Predictive Analytics and Bridge Asset Management

Speakers:

Harsh Rathod, Clara Owen and Daan Arscott

Synopsis:

Traditional inspection procedure for condition assessment of bridge structures is laborious, dangerous, time-consuming, capital intensive and highly dependent on subjective human judgment. Subsequently, bridge asset owners pay a high price per inspection and are sometimes unable to inspect their structures more frequently. The authors present an improved defect detection and quantification algorithm paired with a novel Unmanned Aerial Systems (UAS)-based data collection technology to detect and quantify surface and subsurface defects such as delamination, cracking and spalling. Datasets collected include optical images, infrared images, and acoustic signatures. These are combined and processed to quantify surface and subsurface defects in concrete bridges. Furthermore, the condition assessment on a time scale allows owners to make cost-efficient business decisions on what to repair and when to repair. This allows for targeted asset management, extending the structure's lifespan rather than replacing the entire structure. This approach also allows for building predictive deterioration models using historical performance, which can be utilised for asset management. This methodology was applied at scale on multiple bridge structures located in Canada, USA, New Zealand and Australia. The multi-layered data helped create a baseline model of the structures that can be tracked over a period. The concrete deterioration, such as cracking, spalling, and delamination, were detected, quantified, and mapped to feed into the risk model. With this model, the asset owner can objectively determine whether further checking of a specific element, material research or a complete detailed re-examination is necessary, thereby leading to considerable savings in time and social costs.

Structural Condition Assessment based on Knowledge Transfer

Speakers:
Xutong Zhang, Saeid Talaei, Xinqun Zhu and Jianchun Li

Synopsis:
The existing civil infrastructure deteriorates due to ageing, and environmental and operational loading. Such damage/deteriorates in structure will result in changes of structural dynamic properties. Vibration-based methods can be used to detect and evaluate structure damage or deterioration. these methods are often categorised as model-based and data-driven approaches. The model-based approaches are based on numerical modelling and the damage identified results are significantly affected by various uncertainties, including modelling errors, operational and environmental variations, and measurement noise etc. The data-driven approach, especially the deep learning-based approach, has recently attracted the interest of researchers and engineers. Deep learning has been used for structural damage detection by the trained neural network models from a large amount high quality numerical and experimental data to extract the damage-sensitive feature. In practice, it is very difficult or even impossible to obtain the damage state data from the real structure. This study is to address the issue through the knowledge transfer from numerical simulations to real structures. The case studies have been conducted to show the performance of the proposed method.

A Framework for Structural Damage Detection based on SAP2000-OAPI and Nature Inspired Optimisers

Speakers:
Andrew Reid, Pasra Ghannadi and Andy Nguyen

Synopsis:
Structural model updating is the process of modifying a finite element model using data acquired from the actual structure to predict its behaviour more accurately. These updated models are capable of locating and quantifying damage in real structures. Damage detection methods using nature-inspired optimisers have been developed over the last decade to provide an effective tool for engineers. However, this process requires specialised knowledge in programming and finite element theory. Addressing this issue, this research developed a novel model updating framework using MATLAB and SAP2000-OAPI and tested it in two stages using two case studies. Starting with a planar steel truss, several different objective functions were included and intensive simulations showed that the Slime Mold Algorithm and Equilibrium Optimiser were the best performers. In the second stage, the framework was enhanced to predict the dynamic response of a real truss structure using modal properties from hammer induced vibration data using the best performing optimisers from case study 1. The Equilibrium Optimiser achieved the best result with a natural frequency error of less than 0.5% and Modal Assurance Criteria (MAC) values greater than 0.94 for the first four modes. The final framework is relatively easy to use and can come an effective tool for practicing engineers.

Proactive Approaches to Asset Management: Lessons from Queensland Rail

Speakers:
Amin Miri

Synopsis:
The Transport Industry faces a challenge with numerous assets reaching the end of their design service life while continuing to operate in a tight fiscal environment. Managing within these constraints necessitates an assessment of assets structural integrity and alternate methods to manage risk and prolong their life extension. Queensland Rail has initiated a proactive strategy by implementing structural health monitoring systems on critical assets, with the aim of reducing overall inspection hours and enhancing proactive maintenance. This presentation focuses on the deployment of monitoring systems in a tunnel and a steel truss bridge, providing insights into their background, associated challenges, and an overview of their functionalities.

Port of Townsville Berth 1 Structural Health Monitoring

Speakers:

Mohamed Jaditager and Daniel Whipp

Synopsis:

The Port of Townsville Ltd in collaboration with Rockfield Technologies Australia Pty Ltd have measured and monitored the ship berthing load transfer and movement of a berthing dolphin from several ship berthing events in real time using laser sensors and strain gauges. The objective of the Berth 1 Structural Health Monitoring was to understand the behaviour of the dolphin fenders during ship berthing and the resulting impact to the wharf structure. An analysis of ship berthing events was conducted to correlate berthing characteristics against fender deflection profile and structural response of the wharf to better understand how different ship berthing events were affecting the remaining useful life of the Berth 1 wharf structure.

Session 2a

Chair:
Dr Andy Nguyen

Development of Fiber Bragg Gratings Sensors for Reinforcement Corrosion Detection in Structural Health Monitoring

Speakers:
Shuvashis Saha, Ali Hadigheh, Simon Fleming, Ivan Rukhlenko and Marjorie Valix

Synopsis:

This paper studies the development of fiber Bragg gratings (FBGs)-based optical sensors to detect corrosion in steel reinforcement within concrete structures. Corrosion in the steel reinforcement can be initiated by different factors, including the presence of chloride ions in water and the advancement of the carbonation front through the concrete cover, all of which play a significant role in the rapid progression of corrosion. As corrosion continues to progress, the corrosion-induced products exert pressure on the surrounding concrete, ultimately spalling the concrete cover. In recent years, corrosion has emerged as a significant concern, mainly due to the high costs associated with repairs and the safety hazards linked to potential failures or collapses of infrastructure. Moreover, corrosion is a significant concern in structural health monitoring (SHM), particularly for structures exposed to harsh environments, a relevance highlighted in Australia, where most bridges are near marine environments. The importance of corrosion in SHM drives the development of affordable, non-invasive, and live corrosion detection methods for both new and existing structures. One of the most effective solutions for monitoring corrosion in reinforced concrete under various conditions is the utilization of fiber optic sensors (FOS), offering advantages such as high sensitivity, live monitoring, and resistance to electromagnetic interference. To address this need, we are designing and fabricating a series of strain and temperature sensors based on FBGs to identify the onset of corrosion-induced pressure on steel reinforcement. These sensors monitor the strain effects of corrosion products while compensating for wavelength variations resulting from temperature changes.

Additionally, we will report various characterizing parameters of the fabricated FOSs and the impacts of FBGs for both uniform and non-uniform strain and temperature. A concise overview of the analytical formulation for strain and temperature measurement using the FBGs sensors will be provided. The performance of an FBG-based FOS is typically assessed in terms of its sensitivity. In this research, we will detail the sensitivity of FBG sensors to varying strains and temperatures. This contributes to distinguishing and accounting for different sources of strain, thus facilitating accurate measurement of the strain induced by corrosion products using the developed FBG sensors.

Next-generation coupled structure-human sensing for pedestrian-bridge interaction analysis using data fusion and machine learning

Speakers:

Ulrike Dackermann and Sahar Hassani

Synopsis:

This paper presents an innovative approach for estimating pedestrian bridge load and crowd movement by combining signal processing, data fusion methodologies, and machine learning. The technique utilizes data from both structural sensors and wearable devices. Our methodology encompasses signal preprocessing via Variational Mode Decomposition (VMD) and down-sampling to cleanse and refine the original data. Algorithms are proposed for extracting raw data features and decision-level fusion to effectively eliminate noise and errors from the input data.

2D-Convolutional Neural Networks (CNNs) are first employed separately to the sensing sources and subsequently extended to fuse multi-modal data, encompassing raw, decomposed, and denoised data. This proposed data fusion process enhances the learning models, boosting the system's overall efficiency and robustness.

To validate the proposed technique, experimental data was collected from a simulated crowd scenario on a scaled-down test bridge with advanced structure-human sensing capabilities. The results showcase the exceptional effectiveness of the monitoring solution, achieving peak testing accuracy of 99.62% for single-class motion speed classification, 98.69% for multi-class motion speed and load characterization classification, and an R2 score of 98.42% for load estimation when employing the fusion of denoised signals with VMD. Additionally, the performance of the 2D-CNN model is compared with various machine learning techniques such as Random Forest, KNN, SVM, XGBoost, and Ensemble methods, demonstrating the robustness and superiority of the proposed approach.

Tunnel Displacement Monitoring using Battery-Powered Wireless Radar Sensors

Speakers:

Bimal Paneru, Dick Yau and Simon Igloi

Synopsis:

Infrastructure monitoring and maintenance are crucial for ensuring the safety and longevity of tunnels. This abstract presents an innovative approach to tunnel displacement monitoring utilising battery-powered, wireless data communication, and radar sensors. Radar sensors offer unparalleled accuracy and resilience, making them ideal for tracking tunnel displacements. Unlike traditional methods, radar measurements remain accurate even in dusty environments, reducing maintenance and ensuring data integrity. Moreover, the wireless aspect of the system significantly lowers installation and operational costs. This abstract explores the benefits and feasibility of implementing radar-based displacement monitoring in tunnels, highlighting its potential to enhance safety and reduce maintenance expenses.

Crack identification in beams by a novel modal-based correlation method

Speakers:

Khac Duy Nguyen and Tommy H.T. Chan

Synopsis:

Frequency-based methods have been widely used for crack identification due the convenience of formulating the relationship between cracks and natural frequency changes. However, these methods have some disadvantages such as the need of accurate estimation of numerical mode shapes, false detection in symmetric beams, and the requirement for a good number of modes available for multiple crack identification. This paper presents a simple method to locate and quantify single and multiple cracks in beams using modal strain energy-eigenvalue ratio change from the first few modes. Firstly, cracks are modelled as rotational springs, and the relationship between the crack and stiffness reduction of the corresponding element is formulated based on energy theory. From this relationship, a crack-stiffness reduction curve is developed. Secondly, a modal correlation method using modal strain energy-eigenvalue ratio is employed in conjunction with the developed crack-stiffness reduction curve to locate the cracks and estimate the crack sizes. Numerical study has shown that the proposed method can accurately locate and quantify single and multiple cracks. The proposed method is found to overcome the limitations of the frequency-based methods.

Bridge and Traffic Monitoring (BTM) of the Gateway Arterial Flyover

Speakers:

Raye Newman

Synopsis:

Safety, sustainability, and transport productivity are core objectives of managing a productive bridge network. Over the decades the mass, dimensions and number of heavy vehicles accessing bridge networks has increased and normally accepted margins have decreased. The continuing evolution of heavy vehicles to efficiently transport goods and increasingly large equipment are applying additional pressure to the bridge network and their management.

Bridge and traffic monitoring (BTM) at the Gateway Arterial Flyover (GAF) in Brisbane, Queensland, has given the Queensland Department of Transport Main Roads (TMR) insights into the response of the bridge when heavy vehicles cross over. It has helped to inform assumptions around heavy vehicle loading and their dynamic interaction with the bridge. With that information, TMR now have a clearer understanding on whether the asset is being consumed at the expected rate, or at a faster rate based on the level of access. This has been possible due to the system being able to estimate speed, axle configurations, dynamic effect on the bridge, and develop statistical live load models for the bridge by heavy vehicle type. This is a data-driven, risk-informed asset management of the bridge directly considers the effectiveness of compliance.

Structural repair and access decisions have also been informed with the data collected at GAF. After the data was analysed, the decision to strengthen the piers was confirmed as a priority. Access was initially open to single lane travel and opened to two lane travel at speed for freight vehicles after the monitoring equipment was set up. However, the data helped to understand the composition of vehicles crossing GAF and the risks posed to the structure by heavy vehicles. This has since resulted in lane restrictions and specific conditions imposed to reduce risk to structure and to maintain lane availability for road users.

Session 2b

Chair:
Dr Subhra Majhi

Spatial Positioning in the SHM World.

Speakers:
Brad Dalton

Synopsis:

We all live in a world of absolutes and relatives, some of us do it for a living.

Structural Health Monitoring (SHM) brings together many disciplines in the STEM world; Structural,Sound, Civil, Mechanical, and Chemical Engineers, Architects, Designers, Asset Management Professionals, and Surveyors to name just a few.

The focus for all these people is both time and space, with a focus on how an asset changes over time. To allow models and predictions to be relatable and actionable, most of the time we concentrate on relative changes to an asset i.e., what does it look like today vs. last week, month, or year. However, no structure lives in isolation, most of the time an asset is intrinsically connected to everything around it.

As a result, absolute measurement also plays a part. Absolute measurement is used when precise values are needed in comparison to a natural, unchanging zero point, unlike a relative measurement system where a point of origin is completely arbitrary.

The question is why it matters, let's explore that.

- Measuring the lean of the leaning Tower of Pisa must be on an absolute measurement system to allow its overall movement to be related to other Assets around it.
- A passenger on the plane cares little about what route to take between cities but does care about which seat he or she is going to sit in i.e., 3B (Business Class) vs. 56C (on the tail next to the lavatory). Here we have used a relative measurement system.
- Having explored that there are two other measurement systems we can use, plus there is time but let's hold that thought for a tick. The two other systems are a combination of the first two and order matters.
- Relative Absolute is one method, a great example is a robot in a mine, first, it measures where it is in relation to the walls and roof to locate itself, relative, but once it knows where it is in the tunnel, it also needs to know where it is in the mine, absolute.
- Absolute Relative is used in SHM when we have many buildings, utilities, rail and roads all occupying similar space, absolute but then we want to measure the movement between one part and another i.e., what displacement do I have between a stanchion and a train as it passes over the third pier, relative.
- All of this is dependent on our last measurement system, time, which I'm out of.....

So, let's talk about that at the conference in Townsville where I will explore the importance of space and time in a spatial context as related to SHM.

Asset Condition Monitoring using operational data from SCADA systems.

Speakers:

Madhumenon Krishnamenon and Rabin Tuladhar

Synopsis:

Critical assets are increasingly installed with the Supervisory Control and Data Acquisition (SCADA) application which functions as a repository for operational parameters collected from existing sensors. This multi-variate data stream, reflecting the ground truth on asset usage, forms a viable alternate foundation for condition monitoring workflows. Early warnings on impending failures derived from the analysis of SCADA data in the form of alerts and estimates of Remaining Useful Life (RUL) along with the associated probability of occurrence have the potential to improve asset reliability. In addition, they provide valuable insights for minimising unexpected failures and making informed decision making to optimise the scope, cost and duration of restorative maintenance interventions. Various architectures of Artificial Neural networks (ANN), Auto Encoders, Support Vector Machines (SVM), Decision Trees, Principal Component Analysis (PCA), Isolation Forests, time-series analysis, change point detection, control charts and thresholding are some of the major techniques used for tasks like anomaly detection, fault diagnostics and prognostics considering non-linear and non-stationary operating modes of the assets. In addition, with the majority of SCADA data representing acceptable operating states, normal behaviour models that form the reference to detect deviant behaviour in ongoing condition monitoring are also considered. Predictive models derived from SCADA data are attractive considering the low capital expenditure on hardware and sensors. However, with mean sampling rates of 10 minutes, historical SCADA data used to train the models can fail to detect transient and non-stationary operational behaviours. The quality of such models is further impacted by errors from measurement noise, multiple asset operation states, improper choice of features as well as imbalanced nature of the dataset. This influences the classification of anomalies and reduces confidence in integrating the prognostic deliverable into the maintenance strategy. Besides, the non-availability of large representative datasets from the industry to develop and validate the predictive models and concerns about cybersecurity on accessing the SCADA application are significant challenges.

This work presents the use case of a data-driven model focusing on the detection and diagnostics of anomalies developed from historical SCADA data which can be embedded in condition monitoring workflows.

Nonlinear vibration control of offshore wind turbines under multiple dynamic hazards

Speakers:

Haoran Zuo, Songye Zhu, Kaiming Bi and Hong Hao

Synopsis:

Offshore wind turbines are constructed with increasingly long blades and slender towers to more effectively harvest wind resources, and thus they are more vulnerable to dynamic excitations such as winds, sea waves, and earthquakes. Offshore wind turbine vibration control has been extensively investigated, and most focused on linear vibration control strategies with control performance sensitive to structural frequency changes. Nonlinear energy sinks (NESs) emerge as effective vibration control methods with broadband fashion against structural frequency variations. To further improve the amplitude-dependent control effectiveness of the traditional track NES with a quartic profile only, two novel NESs with newly designed track profiles combining quadratic and quartic polynomials are proposed in the present study. The proposed track NESs is firstly optimized and their performances in terms of effectiveness and robustness in mitigating fixed-bottom offshore wind turbines under the wind, sea wave, and seismic loads are systematically investigated then. Moreover, the track NESs in the response reduction of spar-buoy floating offshore wind turbines are preliminarily explored. In general, the present study paves the way for nonlinear vibration control of offshore wind turbines.

Automated Stromwater infrastructure inspection leveraging deep learning or Convolutional Neural Network

Speakers:

Abdulgani Nur Yussuf, Haosen Chen, Nilmini Weerasinghe, Lei Hou and Kevin Zhang

Synopsis:

Urban infrastructure relies heavily on efficient stormwater pipe systems to manage surface water runoff and prevent flooding. Traditional manual inspections of these systems are labour-intensive, time-consuming, and prone to errors. To address these challenges, this research develops a model that complies with water services (WSA) standards for defect identification by automating stormwater pipe inspections. A neural network, a deep learning algorithm employing a dataset of 1073 Images of real CCTV data of pipelines from Banyule City Council, was used. The model trained with the mean average precision above 0.75. The model offers a cost-effective, time-efficient and reliable approach to pipe inspection providing immense value to the Asset managers ensuring the safety and functionality of the stormwater infrastructure.