# CONTENTS

## Our Centre

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our Vision</td>
<td>4</td>
</tr>
<tr>
<td>About Us</td>
<td>5</td>
</tr>
<tr>
<td>Welcome from the Director</td>
<td>8</td>
</tr>
<tr>
<td>CIES IAC Industry Members 2019</td>
<td>9</td>
</tr>
<tr>
<td>ARC Grants</td>
<td>13</td>
</tr>
<tr>
<td>CIES Awards &amp; Achievements 2019</td>
<td>15</td>
</tr>
<tr>
<td>CIES Promotions 2019</td>
<td>19</td>
</tr>
<tr>
<td>CIES Grants 2019</td>
<td>20</td>
</tr>
</tbody>
</table>

## Our People

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Staff</td>
<td>23</td>
</tr>
<tr>
<td>Farewell</td>
<td>26</td>
</tr>
<tr>
<td>Centre Research Staff</td>
<td>28</td>
</tr>
<tr>
<td>Welcome</td>
<td>29</td>
</tr>
<tr>
<td>PhD Graduates</td>
<td>33</td>
</tr>
</tbody>
</table>

## Our Research

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our Laboratories</td>
<td>36</td>
</tr>
<tr>
<td>New geotechnical research to significantly reduce infrastructure costs</td>
<td>38</td>
</tr>
<tr>
<td>The future is digital</td>
<td>40</td>
</tr>
<tr>
<td>How to save the world, one road at a time</td>
<td>42</td>
</tr>
<tr>
<td>Publications</td>
<td>44</td>
</tr>
</tbody>
</table>
Our Vision

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

We conduct pure and applied research...

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

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

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

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

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

Multi-disciplinary collaboration for the best results

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

In short, CIES offers:

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

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

Steering Committee

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

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

Industry Advisory Committee

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

This report provides an overview of the progress of projects funded by competitive national schemes and industry, and the publications produced by staff and students throughout 2019.

I am proud to present this annual report on our achievements at the Centre for Infrastructure Engineering and Safety (CIES) during 2019. The report outlines the mission of the centre, its governance structure and finances. This report provides an overview of the progress of projects funded by competitive national schemes and industry, and the publications produced by staff and students throughout 2019.

You will see an overview of our teams’ impressive accomplishments during 2019 within this annual report. Collectively our members have secured over $2M research funding, graduated 21 PhD students and published 115 refereed journal papers. In December, the highly competitive Australian Research Council (ARC) Discovery Grants for projects starting from 2020 were announced. CIES staff secured three grants totalling $1.23M.

Six new core academic members joined CIES in 2019, broadening our interests and further strengthening the team. We had the great pleasure to welcome Professor Joshua Zhou, Dr Elena Atroshchenko, Dr Asal Bidarmaghz, Dr Sascha Eisentrager, Dr Ailar Hajimohammadi and Dr Ali Kashani.

We are delighted to celebrate the promotion of Associate Professor Adrian Russell to Professor with effect 1 Jan 2020. In 2019 we farewelled Associate Professor Arnaud Castel.

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

Professor Chongmin Song

Centre Director
CIES IAC Industry Members 2019

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

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

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

Phil 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 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 m and make extensive use of cold-formed steel. In his current role, Murray has been fortunate to blend his academic interests with practical design and he maintains an active role in developing automated design tools for rapid and precise design of racking structures. 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 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.

Jim has extensive experience in running multi-disciplinary 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 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.

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.

Peter 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 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 practice - 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.
Dr Anna Paradowska is Industry Engagement Manager at the Australian Centre for Neutron Scattering, ANSTO as well as a conjoint Professor in Advanced Structure Materials at the University of Sydney.

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

Her specialties include: materials characterisation, in particular neutron and synchrotron residual strain/stress measurements in various materials; and the influence of residual stress on materials performance and to relate them to design or/manufacturing procedures as well as integrity requirements.
Three CIES ARC Discovery Project grants awarded in 2019

The Federal Government Australia Research Council ARC’s Discovery funding schemes recognise the importance of fundamental research to the national innovation system.

The national innovation system includes the people (for example, in government, higher education and business), processes and relationships involved in ‘new’ knowledge in a knowledge-based economy.

A strong capability in fundamental research (sometimes called discovery, basic or blue sky research) will result in the development of new ideas, the creation of jobs, economic growth and an enhanced quality of life in Australia.

The Discovery Program aims to deliver outcomes of benefit to Australia and build Australia’s research capacity through support for:

- excellent, internationally competitive research by individuals and teams;
- research training and career opportunities for the best Australian and international researchers;
- international collaboration; and
- research in priority areas.

In 2019 CIES was proud to received three of these prestigious research grants, with a total of $1.23M.

**Mixed Mode Torsion-Shear-Bending Failure in SFRC Elements.**

**Chief Investigator: Professor Stephen Foster**

**DP200103764 - $384,481**

Summary: In 2017 and 2018 the Australian Standards for the design of concrete bridges and structures were released; these are some of the first in the world, to include design procedures for steel fibre reinforced concrete (SFRC) in a comprehensive way. While rules have been introduced for shear and bending of SFRC girders, the rules exclude the use fibres to carry torsional moments. This study investigates the torsion-bending-shear interaction performance of SFRC members. The study will provide vital data needed for adoption by engineers and Standards bodies.
Time Dependent Behaviour of Fibre Reinforced Concrete Structures.

Chief Investigators: Emeritus Professor Raymond Ian Gilbert (CIES) and Dr Ali Amin (USyd)

DP200102114 - $411,161.00

Summary: The project aims to quantify the initial and long-term cracking and deformation of fibre reinforced concrete structures such as tunnel linings and slabs under sustained in-service loads and conditions. Concrete structures with and without conventional steel reinforcement and containing either steel or polypropylene fibres mixed in the concrete will be tested experimentally and modelled analytically and numerically. Expected outcomes are benchmark experimental data on structural behaviour under sustained loads, development of reliable simulation models and robust design procedures for the control of time-dependent cracking and deformation in fibre reinforced concrete, with reduced maintenance costs and more sustainable concrete structures.

Computational Fracture Analysis of Structures and Materials.

Chief Investigator: Professor Chongmin Song

DP200103577 - $430,601.00

Summary: This project aims to develop a computer simulation technique to address the safety of engineering structures. A novel numerical framework based on the scaled boundary finite element method will be developed to model the fracture process critical to assessing structural integrity. The expected outcomes of this project include an innovative technology for numerical simulation and improved capabilities to generate high-fidelity predictions of structural safety at minimum human efforts. The fully automatic and robust numerical tool developed in this project will help engineers and government authorities to perform safe and cost-effective design and management of engineering structures that are vital to modern economies.

ARC Linkage

2019 ARC Linkage Projects coordinated through other universities

Professor Yu Bai (Monash University); Dr Mehrdad Arashpour; Professor Xiao Lin (Joshua) Zhao (CVEN – UNSW); Dr Wenchi Shou; Mr Tai Hollingsbee; Professor Lawrence Bank:

LP180101080 - Structural assembly for remote housing using fibre reinforced composites.

Partner Organisations: NORTH CO SYSTEMS PTY LTD

Funding: $420,000

Summary: This project aims to address construction challenges in remote housing by off-site manufacturing and on-site assembly using fibre reinforced composites and digital made-to-measure approach. Its goal is to generate interdisciplinary knowledge and practical technologies for reliable, affordable and durable housing in remote harsh environments. Intended results include innovative connections and systems with valuable understanding of their performances under various loading scenarios and accurate digital visualization for remote construction. The outcomes expect to unlock remote development, enhance our competitive strengths for manufacturing and construction industries, and further offer new solutions in post-disaster recovery applications.
CIES Awards & Achievements 2019

Congratulations to all our staff and students on their many achievements and awards in 2019 including the following:

Ian Gilbert – the busy (extremely) retiree!

CIES legend, Ian Gilbert received the inaugural UNSW Emeritus Award 2019 for his significant contributions to the university.

The Award was established by UNSW in order to acknowledge and celebrate the achievements of those Emeriti who have continued to contribute in significant ways to the university. An award spokesperson Andrew Hall, from UNSW's Division of Philanthropy said they were "incredibly impressed by the breadth of work done by Ian Gilbert". And looking at Ian's achievements since he became an Emeritus Professor in 2010, it's not hard to see why.

Ian was the Deputy Director of CIES from 2007 until 2018. Since 2010 he has been the author or co-author of 6 books, four of which are textbooks used both in Australia and overseas in under-graduate and post-graduate courses in structural engineering: Design of Prestressed Concrete to Eurocode 2, (2017); Design of Prestressed Concrete to AS3600-2009, (2016); Structural Analysis: Principles, Methods and Modelling, (2015); Solution Manual for Structural Analysis: Principles, Methods and Modelling, (2015) - all published by CRC Press (Taylor & Francis Group), Florida, USA.

Ian has also published 56 refereed journal papers and 71 refereed conference papers since 2010, and supervised or co-supervised 9 PhD students to completion. He continues to mentor more junior academic staff and post-graduate students in the structural engineering group within the School of Civil and Environmental Engineering at UNSW.

Research Influence

Professor Gilbert's research on the time-dependent deformation of concrete structures has been incorporated into the 1988, 2001, 2009 and 2018 editions of the Australian Standard for Concrete Structures AS3600, in particular the clauses relating to design for deflection control, crack control and creep and shrinkage modelling. As such, Professor Gilbert's research has influenced and will continue to influence the in-service performance of concrete structures designed and constructed in Australia in the last 30 years and in the foreseeable future.

He is the UNSW Representative, and longest serving member, on Standards Australia's Committee BD-002 responsible for the development of the Australian Standard for Concrete Structures AS3600 (1980-present), and the only Australian representative on the main committee of the American Concrete Institute ACI-318 responsible for the development of the American Concrete Structures Code of Practice (2012-2019).
Ehab Hamed -
Australia-China Young Scientists Exchange

CIES Associate Professor Ehab Hamed was awarded the 2019 Australia-China Young Scientists Exchange Programme (YSEP).

The program is a joint governmental initiative funded by the Australian Department of Industry, Innovation and Science and the Chinese Ministry of Science and Technology. It is supported by the Australia-China Strategic Research Fund.

YSEP funds an annual exchange of Australian and Chinese early to mid-career researchers in the fields of science, technology and medicine. A/Prof Hamed, a structural engineer, was among the 16 researchers in Australia who were awarded this program.

CIES Director, Professor Chongmin Song said it was “a real recognition of Ehab’s outstanding work and committed scholarship.”

This prestigious program aims to:

- Increase early to mid-career Australian and Chinese researchers’ understanding of the cultures, particularly the science and research practices and systems, of the two countries
- Develop the participants’ leadership skills as future “science ambassadors” for Australia and China
- Provide a catalyst for long-term, sustainable Australia-China research collaboration

Associate Professor Hamed travelled to China in October 2019 visiting Tsinghua University, Tongji University and Shanghai Jiao-Tong University. He undertook an individual program of research-related visits, meetings, seminars, workshops and symposia.

Hamed’s main research interests include the viscoelastic behaviour of materials and structures; Strengthening of structures with FRP composite materials; Sandwich panels and Precast concrete structures.

Japan awards
Dr Mehri Makki Alamdari

In 2019 CIES academic Dr. Mehrisadat (Mehri) Makki Alamdari was awarded the prestigious award from JSPS (Japan Society for Promotion of Science) to do research in Japan.

Dr. Makki Alamdari is an expert in structural health monitoring, vibration analysis and testing, inverse dynamic problems and signal processing.

During her stay in Japan, at the Infrastructure Innovation Engineering Centre, Department of Civil and Earth Resources Engineering at Kyoto University, Mehri closely collaborated with Professor C. W. Kim, a world-recognised expert in the field of Bridge Health Monitoring at Kyoto University, to develop an advanced drive-by bridge inspection technology using mobile sensing.

This research aims at developing a robust framework for monitoring of bridges in service to evaluate their long-term performance. The main goal is to develop a generic classification system comprised of a feature extractor and a classifier in order to detect, localise and assess any structural change in the bridge solely from the response of the vehicle moving over the bridge.

An award-winning scholar, Mehri is on the Executive of the Australian Network of Structural Health Monitoring (ANSHM), 2017 and a member of The International Society for Structural Health Monitoring of Intelligent Infrastructure (ISHMI). Prior to joining UNSW, she was a research fellow in Data61|CSIRO working on structural health monitoring of the iconic Sydney Harbour Bridge.

The Japan Society for the Promotion of Science is an Independent Administrative Institution, which plays a pivotal role in the administration of a wide spectrum of Japan’s scientific and academic programs. Supported in large part by annual subsidies from the Japanese Government, JSPS’s main functions are: To foster young researchers: To promote international scientific cooperation: To award Grants-in-Aid for Scientific Research: To support scientific cooperation between the academic community and industry, and to collect and distribute information on scientific research activities.
Congratulations to CIES PhD candidate in geotechnical engineering Mohammad Khoshini for winning the 2019 Australian Geomechanics Society (AGS) NSW Young Researchers Award.

Each year the Sydney and Newcastle Chapters of the AGS offer this prestigious AGS NSW Research Award for research in Geotechnical Engineering or Engineering Geology. The award aims to provide a forum for NSW enrolled research students to showcase their research to the wider geotechnical community. The Prize includes $2,000 and the opportunity to publish in the AGS Journal Australian Geomechanics.

Selection criteria for the Award included technical content, originality of content, industry relevance and clarity of written and verbal communication. Mohammad Khoshini’s submission shone on all counts.

Mohammad’s research topic was “Experimental investigation and constitutive modelling of weak rocks subject to mechanical and moisture degradation”.

The work is part of an ARC funded Linkage Project aimed at advancing experimental, theoretical and computational bases for the mechanics of weak rocks. The industry partners of the project are Roads and Maritime Services (RMS), and Pells, Sullivan & Meynink (PSM) Consulting.

"By incorporating our findings on the behaviour of weak rocks," Mohammad says, "confidence in design methods will be increased to the point that costly over-designs can be avoided.

Billions of dollars are expended each year across Australia building infrastructure. High rates of infrastructure spending are expected to continue to meet the needs of Australia’s growing population, which is expected to double by 2060.

Even a conservatively estimated 5% increase in efficiency arising from contributions of this project and improved safety dealing with marginal materials will save infrastructure owners, government and private, tens of millions of dollars each year.”

Mohammad wished to especially thank his supervisors at CIES, Professor Nasser Khalili and Dr Arman Khoshghalib for their generous and insightful support during the course of his research.
Award for Dr Mahdi Babaee — in pursuit of more sustainable and durable concretes.

CIES is delighted to congratulate our recent PhD graduate Dr Mahdi Babaee who has been awarded the Concrete Institute of Australia's National Engineering Bursary Award for 2019.

The Bursary is a biennial award made to postgraduate students studying engineering, chemistry, materials science, building science and other relevant subjects which contribute to the research knowledge base of concrete in Australia. The award is made for excellence in thesis work on concrete and cement based products and processes.

Dr Babaee graduated from UNSW in 2018 following the completion of his thesis entitled "Corrosion of Reinforcement in Alkali-Activated Materials" which was supervised by CIES Associate Professor Arnaud Castel and Associate Professor Hamid Vali Pour.

The increasing demand for sustainable concretes has promoted the development of a category of alternative binders called alkali-activated binders, including materials described as geopolymers, which are produced by the reaction of solid precursors such as fly ash, slag, and metakaolin with alkaline solutions.

As buildings and infrastructures are aging nowadays, the durability aspects of concrete have become more important than in the past, and despite the acceptable mechanical properties of alkali-activated concretes, there are some concerns over their durability and service life as they were brought into service very recently.

Babaei's dissertation investigated various influential parameters involved in the initiation and propagation phases of corrosion of reinforcements in alkali-activated materials, as one of the main causes of deterioration of the concrete structures.

Babaei's research work was undertaken as part of the current CIES and industry pursuit of more sustainable and durable concretes.

David Millar, Chief Executive Officer advised that while the quality of the submissions was extremely high, and the Institute’s judging panel found it an extremely difficult task to split them all, they unanimously selected the thesis by Dr Babaee as the winner of the 2019 Bursary.

Mahdi now works in industry where he remains an advocate of employing new sustainable materials in the construction industry. He is well-recognised internationally for his pioneering works on developing low-embodied-carbon concretes such as geopolymers. His published research is significantly influencing models and concrete standards in Australia and around the world.
Congratulations to CIES academics Mehri Alamdari and Adrian Russell for their so well-deserved promotions in 2019.

In 2019 Dr Mehrisadat (Mehri) Makki Alamdari was promoted from postdoctoral research fellow to Lecturer in the UNSW School of Civil and Environmental Engineering. She is an expert in structural health monitoring, vibration analysis and testing, inverse dynamic problems and signal processing. She is the winner of the prestigious JSPS Award (Japan Society for Promotion of Science). An award-winning scholar, 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 Infrastructure (ISHMII). Prior to joining UNSW, she was a research fellow in Data61|CSIRO working on structural health monitoring of the iconic Sydney Harbour Bridge.

In 2019 Deputy Director of the Centre for Infrastructure and Engineering Safety (CIES), Associate Professor Adrian Russell became a Professor in Geotechnical Engineering in the School of Civil and Environmental Engineering at UNSW. As a geotechnical engineer, Russell looks to understand how infrastructure such as buildings, foundations, tailings storages, roads, tunnels, bridges, railways and ports interact with the ground. His research interests include soil mechanics, rock mechanics and the mechanics of fibre reinforced geomaterials and their use in infrastructure to increase strength and failure resistance. Able to recognise the value of academic-industry partnerships, a number of his research ideas have been successfully implemented within industry including the development of a new type of soil-cement-fibre mix technology for use in retaining wall systems to reduce cost and embodied carbon in partnership with Wagstaff Piling Pty Ltd, and the development of a technique to prevent blockages in ore passes in partnership with Glencore Pty Ltd.

A natural teacher, Russell brings innovation into the classroom with a more creative approach to teaching engineering design. Encouraging students to reach beyond the standard texts for an answer and utilise new technologies while maintaining an understanding of basic concepts is key to developing a more innovative approach to problem solving. Russell’s love of teaching extends outside the university classroom. He also delivers the travelling workshop ‘Unsaturated soil mechanics for practicing engineers’ to industry professionals on behalf of the Australian Geomechanics Society.
## CIES Grants 2019

<table>
<thead>
<tr>
<th>UNSW Investigators</th>
<th>Project Title</th>
<th>Sponsor Name</th>
<th>2019 Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bradford, MA</td>
<td>Buckling capacity of high-strength steel flexural members</td>
<td>Australian Research Council / Discovery Project</td>
<td>130000</td>
</tr>
<tr>
<td>Bradford, MA</td>
<td>The National Key Laboratory of China for Disaster Reduction in Civil Engineering</td>
<td>Tongji University / International Contract</td>
<td>49333</td>
</tr>
<tr>
<td>Foster, SJ; Parvez, MA</td>
<td>Milestone report - Review of total outputs completed and low carbon materials, products and designs for large scale residential and commercial buildings with supporting IT design tools implemented.</td>
<td>CRC For Low Carbon Living Limited / Research Grants</td>
<td>7550</td>
</tr>
<tr>
<td>Gao, W</td>
<td>New generation of sustainable building structures</td>
<td>Beijing Engineering Research Center / International Contract</td>
<td>120000</td>
</tr>
<tr>
<td>Gao, W; Li, G; Zhang, Y</td>
<td>ARC Research Hub for nanoscience based construction material manufacturing (Project 1)</td>
<td>Monash University / ARC Industrial Transformation Research Hub Shared Grant &amp; Shared Industry Partner contributions</td>
<td>68293</td>
</tr>
<tr>
<td>Gilbert, RI</td>
<td>Shrinkage, cracking, self-healing and corrosion in blended cement concrete</td>
<td>Australian Research Council / Linkage Project - Industry Partner CEMENT CONCRETE &amp; AGGREGATES AUSTRALIA</td>
<td>154000</td>
</tr>
<tr>
<td>Hamed, E</td>
<td>Coupled service and ultimate behaviour of high strength composite columns</td>
<td>University of Sydney / ARC Discovery Project Shared Grant</td>
<td>30000</td>
</tr>
<tr>
<td>Kashani, A</td>
<td>Melbourne University Lightweight Concrete R&amp;D Grant Project</td>
<td>University of Melbourne / Sustainability Victoria Research and Development Grant Shared Grant</td>
<td>20000</td>
</tr>
<tr>
<td>Kashani, A</td>
<td>Concrete Road Barriers Project</td>
<td>University of Melbourne / Tyre Stewardship Australia Research Grant Shared Grant</td>
<td>20000</td>
</tr>
<tr>
<td>Khalili-Naghadeh, N</td>
<td>Warragamba Dam Raising - Soil Testing</td>
<td>GHD PTY LTD / Water NSW Subcontract</td>
<td>2000</td>
</tr>
<tr>
<td>Khalili-Naghadeh, N; Khoshghalb, A</td>
<td>Non-isothermal dynamic strain localisation in unsaturated porous media</td>
<td>Australian Research Council / Discovery Project</td>
<td>95000</td>
</tr>
<tr>
<td>Khalili-Naghadeh, N; Russell, A</td>
<td>Modelling creep and time-dependency in unsaturated soils</td>
<td>Australian Research Council / Discovery Project</td>
<td>100000</td>
</tr>
<tr>
<td>Khalili-Naghadeh, N; Russell, A</td>
<td>Experimental investigation and constitutive modelling of reactive soils</td>
<td>Australian Research Council / Linkage Project - Industry Partner Contribution - PSM Consult Pty Ltd &amp; Department of Planning, Transport and Infrastructure (SA)</td>
<td>155960</td>
</tr>
</tbody>
</table>

---

20. OUR CENTRE: UNSW Centre for Infrastructure, Engineering & Safety Report 2019
<table>
<thead>
<tr>
<th>Investigators</th>
<th>Project Title</th>
<th>Sponsor Name</th>
<th>2019 Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Niven, R; Khalili-Naghadeh, N; Pashley, RM</td>
<td>PFAS Source Zone Remediation by Foam Fractionation and In Situ Fluidisation</td>
<td>Australian Research Council Special Research Initiatives/ Industry Partner Contribution - Opec Systems Pty Ltd</td>
<td>350000</td>
</tr>
<tr>
<td>Oldfield, PF; Carmichael, DG</td>
<td>Carbon Value Engineering</td>
<td>CRC For Low Carbon Living Limited / Research Grants</td>
<td>24137</td>
</tr>
<tr>
<td>Russell, A</td>
<td>Evaluating potential static liquefaction of tailings to prevent failures</td>
<td>ARU Linkage Project Industry Partners - Anglo American Services (UK) Limited / Freeport-McMoRan Inc / Teck Resources Limited</td>
<td>84827</td>
</tr>
<tr>
<td>Russell, A</td>
<td>Understanding Earthquake-induced Ground Deformation Risk to Inform City Resilience</td>
<td>ARUP Pty Ltd / Contract Research</td>
<td>18182</td>
</tr>
<tr>
<td>Shen, X; Carmichael, DG</td>
<td>Evaluating Light Detection and Ranging (LiDAR) Sensors for Construction Mapping</td>
<td>Linke &amp; Linke Surveys / Contract Research</td>
<td>50000</td>
</tr>
<tr>
<td>Song, C</td>
<td>Deterioration of structural integrity of ageing ships and marine platforms</td>
<td>University of Newcastle / ARU Linkage Project Shared Grant: Shared Partner Organisation Contribution DSTG, &amp; Pacific ESI</td>
<td>28370</td>
</tr>
<tr>
<td>Song, C</td>
<td>Seismic analysis of cracking and deformations in concrete gravity dams</td>
<td>Australian Research Council / Linkage Project Industry Partners Melbourne Water Corporation / Goulburn-Murray Water / Murray-Darling Basin Authority / Sunwater Limited</td>
<td>173422</td>
</tr>
<tr>
<td>Song, C; Tin Loi, FS</td>
<td>3D contact and fracture analysis for safety assessment of structures</td>
<td>Australian Research Council / Discovery Project</td>
<td>128000</td>
</tr>
<tr>
<td>Song, C; Zhang, J</td>
<td>3D numerical modelling of an underground complex</td>
<td>PSM Admin Pty Limited / Contract Research</td>
<td>8261</td>
</tr>
<tr>
<td>Li, B; Saydam, S; Guivant, J; Shen, X; Rizos, C; Sammut, C; Katupitiya, J; Zlatanova, S</td>
<td>Development of the mobile robot for underground mine 3D mapping and environment monitoring</td>
<td>Jiangsu Tianqin Patent &amp; Technology Co / International Contract</td>
<td>250000</td>
</tr>
<tr>
<td><strong>Total CIES</strong></td>
<td></td>
<td></td>
<td><strong>$2,067,335</strong></td>
</tr>
</tbody>
</table>
Academic Staff

Attard, Mario
Associate Professor
Associate Head – Academic
BE PhD MHEd UNSW, MIE Aust, CEng

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

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

Elena's research interests lie in the area of Computational Mechanics and Numerical Methods, with application to fracture mechanics, acoustics, bending and vibration of composite plates.

Bidarmaghz, Asal
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.

Bradford, Mark
UNSW Scientia Professor
BSc BE PhD USyd, DSc UNSW, CEng, CEng, MASCE, FIE Aust, MInstT

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

Carmichael, D G
Professor
BE MEngSc USyd, PhD Cant, CEng, FIE Aust, MASC


Castel, Arnaud
Associate Professor
BE, MEngSc, PhD Toulouse

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

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

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

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

Research Interests: Online Assessment, Virtual Reality, Project Scheduling, Safety, Construction Defects and Rework.
Douglas, Kurt  
Pells Sullivan Meynink Senior Lecturer of Rock Mechanics,  
Chair External Relations  
BE (Hons1)USyd, PhD UNSW  

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

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

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

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


Eisentrager, Sascha  
Lecturer  
Doctor of Engineering (Computational Mechanics), Otto von Guericke University Magdeburg, Germany  

Sascha's research is within the context of structural health monitoring (SHM) applications, particularly with the development of efficient numerical methods for the analysis of wave propagation phenomena in thin-walled structures. Therefore, the propagation of elastic guided waves (Lamb waves, Love waves, Rayleigh waves, etc.) is an important area for his innovative high order finite element and fictitious domain approaches.

Hajimohammadi, Ailar  
Senior Lecturer  
Ph.D. (sustainable cementitious materials) University of Melbourne  

Ailar's research 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.
Kashani, Alireza  
Lecturer  
BSc, MSc Amirkabir University of Technology, Tehran  
PhD University of Melbourne

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


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


Makki Alamdari, Mehrisadat  
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 Infrastructure (ISHMII). 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 Infrastructure (ISHMII).

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

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

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

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

- **Fell, Robin**
- **Gilbert, Ian**
- **Tin Loi, Francis**
- **Valliappan, Somasundaram**

---

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


---

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

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

---

**Zhao, Xiao Lin (Joshua)**
Professor and Associate Dean (International),
Faculty of Engineering
BE, ME Shanghai Jiao Tong University, PhD and Doctor of Engineering, University of Sydney
MBA (Executive) UNSW/USyd

Professor Xiao Lin (Joshua) Zhao’s current research focuses on hybrid construction utilising seawater, sea sand concrete and fibre reinforced polymers; rehabilitation of aging infrastructure using advanced composite materials; and ultra-high strength steel structures.

---

**Farewell**

During 2019 the Centre sadly farewelled Associate Professor Arnaud Castel - we congratulate him on his wonderful new position and wish him all the very best as Professor at the School of Civil & Environmental Engineering, University of Technology, Sydney.
## Centre Research Staff

### CIES Staff

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chen, Jun</td>
<td>Postdoctoral Fellow</td>
</tr>
<tr>
<td>Chhor, Allen</td>
<td>Senior Research Associate</td>
</tr>
<tr>
<td>Chilwesa, Masuzyo</td>
<td>Research Associate</td>
</tr>
<tr>
<td>Hassanieh, Amirhossein</td>
<td>Research Associate</td>
</tr>
<tr>
<td>Liu, Lei</td>
<td>Postdoctoral Fellow</td>
</tr>
<tr>
<td>Masoumi, Saeed</td>
<td>Research Associate</td>
</tr>
<tr>
<td>Parvez, Md Ahsan</td>
<td>Postdoctoral Fellow</td>
</tr>
<tr>
<td>Saputra, Albert</td>
<td>Postdoctoral Fellow</td>
</tr>
<tr>
<td>Shahbodaghkhan, Babak</td>
<td>Senior Research Associate</td>
</tr>
<tr>
<td>Vahab, Mohammad</td>
<td>Research Associate</td>
</tr>
<tr>
<td>Vo, Thanh Liem</td>
<td>Research Associate</td>
</tr>
<tr>
<td>Wu, Di</td>
<td>Research Associate</td>
</tr>
<tr>
<td>Xing, Weiwei</td>
<td>Research Associate</td>
</tr>
<tr>
<td>Yu, Yuguo</td>
<td>Research Associate</td>
</tr>
<tr>
<td>Zhang, Junqi</td>
<td>Research Associate</td>
</tr>
</tbody>
</table>

### Visiting/Adjunct Academics

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akbarzadeh Chiniforush, Alireza</td>
<td>Visiting Fellow</td>
</tr>
<tr>
<td>Aldred, James</td>
<td>Adjunct Associate Professor</td>
</tr>
<tr>
<td>Delhomme, Fabienne</td>
<td>Visiting Fellow</td>
</tr>
<tr>
<td>Eisentrager, Johanna</td>
<td>Visiting Fellow</td>
</tr>
<tr>
<td>Geha, Shane</td>
<td>Adjunct Professor</td>
</tr>
<tr>
<td>Gong, Weijia</td>
<td>Visiting Senior Lecturer</td>
</tr>
<tr>
<td>Gravenkamp, Hauke</td>
<td>Visiting Fellow</td>
</tr>
<tr>
<td>He, Yiqian</td>
<td>Visiting Fellow</td>
</tr>
<tr>
<td>Kayvani, Kourosh</td>
<td>Adjunct Professor</td>
</tr>
<tr>
<td>Koenke, Carsten</td>
<td>Visiting Professor</td>
</tr>
<tr>
<td>Krahnle, Slavomir</td>
<td>Visiting Senior Lecturer</td>
</tr>
<tr>
<td>Li, Haiyufeng</td>
<td>Visiting Fellow</td>
</tr>
<tr>
<td>Li, Jianbo</td>
<td>Visiting Fellow</td>
</tr>
<tr>
<td>Liang, Heng</td>
<td>Visiting Senior Lecturer</td>
</tr>
<tr>
<td>Rosso, Kevin Michael</td>
<td>Adjunct Professor</td>
</tr>
<tr>
<td>Salmanpour, Amir Hosein</td>
<td>Visiting Fellow</td>
</tr>
<tr>
<td>Shi, Junjie</td>
<td>Visiting Fellow</td>
</tr>
<tr>
<td>Voo, Yen Le</td>
<td>Adjunct Associate Professor</td>
</tr>
<tr>
<td>Wei, Minghai</td>
<td>Visiting Fellow</td>
</tr>
<tr>
<td>Yu, Bo</td>
<td>Visiting Fellow</td>
</tr>
<tr>
<td>Zhang, Zihua</td>
<td>Visiting Fellow</td>
</tr>
</tbody>
</table>
Our Professional & Technical Staff

Technical Services (Kensington)

- Paul Gwynne
  Lab Manager

- Anthony MacKen
  Senior Technical Officer

- William Terry
  Senior Technical Officer

- Luiz Pettersen
  Technical Officer

- Rudino Salleh
  Technical Officer

- Timothy Weston
  Technical Officer

Technical & Professional (Heavy Structure Laboratory Randwick)

- Zhen-Tian Chang
  Laboratory Manager

- Sanjeewa Herath
  Senior Technical Officer

- Tuan Le
  Postdoctoral Technical Assistant

- Ronald Moncay
  Senior Technical Officer

- Benjamin Pauley
  Technical Officer

- Greg Worthing
  Technical Officer

Research Centre Management

- Theresa Wisniewski
  CIES Manager
Dr Elena Astroshchenko

Dr Elena Astroshchenko joined the academic staff at CVEN in 2019 as a Senior Lecturer specialising in computational mechanics and numerical methods. Raised in Russia, Dr Astroshchenko completed her undergraduate and Masters Science degree there, focusing on developing mathematical models for ophthalmology. Then, off to Canada for 6 years and a PhD. It was there, at the University of Waterloo, that Elena’s focus shifted to civil engineering, working as a teaching and research assistant while she completed her own research in computational modelling for fracture mechanics. This research earned her the position of Assistant Professor at the University of Santiago, Chile.

One current project with her colleagues from Santiago is about harvesting energy from piezo-electric plates, but Elena’s main focus will be in acoustics: design optimisation for acoustic devices and structures and health monitoring of structures using sound waves. This work in acoustics takes Elena to the University of Luxembourg each year, where she is an associated member of the international Legato team in computational mechanics. Led by Professor Stephane Bordas, Legato “aims at building intuitive and interactive platforms for computational mechanics problems which allow the users to interact with their models and hence gain insights into unconventional and counter-intuitive phenomena.”

Finite Element Method is the central thesis of computational mechanics. It is employed widely, through software, at commercial levels. Elena Astroshchenko propels her field forward by merging this established numerical method with computer-aided design. Isogeometric Analysis (IGA) is a recent innovation that improves modelling of new designs during development, making modelling easier and quicker. Only developed in the last decade Elena is an expert in an elite but growing field. “It is yet to be licenced commercially, but the many advantages of IGA are making it a popular area for research.”

While Elena and her family loved Chile, she hopes to stay still for a little while, here in Sydney, here at CVEN. “I am very impressed with this School and UNSW. It seems big, not only in terms of size, but in its development and possibilities. But the people are very, very friendly, very supportive. I feel like I am home. I love the multi-cultural society here.”

Dr Asal Bidarmaghz

Arriving in Sydney from her position as a Research Associate with the Centre for Smart Infrastructure and Construction at Cambridge University, Dr Asal Bidarmaghz has found her CVEN welcome enthusiastic, warm and practically helpful: “like they were waiting for me”. As a Lecturer in Geotechnical Engineering, Asal brings to us her extensive knowledge and experience in the nascent field of subterranean geo-energy systems, having received her PhD in Civil Engineering (Geothermal Technologies) from the University of Melbourne in 2015.

“There is a problem, a big problem,” she says. World leaders are not fully acknowledging nor acting upon the true impacts of climate change. Moreover, underground climate change is very rarely considered or discussed. Nor is geo-energy utilised as a resource, even though it is ever present, available and the technology to access it has been developed. But Asal Bidarmaghz is a gently hopeful engineer, who believes in the power of hard work and persistence, bolstered by collegiate support and right-minded institutions.

“The challenge with industry is to create business cases for geo-energy system projects. I feel confident, this is do-able. We cannot go backwards.”

Asal’s research, begun during her PhD in Melbourne and continued at Cambridge, reveals the particular climate change challenges created by ever increas-
ing urbanisation. Cities create ‘urban heat islands’, where temperatures far exceed those of the surrounding rural areas. This promotes the need for electric cooling, the need for resources.

We need to be asking what effect do our underground structures, such as basements, car parks and activities like transport tunnelling, have on the surrounding environment? Could the heat generated by such activities be extracted and exploited as ‘smart heat’? “In city-scale, there are gigawatts of ground energy freely available to us, but there is a lack of understanding as we continue to burn coal. We need the different sectors working together in urban planning.”

The benefits of geospatial research to city planners, asset owners, local authorities and citizens are many and seemingly obvious: alternative, sustainable and free energy resources, optimal use of subterranean spaces in city planning and positive impacts on general wellbeing of urban inhabitants. Frustratingly, Australian industries and governments are not yet fully convinced; perhaps revealing “a resistance to anything new and expensive”, so this continued research is vital to enacting change in our cities.

Dr Sascha Eisentrager

Dr Sascha Eisentrager arrived in Sydney in June 2019 from Otto von Guericke University in Magdeburg, Germany. He is, however, no stranger to Australia, having completed some of his postgraduate studies in Adelaide. As a CVEN Lecturer and a member of the Centre for Infrastructure and Engineering Safety (CIES), Sascha will be developing his research in Computational Mechanics, especially in high order Finite Elements Methods (FEM).

Eisentrager’s enthusiasm for computational mechanics began early in his career and he has continued to refine his approach. “Computational mechanics (CM) is a broad range of different methods, commonly based in numerical approaches, and used to solve partial differential equations. All physical problems present a certain set of partial differential equations (PDEs) to which we have to apply numerical (approximative) methods. I concentrate on Finite Element Methods in the context of high order shape functions. Commercially, FEMs often utilize linear or quadratic shape functions, but I try to exploit the inherent advantages of high order ones.”

Simultaneously, Eisentrager is developing proposals for the German Research Foundation and the Australian Research Council. These projects will investigate modelling the behaviours of complex acoustic materials like dampening foams. These materials exhibit both open and closed cell structures that make modelling a complex challenge, necessitating high performance computing technology. “We will look at the relationship of these complex materials to the environments in which they are used. In urban areas, uses such as engine encapsulation can reduce noise pollution. Engine heat can be retained to increase start up efficiency, reducing emissions and fuel consumption. These materials could have positive effects on urban well-being.”

Eisentrager would also like to build more understanding between the engineering academy and the engineering industry. “Certain commercial computational methods are based in knowledge from the 1980s and 1990s, while the newer computational research has the potential to greatly increase industrial efficiency. Sometimes industry can be a little conservative, reluctant to invest either time or money to adopt new methods.” He sees the distinction between academic researchers and industry as being neatly articulated by the Pareto Principle. “80% of the work is completed in 20% of the time. To get to that final 20% of the work, a big time and resource investment is needed, but it is here that innovation, academic rigor and excitement lie.”
Dr Ailar Hajimohammadi

Dr Ailar Hajimohammadi joined the academic staff of CIES and the School of Civil and Environmental Engineering as a Senior Lecturer. Originally interested in chemical engineering, Dr Hajimohammadi’s PhD research on sustainable cementitious materials shaped her current focus on innovative construction materials and techniques.

This shift to civil and environmental engineering has allowed her research to become more multi-disciplinary and collaborative. “The most innovative way I can approach my research is to look at the problem from different angles,” she reflects. “Rather than just focusing on what I already know, I want to know how others see the problem, how other disciplines are approaching it. In this way new methods, new solutions appear. Useful, important, but also very interesting for me. Multi-disciplinary university structures allow for increased communication, visibility and opportunities for academics to work in less isolated ways.”

For the last 4 years Ailar has been working with a waste recovery group she led under an ARC Linkage program to uptake landfilling wastes and convert them to valuable products.

She also works with industry and the academy on the many innovative applications of sustainable construction materials. These materials can utilise recycled waste products, can create cheaper, more durable materials as alternatives to traditional concrete. Also, they can be designed to provide insulation, retard fire and dampen noise. In fact, sustainable materials and technologies research has the potential to revolutionise the civil engineering and construction industries. Not only does it represent green innovation in its use of waste materials, but it can transform the affordability of our built environment.

“We may have started with concretes, but sustainable alternatives have evolved into more complicated composites, with more load bearing construction potential. There is tremendous growth in its applications for fire-resistant high-rise buildings and for sound dampening road barriers”, both so important in a city like Sydney where high-rise buildings sprout like seedlings and the noise of traffic and construction threatens liveability. “The use of sustainable materials in construction can also extended to other civil applications such as water treatment technologies and soil stabilisation methods, so it is beneficial and interesting to find mutual interest between disciplines.

“Generally, I hope that my research will lead to an increase in the resilience of construction materials while decreasing their negative environmental impact.”

Dr Ali Kashani

In 2019 we welcomed Dr Ali Kashani – a 2018 Churchill Fellow, and expert in the field of sustainable concrete design and technology - specifically waste valorisation and circular economy in concrete design, lightweight concrete, geopolymer concrete, and automated construction 3D printing.

Dr Kashani has extensive experience in research, development, and commercialisation of advanced and sustainable construction materials. His primary research area is ‘Construction Automation’ via development of novel high-performance materials and techniques for construction 3D printing. His other main area of research is sustainable construction materials for the ‘Circular Economy’ including waste valorisation and low-carbon construction materials.

Ali received his BSc and MSc from Iran’s leading technical and engineering university, Amirkabir University of Technology in Tehran. He obtained his PhD in 2015 from The University in Melbourne with research into the rheology and fresh properties of low-carbon geopolymer concrete. As a postdoctoral researcher at The University of Melbourne, his focus widened into development of sustainable lightweight concrete, design of concrete with waste tyre and waste glass, and exploration of the innovative field of construction 3D printing.
He has been the Project Leader in several R&D projects funded (to a total of $645,000) by government entities and construction industry leaders in Australia, to promote research in advanced and sustainable concrete. He continues to look at partnerships with industry. "We are looking forward to working with cement and concrete industries and building standard regulators to prove the viability of using sustainable concrete with recycled materials in different applications”

Automation in construction by 3D printing is another main research interest. And this area is proving equally exciting and fruitful. One of Dr Kashani’s recently papers as a corresponding author about 3D printing was published in the high-impact Elsevier Journal ‘Composites: Part B’ in June 2018. It has attracted 331 citations so far.

It was this area of research which won Ali a prestigious Churchill Fellowship in 2018. The 3D project has the potential, he notes, to assist with more sustainable, faster and safer construction of affordable houses and to provide housing solutions to disadvantaged Australian communities and homeless people. These technologies could also be used to provide rapid accommodation for affected communities after natural disasters such as floods and bushfires.

**Professor Xiao-Lin (Joshua) Zhao**

In 2019 we were delighted to welcome Professor Xiao-Lin (Joshua) Zhao to the School. Professor Xiao-Lin (Joshua) Zhao has very recently taken up an appointment as the new Associate Dean (International) for UNSW Engineering.

Professor Zhao’s very impressive academic background began at Shanghai Jiao Tong University where he commenced study at just 16 years of age. Graduating in 1984, with a Bachelor of Mechanical Engineering, he went on to study his Masters degree in the same field. He graduated in 1987 and came to Australia in 1988 to study at the University of Sydney, this time in the field of Civil Engineering, receiving his PhD in 1993. He completed an MBA from the AGSM in 2007, making him an alumnus of UNSW. He also received a Doctor of Engineering (higher doctorate) from the University of Sydney in 2012.

In 2001 Professor Zhao was appointed Chair of Structural Engineering at Monash University.

Zhao has received several prestigious fellowships, such as the von Humboldt Fellowship of Germany, JSPS (Japan Society for Promotion of Science) Invitation Fellowship of Japan, Distinguished Visiting Fellowship Award from the Royal Academy of Engineering, UK, Visiting Professorship Award from Swiss National Science Foundation, National “1000-Talent” Chair Professorship and Chang Jiang Professorship of China.

He has received 25 grants from the Australian Research Council and served on the ERA (Excellence in Research for Australia) Research Evaluation Committee for Engineering and Environmental Sciences Cluster in 2015 and 2018. He has also supervised 40 PhD students to completion.

More recently, Professor Zhao was Head of the Department of Civil Engineering at Monash University for four years after being Deputy Head and Director of Research in the Department for seven years. Professor Zhao has extensive experience working in international environments leading the Department in several major international initiatives such as the Monash-Sichuan University alliance, Monash-IIT-B academy, Monash-Warwick alliance and Monash-Southeast University Alliance.

We look forward to many opportunities for Professor Zhao to share his extensive knowledge and experience with us.
PhD Graduates

Alireza Akbarzadeh-Chiniforush
Serviceability of Steel-Timber Composite (STC) floors
Supervisor/s: A Akbarnezhad & H Valipour

Qian Huang
Time-dependent behaviour of precast concrete sandwich panels
Supervisor/s: E Hamed

Golnaz Alipour Esgandani
Elasto-viscoplastic modelling of unsaturated soils under static and dynamic loading in 3D stress space
Supervisor/s: N Khalili & A Khoshghalb

Nicka Keipour
Assessment of beam-to-column joint behaviour in steel-timber composite systems
Supervisor/s: H Valipour

Dion Dilina Dissanayake
Automatic image-based adaptive damage analysis (AIBADA) with the scaled boundary finite element method
Supervisor/s: C Song

Hammad Anis Khan
Durability of alkali-activated mortar in sewage environment
Supervisor/s: A Castel

Jinwen Feng
Unified probabilistic and interval analysis of structures with hybrid uncertainties
Supervisor/s: W Gao & G Li

Haiven Li
Dynamic properties of sand-fiber mixtures
Supervisor/s: A Khoshghalb

Maryam Ghareh Chaei
Investigating early age thermal cracking of concrete
Supervisor/s: A Akbar Nezhad & A Castel

Keyan Li
Spectral Stochastic Isogeometric Analysis
Supervisor/s: W Gao

Dinesh Habaragamu Arachchige
Durability of Geo-Polymer Concrete with respect to Alkali Aggregate Reaction (AAR)
Supervisor/s: A Castel

Hugh David Miller
Surface treatment of steel fibres and carbon nanotubes to develop chemical bonds with concrete
Supervisor/s: A Akbarnezhad & SJ Foster

Ying Hong
BIM adoption criteria: measuring potential advantages of BIM before implementation
Supervisor/s: A Akbarnezhad

Hamed Moghaddasi Kelishomi
Constitutive modelling of bonded geomaterials subject to the mechanical and moisture degradation
Supervisor/s: N Khalili & A Khoshghalb
Masoud Moradi
Reserve of strength in prefabricated reinforced concrete slab of bridge decks and RC culverts
Supervisor/s: H Valipour

Farshid Nouri
Experimental and numerical study of steel-timber composite beam-to-column connections with shear-tabs/double web-angles
Supervisor/s: H Valipour

Daniel O’Shea
Hyperelasticity for soft biological tissues and fibre-reinforced composites using orthotropic fourth-order tensors
Supervisor/s: M Attard

Arash Tootoonchi
Numerical aspects of the application of smoothed point interpolation methods in computational geomechanics
Supervisor/s: A Khoshghalb

Rumman Waqas
The behaviour of composite beam-to-column flush end plate connections using blind bolts
Supervisor/s: B Uy

Weiwei Xing
A scaled boundary finite element based node-to-node scheme for contact problems.
Supervisor/s: C Song & FS Tin-Loi

Junqi Zhang
Integrating geometric modeling and structure analysis: towards the digital future of engineering
Supervisor/s: C Song

Sijia Jiang
Evaluation of Lateral Earth Pressure for Unsaturated Soils
Supervisor/s: A Khoshghalb

Zhanpeng Liu
Stability analysis of advanced composite arches
Supervisor/s: W Gao & G Li

Qihan Wang
Machine learning aided stochastic analysis for functionally graded structures
Supervisor/s: W Gao & FS Tin-Loi
Our Laboratories

CIES research and commercial activities are conducted with extensive physical laboratory resources, such as those of the Heavy Structures Research Laboratory, Advanced Materials Research Laboratory, Geotechnical Laboratory and the Advanced Computational Analysis Laboratory (ACAL). Through these state-of-the-art facilities we are able to conduct our blue sky and applied research, for industry and government partners.
Billions of dollars are spent each year across Australia building infrastructure. High rates of infrastructure spending are expected to continue to meet the needs of Australia’s growing population, which is expected to double by the year 2060 (ABS, 2008).

Safety of structures and humans is of crucial importance to engineers and engineering design. Where behaviour and properties of materials are not well understood, engineers will, of necessity, adopt a conservative approach to design to maintain this safety, sometimes at considerable financial cost to the public.

CIES researchers with industry support have recently completed a very successful ARC Linkage Project (LP140101078): Experimental investigation and constitutive modelling of weak rocks subject to mechanical and moisture degradation.

Weak rocks are geomaterials that fall in the boundary between soils and rocks in terms of mechanical properties. Such geomaterials constitute a major portion of the shallow rocks in Australia. Despite their prevalence, the characteristics of weak rocks have been poorly understood mainly due to problematic sampling, lack of proper investigation measures - such as experimental equipment and methods, and the complex mechanical behaviour such materials show.

Indeed, the lack of understanding and predictive tools for the behaviour of weak rocks have over the years led engineers to adopt a conservative and often expensive approach to design.
The Project and Objective:

The aim of this ARC Linkage research project was to advance experimental, theoretical and computational bases for the mechanics of weak rocks, so as to provide scientists and engineers with much-needed predictive tools for quantitative evaluation and assessment of their behaviour in geological settings.

The project used an extensive experimental program, combining rigorous fundamental studies with robust and efficient numerical schemes. By incorporating previously neglected aspects in the behaviour of weak rocks such as mechanical, environmental as well as cyclic loading degradation, it aimed to increase practitioner confidence in the design methods, to the point where costly over designs can be avoided.

The project was led by CIES Professor Nasser Khali- li with other investigators, Dr Arman Khoshghalb and John Rubsov, Director Technical Operations & Support at Roads and Maritime Services. Two CIES PhD students, Hamed Moghaddasi Kelishomi and Mohammad Khoshini, also closely collaborated with the industry partners of the project, TfNSW (formerly RMS), and Pells, Sullivan & Meynink (PSM) Consulting.

The research team conducted research on the development of procedures for cost-effective design of cut batters, soil nailing, retaining structures and bridge foundations in low strength rocks encountered in the Upper Blue Mountain region of NSW.

An extensive experimental program was devised and successfully conducted to completely characterise the material.

Rigorous fundamental studies were performed to understand the mechanisms behind the behaviour of the material and a complete set of constitutive laws for weak rocks describing the degradation effects of cyclic loading, moisture, and damage due to de-bonding of grains and the strongly non-linear deformation behaviour of the rock matrix were developed.

Robust and efficient numerical schemes for the solution of the constitutive equations suitable for implementation into the numerical code FLAC were also developed.

Key Findings

Models, theories and relationships derived from this research will have direct and immediate impact on design, construction and management of geotechnical engineering projects including roads, tunnels, bridges, under- and over-ground excavations.

One of the immediate beneficiaries of the findings of this research is the current upgrade project of Great Western Highway in Upper Blue Mountains of NSW from Leura to Katoomba. The notorious weak rock encountered in the upper Blue Mountain region is no longer an unpredictable difficult material to deal with for geotechnical engineers.

Image Credits:

One hundred and twelve inspired Australians travelled throughout the world during 2019 as recipients of the prestigious Churchill Fellowship, offering them the opportunity to investigate inspiring practices in other countries that will benefit Australian communities.

Amongst the investigative travellers was CIES lecturer and researcher, Dr Ali Kashani, an expert in sustainable construction design and materials.

Dr Kashani was awarded the AV Jennings / Churchill Fellowship to explore the new technology for rapid construction of resilient and low-cost houses by 3D printing – and visited several institutions and organisations involved in the field in six countries - Denmark, Netherlands, France, Switzerland, Italy and Singapore.

Dr Kashani’s aim for his travels was to gather insights and knowledge about the revolutionary construction method: ‘3D Printing of Houses’. The practical knowledge for 3D printing of houses is currently limited in Australia. Dr Kashani investigated current challenges and trends with regards to both manufacturing and building standards.

Kashani believes that the 3D project has the potential to aid with more sustainable, faster and safer construction of affordable houses and to provide housing solutions to disadvantaged Australian communities and homeless people.
"These technologies" he says, "could also be used to provide quick accommodation for affected communities after natural disasters such as floods and bushfires. There is also potential for increased creativity and customisation, with young people able to build their own DIY first home with considerably lower construction costs and minimum skills required."

"3D printing technologies can also enable architects to push the boundaries of construction design, upgrade the skills of construction workers and enable the construction industry to offer vastly different customised house designs at cheaper costs that are based on the needs of each individual customer."

His report back shows that digital construction is feasible, and that it will become part of the future of the construction.

Key findings and recommendations of his Churchill Fellowship are summarized below:

- The range of successful prototypes and projects using digital construction is relatively vast, including houses, apartments, a façade, pedestrian bridges, telecommunication pillars, furniture, landscaping and architectural features.

- Digital construction and 3D printing is in its infancy period and requires further R&D to become a routine construction method, but it can offer all the benefits mentioned above when it matures.

- The main challenges include the adoption of the construction materials and processes for digital construction, lack of legislation and building codes, risks of failure in large-scale construction projects and resistance in the adoption of new technologies by the construction industry.

- With all the challenges and risks, a growing number of small and large businesses and institutions are investing in digital construction to benefit from the sustainable competitive advantages of this new technology.

- The Australian construction industry is lagging behind in adoption of digital construction compared to the developed countries, but this situation can be changed through R&D, collaborative projects, and partnership between research institutes and industries.

Dr Kashani’s full report can be downloaded from the Churchill Trust website:


Image Credit: http://contourcrafting.com/building-construction/
CIES researchers are at the helm of an emission-reducing, green roads project. Concrete made using industrial waste from coal-fired power stations and steel manufacturing is being used in a world-first green roads trial in Sydney.

The CRC for Low Carbon Living-funded project with The City of Sydney is putting the environmentally friendly building product to the test on a busy inner-city street, replacing a 30 metre section of roadway on Wyndham Street in Alexandria. As a major road leading to Sydney Airport, the high traffic volume provides the perfect conditions for the trial.

CIES Professor Stephen Foster, Head of School of Civil and Environmental Engineering, is the CRCLCL project lead and describes the trial as “a huge step forward”.

“This trial will help drive step change in the industry. Many concrete companies are already doing a lot to change, but this trial really gives it another push,” Professor Foster said. “Research into Geopolymer has been undertaken since the 90s, but it’s only now that it’s starting to be commercialised.”

Several members of CIES have been involved in geopolymer research including Professor Foster, Associate Professor Arnaud Castel, Dr James Aldred, Dr Taehwan Kim and Dr Johnson Shen, and the Centre is now recognised as a world expert on sustainable construction materials.

As Professor Foster noted, “This trial is important because we need demonstration projects to accurately assess the performance of Geopolymer over time so that there can be broader uptake. While we’ll monitor the road performance for up to five years,
a lot of the data collected in the first three to 12 months of this world-first trial will be used to confirm our models and strengthen our predictions.”

Made from fly ash and blast furnace slag, Geopolymer generates just 300 kilograms of CO₂ per tonne of cement, compared to the 900 kilograms from traditional cement production.

Concrete contributes seven per cent of all greenhouse gas emissions and in 2018 the world produced about 4.1 billion tonnes of cement, which contributed about 3.5 billion tonnes of CO₂. Alternative, low CO₂ concrete materials offer potential benefits in reducing the greenhouse gas emissions associated with conventional concrete.

Moreover, the low CO₂ concrete has the potential to put the 400 million cubic tonnes of globally documented waste from the coal and steel industries to good use. While a small amount is currently reused in construction, much of it is currently stored on site.

Industry partner: Australian (Iron and Steel) Association and Ash Development Association

Industry partner Craig Heidrich, executive director, Australian (Iron and Steel) Association and Ash Development Association, says the benefits of the trial will be far-reaching.

“Our collaboration with organisations such as the City of Sydney and the publication of the research findings will further de-mystify and promote the use of Geopolymer concrete in construction. Geopolymer concrete has great engineering properties. It is a durable, high performance product that has a low carbon footprint when used in construction,” Mr Heidrich said.

“It’s a fundamental tenet in business that you need to be constantly innovating and investing into new technologies. This trial will provide real examples of Geopolymer concrete use that we can all use.”

Support from City of Sydney- Australia’s first carbon-neutral local government

To test the green concretes durability, the City of Sydney has laid a 15 metres traditional concrete and 15 metres of Geopolymer concrete, a sustainable blend of concrete and recycled materials. Nine sensors have been positioned under the concrete to monitor and compare how the Geopolymer concrete performs.

UNSW Sydney researchers and the CRC for Low Carbon Living (CRCLCL) will then use results from the trial to create the first set of industry guidelines for Geopolymer concrete.

Lord Mayor Clover Moore said the City was committed to finding new ways to lower carbon emissions. “I’m proud that the City of Sydney was Australia’s first carbon-neutral local government and that we’re continuing to take significant steps to reduce our carbon footprint,” the Lord Mayor said. “Local governments are responsible for maintaining local roads, so if we can purchase more environmentally sustainable materials, we can fight climate change and provide quality infrastructure for our community.

“With 70 percent of the concrete produced today going into pavements and footpaths, there is great potential to further lower emissions from our operations.

“We’re continually working with concrete suppliers to reduce the amount of pollution and greenhouse gases emitted during the production of concrete for our local roads, and we already use sustainable green concrete for all our footway renewal works – which adds up to 25,000m2 per year.”

According to Dr Tommy Wiedmann, Associate Professor of Sustainability Research at UNSW, if all concrete produced in Australia was Geopolymer instead of traditional concrete, this would save 12,000 kiloton CO₂ per year. This is equivalent to taking 4.5 million cars off the road per year, or the total food consumption of 2 million households for one year!
Publications


