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CIES – Centre for Infrastructure, Engineering & Safety
School of Civil & Environmental Engineering

ANNUAL REPORT 2018

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Centre for Infrastructure, Engineering & Safety
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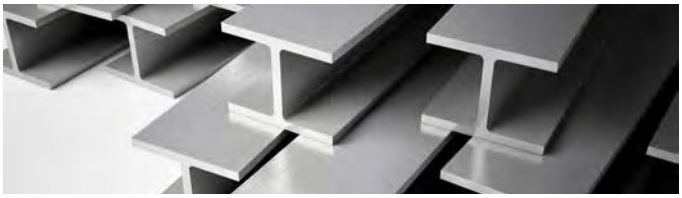

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Our Vision

As an internationally recognised research centre, our vision is to improve the sustainable design, construction and maintenance of economic, effective and safe civil engineering infrastructure to enhance the quality of human life.

CIES was established as a UNSW research centre in January 2007 to facilitate advanced research in all aspects of civil engineering infrastructure, including building structures, bridges, tunnels, roads, railways, pavements and materials.

About Us

We conduct pure and applied research...

At CIES, we apply our skills to engineering and safety assessments of infrastructure. We look at the risk management of buildings, bridges, dams, roads and other infrastructure when subjected to both in-service conditions and overload (or limit) conditions, such as in fire, earthquake, cyclone or blast situations, or when structures are exposed to hostile environments.

The core activities of the Centre are underpinned by a significant number of eminent academic staff of international renown in their respective fields, particularly in structural engineering, geotechnical engineering, advanced materials engineering, pavement engineering, engineering mechanics, computational mechanics and in laboratory testing.

We conduct pure and applied research with funding won from national competitive granting schemes (particularly through the Australian Research Council's Discovery and Linkage Project Schemes) as well as other contestable funding programs, and with direct support from industry.

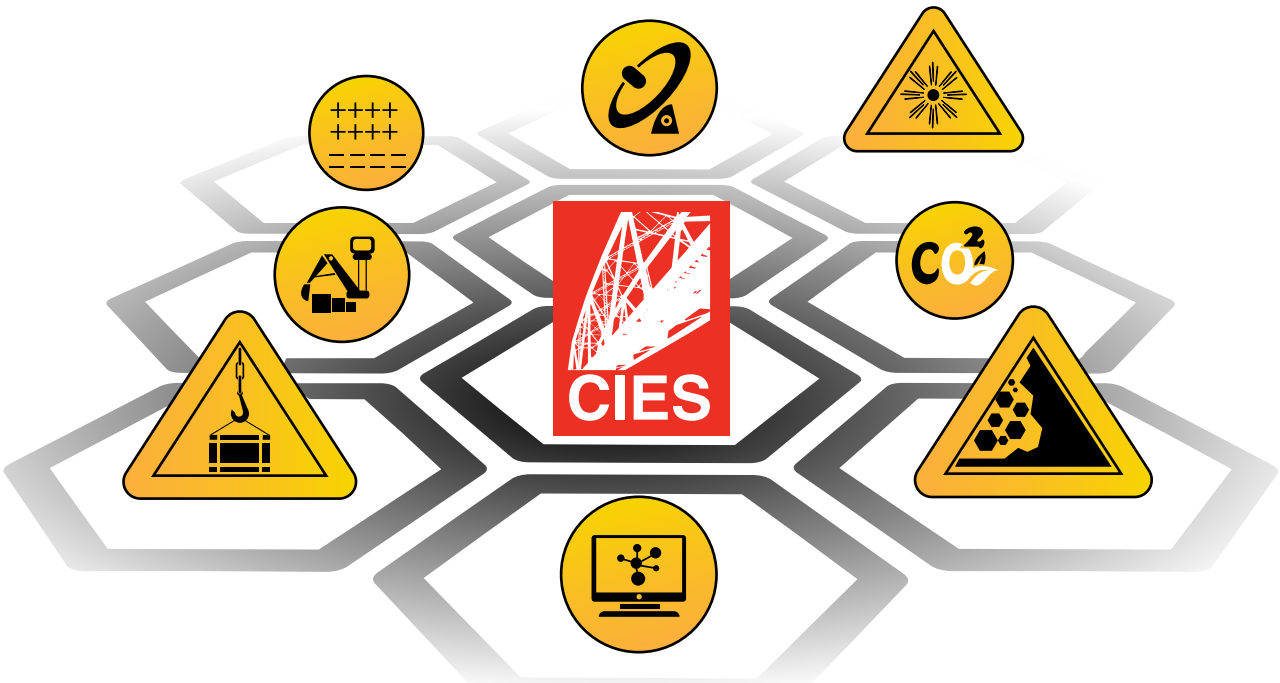
We also undertake commercial activity in collaboration with industry that is challenging and strategic in its nature. These research and commercial activities are conducted with essential physical resources, such as those of the Heavy Structures Research Laboratory, Advanced Materials Research Laboratory, Geotechnical Laboratory and our Advanced Computational Analysis Laboratory (ACAL).

Multi-disciplinary collaboration for the best results

CIES projects incorporate a number of engineering disciplines – from structural engineering to geotechnical engineering, and engineering materials to computational mechanics.

In short, CIES offers:

- World-class interdisciplinary research by a team made up of structural and geotechnical engineers and scientists.
- Access to advanced analytical, computational and experimental techniques and facilities.
- A forum for idea exchange and research collaboration between engineers and scientists.
- The ideal base from which to develop industry proposals and grant funding applications.
- Industry partnerships to secure the practical application of research outcomes.
- Opportunities for postgraduate students in a wide range of relevant disciplines.



Executive Committee

The UNSW Centre for Infrastructure Engineering and Safety is managed by an Executive Committee comprising of the CIES Director, Research Director, two Deputy Directors and the Centre Manager. The committee met on a regular basis to discuss strategy, performance and research opportunities. In addition, input to CIES management is provided by the CIES Academic Group.

Director
Professor Chongmin Song

Research Director
Professor Mark Bradford

Deputy Director 2018
Professor Arnaud Castel

Deputy Director Jan 2018 - May 2018
Professor Nasser Khalili

Deputy Director June 2018 - Dec 2018
Associate Professor Adrian Russell

Centre Management
Theresa Wisniewski

Steering Committee

The Steering Committee meets throughout the year to oversee and monitor the progress of the Centre and to assist the Director in developing strategies to ensure that the goals and objectives of the Centre are realised. The membership of the Management Board for the Centre is:

- Professor Mark Hoffman, Dean, Faculty of Engineering (Chair)
- Professor Chongmin Song, CIES Director
- Professor Mark Bradford, CIES Director of Research
- Associate Professor Adrian Russell, CIES Deputy Director
- Professor Klaus Regenauer-Lieb, School of Minerals and Energy Resources Engineering
- Scientia Professor Deo Prasad, Chief Executive Officer, CRC for Low Carbon Living
- Professor Ismet Canbulat, School of Mineral and Energy Resources Engineering
- Mrs Theresa Wisniewski, CIES Centre Manager

Industry Advisory Committee

The CIES is supported by an Industry Advisory Committee comprising of 12 members from industry and government organisations. The committee meet regularly with CIES academics to promote the engagement of CIES with Industry.

Welcome from the Director

CIES staff have contributed significantly to the maximum research rating of 5/5 ("well above world standard") achieved by UNSW Civil Engineering ...

I am very pleased to be writing my first report as Director of the Centre for Infrastructure Engineering and Safety (CIES). The 2018 Annual Report outlines the mission of the Centre, its governance structure and finances. The Report provides an overview of the progress of projects funded by competitive national schemes and industry, major awards achieved, and the publications produced by staff and students throughout 2018. The achievements recorded in this report are a great source of pride for me and other members of the Executive Committee.

2018 was a productive and successful year for the Centre in our pursuit of research excellence and social impact. Our collective grant income for 2018 was $2.29M while our members secured over $2M in ARC Discovery and Special Research Initiative funding, graduated 15 PhD students, published 1 book and 127 refereed journal papers. CIES staff have contributed significantly to the maximum research rating of 5/5 ("well above world standard") achieved by UNSW Civil Engineering in the 2018 Excellence in Research for Australia (ERA) assessment, and to the School's ranking as first in Australia and 9th in the world (AWRU).

CIES staff have also won worldwide recognition. Congratulations must go to Professor Stephen Foster on fib Honorary Life Membership, and to Dr Angus Murray, Emeritus Professor Ian Gilbert and Associate Professor Arnaud Castel for their 2018 best paper award from the ASCE Journal of Structural Engineering.

We were delighted to celebrate the promotion of two CIES members in 2018. Dr Ehab Hamed was promoted to Associate Professor with effect 1 Jan 2019. Dr Johnson Shen was promoted to Senior Lecturer with effect in 1 July 2018. We had the great pleasure to welcome Theresa Wisniewski as our new Centre Manager.

On behalf of the Executive Committee, I would like to thank all our staff and students who contribute so generously to the continuous success of the Centre. I would also like to express my sincere appreciation and thanks to our industry partners and advisory committee members for their strong support and contributions.

Professor Chongmin Song
Centre Director

About: Professor Chongmin Song obtained his Bachelor of Engineering from Tsinghua University, China and Doctor of Engineering from the University of Tokyo, Japan. After working in academia and industry in Switzerland, he joined UNSW in 2001.

UNSW research led by Professor Song was critical in the development of a numerical method that makes it possible to analyse complicated geometries that are frequently found in construction, and to tackle challenging engineering problems.

Since the development of this method, known as the scaled boundary *finite element method*, its use has been crucial for studying fractures in structures which could be created by stress or natural disasters. The method forms the foundation of software that can automatically convert images and data to numerical models. This allows analysis of critical infrastructure data in seconds or minutes, rather than the hours or days required using existing tools.

The approach means structural engineers can know in advance the dangers to infrastructure, and whether any planned construction or seismic activity would impact the structural integrity of surrounding buildings and regions.

During his academic career, Professor Song has published more than 130 papers in top-tier journals in his research area. His co-authored book -*Finite Element Modelling of Unbounded Media, Wolf and Song, 1996, Wiley* - is widely referenced by researchers and practitioners in earthquake engineering. His second book -*The Scaled Boundary Finite Element Method – Introduction to Theory and Implementation* -was published by Wiley in 2018. Since 2009, he has led seven Australian Research Council Discovery Projects and been involved in or led three Linkage Projects.

CIES IAC Industry Members 2018

Our accomplished and dedicated Industry Advisory Committee meets regularly with CIES academics to further promote our engagement with Industry.

Garry Mostyn
Chair
Principal, PSM

Garry Mostyn graduated from UNSW Australia in civil engineering in 1973. He subsequently completed a master's degree in geotechnical engineering at UNSW and a bachelor's degree in geology and statistics at Macquarie University. He worked as a cadet and engineer with the NSW Department of Public Works and with consulting geotechnical engineers from 1970 until 1986. He then joined the Department of Civil Engineering at UNSW Australia where he lectured in civil and environmental engineering practice and geotechnical engineering. He joined PSM in 1997 as a Principal Consultant while retaining a part time appointment at UNSW.

Garry's fields of specialist expertise include slope engineering; foundation engineering; rock mechanics; geotechnical risk analysis; and forensic engineering. He has authored or co-authored over 80 journal and conference papers. He has worked on major projects throughout Australia and in Thailand and PNG. He has been an active member of several national and international code and practice committees and been involved at the highest levels of the Australian Geomechanics Society and the International Society for Rock Mechanics.

James Aldred
Technical Director - Concrete Future/ AECOM and Adj Assoc Professor - School of Civil & Environmental Engineering at UNSW

James has over 30 years' experience in the concrete industry in Australia, Asia, the Middle East and the United Kingdom. His background includes Technical Director of an international admixtures company, Manager of the High-Performance Concrete Research Group at the National University of Singapore, Technical Manager of Taywood Engineering and Honorary Research Fellow at Imperial College. He is a specialist in concrete technology including mix design, durability, investigations and advice, with a proven record of helping change industry mindset and practices. He was the Independent Verifier for the Burj Khalifa in Dubai which is the world's tallest tower.

James obtained his PhD from Curtin University. He is a Chartered Professional Engineer and a Fellow of the Institute of Engineers Australia, the American Concrete Institute and the Institute of Concrete Technology. James has received the Award of Excellence from Concrete Institute of Australia and the Award for Outstanding and Sustained Contributions to Concrete Technology by ACI International Conferences, as well as the prestigious George Stephenson Medal from Institute of Civil Engineers.

Phil Blundy
Technical Director, AECOM
Engineers Australia, Structural College Board - Immediate Past Chair
BE Civil (Hons 1) 1980, MEngSc (Structural Eng) 1986 UNSW

Phil has nearly thirty years industry experience, at Hyder Consulting, then Cardno, and most recently at AECOM. As Technical Director at AECOM he has worked on projects for all levels of government and private agencies. Phil has been a member of Engineer Australia's Structural College Board for over ten years and is the Immediate Past Chair. He has been particularly involved in research and promotion of Australian Bridge Design Standards

Dr Murray Clarke
BSc BE PhD
FIEAust CPEng
NER APEC
Engineer
IntPE(Aus)
Director
Structural
Engineering APAC

Kathy Franklin
Structural
Engineer - ARUP
MEng (Structural)
Cambridge

Dr James Glastonbury
Technical
Director, Laing
O'Rourke

Dr Murray Clarke is Director of Structural Engineering at Dematic, aglobal engineering company that designs, builds and supports logisticssolutions that optimise material and information flow.

After completing his PhD at the University of Sydney, Murray joined theacademic staff to carry out teaching and research into steel structures,also at the University of Sydney. During this time he published widelyin the field of advanced structural analysis and design of steelstructures.

Murray moved to Dematic in 1999 to initiate the core discipline ofstructural engineering in that organisation. The main fields of Murray's current work include the design of storage racking and associated steel structures such as mezzanine floors to support Dematic's automated systems projects across the Asia Pacific region. Storage racks range in height from a few metres to more than 40 m and make extensive use of cold-formed steel. In his current role, Murray has been fortunate to blend his academic interests with practical design and he maintains an active role in developing automated design tools for rapid and precise design of racking structures. Murray was a member of Standards Australia committee BD/62 responsible for developing AS 4084-2012 _Steel Storage Racking_ and is also a registered technical engineer with the European Racking Federation, a European industry body that develops design codesfor the storage equipment industry in Europe

Kathy has worked on the structural design, analysis and forensic engineering on a wide variety of building and infrastructure projects. Her particular interest and expertise is in structural dynamics (vibration, blast, impact, seismic engineering), solving such problems as design for dancing crowds in pop concerts, pedestrian bridge vibration, lively office floors, achieving low vibration environments for sensitive equipment in laboratories and hospitals, wind, vehicle and machine induced vibration of structures. Projects that she is particularly proud to have been involved with include: Singapore Sports Hub, Kurilpa Bridge Brisbane; Marina Bay Sands Skypark; Sydney Cricket Ground Victor Trumper and Noble Bradman Stands; and "The Birds Nest" Beijing National Stadium. Kathy is passionate about education of the next generation of engineers, and research that will improve delivery of future projects. She regularly guest lectures at UTS, UNSW and USyd and has participated in a number of joint industry/ academia research projects.

James is Technical Director for Laing O'Rourke's Australia business, with key executive level accountability for technical performance in work winning strategy and delivery assurance. He is a member of the Australia Hub executive leadership team with operational and strategic responsibilities for consultant engagement, design management, digital engineering, quality and specialist engineering/ SME disciplines. He manages a team of internal technical specialists covering key market sectors including rail, buildings, airports, defence and resources.

Prior to taking up operational responsibilities, James was Engineering Director within Laing O'Rourke's in-house innovation team - the Engineering Excellence Group. In this role he was responsible for establishing systems and processes to foster construction-related innovation within various project teams including for Alliance and Delivery Partner teams.

James was the Innovation Lead with the Pacific Complete Delivery Partner team on the $4.5B Pacific Highway Upgrade (Woolgoolga to Ballina) where circa 100 innovations were progressed realising approximately $120m in improved public value. He was also instrumental in establishing innovation processes for the North East Programme Alliance (NEPA) as part of Melbourne's level crossing removal programme.

His background includes over 20 years in consulting roles across a range of sectors including transport, mining, oil & gas and tunnelling before joining Laing O'Rourke.

Sam Henwood
(RMS)
BE Civil 1994
UNSW
Director
Pavements &
Geotechnical at
Roads & Maritime
Services, NSW

Prior to becoming Director of Pavements and Geotechnical at RMS, Sam was their senior geotechnical scientist. Prior to this he worked for a number of geotechnical engineering companies, in Australia and in the UK, including Coffey Geotechnics in Sydney and White Young Green in Glasgow.

Peter Key
PhD Structural
Eng, USyd
National Technical
Development
Mgr., Australian
Steel Inst.

Dr Peter Key is a structural engineer with upwards of 25 years' experience in R&D, design, site supervision and project implementation in a design & construct scenario for large steel buildings. His specialties include 3D design, structural design, research & development in construction. His interests have always encompassed the use of IT to bring efficiencies to the AEC industry.

Peter is Australian Steel Institute's National Technical Development Manager and a regular presenter on steel design and construction. He is part of Standards Australia Committee BD-001 responsible for the new AS/NZS 5131 Steel structures - Fabrication and erection. He has also written a range of technical publications including the Structural steelwork fabrication and erection Code of Practice on which AS/NZS 5131 is based.

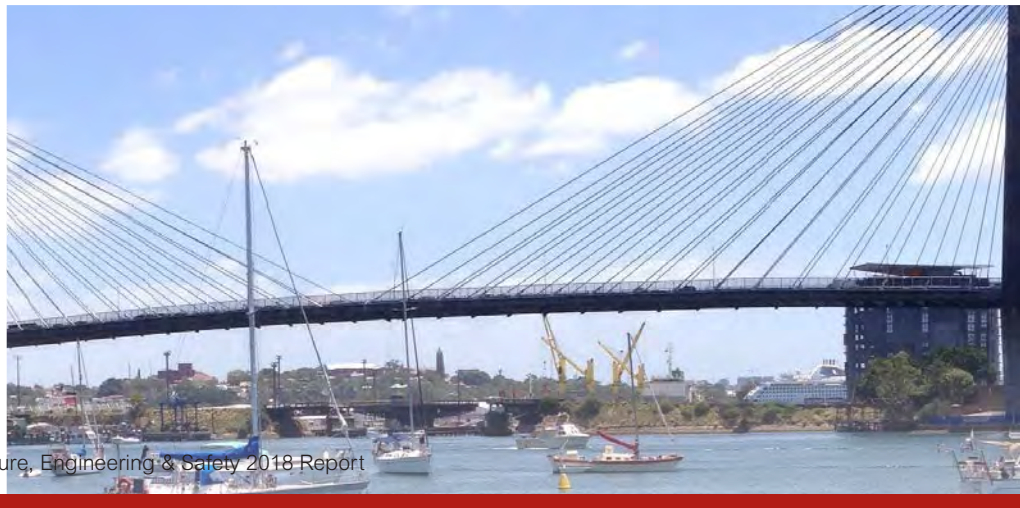
Rod McKay-Sim
Director, Hillside
Engineering Pty
Ltd
Member,
Concrete Institute
of Australia

Rod has been involved in engineering innovation all his professional career. In the 1990s he grew a small agency based company from less than $500K turnover to a strong, profitable business of sales exceeding $30million and operations throughout Australia, New Zealand and Singapore by introducing six ground-breaking engineering technologies (now considered standard practice) in Australia and New Zealand: Since 2006 he has led his own company in innovative research and practise - professional specialties are Concrete Lifting and Anchoring Systems design and technology, Tilt-Up construction systems, and Pre-cast concrete lifting systems. Since 2003 Rod has also been a keen cyclist for charity, five times finisher in the Hartly Challenge (Canberra-Charlottes Pass-Canberra) raising money for Hartley Lifecare - helping disabled people lead happy and productive lives, and a regular in the Sydney to Surfers cycle ride, raising money for Youth Off the Streets.

John Merrick
BE(Civil) Hons
/BCom 1997
USyd, MEngSc
(Struct Eng) UNSW
Snr Tech Director
ARCADIS Aus.Pacific
METRON -
Barangaroo Stn
Design Mgr

John has over 20 years' experience in various types of structures including residential, commercial, retail, educational, health, recreational, stadiums and transport infrastructure in Australia and overseas. He has presented papers at engineering conferences both in Australia, United Kingdom and USA. John is a committee member on BDS - 032 - Composite Structures and BDS-01 Steel Structures.

Some of John's projects include METRON - Underground Station Design and Technical Services (USDTS) Sydney Metro project; West Connex - Building Zone Manager - Responsible for the structural, civil and building services design for all buildings in Stage 1B including 3 ventilation stations, 6 substations, MMC office building, 2 fire pump buildings and 4 tolling buildings;. Barangaroo South -6 storey commercial and 4 storey mixed usage buildings; Australian Embassy in Kathmandu and New Delhi - detailed inspections following 2015 earthquake; Dubai Tower Doha Project manager and design engineer for 88 storey tower currently under construction; Al Harma Tower - project manager for peer review of 413m tower in Kuwait; Port of Townsville - design manager for berth expansion; Inghams Sommerville - design of new steel industrial buildings.



Anna Paradowska
Senior Scientist & Industrial Liaison Manager at the Australian Centre for Neutron Scattering, ANSTO

Anna's current main focus is to develop and manage the Australian Centre for Neutron Scattering - Industrial Liaison Office at ANSTO. Her vision is to promote the Centre's innovation and expertise, connecting business and industry to the Centre's ground-breaking research and modern neutron technology, to support and make a positive impact on Australian and global industry

Her specialties include: materials characterisation, in particular neutron and synchrotron residual strain/stress measurements in various materials; and the influence of residual stress on materials performance and to relate them to design or/and manufacturing procedures as well as integrity requirements.

Warren South
Director- Research & Tech Services at Cement Concrete & Aggregates Australia
B Metallurgy, Mat Sci 1986, PhD 2009 Wollongong

Dr Warren South has worked in the heavy construction materials industry for the past 35 years. He started his working career in cement in 1985 with Blue Circle Southern Cement at Berrima as Assistant Works Chemist, later to become Works Chemist in 1989. During this time he worked on the development of cement and concretes specifically for high durability applications such as the immersed tube units for the Sydney Harbour Tunnel and other important infrastructure projects. As Technical Manager for NZ's Golden Bay Cement he led the development of cements specifically for use in the South Pacific, and the development of inorganic polymer binders for concrete. He gained his doctorate in Civil Engineering from the University of Wollongong in 2010, dealing with the performance of cements based on natural pozzolanic materials available in New Zealand. Warren maintains an active focus on addressing sustainability and resilience in terms of the cement and concrete industry and is a strong advocate for the positive contributions that concrete can make to the durability of the built environment.

CIES Staff Members of the IAC

Professor **Chongmin Song**, Director, CIES

Professor **Mark Bradford**, Research Director, CIES

Associate Professor **Adrian Russell**, Deputy Director, CIES

Professor **Arnaud Castel**

Professor **Stephen Foster**

Professor **Wei Gao**

Professor **Nasser Khalili**

Associate Professor **Hamid Valipour**

Big-picture future-thinking – the virtual city

What would it be like to have a complete and up-to-the-minute virtual picture of our city? Not just for visualisation purposes, or transport mode options, but a virtual city that also includes all the numerical analysis needed for engineering design.

Professor Chongming Song has set himself just such an amazing mission - a possibility which has opened up through his in-depth research over the years.

“My vision is to provide the underpinning computational structural analysis needed to build a fully integrated virtual reality model of a city that includes all the physical and functional data,” he explains. “This means it will include the structural information of all the buildings in the city as well as all the technical information from the ground below, such as the properties of the soil and rock.”

Song says the virtual city is a passion project that has developed organically in the wake of much of his research into computational mechanics (i.e. using computers to simulate the behaviour of anything to do with mechanics, including structural engineering, mechanical engineering, biomedical engineering and other areas). But he says it has been made particularly possible by his creation of a novel numerical method called the scaled boundary finite element method.

“Many years of research has gradually led me to a realisation that the concept of the virtual city might work and now I’m very driven to achieving it,” he continues. “What fascinates me most at the moment is the potential of virtual engineering to improve the safety of structures while also saving time and money.”

Song likens the potential impact of the virtual city to the impact of Google Maps. “Before Google Maps, if I wanted to go somewhere, I needed a hard copy map and it might take a few minutes to work out the best route. Now, you can simply plug in point A and point B on your smartphone and it creates an instantaneous real-time, virtual, responsive route for you to follow,” he says.

“You’ve probably experienced how this has saved time and made your own life easier, but for industries like transportation, the cost savings run into millions of dollars in improved routing and fuel economies. With the virtual city, I am imagining similar time and cost savings for a wide variety of industries and government agencies.”

Virtual reality is increasingly being used in applications including entertainment, personnel training, architecture, design integration and construction to name a few and Song says it is so popular because it is visual and instructive. “You can see colour, layout and geometry etc, which is great, but current virtual reality methods all have a gap: they are not particularly useful for engineering design. You might have the geometry of a building, for example, but you’re unable to dimension the columns and floors. That is where my technology comes in.”

Although the virtual city Song has developed is just a proof-of-concept model at this stage he says he has already designed the technology needed to create it. If he can successfully apply it then everything required for analysis in the future would become automatic.

“Once we have a virtual analysis model we will be able to start doing things like inserting and taking away buildings and tunnels in a fully automated manner. That’s what really differentiates this – it’s incredibly practical and you will no longer need to create that physical model of the work you’re planning to do.”

Song explains that applications for this technology include structural analysis, building information modelling, sustainability assessment and life-cycle maintenance but, really, the only limit is the imagination and he believes there are multiple as yet unforeseen advantages to it.

“You can regard this virtual city like the virtual route I was talking about in Google Maps. If we can give industry the data, they will work out an amazing range of things to do with it,” he says.

“It’s difficult to predict which people might benefit from a new technology but I think the list would include civil engineering firms, government agencies and city planners. Looking to the distant future, I think it could also be applied in other disciplines of engineering such as biomedical engineering or mining.”

Song’s research has attracted considerable acclaim. Since 2009, he has led seven Australian Research Council Discovery Projects and been involved in or led three Linkage Projects with an accumulated research budget of over $4.8M. He explains that a large part of this interest is because his work has demonstrable real-world applications. “We have collaborators all over the world, and many people are already using the methods we’ve discovered,” he says.

Song says that, ultimately, the tool he is thinking of is a big-picture future-thinking asset that he wants to help provide for the benefit of generations to come, but he is under no illusions as to the amount of collaboration required. “This will require a huge amount of data and cooperation but building that momentum is my next area of focus. I am now working hard to establish partnerships with government and industry to ensure virtual engineering becomes a reality.”

Professor Chongmin Song is actively seeking partners to explore the potential of virtual cities. If you are interested in finding out more please contact him: c.song@unsw.edu.au

CIES Awards & Achievements

Congratulations to all our staff and students on their many achievements and awards in 2018 including the following:

Promotions

Congratulations to Dr Ehab Hamed who was promoted to Associate Professor in 2018, with effect 1 Jan 2019.

Associate Professor Hamed (centre) recent interest in is the use of precast concrete in construction mainly in the form of walls. The benefits offered by precast walling have seen precast panels to become the product of choice in the Australian construction market. In many cases, however, Hamed says, such panels are used blindly to some extent without adequate research findings to support methodologies. The influence of the early shrinkage cracking, and the long-term performance of the walls with time under creep and shrinkage is such an area that requires fundamental research. Underestimating these time effects can lead to catastrophic failures or to sever cracking that diminish the value of these products.

Hamed's research in terms of modelling and full-scale testing of precast wall panels aims to establish design guidelines and recommendations that will utilise their best advantages as energy-efficient and load carrying members.

Congratulations to Dr Johnson Shen who was promoted to Senior Lecturer in 2018

Dr Johnson Xuesong Shen is a teacher, researcher and industry expert in the field of engineering construction and management. He is founder and Director of the Autonomy and Intelligence in CONstruction laboratory (AICON) at UNSW. Dr. Shen's research interests lie in Autonomous Systems, Artificial Intelligence, Digital Twins, Smart Sensing, Internet of Things, Mixed Reality, and their applications in the preparation, construction, operation, and maintenance of civil infrastructure and the built environment.

Dr. Shen has extensive research experiences in Real-Time 3D Light Detection and Ranging (LiDAR) Mapping with Unmanned Aerial Vehicles (UAV) or Drones; AI-enabled Automated As-built Building Information Modelling (BIM); Field Emissions and Fuel Consumption Modelling of Construction Equipment; Automated Machine Control and Guidance in Construction, as well as Tunnel Boring Machine Tunnelling Methods and Trenchless Techniques for Urban Underground Infrastructure Construction. He is representing Australia in the Board of Directors of the prestigious International Association for Automation and Robotics in Construction (IAARC).

Concrete Institute of Australia (CIA) 2018 award

L-R: Mr. Hugh Miller (winner), Mr. John Merrick (Senior Technical Director, ARCADIS) and Mr Balbir Singh (runner-up).

Congratulations to CIES PhD student Hugh Miller for his well-deserved Concrete Institute of Australia (CIA) 2018 award.

The NSW branch of the Concrete Institute of Australia (CIA) recently hosted its inaugural Student Pitch Competition. The contest was open to all undergraduate and postgraduate students in NSW whose research relates to concrete materials and their applications. Each competitor delivered a three-minute presentation at The University of Sydney on Thursday, 27 September, 2018

The competition was part of a seminar entitled Innovation in Concrete Technology and Practice, which featured keynote presentations by Dr. David McDonald (Associate – Materials Technology, BG&E) and Mr. Eamon Madden (Group Managing Director, Partridge). The seminar attracted a crowd of experts from academia and industry.

Eight student presentations were made, all by PhD students, and the winner was UNSW's own Hugh Miller (pictured), for his research about surface treatment of fibres to create chemical bonds with a cementitious matrix. Hugh is in his final year of PhD study and is supervised by Professor Stephen Foster and Associate Professor Ali Akbar Nezhad.

The runner-up was Mr. Balbir Singh of Western Sydney University, for his presentation about lightweight concrete. The CIA awarded a prize of $500 to the winner and $250 to the runner-up, as well as a package of CIA publications for both.

The University of Sydney was the venue sponsor and ARCADIS was the event sponsor for the seminar. The CIA intends to repeat the competition on an annual basis.

CIES researchers awarded Best Journal Paper 2018

Summary: Congratulations to Angus Murray, Ian Gilbert, and Arnaud Castel for their prestigious ASCE Journal of Structural Engineering award.



The American Society of Civil Engineers (ASCE) *Journal of Structural Engineering* (JSE) – has awarded 2018 Best Journal Paper in the Materials and Structural Response category to CIES researchers Dr Angus Murray, Professor Ian Gilbert, and Associate Professor Arnaud Castel for their paper on "Spacing of Cracks in Reinforced Concrete Based on a Variable Transfer Length Model".

This paper was chosen by a committee comprised of Associate Editors from about 300 papers accepted for publication in JSE last year.

The CIES paper identified a solution for the classical problem governing the relationship between the average crack spacing and the transfer length, a solution demonstrated to yield accurate estimates of average crack spacing for a wide range of RC tension and flexural members. (Full abstract below)

JSE Editor-in-Chief, Sherif El-Tawil congratulated the contributors for their excellent work. "We are proud to have published your research," he said. "As an award winner, this paper will be heavily promoted by ASCE."

Abstract of the Paper:

A method is proposed to indirectly determine values of the transfer length in cracked RC based on the observed load-deformation responses of RC tension members and their crack configurations under increasing load. The transfer length is characterized on the basis of results of several tension stiffening studies in the literature, including recent tests by the authors.

In the present study, the transfer length is revealed to be strongly load-dependent, accounting for the gradual deterioration of the tension stiffening effect with increasing load.

A solution is identified for the classical problem governing the relationship between the average crack spacing and the transfer length, and it is demonstrated to yield accurate estimates of average crack spacing for a wide range of RC tension and flexural members.

Based on empirical crack spacing distributions of real RC members, a statistical approach is adopted to characterize the minimum and maximum spacing of cracks.

Congratulations to Professor Stephen Foster on fib Honorary Life Membership

At the 5Th *fib* International Congress held in October 2018 in Melbourne, Professor Stephen Foster was awarded the 2018 fib Honorary Membership. The award is given in recognition of significant personal contributions to the work of the *fib*.

The fib, (*Fédération internationale du béton*), is a not-for-profit international association formed by 45 national member groups and approximately 1000 corporate and individual members. Its mission is to develop at an international level the study of scientific and practical matters capable of advancing the technical, economic, aesthetic and environmental performance of concrete construction.

Professor Foster is a member of the fib Presidium and Head of the fib Australian National Delegation. He is a member of the fib journal Structural Concrete Editorial Board since 2017, Deputy Chair of the fib Technical Council since 2015 and a member of numerous *fib* working groups. He was the former Chairman of fib Commission 4 "Modelling of Structural Behaviour and design". He has co-authored fib Bulletins 45, 55, 56, 57, 65, 66, 79, 85 and the Model Code 2010, and is a member of numerous fib working groups, including COM2 "Analysis & Design", COM9 "Dissemination of knowledge", COM10 "Model Codes", TG2.2 "Ultimate limit state models", WP2.2.1corr "Shear in beams", WP2.2.2 "Shear in members with steel fibres", TG2.4 "Computer-based modelling and design", WP2.4.1 "Nonlinear dynamic analysis for seismic evaluation of RC frames", and TG10.1 "Model Code 2020".

Throughout his career Stephen has been involved in a number of research projects involving the use of technology in the development of concrete structures and infrastructure. In the field of High Strength, High Performance, Concrete, he has undertaken extensive research at both the materials and structural levels and has won a number of competitive grants in the field.

His research on Strut-and-Tie Modelling and on High Strength Concrete Columns, much of which was funded through ARC Large and Discovery project grants, now forms the basis of many of the design rules in the Australia Concrete Structures Standard, AS3600-2009. This has impact on many thousands of structures built throughout Australia each year. Similarly, his works on high strength and high performance concretes has provided significant impact on the construction industry through incorporation in the fib Model code draft 2010.

In addition to his experience in testing of high performance, high strength concrete, Professor Foster has developed a powerful non-linear finite element program for the modelling of concrete structures, which has assisted in the development of numerous experimental programmes and in the post analysis of the results. He has considerable research experience on strength and ductility in reinforced concrete structures and has published widely in the field.

He has a strong track record in research publishing over 300 papers and reports, including 4 books, 2 edited books, 10 book chapters, and 121 journal papers. He has graduated 23 PhD students and is currently supervising or co-supervising 12 more.

Stephen is a former Director of the UNSW Centre for infrastructure, Engineering & Safety (CIES), and is currently Head of the UNSW School of Civil & Environmental Engineering (since 2012).

In 2015 Stephen was awarded honorary membership Concrete Institute of Australia, 2015, in recognition of his outstanding contribution to the development and use of concrete in Australia.

International recognition for Associate Professor Arnaud Castel

The establishment of the RIMEL Technical Committee is a significant milestone in the global cause of low carbon concrete.

In 2018 in recognition of his expertise and leadership in the sustainable concrete field, Associate Professor Castel was appointed Chair of a new international Technical Committee (TC) convened by the global body, the International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM).

RILEM's TC will address key questions related to the rate and mechanisms of chloride transport in alkali-activated binders and concretes, with a view toward drafting recommendations for the appropriate selection and application of testing methods. The TC will bring together the world's leading research laboratories and practitioners in this area to ensure that decisions in the design, drafting and use of specifications, and future standards, can be built from this sound scientific basis.

The establishment of the RILEM Technical Committee is a significant milestone in the global cause of low carbon concrete. Castel's work within the UNSW Cooperative Research Centre (CRC) for Low-Carbon Living and his research project 'Performance based criteria for concretes: Creating pathways for low carbon concrete manufacture with existing standards' with colleagues Professor Stephen Foster (UNSW - CVEN) and Professor Jay Sanchayan of Swinburne University, has laid the foundations for such global knowledge and sharing.

Head of School Professor Stephen Foster says that Arnaud's leadership of the new technical committee 'is an important legacy of the CRC project and demonstrates the impact of our UNSW research, and the respect in which it is held, internationally.'

L-R: Peter Engelen, General Manager Planning and Infrastructure, NSW Ports; Ben Modra, UNSW Water Research Laboratory and CRCLCL Project Leader UNSW Professor Stephen Foster at Port Botany NSW. Photo: MediaKoo

Demonstrating the practical use of geopolymer concrete; high density coastal protection units

UNSW Cooperative Research Centre for Low Carbon Living RP1020u1

Researchers: Stephen Foster, Arnaud Castel, Johnson Shen, Ron Cox, Benjamin Modra

Armour units at Port Kembla Credit: WRL

Researchers from CIES have developed a new high-density (low carbon) geopolymer concrete using fly ash and steel furnace slag that greatly enhances the stability of armour units on breakwaters.

It takes about 800 kg of CO2 emissions to generate a tonne of cement, and it is estimated that the manufacture of Portland cement in Australia produces eight million tonnes of carbon emissions per year.

At the same time, Australia generates 14 million tonnes of fly ash (from coal fired power generation) and three million tonnes of various metallurgical slags (from steel manufacture) as industrial by-products, which have considerable potential for full utilisation within a circular economy.

“Steel slag can’t be used in conventional Portland cement concrete as free unhydrated lime reacts with it, so my colleague Associate Professor Arnaud Castel and I asked the question: ‘What happens if we put steel slag into low carbon geopolymer concrete?’” says CIES Professor Stephen Foster, who is one of the world’s top experts in concrete structures development.

“It worked well. There were none of the same reaction issues and, importantly, we found that we had created a very dense material with improved mechanical strength, so the next question became: ‘What are we going to do with this dense concrete?’”

That was when Foster, crossed paths with Associate Professor Ron Cox from the UNSW Water Research Laboratory and they made a serendipitous connection.

“I was describing the new dense concrete we had created, and Ron was telling me how climate change and predicted wave size increases meant Australian coastal protection systems needed to be upgraded, and all of a sudden we melded these two ideas,” continues Foster. “Perhaps our dense geopolymer concrete could be used to create a new type of breakwater armour unit.”

Breakwaters are used as a coastal protection measure to shelter ports, harbours and coastal properties against storms and damaging waves. They usually consist of a compact rubble foundation and quarried rock or manufactured concrete armour units, which are placed in layers on top of the foundation to stabilise the structure against wave action.

Coastal structures in many parts of the world are typically designed for depth-limited breaking wave conditions. With a projected sea level rise of up to 90cm by 2100, the design wave height for these structures is expected to increase. Many will require significant armour upgrades to accommodate these new conditions. For example, a 25% increase in wave height will require the armour mass to be doubled. High density units are important as modest increases in material density lead to large gains in overall stability.


Hanbar armour units Credit: WRL

With the connection made, Foster and Cox reached out to their networks and assembled a large multidisciplinary team of researchers and industry partners to pull the research threads together.

The result is a new concrete mix design which has several impactful benefits. In addition to utilising the by-products of fly ash and steel slag, creating new high value use opportunities, the high density of the concrete means units can be smaller. Smaller units mean smaller rock underlayers and smaller equipment required for construction, providing significant cost reductions and a smaller carbon footprint overall.

“This has the potential to halve the volume of concrete we need to do the same job, so it’s not just that we’ve used a much more sustainable concrete, we’re actually using a lot less of it as well,” says Foster.

Other benefits include increased stability while retaining good interlocking with existing armour; higher tensile strength; improved resistance to deterioration in the marine environment; and, ultimately, a more resilient coastal infrastructure.

Fourteen high density low carbon geopolymer concrete 17-tonne Hanbar units have been cast and placed on the north breakwater at NSW Ports’ Port Kembla Harbour. In terms of next steps, these units will be monitored for stability and integrity and will provide a valuable benchmark for future use of geopolymer concrete.

“This project is an excellent example of how researchers and industry partners can work together to bring innovative technologies to market,” says Foster. “There’s great potential to translate this internationally too – climate change and sustainability are not just Australian problems.”

Project team

The trial has taken a massive collaborative effort across industry and research. It has required innovation, coastal expertise, industry know-how and real commitment from all parties to make it happen. CIES would like to extend our thanks to the following organisations and companies who have contributed to the project:

CRC for Low Carbon Living, NSW Ports, UNSW Water Research Laboratory, Australian Steel Mill Services, Wagner, Cleary Bros, Ash Development Association of Australia, Australasian (iron & steel) Slag Association, Independent Cement & Lime

CIES ARC Grants awarded in 2018

Discovery Projects awarded in 2018 for 2019 commencement

Nasser Khalili; Adrian Russell
Modelling creep and time-dependency in unsaturated soils. **$325,000**

This project aims to present the most complete and rigorous modelling framework for creep and time-dependent behaviour of unsaturated soils in infrastructure. The project will address previously neglected aspects of soil behaviour, such as gradual changes in physical properties with time and strain-rate dependency. The project is expected to enable better predictions of infrastructure performance, improve confidence in design, and avoid unwarranted over-design and the considerable cost this imposes. The project will provide a fully validated predictive computational modelling tool for quantitative assessment of long-term performance and stability of infrastructure such as dams, embankments, tunnels, slopes, buildings and foundations.

Nasser Khalili; Arman Khoshghalb; Bernhard Schrefler
Non-isothermal dynamic strain localisation in unsaturated porous media. **$295,000**

This project aims to present a more complete and rigorous treatment of theory of strain localisation in unsaturated porous media geo-structures subject to thermal, inertia and large deformation effects in a three dimensional setting. The project will provide an improved understanding and an added confidence in dealing with geotechnical engineering problems involving failure and instability. The outcome of this research will be a fully validated predictive tool in the form of a computational model for quantitative assessment of structural integrity, safety, failure, and consequence of failure of geo-structures such as dams, embankments, tunnels, slopes, and above and under-ground excavations.

ARC Linkage Projects

Nasser Khalili; Adrian Russell; Mark Jaksa; Garry Mostyn
Experimental investigation and constitutive modelling of reactive soils.
LP180100235 $342,831
Industry Partners: PSM Consult Pty Limited; DPTI

This project aims to develop the fundamental knowledge, a mechanical framework and practical engineering design tools needed to minimise the effects of reactive soils on infrastructure. Reactive soils undergo significant swelling and weakening upon wetting or intrusion by salt-rich groundwater and shrinkage upon drying. This can result in damage to buildings and infrastructure beyond a state of repair. This project will develop tools, models and theories to detect weaknesses in the design of infrastructure and its foundations built on problematic reactive soils, assess the impact and implement effective remedial measures to improve performance. The project is expected to increase efficiency through improved design and reduced damage, and save infrastructure owners, government and private, tens of millions of dollars each year.

Arnaud Castel; Raymond Ian Gilbert; James Iman Mohammadi Rodd; Warren South.
Shrinkage, cracking, self-healing and corrosion in blended cement concrete,
LP170100912, $321,000
Industry Partners: Cement Concrete & Aggregates Australia

This project aims to investigate the effects of binder quantity and composition on early-age cracking in Australian concretes caused by restrained shrinkage, the subsequent self-healing capability of the cracks, and the possibility of detrimental early chloride induced steel reinforcement corrosion, particularly in marine locations. This project will focus on concrete mix designs and the blends of cement, fly-ash and blast furnace slag that are prescribed in the revised version of the concrete bridge standard for the most severe exposure. This project will lead to a significant improvement in the serviceability and durability of concrete structures in severe environments.

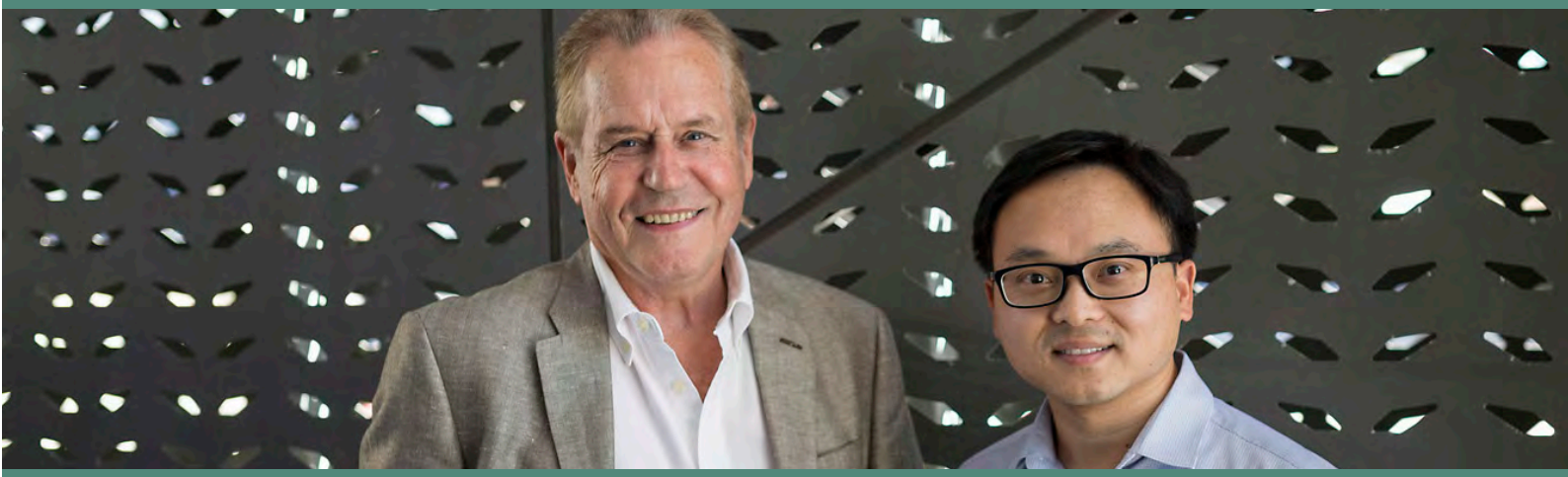
ARC Special Research Initiative Grants

Robert Niven; Nasser Khalili; Richard Pashley; Mark Taylor; Vladimir Strezov; Scott Wilson; Peter Murphy; Steven Phillips. With Macquarie University; OPEC Systems Pty Ltd.
PFAS source zone remediation by foam fractionation and in situ fluidization **$900,000**

Professor Nasser Khalili, with colleagues from UNSW Canberra, UNSW Medicine and Aviation, was awarded $900,000 to develop techniques for extracting PFAS from soils as a liquid concentrate through the use of foam. These techniques could enable PFAS removal efficiencies of greater than 90%, providing entirely new methods for the aggressive removal of PFAS from contaminated sites.

This grant was part of the $8.2 million awarded to nine research projects in the first round of ARC's Special Research Initiative PFAS Remediation Research Program.

OUR PEOPLE



Academic Staff

Attard, Mario
Associate Professor
Associate Head – Academic
BE PhD MHEd UNSW, MIEAust, CPEng

Research Interests: Finite Strain Isotropic & Anisotropic Hyperelastic Modelling; Anisotropic Hyperelastic Modelling of Biological Material; Plasticity Formulation for Confined Concrete Columns; Cover Spalling in High Strength Reinforced Concrete Columns; Lateral Buckling of Thin-Walled Beams.

Bradford, Mark
UNSW Scientia Professor
BSc BE PhD USyd, DSc UNSW, CPEng, CEng, MASCE, FIEAust, MIStructE

Research Interests: High-strength steel structures, steel-concrete composite structures, steel-timber hybrid structures, concrete structures, arches, geometric non-linearity, pavement thermo-upheaval buckling, railway thermo-lateral buckling, design for deconstructability, low-emissions structural paradigms, forensic engineering..

Carmichael, D G
Professor
BE MEngSc USyd, PhD Cant, CPEng, FIEAust, MASC

Research Interests: Management, systems applications of optimisation, synthesis: Identification & analysis: Contracts & disputes: Project delivery: Construction operations: Project management & management functional areas including risk, economics, finances, people resources & scope: Construction management: Problem solving & decision making.

Castel, Arnaud
Associate Professor
BE, MEngSc, PhD Toulouse

Research Interests: Durability of construction materials, low carbon concrete technology, alternative SCMs, Geopolymer concrete, Performance based & service life design, Steel reinforcement corrosion in concrete, serviceability, time-dependent effects, restrained shrinkage induced early age cracking.

Dackermann, Ulrike
Lecturer
Dipl.-Ing. Univ., Technical University of Munich (TUM), PhD UTS

Research interests: Structural Health Monitoring, Non-Destructive Testing, Damage Detection, Structural Dynamics, Artificial Intelligence, Timber Engineering

Davis, Steven
Senior Lecturer
Chair, Teaching & Learning Committee
BE PhD UNSW

Research Interests: Online Assessment, Virtual Reality, Project Scheduling, Safety, Construction Defects and Rework.

Douglas, Kurt
Pells Sullivan Meynink Senior Lecturer of Rock Mechanics,
Chair External Relations
BE (Hons1)USyd, PhD UNSW

My interests lie in the field of rock mechanics and dam engineering. Predicting field properties of rock masses continues to be a major challenge for us to address. My dams research focusses on spillway erosion and backward erosion of dams.

Foster, Stephen
Professor and Acting Head, School of Minerals & Energy Resources Engineering (MERE)
BE NSWIT, MEngSc PhD UNSW, MIEAust, FIEAust

I research the behaviour of structural systems (buildings and bridges) constructed of reinforced and prestressed concrete. I'm particularly interested in bringing new and advanced materials technologies to the engineering of structures. My interests are in the use of high and ultra-high performance concretes, fibre-reinforced concretes and geopolymer concretes and in use of carbon fibre technologies for strengthening and repair of structures and structural systems. I develop physical-mechanical models for use in advanced computational and numerical tools such as FEM and for their use in the study of behaviour of concrete structures that are subjected to extreme events.

Gao, Wei
Professor
BE HDU, ME PhD Xidian, MIIAV, MAAS

Research Interests: Uncertain modelling & uncertain methods: Vehicle-bridge interaction dynamics: Wind and/or seismic induced random vibration: Train-rail-sleeper-foundation-tunnel/bridge system: Stochastic nonlinear system: Vehicle dynamics & vehicle rollover: Structural optimization & control: Smart structures: Stability & reliability analysis.

Hamed, Ehab
Senior Lecturer
BSc MSc PhD Technion

Research Interests: Viscoelastic behaviour of materials and structures, strengthening of structures with FRP composite materials, sandwich panels.

Holdom, Robert
Senior Lecturer

Research Interests: construction management.

Khalili, Nasser
Professor and Acting Head of School CVEN
BSc Teh, MSc Birm, PhD UNSW

Research Interests: Mechanics of unsaturated soils: Flow & deformation in double porosity media: Numerical methods applied to geotechnical engineering: Pavement engineering.

Khoshghalb, Arman
Senior Lecturer
BEng, MEng, Sharif University of Technology, Tehran, PhD UNSW

Research Interests: Mechanics of unsaturated soils, coupled analysis of porous media, advanced numerical methods in geomechanics, modelling discontinuities in porous media, large deformation analysis in geomechanics, stabilisation techniques in computational geomechanics, constitutive modelling of geomaterials, dynamic properties of geomaterials.

Kim, Taehwan
Lecturer
BSc, MSc KAIST, PhD Purdue USA

Research Interests: Advanced and sustainable infrastructure materials: Thermodynamics in cementitious materials and the modelling of their chemical process: Advanced materials characterization techniques: fundamental understanding of chemo-physical reactions in cementitious materials: Microstructure evolution of cementitious materials: Utilizing natural and waste materials to develop low carbon foot-print materials.

Russell, Adrian
Associate Professor
BE, PhD UNSW, PGCert Bristol

Research Interests: Applied unsaturated soil mechanics; Liquefaction of variably saturated soils and tailings; Fundamental modelling of soils linking microstructure to large scale behaviour; Fundamental rock mechanics: Fibre reinforced soils.

Shen, Johnson Xuesong
Senior Lecturer
BEng, MSc Nanjing, PhD Hong Kong Polytechnic University

Research interests: Digital Twins, Artificial Intelligence, Smart Sensing, Autonomous Systems, Internet of Things, Mixed Reality, and their applications in the construction, operation, and maintenance of civil infrastructure and built environment.

Song, Chongmin
Professor and Director CIES
Chair, Computing, IT & Ed Tech Ctte BE
ME Tsinghua, DEng Tokyo

Research Interests: Scaled Boundary Finite-Element Method, Mesh Generation, Dynamic Soil-Structure Interaction, Structural Dynamics & Earthquake Engineering, Fracture Mechanics, Elasto-Plastic-Damage Constitutive Modelling.

Vali Pour Goudarzi, Hamid Reza
Associate Professor
BE, MEngSc, PhD UNSW

Research Interests: Structural mechanics; Development of innovative hybrid steel-timber-concrete structures with emphasis on sustainability and improved structural performance; Behaviour of structures subjected to extreme loads such as earthquake, impact, blast and explosion: Computational mechanics and non-linear finite element modelling of structures: Constitutive modelling of materials.

Emeritus Professors

Fell, Robin

Gilbert, Ian

Tin Loi, Francis

Valliappan, Somasundaram

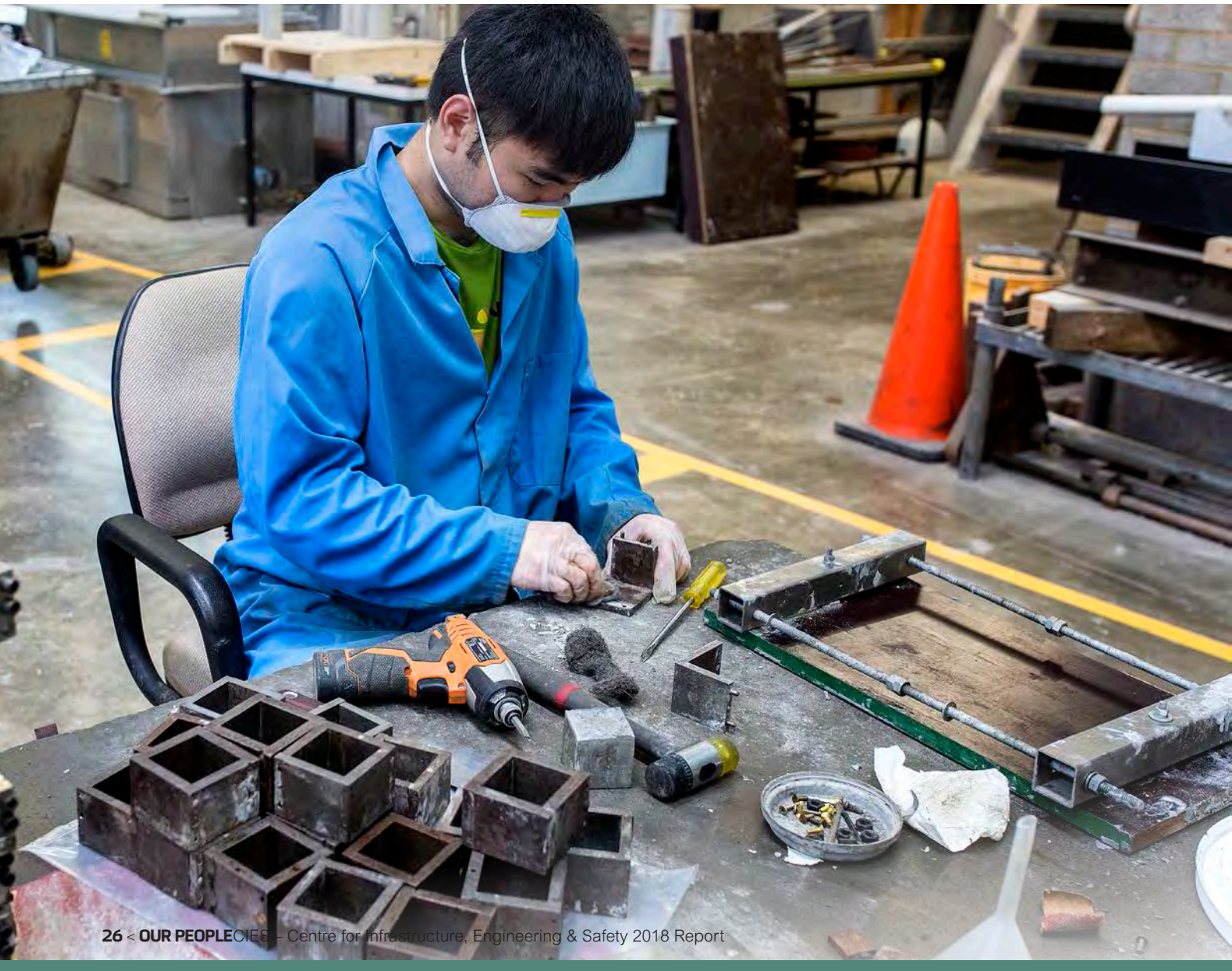
Visiting/Adjunct Academics 2018

Aldred, James	Adjunct Associate Professor
Chen, Denghong	Visiting Fellow
Kayvani, Kourosh	Professorial Visiting Fellow
Koenke, Carsten	Visiting Professor
Pi, Yong Lin	Adjunct Professor
Swarbrick, Gareth Edward	Visiting Fellow
Wei, Minghai	Visiting Fellow
Xie, Wen	Visiting Fellow

Centre Research Staff

CIES

Abdolreza Ataei	Research Associate
Jun Chen	Postdoctoral Fellow
Masuzyo Chilwesa	Research Associate
Amirhossein Hassanieh	Research Associate
Lei Liu	Postdoctoral Fellow
Mehrisadat Makki Alamdari	Postdoctoral Research Fellow
Saeed Masoumi	Research Associate
Md Ahsan Parvez	Postdoctoral Fellow
Albert Saputra	Postdoctoral Fellow
Babak Shahbodaghkhan	Senior Research Associate
Mohammad Vahab	Research Associate
Thanh Liem Vo	Research Associate
Di Wu	Research Associate
Yuguo Yu	Research Associate



Our Professional & Technical Staff

Technical Services (Kensington)

Paul Gwynne
Lab Manager

Anthony MacKen
Senior Technical Officer

William Terry
Senior Technical Officer

Luiz Pettersen
Technical Officer

Rudino Salleh
Technical Officer

Timothy Weston
Technical Officer

Technical & Professional
(Heavy Structure Laboratory Randwick)

Zhen-Tian Chang
Laboratory Manager

Sanjeewa Herath
Senior Technical Officer

Ronald Moncay
Technical Officer

Benjamin Pauley
Technical Officer

Greg Worthing
Technical Officer

Research Centre Management

Theresa Wisniewski
CIES Manager

Sanchia Yip
Acting Centre Manager (Jan – August 2018)

Andreia Heslin
Administrative Officer CIES/WRC

Welcome and Farewell

Welcome

In 2018 CIES welcomed a new Centre Manager Theresa Wisniewski.

Theresa has extensive experience in UNSW finances and administrative systems, as well as people management and care. She is totally efficient, resourceful, creative and a great community builder. We are thrilled to have her on board.

Farewell

Top: Dr Ali Amin, Dr Ali Akabarnezhad
Below: Irene Calaizis

In 2018 CIES farewelled two academic staff - Dr Ali Amin, now a Lecturer at University of Sydney; and Dr Ali Akbarnezhad, now Associate Professor at University of Sydney. We wish them all the very best in their future careers

Long time Centre Manager Irene Calaizis left us for wonderful new adventures in April 2018.Farewell and thank you Irene for all your service.

PhD Graduates

PhD

Rebecca **Allan**
Backward Erosion Piping
Supervisor/s: KJ Douglas

Abdulaziz Saud A **Almohssen**
A new methodology for tracking the performance of subcontractors in the construction industry
Supervisor/s: SR Davis

Seyed Mahdi **Babaee**
Corrosion of reinforcement In alka-li-activated materials
Supervisor/s: A Castel

Khalegh **Barati**
Modeling Fuel Use, Emissions and Mass of On-Road Construction Equipment through Monitoring Field Operations
Supervisor/s: JX Shen

Nassim **Ghosni**
Fibre reinforced concrete structures
Supervisor/s: H Vali Pour, SJ Foster

David **Green**
Probabilistic analysis for computa-tional mechanics with applications in Civil Engineering
Supervisor/s: KJ Douglas

Huan **He**
Dynamic properties of crushable soils
Supervisor/s: A Khoshghalb

Lei **Liu**
Fluid-structure interaction analysis using the scaled boundary finite element method
Supervisor/s: S Song

Afshin **Mellati**
A robust and automatic elastic compensation
method forcollapse load determina-tion of structures
Supervisor/s: C Song and FTin-Loi

Angus **Murray**
In-Service Behaviour of Reinforced Concrete based on a Variable Transfer Length Model
Supervisor/s: A Castel, RI Gilbert

Nur Kamaliah **Mustaffa**
Emissions, production and cost in construction operations
Supervisor/s: DG Carmichael

Zahra Sadat Moussavi **Nadoushani**
A computational approach for estimating and minimizing construc-tion-related and end-of-life carbon footprint of concrete structures
Supervisor/s: A Nezhad

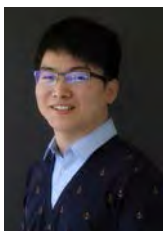
ME

Amin **Noushini**
Low carbon concrete design
Supervisor/s: A Castel & RI Gilbert

Weebadda Arachchilage S **Perera**
Study causes of defect occurence and issues
Supervisor/s: SR Davis

Bambang **Piscesa**
Modeling confined concrete using plasticity formulation
Supervisor/s: MM Attard

Reza **Taheriattar**
Sustainability and adaptable/flexible infrastructure
Supervisor/s: DG Carmichael



Jia **Wang**
Behaviour and design of demount-able composite frames with-beam-to-column bolted joints
Supervisor/s: C Song and B Uy

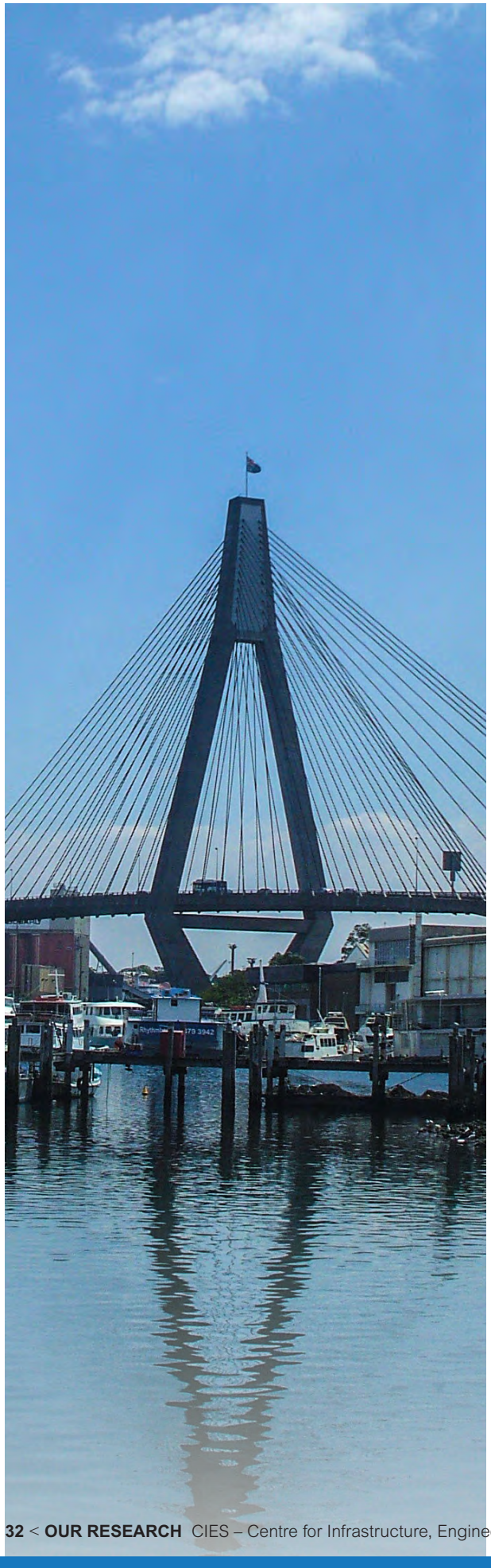
Junchao **Wang**
Integrating CAD geometry and scaled boundary finite element analysis
Supervisor/s: C Song

Binhua **Wu**
Time-variant hybrid stochastic interval uncertainty analysis of concrete-filled steel tubular arch structures
Supervisor/s: W Gao

Mingnan **Li**
Soil dynamics
Supervisor/s: A khoshghalb, K Senetakis

Yang **Yang**
Finite Element Analysis of Thermal Upheaval Buckling of Concrete Pavement
Supervisor/s: MA Bradford

OUR **RESEARCH**



A composite steel-timber structural system.

Investigators: Mark Bradford (Lead); **Hamid Valipour**

Funding Information: ARC Discovery Project DP160104092

Total Amount: $435,000

Commencement Year: 2016

Years Funded: 3

Fields of Research: 090506 - Structural Engineering; 090502 - Construction Engineering; 090503 - Construction Materials

Socio-Economic Objective: 870401 - Civil Construction Processes; 870305 - Timber Materials; 879802 - Management of Greenhouse Gas Emissions from Construction Activities

About: This project aims to deliver a novel composite steel–timber system that alleviates many of the environmental concerns of the industry, while improving efficiency by using lighter materials.

It aims to develop a unique composite system comprised of steel I-section beams and prefabricated timber slabs, with shear connection being provided by bolting or screws.

The project plans to assess the structural system experimentally and numerically, and to craft guidelines for the safe and efficient design of these members.

The novel lightweight composite system would enhance the speed of construction, allow for deconstructability and reuse and, because plantation timber sequestrates carbon dioxide, have a low carbon footprint. ✶

Composite structures of high-strength steel and concrete

Investigators: Mark Bradford (Lead); Brian Uy; Yanlin Guo; Li Xian Dai

Funding Information: ARC Linkage Project LP150101196

Total Amount: $380,000

Commencement Year: 2015

Years Funded: 3

Participating Organisations: Tsinghua University, Beijing; China Construction Steel Structure Corp. LTD

Fields of Research: 090506 - Structural Engineering; 091207 - Metals and Alloy Materials

Socio-Economic Objective: 870302 - Metals (e.g. Composites, Coatings, Bonding); 879802 - Management of Greenhouse Gas Emissions from Construction Activities; 870202 - Commercial Construction Design

About: This project plans to investigate the use in building frames of composite steel-concrete members that use high-strength steel (HSS) instead of mild steel (MS).

HSS is finding increased use in construction, and HSS has a much greater strength-to-weight ratio than MS, leading to lighter composite structures, less material usage and smaller foundations. Overall, this reduces the cost and carbon footprint of steel-framed buildings.

The investigation is planned to involve physical testing, numerical studies, developing structural models and crafting design guidance for T-beams, columns and joints.

The major intended outcome of the project is design guidance that will support the expanded use of HSS.✶

Modelling and testing corroding reinforced concrete structures

Investigators: Arnaud Castel (Lead); Abhijit Mukherjee (Curtin)

Funding Information: ARC Discovery Project DP160104731

Total Amount: $370,000:

Commencement Year: 2016

Years Funded: 3

Participating Organisations: Curtin University of Technology

Fields of Research: 090503 - Construction Materials; 090505 - Infrastructure Engineering and Asset Management

Socio-Economic Objective: 870301 - Cement and Concrete Materials; 870501 - Civil Building Management and Services; 879802 - Management of Greenhouse Gas Emissions from Construction Activities

About: The project aims to develop models and methods to enable the early detection of active steel corrosion.

Most of Australia's critical infrastructure is located on or near the coast in high saline conditions and is exposed to a high risk of reinforcing steel corrosion. Our ability to design and monitor such structures is crucial.

The first part of the project aims to develop an innovative finite element model to improve the prediction of both active steel reinforcement corrosion and the time to concrete cracking in a chloride environment.

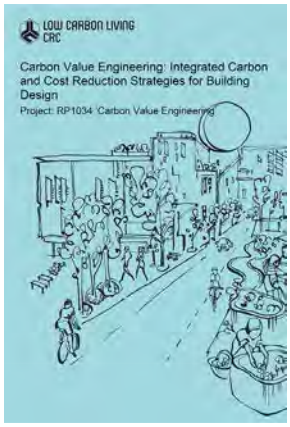
It then plans to develop a non-destructive method, combining ultrasonic waves-based technology and acoustic emission, to detect active steel corrosion before any damage is visible on the structure.✶

Carbon Value Engineering: Integrated Carbon and Cost Reduction Strategies for Building Design

Researchers: Mehdi Robati, Philip Oldfield, Ali Akbar Nezhad and **David Carmichael**

UNSW Cooperative Research Centre for Low Carbon Living RP1034:

#Value engineering, #Embodied Carbon, #Lifecycle Cost, #Lifecycle Carbon, #CO_2-e, #Lifecycle



CIES construction management academic Professor David Carmichael has been working with UNSW and USyd colleagues at the UNSW Cooperative Research Centre for Low Carbon Living on the Carbon Value Engineering project.

This project aims to maximise the reduction of embodied carbon in the built environment. Rather than proposing a new process for these reductions, it adapts the industry-standard practice of value engineering (VE) for integrated carbon and cost minimisation.

The research presents a Carbon Value Engineering framework. This is a quantitative value analysis method, which not only estimates cost but also considers the carbon impact of alternative design solutions. It is primarily concerned with reducing cost and carbon impacts of developed design projects; that is, projects where the design is already a completed to a stage where a Bill of Quantities (BoQ) is available, material quantities are known, and technical understanding of the building is developed.

The project set out to answer two research questions:

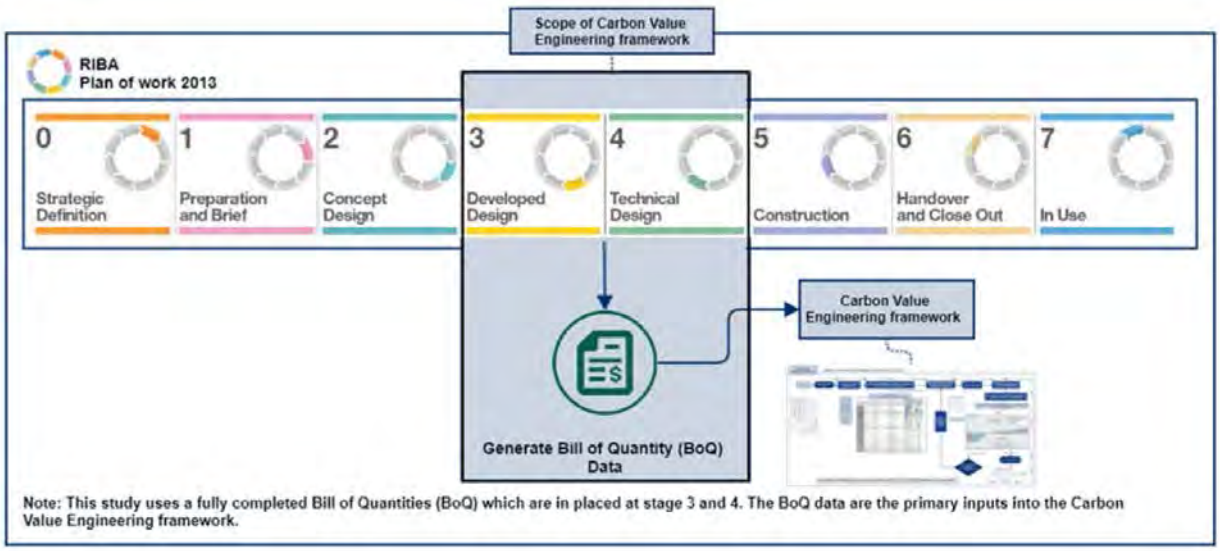
1. What is the impact of value engineering in its current form on building embodied carbon, and life-cycle carbon emissions?

2. To what extent can the process of value engineering be adapted to maximise the reduction of embodied and life-cycle carbon emissions early in the design phase while also securing economic value?

In the first stage (Embodied Carbon and Capital Cost Impact of Current Value Engineering Practices: A Case Study) the researchers determined that the traditional VE processes driven only by cost can reduce building embodied carbon emissions through dematerialisation. However, such reductions were small, with VE strategies applied to a case study building reducing material costs by 0.72%, and initial embodied carbon by 1.26% (6.67kg CO_2-e/m2) within a cradle-to-gate framework.

In the final report, they will demonstrate how considering cost and carbon simultaneously during VE can yield significant carbon and cost reductions at a late design stage, without fundamentally changing the building design (form, orientation, planning, etc).

http://www.lowcarbonlivingcrc.unsw.edu.au/resources/crc-publications/crclcl-project-reports/rp1034-carbon-value-engineering-integrated-carbon ✶



A mix design approach to reduce early-age thermal cracking of concrete


Investigators: Arnaud Castel (Lead); **Stephen Foster;** Ali Akbarnezhad; Redmond Lloyd (Boral)

Funding Information: ARC Linkage Project LP150100725
Total Amount: $299,000
Commencement Year: 2015
Years Funded: 3
Participating Organisations: BORAL CEMENT LIMITED
Fields of Research: 090503 - Construction Materials
Socio-Economic Objective: 870201 - Civil Construction Design

About: The aim of this project is to determine the fundamental mechanics of early age thermal cracking in mass concrete elements and in members with high cement contents, and to develop a tool to predict early age cracking.

Early age thermal cracking in concrete due to heat of hydration and thermal gradients is a major engineering problem and is undesirable for durability and structural performance, as well as aesthetics and project economics.

The risk of thermal cracking is higher for concrete elements with relatively low surface area to volume ratio. This includes concrete dams, large bridge decks and in large foundations including the foundations of wind turbines. The damage resulting from early age thermal cracking is complex. Once cracking has started harmful materials can enter the crack and reduce the service life of the concrete.

The research outputs include new theories and relationships from which advanced engineering models will be derived that will support improved design and construction of mass concrete elements.

Working closely with industry throughout the project, and utilising the advances made in measurement, characterisation methods, computational methods, multiphysics simulation and optimisation methods, the research team believes they have devised a novel solution to this old and important problem.

In solving it the researchers hope to provide greatly enhanced reliability to designers and suppliers of cement products. If successful, millions of dollars currently spent on restoration and maintenance could potentially be saved. ✶

Shrinkage, cracking, self-healing and corrosion in blended cement concrete


Investigators: Arnaud Castel (Lead); **Raymond Ian Gilbert;** James Iman Mohammadi Rodd; Warren South

Funding Information: ARC Linkage Project LP170100912

Total Amount: $321,000

Commencement Year: 2018

Years Funded: 3

Participating Organisations: CEMENT CONCRETE & AGGREGATES AUSTRALIA

Fields of Research: 090503 - Construction Materials; 090506 - Structural Engineering

Socio-Economic Objective: 870301 - Cement and Concrete Materials; 870201 - Civil Construction Design; 870401 - Civil Construction Processes

About: This project aims to investigate the effects of binder quantity and composition on early-age cracking in Australian concretes caused by restrained shrinkage, the subsequent self-healing capability of the cracks, and the possibility of detrimental early chloride induced steel reinforcement corrosion, particularly in marine locations.

The project will focus on concrete mix designs and the blends of cement, fly-ash and blast furnace slag that are prescribed in the revised version of the concrete bridge standard for the most severe exposure.

This project will lead to a significant improvement in the serviceability and durability of concrete structures in severe environments.✶

Characterisation of shear and tensile fracture of ultra-high performance fibre reinforced concrete

Investigators: Stephen Foster (Lead); Frank Vecchio

Funding Information: ARC Discovery Project DP170104618

Total Amount: $379,500

Commencement Year: 2017

Years Funded: 3

Participating Organisations: University of Toronto, Canada

Fields of Research: 090506 - Structural Engineering

Socio-Economic Objective: 870301 - Cement and Concrete Materials; 870401 - Civil Construction Processes; 870201 - Civil Construction Design

About: This project aims to investigate the shear-tension interaction performance of ultra-high performance fibre reinforced concrete (UHPFRC).

In January 2014, the draft Australian Standard for the design of concrete bridges was released; this is the first standard in Australia, and one of the first in the world, to include comprehensive design procedures for steel fibre reinforced concrete (SFRC).

Rules allow conventional, strain softening SFRC, but exclude the use of strain hardening UHPFRC because of insufficient research on core aspects of the materials when conventionally reinforced.

The study expects to provide the vital data engineers and Standards bodies need to adopt UHPFRC.✶

Unified non-deterministic dynamic safety assessment of softening structures

Investigators: Wei Gao (Lead); Yong-Lin Pi; Sawekchai Tangaramvong

Funding Information: ARC Discovery Project DP160103919

Total Amount: $390,000

Commencement Year: 2016

Years Funded: 3

Fields of Research: 090506 - Structural Engineering

Socio-Economic Objective: 970109 - Expanding Knowledge in Engineering

About: This project aims to develop a high-performance tool for the dynamic safety assessment of softening structures.

The assessment of structures that exhibit softening, either at constitutive level or structural level, is essential for design and rehabilitation purposes, especially when the inevitable uncertainties in the system parameters need to be accounted for.

This project aims to develop an advanced and unified framework that can model both stochastic and nonstochastic processes for these purposes. An advanced mixed finite element model underpins this framework, and both formulation and solution algorithms are based on mathematical programming formalism.

The developed computational tool would be able to perform pure stochastic, pure nonstochastic, hybrid uncertain analyses and dynamic reliability assessment of structures.✶

Time-dependent behaviour of precast concrete sandwich panels

Investigators: Raymond Ian Gilbert (Lead); **Ehab Hamed**

Funding Information: ARC Discovery Project DP160102027

Total Amount: $330,000

Commencement Year: 2016

Years Funded: 3

Fields of Research: 090506 - Structural Engineering

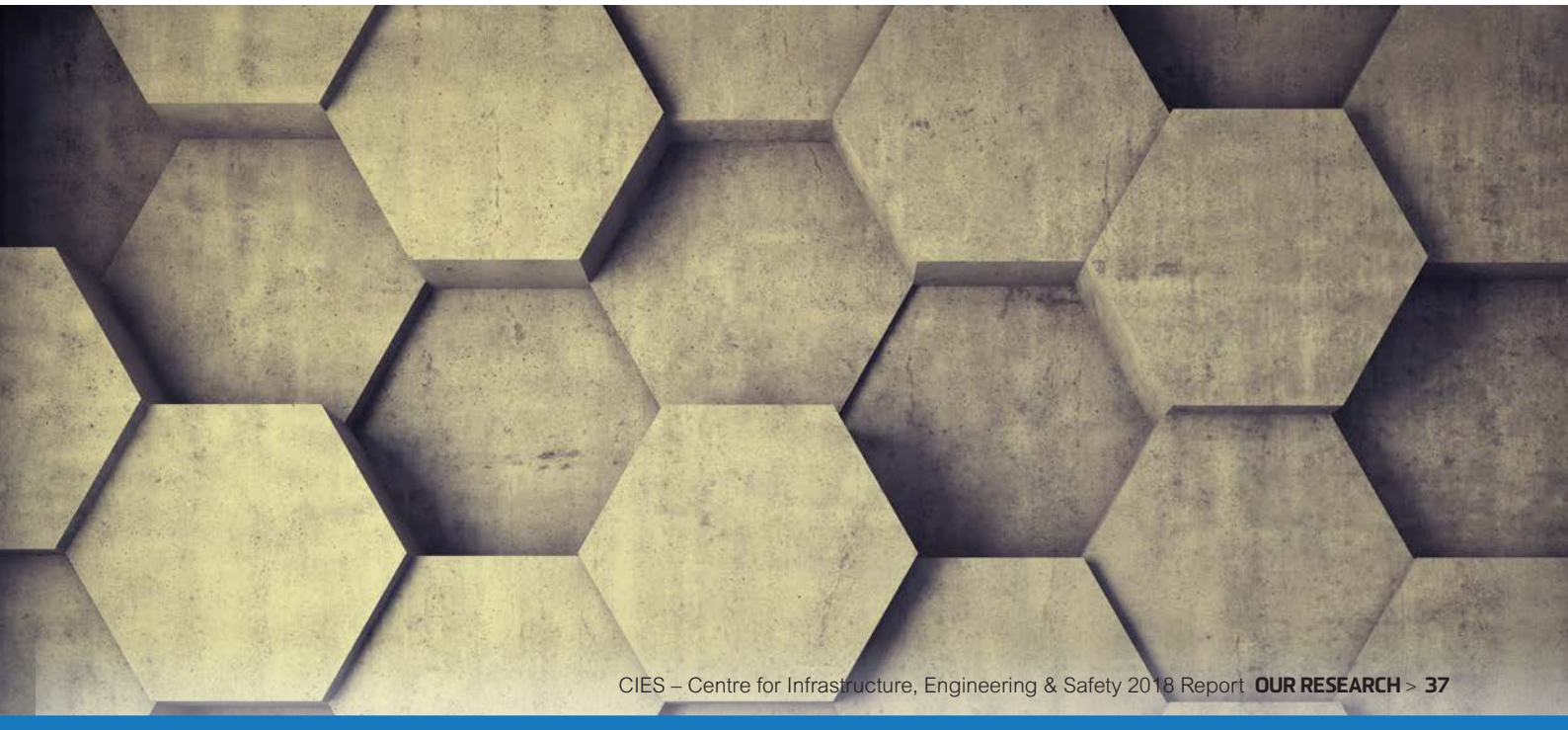
Socio-Economic Objective: 870101 - Civil Construction Planning; 970109 - Expanding Knowledge in Engineering; 870301 - Cement and Concrete Materials

About: This project seeks to improve understanding of the long-term structural behaviour of precast concrete sandwich panels and thus facilitate their use in civil engineering applications.

These panels offer many advantages over traditional concrete panels mainly due to their excellent thermal insulation and their use in civil and industrial engineering applications is expanding.

Nevertheless, the literature reveals a lack of confidence in their design due to the absence of reliable numerical models and test data of their long-term structural behaviour.

This project aims to provide insight into the nonlinear long-term behaviour of such panels by developing new theoretical models that will be validated by laboratory testing.✶



PFAS source zone remediation by foam fractionation and *in-situ* fluidisation

Researchers: Robert Niven (ADFA), **Nasser Khalili**, Richard Pashley, Mark Taylor; Vladimir Strezov; Scott Wilson; Peter Murphy; Steven Phillips.
With Macquarie University; OPEC SYSTEMS PTY LTD

ARC Special Research Initiatives. 2018 – 2021 $900,000

Researchers from UNSW Sydney have secured funding from the Australian Research Council (ARC) to begin ground-breaking work addressing environmental contamination caused by per- and poly-fluoroalkyl substances (PFAS), chemicals used in everyday commercial products including firefighting foams and pesticides.

CIES Professor Nasser Khalili was awarded $900,000 with colleagues from UNSW Canberra, UNSW Medicine and Aviation, to develop techniques for extracting PFAS from soils as a liquid concentrate through the use of foam. These techniques could enable PFAS removal efficiencies of greater than 90%, providing entirely new methods for the aggressive removal of PFAS from contaminated sites.

PFAS are a class of chemicals that are fire-resistant and repel water, fat and other substances. They are used extensively in common household products like pizza boxes and popcorn bags, non-stick cookware, carpet and water-repellent clothing. But their resistant properties also make them difficult to eliminate from the environment; they do not dissolve in water, take decades to break down, are pervasive and spread easily. PFAS has been found in environments as remote as the Arctic Circle.

The grant is part of the $8.2 million awarded to nine research projects in the first round of ARC's Special Research Initiative PFAS Remediation Research Program. The Program aims to facilitate the development of innovative technologies to investigate and remediate PFAS-contaminated environments including soil, groundwater, waterways and marine systems. Up to $13 million is available to support a range of research projects.

Professor Mark Hoffman, Dean of Engineering at UNSW, said: "The technology our researchers are developing is potentially game-changing in terms of lowering the cost of remediation and its efficacy. This will lead to the clean-up of more PFAS-contaminated areas across the country, ensuring Australians have access to cleaner environments." .✶

Evaluating potential static liquefaction of tailings to prevent failures

Investigators: Andries Fourie (Lead-UWA); Jayan Vinod; Md. Mizanur Rahman; **Adrian Russell**; Imran Gillani; Michael Davies; John Lupo; Stephen Liddell; Todd Martin; Georgia Lysay; Tamara Johndrow; Caius Priscu

Funding Information: ARC Linkage Project LP160101561

Total Amount: $630,000

Commencement Year: 2017

Years Funded: 3

Administering Organisation: The University of Western Australia

Participating Organisations: The University of New South Wales; University of Wollongong; University of South Australia; Newmont Mining Corporation; Rio Tinto Services Ltd; Teck Corporation; BHP Billiton PLC; Anglo American; Freeport-McMoRan Inc.

Fields of Research: 090501 - Civil Geotechnical Engineering

Socio-Economic Objective: 849804 - Management of Solid Waste from Mineral Resource Activities

About: This project aims to reduce risk in the mining industry from failing mine tailings by producing a methodology for predicting the susceptibility of these tailings to static liquefaction.

The impact of a mine tailing failure is catastrophic to the downstream community. The project brings together a number of industry partners committed to assisting with verification and adoption of characterisation and designed tools development in this project.

This proposal will integrate results from laboratory element, centrifuge and calibration chamber tests with numerical modelling and in-situ tests to produce a methodology for predicting the susceptibility to static liquefaction.✶

Evaluating Light Detection and Ranging (LiDAR) Sensors for Construction Mapping


Researchers: Johnson Shen & David Carmichael

CIES Industry Contract Research – with Linke & Linke Surveys

Construction productivity is about cost, time, sustainability and safety. Some of the main challenges in construction surveying are producing end-of-month volumetric measurements for project management, the extremely narrow timeframe for conducting site surveying, hazardous working environments and the dire shortage of skilled surveyors.

Dr Johnson Shen has partnered with local surveying firm Linke & Linke Surveys to develop a Remotely Piloted Aircraft System (RPAS) using spinning Light Detection and Ranging (LiDAR) technology that delivers fast, accurate, real time 3D maps of targeted areas. As Director of Linke & Linke, James Linke notes, "Engineering is moving towards real-time reporting. Information that's two days or two weeks old is not as valuable anymore."

Weighing just twelve kilograms, the small RPAS can travel for up to thirty minutes above any terrain, gathering data at millions of points per second and intensifying accuracy with every subsequent sweep. Cost savings are enormous and can be in the region of three thousand per cent when compared with one surveyor gathering the same amount of data.

While the "super drone" is not a cure-all or magic panacea – there will always be some construction or land surveying tasks which require higher fidelity techniques and methodologies – it does meet an extraordinary amount of construction and surveying challenges. It reduces cost and time enormously. It reduces the risks a surveyor might face in the field or onsite. It allows surveyors to meet deadlines whilst maintaining quality and accuracy. It fills a gap in an industry in need of more surveyors.

But perhaps more than anything it propels surveying and construction practices forward into a future with unlimited applications and possibilities. As Dr Shen says: "Drone technology is quite generic so it can be useful in many industries. For instance, it can be used on farms, assessing bio mass." It can be used to assess natural disasters. It can help predict bushfire likelihood by generating heat maps of bushlands.

This is a state-of-the-art technological development and Dr Shen and his Linke & Linke partners are at the forefront despite the company being an SME enterprise which has received only relatively small amounts of funding. It is an amazing achievement of collaboration and planning.

Dr Johnson Shen believes that 'hard' technological developments start with the 'soft' issue of relationship, mutual respect and shared understanding. "Industry engagement can start small. We build the relationship and the trust while we refine the scope of collaboration and customise our research to make the knowledge applicable."

Dr Johnson Shen is an up and coming force in technology for engineering. His research interests include automation, robotics, RPAS and hybrid variations for longer endurance, Artificial Intelligence (AI), Internet of Things (IoT), virtual reality, mixed reality, remotely piloted ground vehicles to assist in indoor mapping… the list goes on.

As he notes, "That is the beauty of industry and academic collaboration: universities bring cutting edge research equipment and an ever-developing body of expertise while industry puts it into practice."✶

Research partners - James Linke and Dr Johnson Shen

A scaled boundary framework for adaptive and multiscale structural analysis

Investigator: Chongmin Song (Lead)

Funding Information: ARC Discovery Project DP160104628
Total Amount: $390,000
Commencement Year: 2016
Years Funded: 3
Fields of Research: 090506 - Structural Engineering
Socio-Economic Objective: 970109 - Expanding Knowledge in Engineering

About: This project aims to establish an innovative numerical framework for the computer simulation of systems of engineering structures subject to dynamic loadings.

Scaled boundary polytope elements and an octree algorithm for mesh generation are proposed for adaptive nonlinear dynamic analysis at multiscales.

It is anticipated that the numerical modelling and simulation will be performed automatically from the material meso-structures to achieve reliable predictions at minimum human and computational efforts.

The intended outcome of this project is an innovative technology for numerical simulation and a rational predictive tool useful for the planning, design and management of engineering structures, and for the virtual testing of materials.✶

Three-dimensional contact and fracture analysis for safety assessment of structures

Investigators: Chongmin Song (Lead); **Francis Tin-Loi**

Funding Information: ARC Discovery Project DP180101538
Total Amount: $405,993
Commencement Year: 2018
Years Funded: 3
Fields of Research: 090506 - Structural Engineering
Socio-Economic Objective: 970109 - Expanding Knowledge in Engineering

About: This project aims to address the safety assessment of engineering structures considering interfaces and cracks, which are nearly always the weakest parts of a structure system.

Novel numerical approaches to model the contact of interfaces and crack faces and to simulate crack propagation under variable loads will be established based on the scaled boundary polytope elements and mathematical programming.

It is anticipated that the developed numerical simulation tool will be robust and fully automatic. The intended outcome of this project is an innovative technology for numerical simulation and a rational predictive tool useful for cost-effective and timely planning, design and management of engineering structures.✶

Seismic analysis of cracking and deformations in concrete gravity dams

Investigators: Chongmin Song (Lead); Ean Tat Ooi

Funding Information: ARC Linkage Project LP160101229
Total Amount: $351,731
Commencement Year: 2017
Years Funded: 3
Participating Organisations: Federation University Australia; Melbourne Water Corporation; Murray-Darling Basin Authority; Goulburn-Murray Rural Water Corporation; Sunwater Limited
Fields of Research: 090506 - Structural Engineering; 090505 - Infrastructure Engineering and Asset Management
Socio-Economic Objective: 870201 - Civil Construction Design; 960912 - Urban and Industrial Water Management

About: This project aims to establish a rational predictive capability for the responses of concrete gravity dams subject to extreme design earthquakes.

This will include the development of innovative numerical methods for effective modelling of crack propagation and closure, large slips on crack faces and weak interfaces, dam-reservoir interaction, dam-foundation interaction and automatic mesh generation.

The expected outcomes of the project will be a significantly improved prediction tool. It is also anticipated that the project will result in improvements in dam and public safety, and more efficient use of funds for dam safety upgrades and management.✶

CIES Grants 2018

CIES Investigators	Topic	Partners/ Providers	2018 Amount
Bradford, MA	Buckling capacity of high-strength steel flexural members	Australian Research Council / Discovery Project	$130,000.00
Bradford, MA	Composite Structures of High-Strength Steel and Concrete	Australian Research Council / Linkage Project China Construction Steel Structure Corp. Ltd / ARC Linkage Project Industry Partner Contribution	$222,333.00
Bradford, MA | Vali Pour Goudarzi,	Composite steel-timber structural system	Australian Research Council / Discovery Project	$145,000.00
Castel, A	Durability of underground concrete pipes in chloride environment	Concrete Pipe Association of Australasia (CPAA) / Contract Research	$28,400.00
Castel, A	Modelling and testing corroding reinforced concrete structures	Australian Research Council / Discovery Project	$120,000.00
Castel, A | Foster, SJ | Nezhad, AA	A mix design approach to reduce early-age thermal cracking of concrete	Australian Research Council / Linkage Project	$53,000.00
Castel, A | Gilbert, RI	Shrinkage, cracking, self-healing and corrosion in blended cement concrete	Australian Research Council / Linkage Project	$48,000.00
Chang, Z | MacKen, AP | Herath, HMS	Investigation of concrete tensile stress-strain behaviour	Boral Resources (NSW) Pty Ltd / Contract Research	$7,565.00
Chang, Z | Vali Pour Goudarzi,	Investigation of steel-timber joints	Strongbuild Commercial / Contract Research	$21,900.00
Foster, SJ	Characterisation of Shear and Tensile Fracture of UHPFRC	Australian Research Council / Discovery Project	$129,500.00
Foster, SJ	Independent review of High Modulus, High Strength Concrete	Boral Concrete / Contract Research	$10,891.00
Foster, SJ	Steel Fibre Reinforced Concrete Static and Fatigue Round Panel Testing	BOSFA / Contract Research	$13,636.00
Foster, SJ | Castel, A | Shen, X | Cox, R | Modra, BD	RP1020u1: Demonstrating the practical use of geopolymer concrete: high density coastal protection units	CRC For Low Carbon Living Limited / Research Grants	$1,000.00
Gao, W	New generation of sustainable building structures	Beijing Engineering Research Center / International Contract	$80,000.00
Gao, W | Li, G | Zhang, Y	ARC Research Hub for nanoscience based construction material manufacturing (Project 1)	Monash University / ARC Industrial Transformation Research Hub Shared Grant Monash University / ARC Industrial Transformation Research Hubs - Shared Industry Partner Contributions	$22,764.00
Gao, W | Pi, YL	Unified nondeterministic dynamic safety assessment of softening structures	Australian Research Council / Discovery Project	$140,000.00
Gao, W | Tin Loi, FS	Advanced analysis and safety assessment framework for structures under uncertainty	Lindenbaum Pty Ltd / Contract Research	$40,000.00
Gilbert, RI | Castel, A	Shrinkage and cracking of concrete	CEMENT CONCRETE & AGGREGATES AUSTRALIA / Contract Research	$50,000.00
Gilbert, RI | Hamed, E	Time-dependent behaviour of precast concrete sandwich panels	Australian Research Council / Discovery Project	$100,000.00
Hamed, E	Coupled service and ultimate behaviour of high strength composite columns	University of Sydney / ARC Discovery Project Shared Grant	$30,000.00
Khalili-Naghadeh, N	Unsaturated clays in free-standing railway embankments - monitored field trial	GHD PTY LTD / Contract Research	$9,000.00
Niven, R | Khalili-Naghadeh, N | Pashley, RM	PFAS Source Zone Remediation by Foam Fractionation and In Situ Fluidisation	Australian Research Council / Special Research Initiatives	$100,000.00
Oldfield, PF | Nezhad, AA | Carmichael, DG	Carbon Value Engineering	CRC For Low Carbon Living Limited / Research Grants	$78,765.00
Raval, SA | Shen, X	Improved structural mapping of pit walls using UAV based mobile laser scanning	Australian Coal Research Limited / Australian Coal Association Research Program	$26,419.00

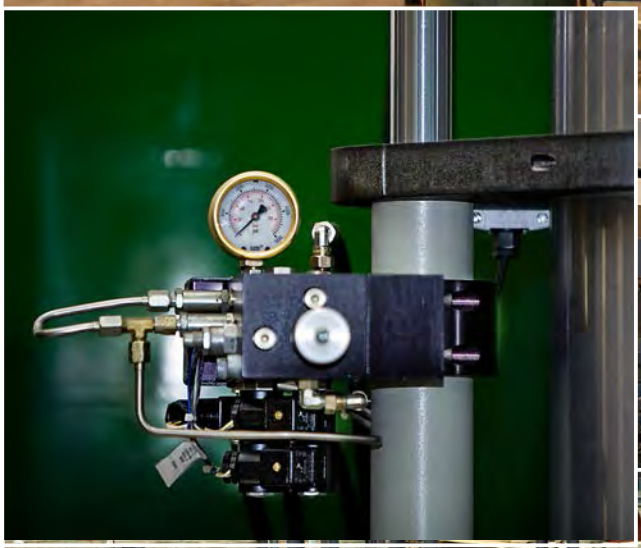
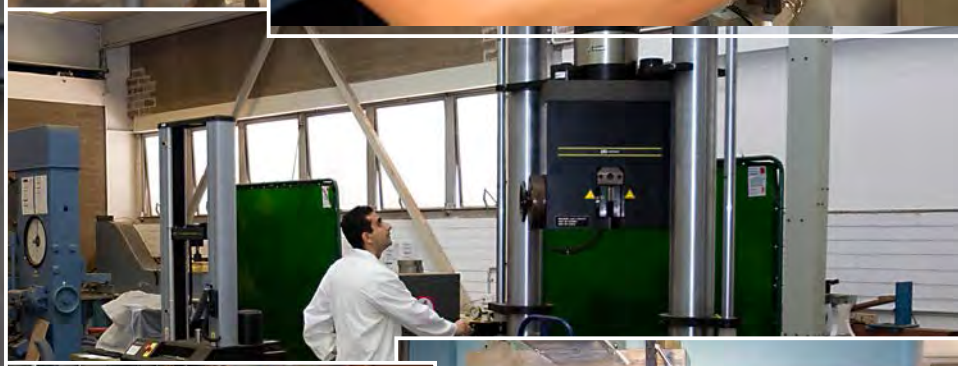
CIES Investigators	Topic	Partners/ Providers	2018 Amount
Russell, A	Evaluating potential static liquefaction of tailings to prevent failures	Teck Resources Limited / ARC Linkage Project Industry Partner Contribution Anglo American Services (UK) Limited / ARC Linkage Project Industry Partner Contribution Freeport-McMoRan Inc / ARC Linkage Project Industry Partner Contribution	$84,827.00
Shen, X | Carmichael, DG	Construction Drilling Robot - TechVoucher Project	Smart Welding Solutions / Contract Research	$15,000.00
Shen, X | Carmichael, DG	Evaluating Light Detection and Ranging (LiDAR) Sensors for Construction Mapping	Linke & Linke Surveys / Contract Research	$50,000.00
Song, C	Deterioration of structural integrity of ageing ships and marine platforms	University of Newcastle / ARC Linkage Project Shared Grant University of Newcastle / ARC Linkage Project - DSTG Shared Partner Organisation Contribution University of Newcastle / ARC Linkage Project - Pacific ESI Shared Partner Organisation Contribution	$44,622.00
Song, C	Scaled boundary framework for adaptive and multiscale structural analysis	Australian Research Council / Discovery Project	$130,000.00
Song, C	Seismic analysis of cracking and deformations in concrete gravity dams	Australian Research Council / Linkage Project Melbourne Water Corporation / ARC Linkage Project Industry Partner Contribution Goulburn-Murray Water / ARC Linkage Project Industry Partner Contribution Murray-Darling Basin Authority / ARC Linkage Project Industry Partner Contribution Sunwater Limited / ARC Linkage Project Industry Partner Contribution	$175,230.00
Song, C | Tin Loi, FS	3D contact and fracture analysis for safety assessment of structures	Australian Research Council / Discovery Project	$141,400.00
Vali Pour Goudarzi,	Finite element analysis of high-strength concrete column/wall to normal strength slab	Taylor Thomson Whitting (NSW) Pty Ltd / Contract Research	$8,260.00
Vali Pour Goudarzi, | Chang, Z	Investigation of structural behaviours of timber stud walls with OSB panels	Strongbuild Commercial / Contract Research	$34,890.00
TOTAL CIES 2018			**$2,292,402.00**

OUR PUBLICATIONS & RESOURCES

Our Laboratories

CIES research and commercial activities are conducted with extensive physical laboratory resources, such as those of the Heavy Structures Research Laboratory, Advanced Materials Research Laboratory, Geotechnical Laboratory and the Advanced Computational Analysis Laboratory (ACAL). Through these state-of-the-art facilities we are able to conduct our blue sky and applied research, for industry and government partners.



Our Publications

CIES Research Publications 2018

Books: 1
Chapters in Books: 1
Conference Papers (published): 24
Journal Articles: 124

All CIES Staff in **BOLD.**

Books

Song, C. (2018). The Scaled Boundary Finite Element Method: Introduction to Theory and Implementation. Wiley.

Book Chapters

Khoa, N. L. D., **Alamdari, M. M.**, Rakotoarivelo, T., Anaissi, A., & Wang, Y. (2018). Structural Health Monitoring Using Machine Learning Techniques and Domain Knowledge Based Features. In J. Zhou, & F. Chen (Eds.), *Human and Machine Learning* (pp. 409-435). SPRINGER. doi:10.1007/978-3-319-90403-0_20

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Piscesa, B., **Attard, M. M**., & Samani, A. K. (2018). 3D Finite element modeling of circular reinforced concrete columns confined with FRP using a plasticity based formulation. Composite Structures, 194, 478-493. doi:10.1016/j.compstruct.2018.04.039

Yang, G., & **Bradford, M. A.** (2018). Thermal-induced upheaval buckling of concrete pavements incorporating the effects of temperature gradient. Engineering Structures, 164, 316-324. doi:10.1016/j.engstruct.2018.02.002

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Liu, A., Yang, Z., **Bradford, M. A.**, & **Pi, Y. L**. (2018). Nonlinear dynamic buckling of fixed shallow arches under an arbitrary step radial point load. Journal of Engineering Mechanics, 144(4). doi:10.1061/(ASCE)EM.1943-7889.0001425

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Xu, T., Huang, J., **Castel, A.**, Zhao, R., & Yang, C. (2018). Influence of steelconcrete bond damage on the dynamic stiffness of cracked reinforced concrete beams. Advances in Structural Engineering, 21(13), 1977-1989. doi:10.1177/1369433218761140

Babaee, M., & **Castel, A.** (2018). Chloride diffusivity, chloride threshold, and corrosion initiation in reinforced alkali-activated mortars: Role of calcium, alkali, and silicate content. Cement and Concrete Research, 111, 56-71. doi:10.1016/j.cemconres.2018.06.009

Noushini, A., Hastings, M., **Castel, A.**, & Aslani, F. (2018). Mechanical and flexural performance of synthetic fibre reinforced geopolymer concrete. Construction and Building Materials, 186, 454-475. doi:10.1016/j.conbuildmat.2018.07.110

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Yu, Y., **Chen, X.**, **Gao, W**., Li, Q., **Wu, D.**, & Liu, M. (2018). Stochastic leaching analysis on cementitious materials considering the influence of material uncertainty. Construction and Building Materials, 184, 186-202. doi:10.1016/j.conbuildmat.2018.06.211

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Huang, Y., **Hamed, E**., **Chang, Z. T.**, & **Foster, S. J.** (2018). Time-dependent buckling testing of eccentrically loaded slender high-strength concrete panels. ACI Structural Journal, 115(1), 41-51. doi:10.14359/51700913

Mahmood, S. M. F., Agarwal, A., **Foster, S. J.**, & **Valipour, H.** (2018). Flexural performance of steel fibre reinforced concrete beams designed for moment redistribution. Engineering Structures, 177, 695-706. doi:10.1016/j.engstruct.2018.10.007

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