UNSW SYDNEY

CIES: CENTRE FOR INFRASTRUCTURE ENGINEERING & SAFETY

CIVIL & ENVIRONMENTAL ENGINEERING

ANNUAL REPORT 2022

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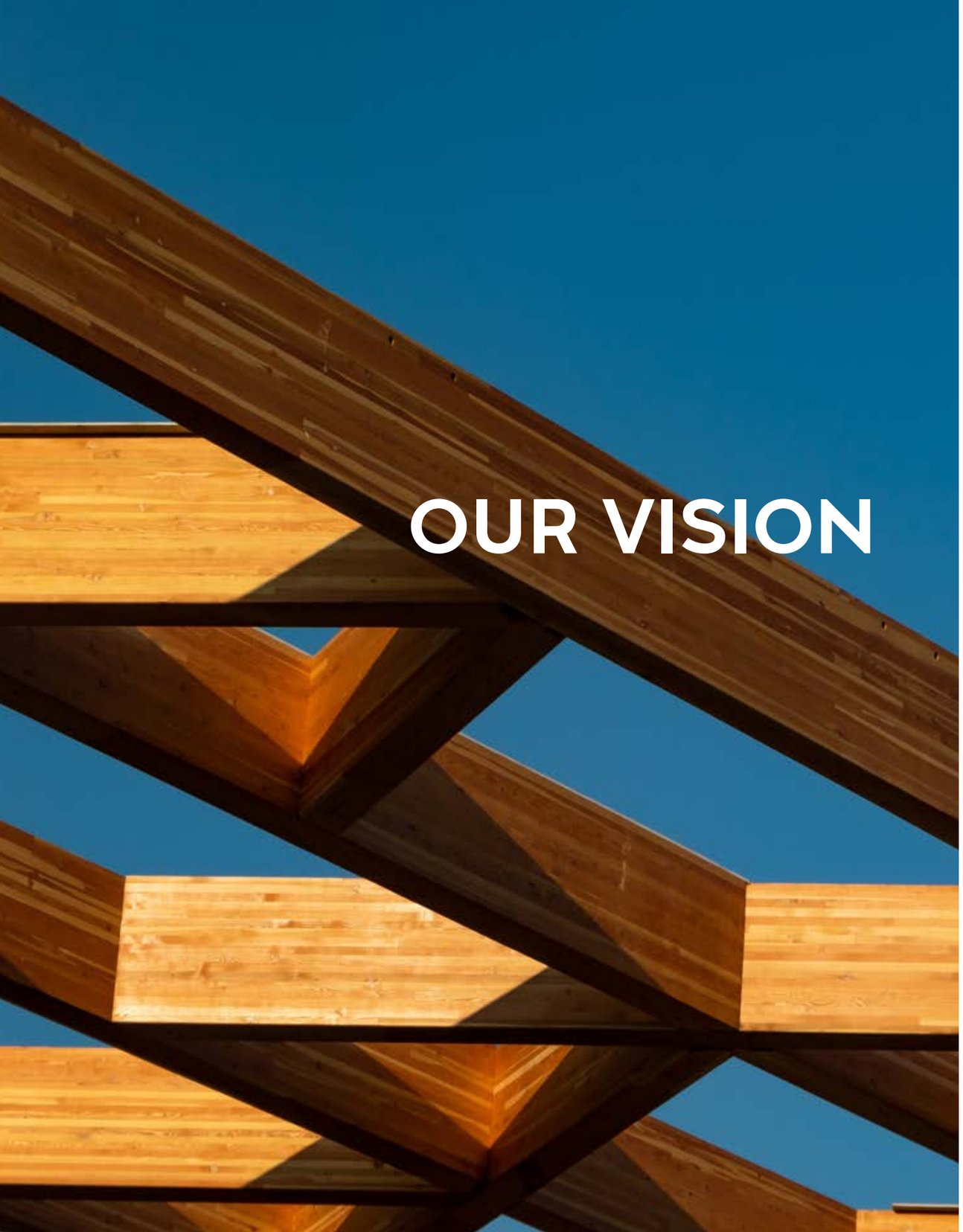
OUR CENTRE



OUR VISION

Our vision is to be the leading internationally recognised research centre in the region for investigating, understanding and predicting the safety and behaviour of engineering infrastructure under in-service and limit conditions.
We achieve this as an integral part of a circular economy, dedicated to high societal productivity and minimised waste.

We aim to be the nexus of the various scientific disciplines in the broad fields of engineering infrastructure; its design, evaluation, construction, performance, retrofit and reuse.

ABOUT US

WE CONDUCT PURE AND APPLIED RESEARCH

The Centre for Infrastructure Engineering & Safety (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, dams, and the like. It has expanded to include construction management, advanced systems, and low-carbon technologies.

THE CORE activities of the Infrastructure Centre are underpinned by a significant number of eminent academic staff of international renown in their respective fields, particularly in structural engineering, geotechnical engineering, construction management, 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 grant programs (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.

The composite of structural, geotechnical, construction and materials academics and researchers in the Infrastructure Centre is the leading group in Australia and in the region, with a demonstrated capability for delivery of research outcomes.

Ideally located at UNSW Sydney's School of Civil and Environmental Engineering, CIES projects incorporate several engineering disciplines – from structural engineering to geotechnical engineering to construction and management, and engineering materials to computational mechanics.

MULTI-DISCIPLINARY COLLABORATION FOR THE BEST RESULTS

At CIES, we apply our skills to engineering and safety assessments of infrastructure. In particular, we look at the construction and 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 exposed to hostile environments and climatic variations.

The Centre aims to promote multi-disciplinary collaboration across engineering, science and the built environment at UNSW and to foster international and interdisciplinary research collaborations and partnerships with industry.

IN SHORT, CIES OFFERS:

- World-class interdisciplinary research by a team made up of structural and geotechnical engineers and scientists, and advanced systems and management personnel engaged in construction planning.
- Access to advanced analytical, computational and experimental techniques and facilities.
- A forum for idea exchange and research collaboration between engineers, scientists and planners.
- 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.

WELCOME

I am very proud to present this annual report on our achievements at the Centre for Infrastructure Engineering and Safety (CIES) in 2022.

The report outlines the mission of the centre, its governance structure, and profiles our staff and their achievements. It also provides a list of current projects funded by competitive national schemes and industry, our laboratories, and the publications produced by our staff and research students throughout 2022.

It also includes the inaugural report from RIIS, the ARC Industrial Transformation Research Hub - Resilient and Intelligent Infrastructure Systems (RIIS) in Urban, Resources and Energy Sectors, led by CIES Scientia & PSM Professor Nasser Khalili. Congratulations to RIIS – it's been a wonderful start to your great work.

Our team's accomplishments during 2022 were undeniably impressive. Collectively our members were active on over forty industry and government funded research projects to an annual value of $4.2M, secured highly competitive Australian Research Council (ARC) Discovery and Linkage Project grants, graduated ten PhD students, and published 122 refereed journal papers, 3 book chapters and one book.

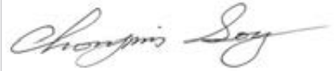
In 2022 four of our academic staff received promotions from UNSW. We welcome the recognition of our staff by UNSW for all their hard work as researchers and educators, and their constant endeavours in translating their extensive knowledge into industry practice, for the good of the community.

In 2022 we welcomed Dr Mohsen Kalantari and Dr Daniel O'Shea to the CIES academic team, and farewelled Dr Sascha Eisentrager and Professor Xiao Lin (Joshua) Zhao. In our hardworking and utterly crucial CIES technical staff team we welcomed Dr Farj Elhadayri and farewelled Tim Weston.

Sadly in 2022 we made our final farewells to two long serving colleagues, Professor Somasundaram Valliappan and legendary Technical Officer Frank Scharfe.

On behalf of the Executive Committee, I would like to thank all our staff and students who contributed so generously to the success of the Centre as we emerge from the pandemic, having kept our crucial laboratory and industry research going and our ambitions still firing.

I would also like to express my sincere appreciation and thanks to our industry partners and advisory committee members for your strong support and important contributions.



Professor Chongmin Song
CIES Director

CIES LEADERSHIP COMMITTEES 2022

EXECUTIVE COMMITTEE

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

Professor **CHONGMIN SONG**
Director

Scientia Professor **MARK BRADFORD**
Research Director

Professor **GANGADHARA PRUSTY**
Deputy Director

Professor **HAMID VALIPOUR**
Deputy Director

GRACE ZHU
Centre Manager

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 Maurice Pagnucco, Deputy Dean, Faculty of Engineering (Chair)
- Professor Chongmin Song, CIES Director
- Scientia Professor Mark Bradford, CIES Director of Research
- Scientia Professor Nasser Khalili, Head of School, UNSW Civil & Environmental Engineering
- Professor Klaus Regenauer-Lieb, School of Minerals and Energy Resources Engineering
- Scientia Professor Deo Prasad, School of Built Environment
- Professor Ismet Canbulat, School of Mineral and Energy Resources Engineering
- Grace Zhu, 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.

CIES IAC INDUSTRY MEMBERS 2022

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 A/
Professor - UNSW
Civil & Environmental
Engineering

James Aldred 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.

PHIL BLUNDY
Technical Director, AECOM and Immediate Past Chair Engineers Australia, Structural College Board

Phil Blundy 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
Director, Structural Engineering APAC, Dematic, FIEAust CPEng NER APEC Engineer IntPE(Aus)

Dr Murray Clarke is Director of Structural Engineering at Dematic, a global engineering company that designs, builds and supports logistics solutions that optimise material and information flow.

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

Murray moved to Dematic in 1999 to initiate the core discipline of structural 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 metres 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 codes for the storage equipment industry in Europe.

KATHY FRANKLIN
Associate
Principal- ARUP

Kathy Franklin 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.

JIM FORBES
Chairman Australian Standard Committee BD-002

Jim Forbes is Chairman of Australian Standard committee BD-002, responsible for AS 3600, the Australian Concrete Structures Code, and represents Australia on the International Standards Organisation TC71 committee.

With over 50 years in the construction industry, Jim has been involved with the planning, design, coordination and supervision of a wide variety of civil engineering and building projects.

His expertise covers Concrete Structures, Tall Buildings, Mining, Aerospace and Transport Infrastructure. Having developed considerable experience in transport projects, he applies a unique blend of building and transport skills to public and private transport projects across Australia.

His broad experience in civil engineering has seen him involved in projects which require holistic solutions to complex engineering, transportation and planning challenges. These have typically involved major infrastructure development projects, from initial master planning to completion.

Jim has extensive experience in running multidisciplinary teams and has an enviable reputation for identifying the winning elements of Design and Construct projects.

His acknowledged expertise in concrete and concrete structures led him towards a strong involvement with the Concrete Institute of Australia and the Federation Internationale du Beton and he has served as President of each of these organisations.

SAM HENWOOD
Director Pavements and Geotechnical Transport for NSW

Sam Henwood has been practising as a geotechnical engineer since graduating from UNSW in 1994 having worked extensively in both Australia and the United Kingdom in both the private and public sectors. Since 2016, he has led the Transport for NSW (formally Roads and Maritime Services) Pavement and Geotechnical section in his current role as Director Pavements and Geotechnical.

He is responsible for 55 professional staff with 5 direct reports and manages technical risk in pavements, geotechnical engineering, geoscience and materials disciplines. Sam is the Transport for NSW representative on the Austroads Pavement Task Force, managing technical development in pavement engineering. Sam has taken a lead in the use of recycled materials in road construction.

Prior to joining Roads and Maritime Sam worked as a consultant. He was responsible for the successful completion and management of geotechnical projects and has experience of geotechnical interpretation and design, pavement design, drainage design, client liaison, resource allocation, project planning, quality control and financial accountability.

He has worked on major infrastructure projects including highways, rail and ports, residential and commercial developments, local roads and tailings dam design. He has extensive experience in the UK rail sector particularly in Scotland and northern England.

He has also spent his formative years in an earthworks testing laboratory.

PETER KEY
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 McKay-Sim 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
Snr Tech Director
ARCADIS Aus.Pacific
METRON - Barangaroo Stn Design Mgr

John Merrick has over 20 years' experi-ence 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.

JESSICA QIU
Major Project Executive, WSP in Australia

Jessica Qiu is a project executive with international charterships. She is a highly experienced project management professional with extensive experience in the conceptualisation, planning, design, management and construction of large infrastructure projects. She brings a wealth of knowledge to the project with her specialist skills in project/program management, commercial management, project governance, quality management, business-focused strategy development and technical engineering knowledge. Her experiences in large infrastructure projects as a contractor, consultant and client representative enable her to form the most suitable solution with bespoke innovative practices for each project, adding value and creating long-lasting high-quality results for the client. Her exceptional skills in project governance, engineering management, and knowledge of construction, and legal and business practices, enable her to deliver achievable integrated solutions and manage project delivery in a timely, efficient, and collaborative manner. She has a valuable understanding of project approval, staging and delivery in complex Alliance, Public-Private Partnership and Design and Constructs contract settings. She brings enterprise design skills to establish an efficient project delivery framework, balancing the four governance pillars (Project/ Commercial/Technical, and Cultural) in achieving an exception overall governance system.

She was the president of Engineers Australia Sydney during 2020-2021 and has led various industry initiatives such as the Innovation Network, the Western Sydney Initiative, Education Support – Cradle to Graduation, Migrant Engineer Support etc. She is also on the Industry Advisory Board for UNSW, Western Sydney University, and lectured at the University of Swinburne linking higher education institutions with the engineering and technology industry.

CIES STAFF MEMBERS OF THE IAC

Professor **CHONGMIN SONG**, Director, CIES

Professor **HAMID VALIPOUR** Deputy Director, CIES

Scientia Professor **MARK BRADFORD** Research Director, CIES

Professor **WEI GAO**

Professor **ADRIAN RUSSELL**

Associate Professor **EHAB HAMED**

CIES AWARDS & ACHIEVEMENTS

In 2022 CIES academics PSM Professor Nasser Khalili, Dr Arman Khoshghalb and Dr Babak Shahbodagh working with inter-University colleagues Professor Jie Li from RMIT and Emeritus Professor Harry Poulos (USyd) were awarded a prestigious ARC Discovery Project grant for 2023.

CIES ARC Discovery Grants

DP230102874: $470,000

Their geotechnical engineering project 'Pile foundations in unsaturated soils: a mechanistic framework' will develop a mechanistic approach to pile foundation design in variably saturated soils through integrated expertise in the fields of unsaturated soil mechanics, material nonlinearity, numerical modelling, limit analysis and experimental investigation.

It will achieve a rigorous understanding of pile behaviour in unsaturated soils subjected to monotonic loading through a comprehensive program of scaled laboratory testing, numerical and theoretical analyses.

The models, theories, mechanics and predictive tools arising from this research will have direct and immediate impact on the planning, design, construction and management of many types of infrastructure involving pile foundations in industrial and residential developments.

Industry Grants – Ailar Hajimohammadi. ARC Linkage and EPA Grants

Associate Professor Ailar Hajimohammadi conducts investigations into innovative and more sustainable construction materials, as well as resource recovering strategies for a circular economy in civil and construction projects. In 2022 she received two major grants to support her work.

"It is essential to adopt a concrete material technology that is cost-effective, sustainable and can effectively attenuate noise"

Waste-derived concrete noise barriers

Associate Professor Hajimohammadi was awarded a $210,000 ARC Linkage funding in 2022 for a project that will develop high-performance lightweight concrete noise walls and acoustic barriers that use recycled tyre and glass products. These products will improve sound absorption, and address environmental problems associated with the mining of river sands and stockpiling of waste tyre and glass products.

One of the popular solutions in Australia to enhance the noise absorption of concrete is the use of autoclaved aerated concrete (AAC). However the manufacturing process of aerated concrete is expensive, further increases the carbon footprint of AACs, and is not environmentally sustainable.

"It is essential" says Associate Professor Hajimohammadi, "to adopt a concrete material technology that is cost-effective, sustainable and can effectively attenuate noise."

To have high-performance, cost-effective, and sustainable noise walls, Associate Professor Hajimohammadi's project will develop concrete mix designs made with waste glass (WG) and end-of-life tyres (EOLT) and will address several challenges for the large-scale adoption of waste-derived concrete noise barriers.

Dr Hajimohammadi leads the UNSW research on the project along with Professor Stephen Foster, A/Professor Hamid Valipour from CIES and Dr Danielle Moreau from UNSW Mechanical and Manufacturing Engineering. Industry partners are Flexiroc Australia and Tyre Stewardship Australia.

Solar recycling industry

Through the NSW EPA's Circular Solar Grants Program - Phase 2, Associate Professor Hajimohammadi will receive $330,962 funding for her work in supporting the NSW solar recycling industry with research into solar photovoltaic (PV) glass recycling and its reuse in construction projects, as a component of innovative geopolymer concretes. Industry Partner is PV Industries P/L.

EPA forecasts that NSW will generate 3,000–10,000 tonnes per year of waste solar PV panels and battery storage systems by 2025, rising to 40,000–71,000 tonnes per year by 2035.The main component of PV waste is glass. The recycling of waste glass of solar panels, therefore, is a crucial issue.

Associate Professor Hajimohammadi's research group at CIES aims to investigate and compare the possibility of using waste glass powder derived from PV modules as a partial precursor in producing geopolymer concrete. Designing and thoroughly testing a geopolymer concrete mix which incorporates recycled solar panel glass will be conducted at CIES laboratories for a period of two years.

Mark Fowler, Managing Director PSM and Professor Stephen Foster, Dean UNSW Engineering, sign the agreement to PSM's sponsorship and partnership with UNSW, Sept 2022 Behind: L-R: Garry Mostyn, Principal PSM, PSM Professor Nasser Khalili, HoS Civil & Environmental Engineering, Professor Anne Simmons AM, UNSW Provost, & Dr Kurt Douglas, PSM Senior Lecturer of Rock Mechanics.

PSM Professorship

For fifteen years leading geotechnical consultancy PSM have supported an academic position at UNSW Civil & Environmental Engineering – with CIES academic Dr Kurt Douglas filling that role as the PSM Senior Lecturer of Rock Mechanics. The relationship allowed PSM to have direct access to an academic expert 'on tap' while UNSW kept in direct contact with leading geotechnical practitioners, assisting with and learning from their challenges in an ever-changing industry.

"PSM are a cutting-edge, innovative company who are constantly raising the bar in geotechnical design."

In September 2022 PSM stepped up their support to add a new Professorship and CIES Deputy Director Scientia Professor Nasser Khalili is proud to take on the new mantle of PSM Professor. "PSM are a cutting-edge, innovative company" he said, "who are constantly raising the bar in geotechnical design. CIES has many links with them, through shared industry research projects and personnel, and they have employed many of our best students. I'm delighted that the relationship continues to deepen and expand through this new Professorship. "

"UNSW are leaders in geotechnical engineering education and research and the teaching and research team at CIES have made major contributions to the profession over many years," said Mark Fowler, PSM's Managing Director. "By supporting these academic roles, we are giving something back."

PSM Professor Nasser Khalili is an international leader in geotechnical engineering, computational geomechanics and unsaturated soil mechanics. His work encompasses roads, tunnels, mines, dams, earthquake engineering and groundwater projects.

Dr Douglas's expertise covers rock mass strength and deformation prediction, spillway erosion assessment and piping within embankment dams. His research looks at how to better predict the properties of rock so that foundations, tunnels, slopes and dams can be more efficiently designed.

UNSW gratefully acknowledges the generous support of PSM to advance research in geotechnical engineering and rock mechanics through the PSM Professor and the PSM Senior Lecturer academic positions.

Elected to ATSE

PSM Professor and Scientia Professor Nasser Khalili FTSE was amongst 27 academics elected in October 2022 as new Fellows of the Australian Academy of Technological Sciences and Engineering (ATSE). ATSE is Australia's foremost impact network for leading applied scientists, technologists and engineers.

Professor Khalili is an international leader in geotechnical engineering, computational geomechanics and unsaturated soil mechanics. His work encompasses roads, tunnels, mines, dams, earthquake engineering and groundwater projects.

He has contributed to projects of national and international interest including the stability assessment of the Olympic Stadium site at Homebush Bay and the seismic hazard investigation for Sydney Airport's third runway.

National design guidelines for embankment dams include Nasser's seismic analysis. His assessment of the Hume Dam helped determined the cause of increasing movement in the dam's core-wall and the design of an effective solution.

Professor Khalili currently oversees a project diverting 10,000 tonnes of paper and plastic waste into road construction, creating technical leadership in Australian recycling and reducing infrastructure costs.

He is also Director of the ARC Industry Transformation Research Hub for Resilient and Intelligent Infrastructure Systems (RIIS) (NSW).

Nasser says his top priorities as a Fellow will be to promote the quality of science, technology, and engineering education at all levels, particularly amongst high school students and the broader community; and to engage industry, government, research leaders, and infrastructure stakeholders to facilitate the implementation of integrated science-based practical solutions to address the challenges facing Australia's infrastructure.

Congratulations to Nasser!

"Professor Khalili is an international leader in geotechnical engineering, computational geomechanics and unsaturated soil mechanics."

President of global organisation fib

In June 2022 UNSW Dean of Engineering and CIES **Professor Stephen Foster** was elected President of the International Federation for Structural Concrete (fib).

"His work has provided significant impact on the construction industry through incorporation in the fib Model Code 2010"

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.

The role of President reflects Stephen's long-term contribution to community on research and education. He had served the fib as Vice President for the previous two years. In 2018 he was awarded Honorary life member in recognition of his significant personal contributions to the work of the fib, and for which he was also made a Fellow.

Professor Foster received his PhD from UNSW in 1993 and has a distinguished record in the field of structural concrete and concrete materials. His main research interests are in the fields of bringing new materials technologies to the design of concrete structures, including fibre and ultra-high-performance concrete, low carbon construction materials such as Geopolymer, and alkaline activated concretes and high strength reinforcing steels.

His research on Strut-and-Tie Modelling, on High Strength Concrete Columns and Steel Fibre Reinforced Concrete, much of which was funded through ARC Discovery and Linkage project grants, now forms the basis of many of the design rules in the Australian Concrete Structures Standard, AS3600-2018. This has impact on many thousands of structures built throughout Australia each year. Similarly, his work has provided significant impact on the construction industry through incorporation in the fib Model Code 2010.

In 2015 Stephen was awarded honorary membership of the Concrete Institute of Australia (CIA) in recognition of his outstanding contribution to the development and use of concrete in Australia. He is a Fellow of Engineers Australia, and a member of several Australian and international Standards Committees.

Our heartiest congratulations to Professor Foster on all his achievements.

A gold medal in the Geomechanics Olympics

PSM & Scientia Professor Khalili Nasser delivered a state-of-the-art lecture on saturated soils at the 20th international conference on Soil Mechanics and Geotechnical Engineering (ICSMGE) held in Sydney in May 2022.

Over the course of the Conference seven State of the Art Lectures were delivered by fourteen global experts on topics including Biomediated-bioinspired Geotechnics, Earthquake Geotechnical Engineering, Energy, Environmental Geotechnics, Saturated Soils, Tailings Dams, and Transportation Geotechnics.

'It was a major honour to present the SOA in this gathering,' Professor Khalili said, 'Someone said it is like receiving a gold medal in the Olympics!'

Professor Khalili is credited with the development of the first thermodynamically consistent framework for constitutive modelling of unsaturated porous media. Similarly, his research into the mechanics of double porosity media has set an international benchmark in numerical modelling of fractured porous media.

His lecture partner at ICSMGE 2022 was Enrique Romero, Head of the Geotechnical Laboratory in the Department of Civil and Environmental Engineering at the Universitat Politècnica de Catalunya (Spain).

Professors Khalili and Romero received a certificate of presentation from ICSMGE2022, from the Session Chair, Jean-Louis Briaud, Distinguished Professor of Civil Engineering at Texas A&M University.

University of Auckland Fellowship for Johnson Shen

CIES academic Dr Johnson Xuesong Shen was awarded the prestigious Whakapukahatanga Taiao Research Fellowship by the Department of Civil and Environmental Engineering at the University of Auckland, New Zealand.

This research fellowship is awarded to international scholars of superior academic research ability in any civil and environmental engineering discipline, to work at the University of Auckland with UA research staff. Previous winners have included leading academics from Harvard and MIT, Tsinghua University and Virginia Tech.

Johnson gave a series of seminars on research, industry collaboration and education at the University of Auckland when he visited them in September 2022.

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.

He represents Australia in the Board of Directors of the prestigious International Association for Automation and Robotics in Construction (IAARC).

Early Career Researcher Award for Dr Mohammad Vahab

In October 2022 CIES Lecturer and Chief Investigator (CI) at the Research Hub on Resilient and Intelligent Infrastructure Systems (RIIS) Dr Mohammad Vahab received the IACMAG Excellent Paper Award for individuals 45 years and under for his paper "X-FEM Modeling of Multizone Hydraulic Fracturing Treatments within Saturated Porous Media".

The International Association for Computer Methods and Advances in Geomechanics (IACMAG) Excellent Paper Award recognises excellent research contributions published through refereed paper(s) in archived journals.

In his paper, published in Rock Mechanics and Rock Engineering (2018) 51:3219–3239, a fully coupled hydro-mechanical model was presented for the study of multizone hydraulic fracturing. Several numerical examples were presented to demonstrate the robustness of the proposed X-FEM framework in the study of multizone hydraulic fracturing treatments through saturated porous media. The results appear to accord with the field observations reporting numerous failed attempts of multistage multizone fracturing treatments, which provide great insight into the complexities encountered in practice.

About Dr Mohammad Vahab

The focus of Dr Vahab's research is numerical simulation by employing the state-of-the-art computational methods, namely: Extended Finite Element Method (XFEM); Non-differentiable Energy Minimisation using Discontinuous Galerkin Method (DG); and Phase-field Method (PF).

"Dr Vahab specializes in the hydro-mechanical coupling processes in saturated/ unsaturated porous formations"

Dr Vahab specializes in the hydro-mechanical coupling processes in saturated/ unsaturated porous formations. This involves the development of physical models as well as advanced computational frameworks in relation to the hydraulic fracturing treatments in neat, fractured and/or layered domains.

Dr Vahab is currently investigating the use of deep learning in the study of complex mechanical responses of geo-infrastructures by means of the Physics-Informed Neural Networks (PINNs). The project in particular aims for sustainability, serviceability, resilience, planning, decision making, and safe operations. Dr Vahab contributes to the RIIS Hub in discovery, inversion, and data processing with the purpose of health monitoring of infrastructure across Australia, which is a key to sustainability in engineering design and practice.

PhD researcher Soheil Heydari – making green roads.

In 2022 CIES PhD researcher Soheil Heydari won the School of Civil & Environmental Engineering's Three Minute Thesis (3MT) competition. The 3MT format requires higher degree researchers to speak to the core of their years' long and incredibly detailed research to communicate their work – its reasons, findings and uses – to the public in just three minutes.

Soheil's thesis topic is The Application Of Recycled Plastic In Asphalt. His supervisors are Scientia Professor Nasser Khalili and Dr Ailar Hajimohammadi.

His PhD research aim is to find an application for waste plastics in road construction, instead of bitumen. 'It's going to be two birds with one stone!', he explains. 'We are going to make the roads green, and use the waste plastics at the same time.'

By mixing different types of waste plastics, and doing some special treatments, Soheil's team created a very sticky black material, that looks very similar to bitumen. With three main differences though, he said. 'First, it is way cheaper than bitumen. Secondly, it outperforms bitumen. And thirdly, it is environmentally friendly.'

This is the first binder material that has been created 100% from waste materials. The novel technique works with any type of plastic and is not sensitive to contaminations. If all new roads in Australia were made using this novel binder, says Soheil, there will be no waste plastic left to bury under the ground.

'It's 100 percent from waste plastics,' says Soheil, 'so even though its black, it is very green.'

"First, it is way cheaper than bitumen. Secondly, it outperforms bitumen. And thirdly, it is environmentally friendly."

CIES Staff Promotions 2022.

Congratulations to the following staff for their well-deserved promotions in 2022

Professor Hamid Valipour
Professor Hamid Valipour's work over the last decade has focused on the development of innovative structural systems with lower energy and carbon footprints, which are easier to fabricate, assemble and dismantle than those of current practice. Valipour's vision is for the widespread uptake of hybrid structural systems that fully exploit the advantages of steel, concrete and engineered timber to reduce the self-weight, cost and negative environmental impact of current structures, and also enhance opportunities for deconstruction, reusing and upgrading of structures.

Associate Professor Ailar Hajimohammadi
A/Prof Ailar Hajimohammadi received her Ph.D. on sustainable construction materials from the University of Melbourne. Her research examines the chemistry of materials to develop innovative construction elements with attractive properties. She is involved in several grant-winning industry projects investigating waste management and resource recovering strategies towards a circular economy in civil and construction projects.

Senior Lecturer: Dr Asal Bidarmaghz
Dr Asal Bidarmaghz specializes in geo-energy systems, hydro-thermo-mechanical characteristics of urban subsurface and underground structures synergistically with above/underground built environment. Her research has led to new urban-scale methods and tools for predicting the ground temperature and groundwater distributions at high resolutions in the presence of underground heat sources and sinks. She is the task force leader for underground climate change initiative at the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE).

Senior Lecturer: Dr Ali Kashani
Dr Ali Kashani's expertise is in Sustainable Construction. A Churchill Fellow in Construction Automation and 3D Printing, he has extensive experience in research, development, and commercialisation of advanced and sustainable construction materials. One of his research areas is in Construction Automation, via development of novel high-performance materials and techniques for robot-aimed construction including 3D printing. Another research focus is on the Circular Economy including waste valorisation, carbon capturing and mineralisation, low-carbon construction materials, sustainable concrete, and alkali-activated materials (geopolymers).

RIIS 2022 FIRST YEAR REPORT

ARC Industrial Transformation Research Hub - Resilient and Intelligent Infrastructure Systems (RIIS) in Urban, Resources and Energy sectors.

Towards productive, connected, sustainable and smart infrastructure.

Australian Government
Australian Research Council

About RIIS

RIIS is an industry and ARC funded research and innovation hub for smart infrastructure. It engages with industry, government, and the community to develop and implement science-based policy and integrated practical solutions to the current and future challenges facing Australia's urban resources and energy infrastructure.

RIIS will deliver transformational technologies to address Australia's critical infrastructure needs. It will integrate advances in sensor technology, connectivity, data analytics, machine learning, robotics, smart materials, and reliable models to deliver resilient and adaptive infrastructure systems in urban, energy and resource sectors – sectors critical to Australia's prosperity and well-being.

Director's Message

With all agreements fully executed between Industry and Universities – the Australian Research Council (ARC) approved an official work start date for the Hub of 20 July 2022, with a formal ARC launch to be held at UNSW Council Chambers in 2023.

RIIS began its work in 2022 with four university partners - UNSW Sydney, University of Melbourne, Queensland University of Technology, and Western Sydney University - and 19 industry partners – these include five new partners gained since the ARC award in 2021.

The Hub provides opportunities for industry and university partners to develop, co-design, develop, and enhance technologies suitable for safe and sustainable operations, further enhancing the resilience and intelligent capability of existing and new infrastructure, transportation networks, distribution systems, minerals and energy sectors, and other hard infrastructure.

By the end of 2022 we were working on several major projects including

- Development of computational tool for data-driven structural safety assessment and service life prediction
- Automated Scan-vs-BIM for Real-Time Construction Progress Management of Infrastructure Projects
- Infrastructure protection utilising real time monitoring of affected catchments by developing predictive models during flash flooding events.
- Bayesian Techniques for Rail Reliability Modelling and Maintenance Decision Support
- Data Integration with Spatial Digital Twin for No Spill Network and Fibre Optic System for Pipeline Monitoring
- Predictive Maintenance for Building Electrical Assets

Our aspiration is to make a step change in the way infrastructure is designed, constructed, monitored, managed, and maintained. As we all know, significant advances have been made in digital technologies in recent years, to the extent that they now touch every facet of our lives. They have the potential to revolutionise infrastructure and engineering in ways that we could not have imagined even a few years ago. RIIS is part of that revolution.

Scientia Professor Nasser Khalili
RIIS Hub Director & Lead Chief Investigator

"Our aspiration is to make a step change in the way infrastructure is designed, constructed, monitored, managed, and maintained."

RIIS EXECUTIVE COMMITTEE

Professor **NASSER KHALILI**
RIIS Hub Director & Lead Chief Investigator, UNSW Sydney

Professor **ABBAS RAJABIFARD**
RIIS Hub Deputy Director and Lead Chief Investigator, UoM

Professor **ISMET CANBULAT**
Chief Investigator, UNSW Sydney

Professor **TOMMY CHAN**
RIIS Hub Lead Chief Investigator, QUT

Professor **BIJAN SAMALI**
RIIS Hub Lead Investigator, WSU

Professor **SISI ZLATANOVA**
RIIS Hub Lead Chief Investigator, UNSW Sydney

Ms **THERESA WISNIEWSKI**
RIIS Business Manager, UNSW Sydney

Research and Innovation Themes & Leaders

RIIS has the potential to transform advanced manufacturing, service and infrastructure engineering in Australia focussing on five main themes:

Theme 1 Ubiquitous Sensing, Intelligent and Adaptive systems

- Robust, low energy sensors and actuators
- Ubiquitous positioning, sensing & communications
- Internet of Things (IoT) & sensing platforms
- Signal processing, network and sensing optimization

Leader: **Professor Chun-Hui Wang**, UNSW Sydney

Theme 2 Data collection, security and integration

- Robotics, satellite, UAV, autonomous systems for data collection
- Big data management storage & transmission
- Data security, robustness and reliability

Leader: **Professor Claude Sammut** UNSW Sydney

Theme 3 Modelling, simulations and prognostics

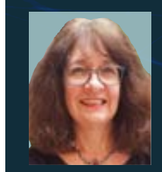
- Predictive modelling simulation & performance assessment
- Physics-informed artificial intelligence machine learning & explanation
- Real-time analytics – adaptive decisions

Leader: **Professor Nasser Khalili**, UNSW Sydney

Theme 4 Infrastructure health monitoring and predictive maintenance

- Degradation quantification & failure prediction
- Risk & safety
- Service life assessment
- Remedial & renewal technologies

Leader: **Professor Tommy Chan**, QUT



Theme 5 Spatial data, Digital Twins and decision support

- Integration & structuring of data & prognosis
- Digital twins & decision support
- Visualisation, virtual reality & interactive guidance systems
- Adaptive, intelligent & resilient design

Leader: **Professor Sisi Zlatanova**, UNSW Sydney

Deliverables

The Hub will engage with industry, government, and the community to unlock scientific roadblocks, deliver foundational skills for industry professionals and researchers, and translate research and development into real-world commercial opportunities.

DELIVER the next generation of sustainable technologies for design, real-time performance analysis and life-management of Australia's critical infrastructure in urban, energy and resources sectors.

SOLVE current industry challenges and translate research and development into commercial opportunities.

DESIGN novel and powerful health-monitoring technologies including non-destructive, non-contact dynamic diagnostic systems for asset protection.

ENABLE creating a collaborative environment for government, industry, and academia to testbed the innovative ideas and support the government for data-driven and evidence-based decisions and strategies.

DEVELOP Australia's next generation of fully validated robust, commercially viable, digital technologies for design and delivery of the nation's hard infrastructure to achieve competitiveness in domestic and export markets.

LEVERAGE technologies in IoT and robotics, autonomous systems, big data, and high-level computing to build fit-for-purpose mobility platforms to cope with tasks in structured and unstructured environments, particularly assets located in remote regions.

TRAIN a cohort of highly competent and motivated young professionals through research and development programs carried out in partnership with participants from all sectors of the infrastructure industry.

ASSIST in creating a cohesive innovative technical skills supply chain to address the future technological requirements of the industry, with improved planning, decision making and safe operations and resiliency.

DISSEMINATE discoveries and advances in technology and facilitate adoption through effective engagement with the engineering partner organisations, peak bodies, businesses, stakeholders and broader engineering and scientific communities.

UNIVERSITY PARTNERS

UNSW SYDNEY

QUT Queensland University of Technology

WESTERN SYDNEY UNIVERSITY

INDUSTRY PARTNERS

Spatial Vision · Asset Institute · ROOBUCK · LINKE & LINKE · Lindenbaum

Geoscape · MINCKA · FRONTIER · EMERSON

AAM · HAWK · Rockfield · Azure Mining Technology

South East Water · Ports Australia · HYQUALTY CONSTRUCTION

SECTION 2

OUR PEOPLE

ACADEMIC STAFF

ATROSHCHENKO, ELENA
Senior Lecturer
MSc in Mechanics and Applied Mathematics, Saint-Petersburg State University
PhD in Civil Engineering, University of Waterloo, Ontario

Research Interests: Computational Mechanics and Numerical Methods, with application to fracture mechanics, acoustics, bending and vibration of composite plates.

BRADFORD, MARK
UNSW Scientia Professor
BSc BE PhD USyd DSc UNSW FTSE CPEng CEng PE Dist.MASCE FIStructE FIEAust.

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.

BIDARMAGHZ, ASAL
Senior Lecturer
PhD Civil Engineering (Geothermal Technologies) University of Melbourne

Research Interests: Energy geo-structures and geothermal systems, Investigating the impacts of urbanization on subsurface temperature increase at the city-scale, Uncertainty analysis of large scale subsurface hydro-thermal models.

DACKERMANN, ULRIKE
Lecturer
Dipl.-Ing. Univ., Technical University of Mu-nich (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

Research 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 Dean of UNSW Engineering, BE NSWIT, MEngSc PhD UNSW, MIEAust, FIEAust

Research Interests: 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.

HAJIMOHAMMADI, AILAR
Associate Professor
Ph.D. University of Melbourne

Research Interests: Examines the chemistry of materials to develop innovative construction elements with attractive properties. She is also investigating waste management and resource recovering strategies towards the circular economy in civil and construction projects.

HAMED, EHAB
Associate Professor
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.

KALANTARI, MOHSEN
Associate Professor
BE (Surveying), MEng GIS - UT, Tehran, PhD Geomatics, GradCert Uni Teaching - U Melbourne

Research Interests: Digital Engineering, Space situational Awareness, Geospatial Data, LiDAR, Geographic Information Systems (GIS), Cadastral Surveying, Building Information Modelling (BIM), Land Administration. Mohsen is a co-founder of Faramoon, a geospatial technology company which, amongst other things, converts point cloud data to 3D models.

KASHANI, ALIREZA
Senior Lecturer
BSc, MSc Amirkabir University of Technology, Tehran
PhD University of Melbourne

Research Interests: Lecturer and Churchill Fellow in Sustainable Construction Automation and 3D Printing with extensive experience in research, development, and commercialisation of advanced and sustainable construction materials. Research areas include development of novel high-performance materials and techniques for construction 3D printing, and sustainable construction materials for the 'Circular Economy' including wastes valorisation, low-carbon construction materials and sustainable concrete.

KHALILI, NASSER
UNSW Scientia & PSM Professor
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.

MAKKI ALAMDARI, MEHRISADAT
Senior Lecturer
BSc Sharif, MSc Iran University of Science and Technology, Mech Eng
Manitoba, PhD UTS

Research Interests: Structural Health Monitoring, vibration analysis and testing, structural dynamics, inverse dynamic problems, signal processing and data mining. Mehri is on the Executive of the Australian Network of Structural Health Monitoring (ANSHM), and a member of The International Society for Structural Health Monitoring of Intelligent Infra-structure (ISHMII).

O'SHEA, DANIEL
Lecturer
BE (Civil), PhD UNSW

Research Interests: Computational Mechanics, Biomechanics, Continuum Mechanics, Hyperelasticity, Advanced Finite Element Methods, Shell Analysis, Fibre-Reinforced Composites. Expert in applied mathematics, computational mechanics, devising models for nonlinear material behaviour, with application to biological tissues and advanced manufactured composites.

RUSSELL, ADRIAN
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.

SHAHBODAGHKHAN, BABAK
Lecturer
MSc Uni of Tehran, PhD Kyoto University

Research Interests: Computational Geomechanics, Dynamics of Unsaturated Soils, Constitutive Modelling of Geomaterials, Seismic Analysis of Geostructures, Dynamic Soil-Structure Interaction.

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
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.

TIWARI, ROHIT
Lecturer
MEng Indian Institute of Technology,
PhD Uni of Melbourne

Research Interests: Geotechnical Earthquake Engineering, Performance Based Seismic Design of Geo-structures. Rohit has a strong background in experimental investigations of seismic actions in Earth Retaining Structures and calibration of numerical non-linear material models.

VAHAB, MOHAMMAD
Lecturer
PhD Sharif University of Technology

Research Interests: Numerical simulation by employing the state-of-the-art computational methods, specializes in the hydro-mechanical coupling processes in saturated/unsaturated porous formations. This involves the development of physical models as well as advanced computational frameworks in relation to the hydraulic fracturing treatments in neat, fractured and/or layered domains.

VALIPOUR GOUDARZI, HAMID REZA
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

CARMICHAEL, DAVID

FELL, ROBIN

GILBERT, IAN

TIN LOI, FRANCIS

VALLIAPPAN, SOMASUNDARAM

CENTRE RESEARCH STAFF

CIES Staff

Al-Damad, Iman Munadhil Abbas	Research Associate
Chen, Xiaojun	Research Fellow
Chhor, Allen	Senior Research Associate
Feng, Yuan	Research Associate
Jayathilakage, Roshan	Research Associate
Kumar, Ankit S.	Research Associate
Liu, Xinpei	Senior Research Associate
Mohana Kumar, Lakshminarayanan	Research Associate
Mohseni, Ehsan	Research Associate
Salehi Dezfooli, Mojtaba	Research Associate
Ya, Shukai	Research Associate
Yu, Yang	Research Associate

Visiting/Adjunct Academics

Aldred, James	Adjunct Associate Professor
Zhao, Xiao Lin (Joshua)	Adjunct Professor
Song, Haemin	Visiting Fellow

FAREWELLS

In 2022 CIES farewelled **Dr Sascha Eisenträger,** a leading light in our computational mechanics research group, who returned to Germany to take up a position as Senior Researcher at Technische Universität Darmstadt. We wish Sascha and Dr Johanna Eisenträger all the very best in their new roles.

We also farewelled **Professor Xiao Lin (Joshua) Zhao**, Associate Dean (International) of UNSW Engineering, now Chair Professor of Civil Infrastructure at the Department of Civil and Environmental Engineering at Hong Kong Polytechnic University. Professor Zhao remains an Adjunct Professor with CIES.

PROFESSIONAL AND TECHNICAL STAFF

Technical Services - Kensington

PAUL GWYNNE
Lab Manager

RUDINO SALLEH
Senior Technical Officer

TIMOTHY WESTON
Technical Officer

LUIZ PETTERSEN
Technical Officer

WILLIAM TERRY
Senior Technical Officerr

FARJ ELHADAYRI
Technical Officerr

Technical and Professional - Heavy Structure Laboratory Randwick

DR ZHEN-TIAN CHANG
Laboratory Manager

SANJEEWA HERATH
Senior Technical Officer

TUAN LE
Technical Officer

RONALD MONCAY
Senior Technical Officer

GREG WORTHING
Technical Officer

Research Centre Management

GRACE ZHU
CIES Centre Manager

THERESA WISNIEWSKI
RIIS Business Manager

PHD GRADUATES 2022

MOHAMMED ALNAHHAL
Supervisor: Taehwan Kim
Rheology and Durability of Alkali-Activated Materials Made of Rice Husk Ash-Derived Sodium Silicates

MAHMOUD HAMMAD
Supervisor: Hamid Vali Pour Goudarzi
Timber-Steel-Concrete Hybrid Connections

AHMAD JAFARI
Supervisor: Nasser Khalili
Numerical Modelling of Hydro-Mechanical Coupling Processes in Fractured Porous Media

AMI KARIMI NOBANDEGANI
Supervisor: Hamid Vali Pour Goudarzi
Timber and Timber-Timber Composite (TTC) Beams with Openings: Laboratory Experimentation and Nonlocal Finite Element Simulation

LAYLA KIA
Supervisor: Hamid Vali Pour Goudarzi
Development of Expressive Timber-Steel Hybrid Exoskeletal Systems for Tall Timber Structures

XUEQING LU
Supervisor: Steve Davis
Examining Safety Behaviour on Construction Sites Using Virtual Reality

YATONG NIE
Supervisor: Hamid Vali Pour Goudarzi
Short- and long-term performance of timber-timber composite (TTC) system

SHUKAI YA
Supervisor: Chongmin Song
Seismic Analysis of Post-tensioned Gravity Dams using Scaled Boundary Finite Element Method

SAAD YOUNAS
Supervisor: Ehab Hamed
Time dependent behaviour of high strength concrete filled steel tubes

YINGDA ZHANG
Supervisor: Taehwan Kim
Modelling early age cracking in blended cement concrete

WELCOME NEW STAFF

A warm welcome to Dr Mohsen Kalantari.

Mohsen is a co-founder of a geospatial technology company called Faramoon, which, amongst other things, converts point cloud data to 3D models. Mohsen is passionate about research and translating it into impactful solutions to address societal challenges. Previously, he lectured in the Department of Infrastructure Engineering at the University of Melbourne. Before his academic career, he worked with the surveying and spatial industry through his role in the Department of Environment, Land, Water and Planning (DELWP) as the Victorian coordinator of a nationwide land and survey information modernisation initiative, ePlan.

Mohsen has a wealth of experience developing successful research grant applications, engaging with the industry and profession, building strong research teams, conducting research in Australia and overseas, and leading a research centre. His area of research covers land administration, 3D spatial Data Infrastructure, and the nexus of construction engineering and geospatial engineering, most notably BIM and digital engineering.

Mohsen brings in-depth and rich skills in university teaching, developing teaching grants, coordinating degrees, inter/cross-disciplinary/online curriculum development, accreditation, and assisting students in their studies. In this context, he envisions developing teaching methods considering that university learners have grown up with digital technologies. This philosophy also entails that today's formal learning classroom and online distance learning systems keep students motivated.

Mohsen has a wealth of experience developing successful research grant applications, engaging with the industry and profession...and leading a research centre.

Associate Professor Kalantari brings strong industry and professional links with Australian and international bodies and government agencies such as the United Nations, World Bank, Open Geospatial Consortium, Inter-governmental Committee on Surveying and Mapping (ICSM), mapping and land authorities across Australia, Singapore Land Authority, Surveying and Mapping Agency of Malaysia as well as the private sector.

Beyond contributions to academia, Mohsen's research has had a demonstrable contribution to industry; most notably, his co-founded start-up company Faramoon has licensed technology developed in his research group for commercialisation purposes. He aims to foster a mindset that advocates the importance of entrepreneurship in academic research to raise the culture of entrepreneurship in the Centre and School.

A warm welcome to Dr Daniel O'Shea.

Welcome to Dr Daniel O'Shea, an expert in applied mathematics, computational mechanics, and in devising models for nonlinear material behaviour - with application to biological tissues and advanced manufactured composites.

Daniel has been an associate lecturer in the School of Civil & Environmental Engineering since September 2018 and is a passionate educator and education innovator as well as conducting high level mathematical and engineering research. He has been a proponent and developer of blending learning assets for the online delivery of courses at UNSW, with a 95% approval rating as an educator among the large interdisciplinary engineering / math cohorts he has taught at UNSW.

His PhD completed at UNSW in 2019 and supervised by A/Prof Mario Attard and Prof David Kellermann, was in the fields of Applied Mathematics / Engineering, covering related sub fields of Continuum Mechanics, Constitutive Modelling, Model Optimisation, Hyperelasticity, Differential Calculus, Non-linear Finite Element Analysis, Advanced Fibre-Reinforced Composites, and Biological Tissues.

He has been a proponent and developer of blending learning assets for the online delivery of courses at UNSW

His thesis title was: "Hyperelasticity for Soft Biological Tissues and Fibre-Reinforced Composites using Orthotropic Fourth-Order Tensors" The dissertation conducted an exploration into the scientific field of nonlinear continuum mechanics; the fusion of physics and mathematics commissioned to describe the motion of material bodies. Learning about the mechanical workings of natural bodies imbues engineers with the capability to design materials that may be specified for a certain role. In modern society, fibre-reinforced composites are on the leading edge of engineered materials, finding extensive application in aeronautical, biomedical, and construction industries.

The thesis aimed to provide further advancement in the means of describing orthotropic mechanical processes. In biomechanics, pursuit of such research will improve abilities to predict and detect abnormal tissue behaviour, and to engineer solutions in the form of advanced medical imaging and prosthesis development.

Daniel has had his work published in the International Journal of Solids and Structures and presented at international conferences including the International Conference for Composite Materials (ICCM21), Xi'an, China and the European Solid Mechanics Conference (ESMC2018), Bologna, Italy.

Daniel is also a bushcare volunteer with Randwick City Council.

VALES IN 2022

Professor Somasundaram Valliappan

CIES Emeritus Professor Somasundaram Valliappan (Val) passed away on 12 Dec 2022. Val, as he was affectionately known, was an internationally renowned expert in computational mechanics, and an active member of academic staff from 1969 until his retirement in 2003. He was a Fellow of the International Association Computational Mechanics, the Institution Engineers Australia, and the American Society of Civil Engineers.

He was described as 'a towering figure' by one of his many PhD students, PSM & Scientia Professor Nasser Khalili. "He was a mentor to many staff within the School" Professor Khalili said, "and will be immensely missed by all those who have been fortunate enough to know him."

Somasundaram Valliappan was born on June 15, 1933 in Devakottai, India. He graduated with a BE from Annamalai University in 1955, and married Kamala in 1956. He lectured at Annamalai for some years before undertaking a Master of Science at Boston's Northeastern University, graduating in 1963. A Doctor of Philosophy, under the direction of the famous mathematician and civil engineer Professor Olgierd Cecil Zienkiewicz at the University of Wales (Swansea) soon followed.

"He was a mentor to many staff within the School and will be immensely missed by all those who have been fortunate enough to know him"

Val's PhD on 'Non-Linear Stress Analysis of two Dimensional Problems with Special Reference to Rock and Soil Mechanics' was completed in 1968. His 1969 publication 'Elasto-plastic solution of engineering problems; initial stress, finite element approach' (with Olgierd Cecil Zienkiewicz and Ian P. King) was, and is, a major contribution to the analysis of inelastic problems in the transient state.

Val and his family came to Australia in 1969 where he joined the academic staff of UNSW's School of Civil Engineering. From 1973 to 1980 he and Professor Ian Lee worked on several projects together including looking at strength and deformation characteristics of soils, rocks and composites due to static and dynamic loading.

From these projects, numerical techniques, supplemented by experimental investigations, were developed for the solutions of anisotropic and nonlinear consolidation, soil-structure interaction including raft-pile foundations, isotropic and anisotropic plasticity solutions for foundations, foundations subjected to dynamic and earthquake loadings, retaining structures, interaction of tunnel openings, and mining subsidence and liquefaction.

These important investigations into the behaviour of soils and rocks facilitated the execution of several practical problems for various NSW Government organizations such as the Public Works Department, the Water Board and Electricity Commission, including stress analysis of Hume, Parramatta and Warragamba dams; prediction of mining subsidence in Newcastle; earthquake effects on the intake Tower of Mangrove Creek Dam, and the liquefaction potential of ash dam foundations.

Val also produced classic texts which made significant contributions to the global body of civil engineering knowledge, as well as becoming seminal textbooks which have served generations of students, including Finite Element Analysis in Geomechanics, (1979) Unisearch Ltd, Sydney, and Continuum Mechanics –Fundamentals, (1981) AA Balkema, Netherlands.

In the 1980's Valliappan led a research group which concentrated on developing analytical and numerical approaches based on sound theoretical principles to solve complex problems in geomechanics. The highlights of Valliappan's work during this period, with several projects supported by ARC funding, were in the areas of fracture mechanics (Valliappan, Viriyawan Murti and Kok Keng Ang), damage mechanics (Valliappan, Zhang Wohua and Mehdi Yazdchi), and fuzzy finite elements (Valliappan and Tuan Duc Pham). In particular Valliappan's work on the application of fuzzy finite element analysis to geotechnical problems attracted international attention, and he was promoted to Professor in 1994.

Val retired in 2003 but continued as an Emeritus Professor with many technical, academic and professional community projects and collaborations.

In 1999 Valliappan was one of the initiators of the APACM which brings together 13 Computational Mechanics associations in the Asia-Pacific region. The APACM congress (APCOM) awards an important medal bearing his name every 3 years since 2013.

Val retired in 2003 but continued as an Emeritus Professor with many technical, academic and professional community projects and collaborations. He was an Honorary Member of the International Association of Computational Mechanics (IACM) and had served as Vice President of IACM and President of APACM.

Our sincere condolences go to Val's family – his wife Kamala and children: Vimala, Asha, and Trisha. Vale Val, and thank you.

Frank Scharfe.

Frank Scharfe, who passed away in October 2022, was a Technical Officer based at the Randwick Heavy Structures Lab (HSL) for almost forty years, from the 1970s until the late 2000s.

"Frank has left an indelible imprint in the Lab and in the School," said Laboratory Manager Paul Gwynne.

Frank's long-time colleague, HSL Senior Technical Officer Ron Moncay, recalled that Frank had always been someone "who was happy to go out of his way to help out anyone who came to him." He was also known for his wide-ranging knowledge and opinions on political and other matters. "I fondly remember our informative discussions and even heated debates on almost any subject within and outside the Uni," said Ron.

Dean of UNSW Engineering, Professor Stephen Foster said "I knew Frank well, right back to the work on my PhD. Frank was very dedicated and highly valued by everyone that he worked and socialised with. The numbers of PhD and Masters students alone that he supported, and contributed to their work, would number in the many dozens."

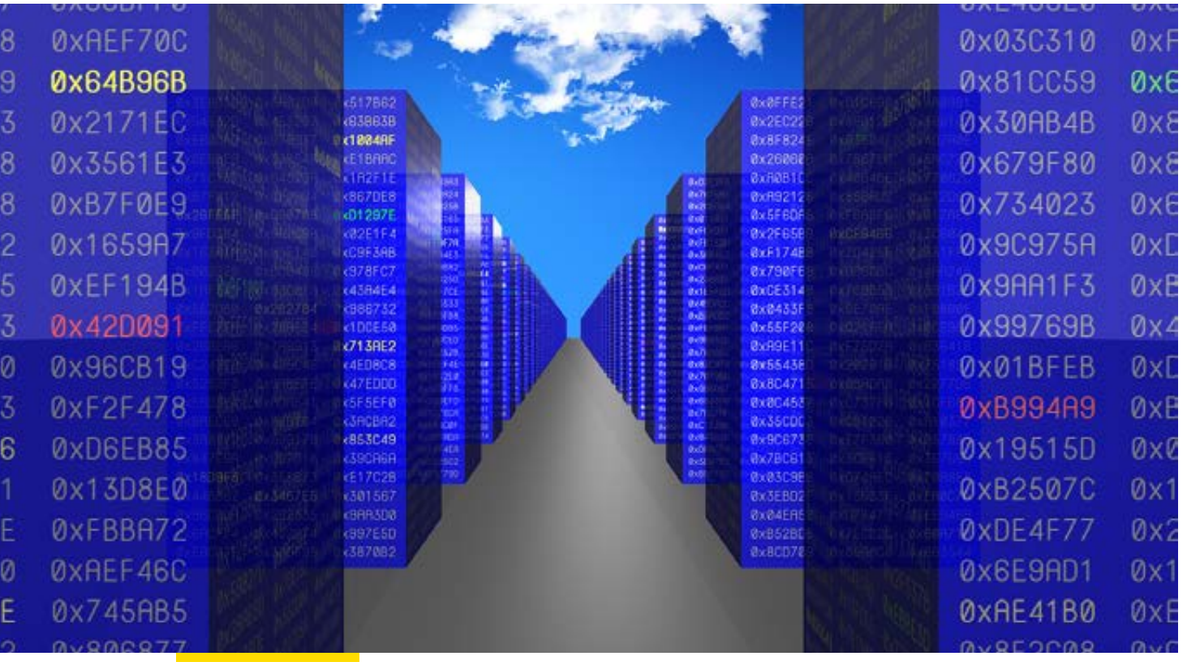
After his retirement in the late 2000s, Frank became a Visiting Fellow and continued to help out his colleagues for several years.

"Frank was a selfless person and contributed to running of the Heavy Structures Lab in every way possible that he could," said PSM & Scientia Professor Nasser Khalili. "He was a wonderful example of a good citizen. My condolences to all his friends and family."

"Frank has left an indelible imprint in the Lab and in the School."

SECTION 3

OUR RESEARCH



CIES RESEARCH HIGHLIGHTS

Digital Infrastructure Engineering and BIM – new capabilities at CIES

We investigate using digital technologies and processes to design, construct, and operate physical infrastructure such as buildings, bridges, and highways. Our research develops digital methods operating on technologies such as Lidar, photogrammetry, building information modelling (BIM), and geographic information systems (GIS) to create, simulate, analyse, and optimise designs. Our current projects include:

- Developing BIM-based methods to optimise construction demolition (2019-2023)
- Digital engineering in tertiary education (2020- 2024)
- Developing approaches to use point cloud for structural analysis (2023)
- Developing methods to use mobile laser scanning to identify defects on roads (2023)
- Extending International BIM standards for various types of infrastructure systems (2023)
- Using Digital engineering to verify recycled material (2023- 2026)

For more information and collaboration, please get in touch with Digital Infrastructure Engineering and BIM lead Associate Professor Mohsen Kalantari (mohsen.kalantari@unsw.edu.au).

CIES research assists first printed house in the southern hemisphere.

In 2022 CIES academic Dr Ali Kashani in partnership with Contour 3D, developed a 3D printing mortar that was utilised for onsite printing of the first house in the southern hemisphere.

The 60 sqm, 3 m high structure, which was built as a poolside cabana, featuring a living area, dining area, bathroom and bar, was part of The Block Show of Channel 9 on Tuesday 13 Sept and featured in the Sydney Morning Herald and The Age.

The concrete mix used in the printing process was designed with the help of Dr Kashani, using recycled materials. Kashani who is a Churchill Fellow in Construction 3D Printing has extensive experience in research, development, and commercialisation of advanced and sustainable construction materials.

Dr Kashani and PhD student Hamid Bayat worked closely with Contour 3D for more than twelve months to develop the special concrete with appealing finish that could stand in place while drying as well as meeting strength and durability requirements.

The team hopes eventually to develop a concrete mix that will use more recycled materials and will be self-insulating, so additional insulation will not be needed. They also hope to introduce artificial intelligence to the printer, which could change the concrete mix used depending on the weather, or for day and night printing when temperatures change.

Dr Kashani notes that while 3D printing is used in the building industry for some prefabricated elements which are assembled on site, its use is not mainstream. He intends to change that.

So too does Contour3D founder Nick Holden, who says that Australia can become a leader in advanced manufacturing technology. 'By constantly pioneering the disciplines of material sciences, advanced robotics, software development and precision engineering we will revolutionise the way we build.'

"The concrete mix used in the printing process was designed with the help of Dr Kashani, using recycled materials"

Above: Hamid Bayat and Ali Kashani in CIES labs

Professor Adrian Russell - focus on knowledge transfer.

In May 2022 Professor Russell gave a presentation for the Australian Geomechanics Society (AGS), in which he focused on the uptake of unsaturated soil mechanics in engineering practice.

In his talk entitled, 'The mechanics of unsaturated soils and tailings - With comments on practical applications', Adrian outlined industry changes and trends in Australia, including good practices and commonly made mistakes. He then gave examples of research outcomes related to strength and stability calculations and showed how they can be applied routinely in commercial software. Adrian also outlined areas where additional knowledge is needed. Presentation slides are available here.

A recently completed Linkage Project aimed to reduce risk in the mining industry from failing mine tailings. Adrian and his research team discovered how to characterise tailings, and assess liquefaction propensity, when they are partially saturated. They are now reaching out to a global and local audience, educating them on a pressing problem that is vital to reducing the number of tailings dam failures, which can be catastrophic to the downstream community.

In October 2022 Adrian delivered a keynote lecture on the topic at a conference in Peru, the 1st International Congress of Geotechnical Engineering GEOUPC - CIIGGUPC 2022, and in

November he delivered a lecture to members of an international Technical Committee on Tailings and Mine Waste (TC221) in a special webinar, hosted by Technische Universität München, Germany.

These complement multiple special lectures Adrian gave on the topic earlier this year through the Tailings Center in the USA; the AGERP International Workshop on Unsaturated Soils; the University of Chile; to SRK Consulting in Argentina and Ghana; and at the 8th International Conference on Tailings Management conference in Chile.
Selected lecture recordings can be viewed at:

https://youtu.be/0dvOLC7ciSI

https://youtu.be/d_0A2p2f5uk

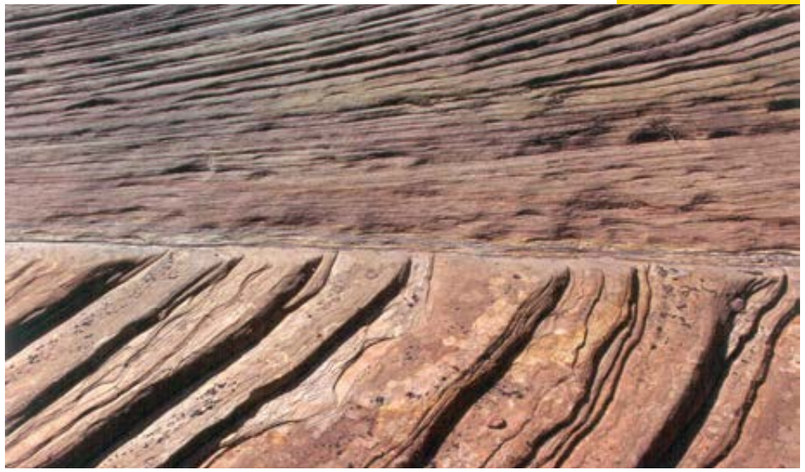
In his latest research paper, Prof. Russell and his team have shown practitioners how to estimate the post-earthquake strength of a tailings when unsaturated.

'The CPT interpretation methods and strength assessments used in industry prior to these discoveries were developed primarily for saturated natural soils,' says Prof. Russell. 'There are many differences between saturated natural soils and tailings in a dam, with tailings being siltier, or more dust-like, and unsaturated in many cases.

'This rectifies what many falsely assume: that unsaturated tailings do not liquefy in an earthquake. This means engineers can use improved strength estimations in any earthquake stability assessment to accurately identify which TSFs are more at risk of failure.'

In November 2022 Adrian was invited to join the editorial board of Géotechnique. This is the most prestigious journal in the field of geotechnical engineering and is indicative of the international standing and impact of Adrian's work.

"There are many differences between saturated natural soils and tailings in a dam, with tailings being siltier, or more dust-like, and unsaturated in many cases."



Opposite: A bridge over the Hunter River near Morpeth, New South Wales.

DECRA bridge safety

CIES academic Dr Mehrisadat Makki Alamdari has spent the last decade inspecting bridges, analysing their data and finding more efficient ways to perform structural health assessments to ensure they remain safe. One of the new projects she is working on is developing a vehicle-mounted sensing system that whizzes across bridges to build a snapshot of their health and safety.

Dr Makki Alamdari says that all of Australia's 53,000 bridges – from Sydney Harbour to the Swan River and everything in between – are visually inspected at the very least, every year. But increasing volumes of traffic and larger, heavier vehicles have increased the load that bridges now have to bear. More than ever, regulators and governments need to make reliable predictions about bridge safety which require more resources and more funding for their upkeep.

"My DECRA brief is to come up with advanced signal processing techniques to extract the vibration response of a moving vehicle."

Dr Makki Alamdari is drawing on her expertise in structural health monitoring and vibrational analysis to develop a new mobile technology that strikes a balance between efficiency and economy. Rather than loading up a bridge with expensive sensors, what if you were to put sensors on vehicles that measure the state of the bridge as they pass over it?

'My DECRA brief is to come up with advanced signal processing techniques to extract the vibration response of a moving vehicle and then build a data-driven algorithm using machine learning and artificial intelligence to compile a database about key indicators of the bridge's structural health,' she says.

Her team, in collaboration with partners at Kyoto University (Japan) use a cable-stayed bridge with a span of about 50m, to test a small prototype vehicle. 'The car will move back and forth many times to collect a rich dataset of the bridge,' says Dr Makki Alamdari. 'Once data is collected, they will be analysed off-line in the office to see if there are any anomalies compared to the benchmark state.'

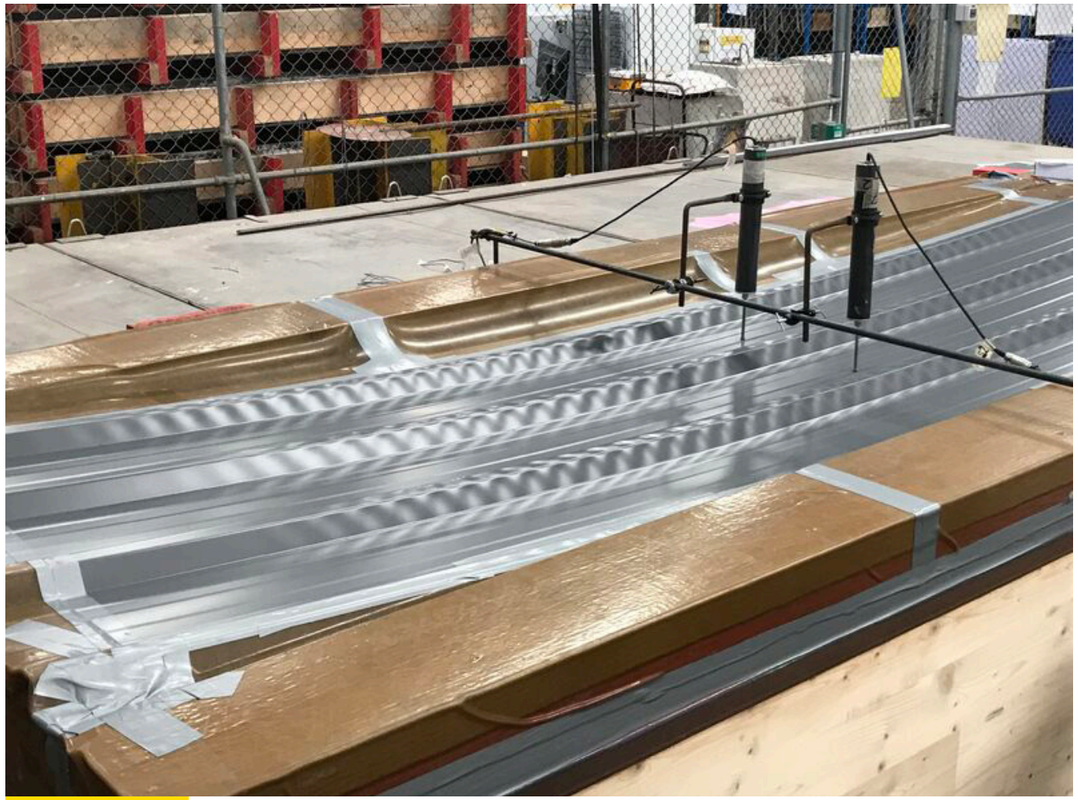
'The next step in our testing was to gradually introduce artificial damage into the structure of the bridge and verify that our signals reveal this damage, purely by processing the response of the vehicle.'

'In the laboratory we have proven that we can monitor the health status of the bridge using this technology,' she says. 'But in the field it's always a different story. That work comes next.'

Dr Makki Alamdari is hopeful that mobile sensor vehicles may be commercially available by the end of the decade. 'To get it to the required level involves a lot of work in terms of advancing and tuning the parameters of your algorithm and increasing the sensitivity of your sensors. All those things need to be just right to ensure the technology works in the way we intend.'

About Dr Mehri Makki Alamdari:
Dr Alamdari's expertise is structural health monitoring, vibration analysis and testing, inverse dynamic problems and signal processing. She was the recipient of the highly competitive ARC Discovery Early Career Research Award (DECRA) in 2020. As an award-winning scholar, Mehri is on the Executive of the Australian Network of Structural Health Monitoring (ANSHM), a member of The International Society for Structural Health Monitoring of Intelligent Infrastructure (ISHMII), a member of International Association for Bridge Maintenance and Safety (IABMAS), and a steering committee member in the Australia, New Zealand and Oceania Researchers in Japan Network (ANZOR Japan Network). Prior to joining CIES, she was a research fellow in Data61|CSIRO (since 2015) working on structural health monitoring of the iconic Sydney Harbour Bridge.

"In the laboratory we have proven that we can monitor the health status of the bridge using this technology"



Associate Professor Ehab Hamed

Saving energy – saving the planet

Associate Professor Ehab Hamed has been researching light weight insulated sandwich panels for several years, as part of his interest in technologies that significantly reduce the cost and energy needed for heating and cooling buildings, with an overall positive impact on the environment.

Typically used in roofs, external walls, and cladding, these insulated panels offer several advantages in terms of their light weight and pre-insulated properties. The panels are constructed of two thin flat or profiled steel skins that are separated by a thermal insulation core.

The panels have undergone rigorous testing over time including being exposed to various temperature cycles using a thermal blanket and a vacuum chamber. The development of numerical models has also been used for their analysis, to provide a better understanding of the long-term performance in buildings.

Associate Professor Hamed is an expert in the field of structural engineering, with intensive research experience and previous experience in working with industry on research and consultancy projects. He is also involved in professional organizations such as Standards Australia and the American Concrete Institute, that deal with delivering design and safety guidelines for structural engineers.

Inaugural Open Day for Industry and Alumni

CIES held its first Open Day on 8th November 2022 with presentations from CIES academics and tours of our laboratories. Fifty people attended the Open Day, which was a fantastic opportunity for external and on-campus partners to learn more about the current research and plans of CIES, to meet our industry leading researchers, and to get hands-on experience and insight into our projects and capabilities through laboratory tours.

The Open Day began with lunch, followed by presentations by several CIES research leaders, including Professor Mark Bradford, Associate Professor Hamid Valipour and Dr Ali Kashani.

Attendees were then guided through the Heavy Structures Research Laboratory - Randwick Campus, and on UNSW Kensington main campus, the Construction Laboratory, Geotechnical Laboratory, and the Infrastructure (Advanced Materials) Research Laboratory.

Professor Hamid Valipour was lead organiser of the Open Day, ably supported by A/Prof Ehab Hamed, Dr Ali Kashani, Dr Arman Khoshghalb, Dr Taehwan Kim, and Dr Johnson Shen, and by CIES laboratory managers Dr Zhen-Tian Chang and Paul Gwynne.

Grateful thanks also to the laboratory technical staff, to our PhD research students for their assistance, to CIES Manager Grace Zhu, and to the UNSW Engineering External Relationship Team for their help with organising the inaugural Open Day.

A fantastic opportunity for external and on-campus partners to learn more about the current research and plans of CIES...

CIES RESEARCH GRANT INCOME 2022

CIES INVESTIGATORS	PROJECT TITLE	SPONSOR NAME	2022 AMOUNT
Bidarmaghz, A	Simplified modelling of open loop coaxial ground heat exchanger wells in the Perth Basin	University of Melbourne / Hot Dry Rocks - Subcontract	4,500
Bradford, MA	Vulnerability of Steel Lattice Towers to Fire	Australian Research Council / Discovery Project	112,883
Foster, SJ	Mixed Mode Torsion-Shear-Bending Failure in SFRC Elements	Australian Research Council / Discovery Project	130,000
Foster, SJ, Hajimohammadi, A	A study into Long-Term Performance of Geopolymer Concrete and Assessment of Field Performance	Transport for NSW / State Government Contract	35,000
Foster, SJ, Hajimohammadi, A	Concrete Mixes for Durability: A Hybrid Mathematical Optimisation Approach	ARC Linkage Project with Boral Shared Business Service P/L	171,000
Gao, W	Topological Design of Mechanical Meta-Structures	University of Technology, Sydney (UTS) / ARC Discovery Project Shared Grant	50,000
Gao, W	ARC Research Hub for Transformation of Reclaimed Waste Resources to Engineered Materials and Solutions for a Circular Economy	RMIT / ARC Industrial Transformation Research Hub Shared Grant & Collaborting Organisation	120,000
Gilbert, RI	Time Dependent Behaviour of Fibre Reinforced Concrete Structures.	ARC Discovery Project	100,000
Hajimohammadi, A, Foster, SJ, Vali Pour Goudarzi, HR	Development of Novel Concrete Noise Walls Incorporating Recycled Materials	ARC Linkage Project with Tyre Stewardship Australia & Flexiroc Australia	79,500
Hajimohammadi, A	The uptake of Solar PV glass in construction applications	PV Industries Pty Ltd / NSW EPA Circular Solar Trials Grants Program Shared Grant	57,807
Hajimohammadi, A, Kim, T	Investigating the reuse of glass from waste photovoltaic modules for construction applications	PV Industries Pty Ltd / NSW EPA Circular Solar Trials Grants Program Shared Grant	44,910
Hajimohammadi, A Kim, T, Foster, SJ	Next generation sustainable concrete: trialling recycled glass in geopolymer concretes	John Holland Pty Ltd / NSW EPA Civil Construction Market Program Shared Grant	72,017
Hajimohammadi, A, Vali Pour Goudarzi, HR	Implementation of recycled rubber for acoustic applications	Tyre Stewardship Australia / Flexiroc Australia Pty Ltd	108,000
Kashani, A	Developing a mortar for 3D printing using a gantry system	Contour 3d Pty Ltd / Contract Research	10,302
Kashani, A, Al-Damad, IM	Development of Sustainable Concrete with Glass Waste Mixes	Department of Industry, Science and Resources / Innovation Connections Contract,	37,378
Kashani, A, Kim, T, Foster, SJ, Al-Damad, M	Development of Sustainable Concrete with Glass Waste Mixes	XL Precast Pty Ltd / Innovation Connections Contract	18,689
Khalili-Naghadeh, N	Earthworks Pore Pressure Response and Consolidation Analysis	Beca Pty Ltd / Contract Research	52,667
Khalili-Naghadeh, N	Strength Characterization of FRV	GHD Pty Ltd / Contract Research	43,000
Khalili-Naghadeh, N, Bidarmaghz, A, Vahab, M	Non-differentiable Energy Minimisation For Modelling Fractured Porous Media	Australian Research Council / Discovery Project	121,000
Khalili-Naghadeh, N, Hajimohammadi, A, Shahbodaghkhan, B	Recycling plastic and paperboard waste to develop value-added asphalt	State Asphalts NSW Pty Ltd / DIIS - Cooperative Research Centre Projects (CRC-P's) Shared Grant	363,167
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC Industry Transformation Research Hub for Resilient and Intelligent Infrastructure Systems (RIIS) in Urban, Resources and Energy Sectors	Australian Research Council / Industrial Transformation Research Hubs	415,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC Industrial Transformation Research Hubs (ITRH) - RIIS Industry Partner Contribution	Kumul Petroleum Holdings Limited	200,050
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Lindenbaum Pty Ltd	50,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Linke & Linke Surveys	100,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Azure Mining Technology Pty Ltd	150,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Crypses Pty Ltd	10,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Asset Institute Limited	50,000

CIES INVESTIGATORS	PROJECT TITLE	SPONSOR NAME	2022 AMOUNT
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	AAM Pty Ltd	25,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	South East Water	25,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Spatial Vision Innovations Pty Ltd	15,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Mincka Engineering Pty Ltd	50,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Spatial Information Systems Research (FrontierSI)	50,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Investment NSW / NSW RAAP - Co-Investment in Industrial Transformation Research Program (Hubs and Centres)	100,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Emerson Process Management Australia P/L	100,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Hawk Measurement Systems Pty Ltd	50,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Rockfield Technologies Australia Pty Ltd	30,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Hyqualty Construction Pty Ltd	20,000
Khalili-Naghadeh, N, Gao, W, Shen, X, Shahbodaghkhan, B, Vahab, M	ARC ITRH -RIIS Industry Partner Contribution	Sycamore Civil Group Pty Ltd	20,000
Khoshghalb, A	Cyclic simple shear tests on tailings samples 1 & 2	ATC Williams Pty Ltd / Contract Research	26,270
Kim, T	Self-Healing Concrete for Mitigation of Chloride induced Steel Corrosion	University of Technology, Sydney (UTS) / ARC Discovery Project Shared Grant	3,500
Kim, T, Hajimohammadi, A	Decarbonising built environments with hempcrete and green wall technology	University of Technology, Sydney (UTS) / ARC Linkage Project Shared Grant	7,000
Makki Alamdari, M	Developing an Advanced Drive-by Bridge Inspection Technology	Australian Research Council / Discovery Early Career Researcher Award (DECRA)	83,982
Russell, A	Preventing mining disasters: reducing the risk of tailings dam failure	Australian Research Council / Future Fellowship	260,000
Russell, A	Tailings Dams Stage 2 - Methods to incorporate suction in to data interpretation and stability assessment	BHP Billiton Olympic Dam Corporation Pty Ltd / Contract Research	50,000
Song, C	Computational fracture analysis of structures and materials	Australian Research Council / Discovery Project	135,000
Song, C	Ship response under corrosion, fatigue and complex sea-state environments	University of Newcastle / ARC Linkage Project Shared Grant, DSTG & Pacific ESI Shared Partner Contributors	95,709
Vali Pour Goudarzi, HR	Uniaxial static and cyclic(fatigue) compression tests on standard cylinders.	Wagners EFC Pty Ltd / Contract Research	26,241
Vali Pour Goudarzi, HR	Testing concrete with chain reinforcement	Rioflex Pty Ltd / Contract Research	28,030
Vali Pour Goudarzi, HR	Performance evaluation of one touch couplers under service and ultimate loads	Onefab Engineering Pty Ltd / Contract Research	29,525
Vali Pour Goudarzi, HR	Shear and tension testing of the timber-plasterboard joints with mechanical fasteners	Viridi Group Pty Ltd / Contract Research	33,083
Vali Pour Goudarzi, HR	Buckling of longitudinal steel bars in columns	InfraBuild Steel / Contract Research	10,411
Vali Pour Goudarzi, HR	Testing of timber-steel composite floor (Strongfloor module)	Viridi Group Pty Ltd / Contract Research	5,511
Vali Pour Goudarzi, HR | Bradford, MA	Torsion in innovative timber composite floors	Australian Research Council / Discovery Project	110,000
Vali Pour Goudarzi, HR | Chang, Z	Testing and analysis of timber I-joists	GAK Wood Pty Ltd / Contract Research	10,379
Vali Pour Goudarzi, HR | Foster, SJ	Connections for hybrid steel-timber-concrete structures	Australian Research Council / Discovery Project	110,000
TOTAL			**4,216,511.00**

CIES LABORATORIES EQUIPMENT AND CAPABILITIES

Our laboratories

CIES research and commercial activities are conducted within extensive physical laboratory resources, with a wide variety of equipment. These state-of-the-art facilities enable us to undertake our cutting-edge research, and thorough and timely industry investigations.

Our Cementitious Materials Laboratory is equipped with cutting-edge facilities for measuring cement and concrete materials characterisation and for durability testing. This includes: Thermogravimetric Analysis (TGA); isothermal calorimeter; laser Flash analyser; Plasma CVD equipment; eleven channels potentiostat for standard steel reinforcement corrosion testing; accelerated carbonation chamber; sorption-desorption testing apparatus and more.

Our Construction Automation Laboratory: This new research facility will be used to fundamentally research, develop, refine, and systematically evaluate automated construction techniques for increased collaboration with industry, leading to rapid technology transfer. The state-of-the-art research facility will enable new methods of digital 3D printing by addressing the reinforcement issue and other main challenges of construction 3D printing.

CIES can play an important role in construction automation not only in Australia but also internationally by fulfilling the need for a research facility to implement collaborative robots for construction activities. This research facility will be used for other construction automation processes including modular construction and structural assembly, shotcreting, BIM integration, automated demolition, and automated bricklaying. It can also be used for cross-disciplinary projects by UNSW researchers, the construction industry and other researchers around the world.

Our Geotechnical Engineering Laboratories: The scale of capability for geotechnical engineering research and testing is not available in any other university in Australia. Importantly, triplicates (or more) of the most highly used equipment (triaxials and oedometer/CRS frames) are available enabling an ambitious program of experiments to be completed in a timely manner.

Our Heavy Structures Laboratories are equipped with state-of-the-art servo-controlled hydraulic actuators and universal testing machines to maintain a capacity for high load testing, ranging from 10 kN to 5000 kN. We combine strength testing with X-Ray measuring of laboratory specimens under load. This improves understanding at the materials level for the development of refined, mechanically based, structural models.

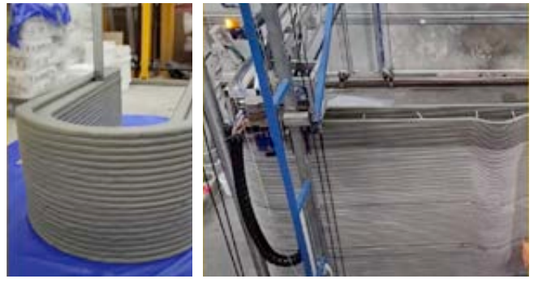
It can also be used for cross-disciplinary projects by UNSW researchers, the construction industry and other researchers around the world.

In 2022 UNSW created short videos about CIES research laboratories.

These videos are viewable on YouTube

Professor Hamid Valipour introduces the Heavy Structures Laboratory at UNSW

https://youtu.be/1apBK-bqlCY



Associate Professor Ehab Hamed, Dr Ali Kashani and Dr Arman Khoshghalb discuss their laboratory research projects.

https://youtu.be/jNWR6yFFNAk

CIES Testing Capability for Construction Materials

CIES laboratories are well equipped to conduct any type of experiment related to construction materials.

1. MATERIALS

- Concrete (from conventional Portland cement-based concrete to alternative concrete, including 3D printable concrete)
- Asphalt
- Timber
- Any components of construction materials including Portland cement, aggregates, supplementary cementitious materials, emulsion, industrial by-wastes, etc.
- Development of the optimum mixture design and the sustainable mixture design

2. MECHANICAL TESTS

- Setting time, slump, rheological properties
- All types of strength tests
- Creep tests
- Shrinkage tests (chemical, autogenous, and drying shrinkages)
- Thermal cracking tests
- Restrained shrinkage cracking tests

3. DURABILITY TESTS

- Various chemical attacks (acid attack, sulfate attack, and chloride attack)
- Corrosion potential tests
- Chloride diffusion tests
- Alkali-silica reaction
- Carbonation
- Water absorption

4. CHARACTERISATION OF MATERIALS

- Elemental composition and mineralogical composition of materials
- Materials reactivity as construction materials
- Thermal properties of materials
- Electrical properties
- Microstructure changes
- Pore structural changes

CIES Equipment for Construction Materials Testing

1.1 MECHANICAL PROPERTIES

- Strength testing machines
  - Avery 1800kN Concrete Compression testing machine
  - Satec 3Mn Static compression testing machine
  - INSTRON 10kN Universal testing machine
- Different sizes of mixers
- Flow table tests
- VICAMATIC-20UTCM (Automatic Vicat apparatus for setting time)
- Discovery Hybrid Rheometer – 2 for the rheological properties
- Shrinkage and creep testing apparatus
- Corrugated autogenous shrinkage apparatus (in compliance with ASTM C1698)
  - Apparatus for chemical shrinkage (in compliance with ASTM C1608)
  - Concrete prism drying shrinkage
  - Compressive creep test
  - Tensile creep test
- Rigid cracking frame for thermal cracking of the concrete
- 3D printing robotic arms

1.2 DURABILITY TESTS

- Corrosion tests
  - Chloride bulk diffusion test
  - Rapid chloride penetration test
  - Rapid chloride migration test
  - Robotic titrosampler analysis of the chloride profile in concrete
  - Potentiometer for the corrosion potential measurement (VMP3-01/Z DC +EIC channels)
- Environmental control chambers (humidity and temperature)
- Carbonation chamber
- Glove boxes to control the environments

1.3 CHARACTERISATION OF MATERIALS

- Thermogravimetric analysis (Q600-SDT simultaneous SDC-TGA)
- Thermal diffusivity measurement (LFA-3467 Hyperflaseh)
- Thermal conductivity (Trident C-therm)
- Adsorption and desorption analyzer for pore size distribution and surface area (NOVAtouch NT 4LX)
- Ball mill grinder (Fritsch Pulverisette-6 Mill)
- Mercury Introsion Porosmetry (Micromeritics autopore 9520)
- Ultrasonic pulse velocity measurement (Pundit PL200 Ultrasonic tester)
- Surface electrical resistivity measurement (Proceq concrete resistivity meter)
- Particle size distribution analyzer (Malvern Mastersizer)
- Fourier transformation infrared (FTIR) spectroscopy (PerkinElmer FTIR)
- Concrete pore solution analysis (Pore solution extraction device and Inductively coupled plasma – optical emission spectroscopy)

4. ALL OTHER ANALYTICAL CHARACTERISATION TECHNIQUES ARE AVAILABLE IN MARK WAINWRIGHT ANALYTICAL CENTRE AT UNSW

- Scanning electron microscopy – Energy dispersive spectroscopy
- X-ray fluorescence (XRF)
- X-ray diffraction (XRD) facility
- Tyree X-ray CT facility
- Nuclear magnetic resonance (NMR) facility

CIES Geotechnical Engineering Laboratories

Our well-equipped geotechnical engineering laboratories contain a diverse range of soil, rock and asphalt testing equipment, along with specialist and advanced equipment used to support industry-focused research. Our researchers are award-winning and recognised globally as leaders in their field. The scale of our laboratory capability is not available in any other university in Australia.

EQUIPMENT INCLUDES:

- Earthquake shaking table (permitting simultaneous horizontal and vertical motion) and laminated shear stack – 2.6 tonne models http://www.cies.unsw.edu.au/news/earthquake-research-given-a-shake-up
- Calibration chamber for CPT testing (adaptable for pile testing, pressuremeter testing and dilatometertesting) https://www.linkedin.com/feed/update/activity:6422264686678540288/
- 2cm2 cone, Hyson 100kN penetrometer, logging system and calibration chamber for housing large unsaturated soil and tailings samples
- Enterprise level dynamic triaxial testing facility for saturated and unsaturated samples (x2)
- Enterprise level dynamic simple shear testing facility for saturated and unsaturated samples (x1)
- Enterprise level dynamic true triaxial testing facility for saturated and unsaturated samples (x1)
- Consolidometers (CRS and standard) (for testing saturated and unsaturated samples 50100mm diameter) (x 4)
- Slurriometer (for testing saturated and very soft (tailings like) deposits, 50mm diameter) (x 1)
- Resonant column testing facilities for saturated and unsaturated samples (x2)
- Rock triaxial cell for testing samples 25mm, 50mm or 100mm diameter at cell pressures up to 64MPa (x1)
- Bishop Wesley triaxial equipment for testing saturated and unsaturated soils (x 4, including one for testing at elevated temperatures)
- Triaxial cells for saturated soil samples 100mm and 200mm diameters (x 2)
- Standard triaxial cell for testing saturated samples of 50mm diameter (x1)
- Ring shear equipment for assessing residual strength within soil and at interfaces (Bromhead type) (x1)
- Shear boxes (for testing samples 100mm by 100mm) (x 4)
- Large shear box (for testing samples 300mm by 300mm) (x1)
- Lysimeter lights and frames to simulate sun drying
- Lateral earth pressure rig – 3 tonne models
- Shallow foundation testing rig – 2 tonne models
- Soil pressure plates for determining relationship between suction and moisture content (x4)
- Osmotic equipment for determining relationship between suction and moisture content
- Filter paper equipment for determining relationship between suction and moisture content
- Bespoke soil erosion testing equipment (pinhole erosion, suffusion, internal erosion and surface erosion)

Inventory of Major Testing Facilities at Heavy Structures Lab

- A RED Testing Frame with INSTRON 5 MN Compression/Tension actuator for static or low frequency dynamic tests
- A YELLOW Testing Frame with two INSTRON 500 kN Compression/Tension actuators for individual or collaborative static or dynamic/fatigue tests
- A GREEN Testing Frame with one INSTRON 1.2 MN Compression/Tension actuator and one INSTRON 300 kN HORIZONTAL Compression/Tension actuator for individual static or dynamic/fatigue tests
- 1 MN INSTRON Tension/Compression Universal testing machine for static or dynamic/fatigue tests
- 250 kN INSTRON Tension/Compression Universal testing machine for static or dynamic/fatigue tests
- 2 MN INSTRON testing machine for static Compression tests
- A Steel Frame (Gray) with a 2.5 MN compression ram for long term loading tests
- A Steel Frame (Blue) with a 2 MN compression ram for long term loading tests
- A 29.3 x 9.75 x1.22m prestressed reinforced concrete floor area provided a strong structural footing for 3 major testing frames (Red, Yellow and Green) plus quite a few anchor points for setting up small steel frames for short/long term loading tests
- A climate (Temperature and R/H) controlled room with 6+ creep rigs for creep testing
- A 5t overhead bridge crane, a 10m vertical mast Elevated Work Platform (EWP), 2 forklifts (2.5t and 1.5t) and a battery Walkie (1.3t) enabled mobile handling and setting up/disposal of large and heavy specimens
- A VIC-3D DIC (Digital Image Correlation) system enables advanced 2D and 3D strain measurements of specimens during experimental testing

CIES PUBLICATIONS 2022

APA6 Citation. CIES Author/s in bold

In 2022 CIES researchers published one book, 3 book chapters, and 121 refereed Journal articles.

BOOK

Warner R., **Foster S.**, Kilpatrick, A., and Gravina, R., "Prestressed Concrete", 5th Ed., Pearson, 2022, 667 pp., ISBN. 978-0-6557-0639-7.

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